


Jul 69

750p.


EDRS Price MF-$3.00 HC Not Available from EDRS.


Described are 2,589 research projects under the general headings of: Properties of Water, Water Motion, Meteorology, Survey and Prediction, Living Systems (non-human), Public Health and Safety, Marine Geology, Engineering and Technology, Costal Zone Management and Use, Legal Studies, Education and Training, and Facilities. Each description outlines the objectives and approach of the project. The name of the principal investigator and the address of the institution are given, and supporting agencies are identified. There is a subject index, a principal investigator index, a contractor index, and a supporting agency index. (EB)
A Catalog of Unclassified Marine Research Activities
Sponsored During FY 1968 by Federal and Non-Federal Organizations

Executive Office of the President
National Council on Marine Resources and Engineering Development

July 1969
THE NATIONAL COUNCIL ON MARINE RESOURCES AND ENGINEERING DEVELOPMENT

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E D W A R D W E N K, JR.
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Executive Office of the President
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July 1969
FOREWORD BY THE VICE PRESIDENT OF THE UNITED STATES

The establishment of a long-range program to utilize the oceans for the benefit of all mankind was set forth as a national policy by the Marine Resources and Engineering Development Act of 1966. Meeting marine science needs and opportunities in turn depends significantly upon a strong research capability. Such research encompasses a broad spectrum of disciplines in support of, among others, the development of living and non-living resources, environmental prediction, conservation and recreation, maritime commerce, and national security activities. While these endeavors are supported largely by the Federal Government, they are conducted in some 95 academic institutions; several hundred State and local organizations and laboratories; over 35 private foundations and professional associations; hundreds of industrial organizations; as well as in more than 85 Federal laboratories.

Maximizing benefits from the Nation's growing investment in the oceans requires developing the full potential of this widely dispersed research capability. Because of the very number and diversity of organizations and activities involved, however, there is a serious hazard of unwitting duplication or gaps in research efforts. Complete information about on-going research and effective information transfer thus become key elements for assuring that individual scientists, engineers, administrators, and policy officials have access to knowledge of "what is being done, where, and with whose support."

Toward that end, the National Council on Marine Resources and Engineering Development is releasing this report: Marine Research—Fiscal Year 1968. The 2589 project descriptions contained herein should assist participants in Government, industry, and universities to select new areas for research, while avoiding wasteful duplication. By identifying individuals and organizations active in the same or closely aligned fields, communication of ideas, opinions, and data should be facilitated. And policy planning and decision making at all levels should be enhanced by the overview this compilation provides of the scope, balance, and texture of marine research.

Although invitations for contributions to the catalog were extended to over 400 non-Federal sponsors, this first national inventory of marine research still lacks information about many relevant non-proprietary projects. In addition, marine technology, ocean operations, and capital expenditures are not covered. It is hoped that among the benefits from this publication will be expanded recognition of the value of descriptive information about marine programs, and support for activities designed to improve the flow of information among specialists working in this area. I commend this report to all of those interested in the marine sciences—in their endeavors to help this Nation achieve the goals of more effective use of the seas.

SPIRO T. AGNEW,
Vice President
INTRODUCTION

One facet of the United States' marine science program, set forth in the Marine Resources and Engineering Development Act of 1966 (PL. 89-454) is:

"The effective utilization of the scientific and engineering resources of the Nation, with close cooperation among all interested agencies, public and private, in order to avoid duplication of effort, facilities, equipment, or waste."

To fulfill its responsibility to assist the President with implementing the Act, the National Council on Marine Resources and Engineering Development has recognized that achievement of this objective depends critically upon the availability of comprehensive, definitive and timely information about the Nation's marine science activities and capabilities. Toward this end, the Council assigned to the Science Information Exchange (SIE) in April 1968 the responsibilities as a national center to collect and disseminate information about current, unclassified marine research. In October, the Council contracted with SIE for preparation of a catalog of marine research sponsored by the United States during fiscal year 1968.

Marine Research—Fiscal Year 1968 is the product of an inventory of Federal and non-Federal organizations with ocean-related research programs and interests. It contains descriptive summaries of 2,589 unclassified projects which were funded, either for the first time or as continuing efforts, during that fiscal year. Associated with these projects, and identified by name and address, are 3,022 investigators; 457 contractors; 25 Federal supporting agencies; and 95 non-Federal sources of support.

The projects referenced in the catalog cover basic and applied research on the marine environment and its resources. This environment is defined to comprise the oceans, the estuarine and coastal areas, and the Great Lakes. For purposes of project selection, contributors were requested to interpret the guideline definitions in a broad sense so that pertinent items would not be overlooked. Research on properties of saline water systems, the behavior of materials in seawater, and techniques of desalination sponsored by the Office of Saline Water is omitted because these data are presented in the annual Water Resources Research Catalog which SIE prepares for the Department of the Interior. In addition, the level of project funding is not presented in this first edition since it was absent on almost one-half of the marine research summaries registered at SIE.

It is hoped that the document will be of sufficient value to encourage users to maintain complete and current records of their projects at SIE, thereby providing a central source for comprehensive marine research information.

The catalog could not have been produced without the full cooperation of the Federal agencies and State and private institutions which reviewed, updated, and supplemented the records of their research on file at SIE. Special appreciation is extended to the many industrial organizations that provided project descriptions to SIE for the first time in support of this inventory. Finally, we wish to acknowledge the effort made by the Science Information Exchange in completing its work with skill and on schedule, and the direction of the project by Mr. Bill Long of the staff of the National Council on Marine Resources and Engineering Development.
EDITOR'S NOTE

On 30 April 1968, the National Council on Marine Resources and Engineering Development designated the Science Information Exchange of the Smithsonian Institution to be the national information center for unclassified, current marine science research information. Specifically, the Exchange undertook the responsibilities of a National Center for receiving, compiling, cataloging, and disseminating information concerning unclassified ongoing research and development activities in the Marine Sciences.

Marine Research—Fiscal Year 1968, prepared by the Science Information Exchange at the request of the National Council on Marine Resources and Engineering Development, is a part of this continuing mission in the marine information area. It provides information on 2,589 projects, supported by both Federal and non-Federal funds. In addition to projects registered with the Exchange, requests for ongoing research projects were made to some 385 non-Federal sources of marine research in an effort to supplement the non-Federal research already registered.

The research listed has been forwarded for inclusion by the supporting agencies. Frequently, more than one agency sponsored a single research project, sometimes resulting in the receipt of multiple records for the same research effort. If these project descriptions were essentially the same, only one was included in the document. However, all sources of support are identified for each project summary appearing in the catalog.

The projects included herein were reviewed, updated, and designated as marine research by the original source of material: Federal and state agencies, private industry, academic institutions, private foundations, or individual scientists. They were assigned to chapters and subchapters according to their subject matter. In addition to the summaries of the 2,589 projects, the catalog contains the following indexes: Subject Index, Investigator Index, Contractor Index, and Supporting Agency Index. The information which appears in the summaries and indexes was taken directly from the project records as received by the Exchange.

The Subject Index was developed by the Science Information Exchange. Each project has been indexed to an average of five terms which are arranged in hierarchies indicating relationships between broader and narrower concepts. The index term is followed by the project title, additional keywords used in indexing, and the chapter and subchapter number of the project. All terms were selected to emphasize the marine aspects of the project and are as specific as the language of the summary. A project which deals with “wave-built terraces” will be indexed to that specific term under a hierarchy consisting of the term “depositional features” and the still broader term “shorelines-geomorphic studies.” Thus, one must turn to the high level term “shorelines-geomorphic studies” to find projects dealing with wave-built terraces, but he will also find all geomorphic shoreline studies grouped together in the same section. To further aid in locating subject areas, the last high level hierarchical term to appear on a sheet of Subject Index page is also printed in the upper left-hand corner of that page and the last high level term to appear on the right-hand page will also appear in the upper right-hand corner of that page in dictionary fashion.

The Supporting Agency Index consists of a single alphabetic listing of both Federal and non-Federal sources of support. In view of the large number of state agencies and departments, they are displayed as a combined group under each state. All investigators cited on the source document are included in the Investigator Index. An asterisk is used to designate the individual specified as principal investigator. However, in some instances it is apparent that the “principal investigator” denoted on the source document is, in fact, a program manager who is not working at the contractor location given in the project summary. The Contractor Index is an alphabetic listing of the performing organizations and their locations.

All of the indexes in this catalog were generated by means of a computer, necessitating a limitation on the number of characters available for index terms and captions. Thus, in some instances, abbreviations had to be used.

We hope that the users of the catalog will advise the Science Information Exchange of any errors of omission or commission that have been made. Also critiques of this volume are encouraged so that future editions might best reflect the information therein in a format and with indexes which are most convenient and acceptable to the user.

MONROE E. FREEMAN, Director
Science Information Exchange
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>FOREWORD</td>
<td>iii</td>
</tr>
<tr>
<td>INTRODUCTION</td>
<td>v</td>
</tr>
<tr>
<td>EDITOR'S NOTE</td>
<td>vi</td>
</tr>
<tr>
<td>DESCRIPIONS OF RESEARCH PROJECTS</td>
<td></td>
</tr>
<tr>
<td>1. Properties of Water</td>
<td></td>
</tr>
<tr>
<td>1A. Acoustical Properties</td>
<td>1</td>
</tr>
<tr>
<td>1B. Chemical Properties</td>
<td>9</td>
</tr>
<tr>
<td>1C. Electrical Properties</td>
<td>19</td>
</tr>
<tr>
<td>1D. General and Miscellaneous Properties</td>
<td>20</td>
</tr>
<tr>
<td>1E. Optical Properties</td>
<td>23</td>
</tr>
<tr>
<td>1F. Pressure-Density</td>
<td>24</td>
</tr>
<tr>
<td>1G. Thermal Properties</td>
<td>24</td>
</tr>
<tr>
<td>2. Water Motion</td>
<td></td>
</tr>
<tr>
<td>2A. Circulation-Currents</td>
<td>27</td>
</tr>
<tr>
<td>2B. Convection-Mixing-Upwelling</td>
<td>35</td>
</tr>
<tr>
<td>2C. General Water Motion</td>
<td>37</td>
</tr>
<tr>
<td>2D. Tides-Sea Levels-Sea States</td>
<td>39</td>
</tr>
<tr>
<td>2E. Wave Dynamics</td>
<td>41</td>
</tr>
<tr>
<td>3. Meteorology</td>
<td></td>
</tr>
<tr>
<td>3A. Air-Sea Interaction</td>
<td>46</td>
</tr>
<tr>
<td>3B. Hurricanes-Storms</td>
<td>53</td>
</tr>
<tr>
<td>3C. General Meteorology-Climatology</td>
<td>55</td>
</tr>
<tr>
<td>3D. Sea Ice-Glaciology</td>
<td>57</td>
</tr>
<tr>
<td>3E. Weather Modification</td>
<td>60</td>
</tr>
<tr>
<td>4. Survey and Prediction</td>
<td></td>
</tr>
<tr>
<td>4A. Data Networks</td>
<td>60</td>
</tr>
<tr>
<td>4B. Data Processing and Analysis</td>
<td>63</td>
</tr>
<tr>
<td>4C. Environmental Prediction</td>
<td>66</td>
</tr>
<tr>
<td>4D. Mapping, Charting and Geodesy</td>
<td>67</td>
</tr>
<tr>
<td>4E. Model Studies</td>
<td>69</td>
</tr>
<tr>
<td>4F. Navigation</td>
<td>73</td>
</tr>
<tr>
<td>4G. Surveys-Cruises</td>
<td>77</td>
</tr>
<tr>
<td>4H. Remote Sensing-Space Oceanography</td>
<td>80</td>
</tr>
<tr>
<td>4I. Economic Analysis</td>
<td>86</td>
</tr>
<tr>
<td>5. Living Systems (non-human)</td>
<td></td>
</tr>
<tr>
<td>5A. Fish Populations</td>
<td>89</td>
</tr>
<tr>
<td>5B. Fish Habitats</td>
<td>115</td>
</tr>
<tr>
<td>5C. Fish Physiology, Biochemistry</td>
<td>122</td>
</tr>
<tr>
<td>5D. Mollusks-Crustacea</td>
<td>139</td>
</tr>
<tr>
<td>5E. Animals, Other</td>
<td>165</td>
</tr>
<tr>
<td>5F. Plants</td>
<td>187</td>
</tr>
<tr>
<td>5G. Microorganisms-Plankton</td>
<td>196</td>
</tr>
<tr>
<td>5H. Ecology, General</td>
<td>213</td>
</tr>
<tr>
<td>5I. Productivity-Biochemistry</td>
<td>224</td>
</tr>
<tr>
<td>6. Public Health and Safety</td>
<td></td>
</tr>
<tr>
<td>6A. Food and Food Sanitation</td>
<td>241</td>
</tr>
<tr>
<td>6B. Hyperbaric Medicine and Adaptation</td>
<td>241</td>
</tr>
<tr>
<td>6C. Marine Toxins-Pharmaceuticals</td>
<td>254</td>
</tr>
<tr>
<td>6D. Safety at Sea</td>
<td>256</td>
</tr>
<tr>
<td>6E. Water Quality and Pollution</td>
<td>260</td>
</tr>
<tr>
<td>6F. Safety at Sea</td>
<td>260</td>
</tr>
</tbody>
</table>

IX
<table>
<thead>
<tr>
<th>Subject Area</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>7. Marine Geology</td>
<td>269</td>
</tr>
<tr>
<td>7A. Economic Geology</td>
<td>269</td>
</tr>
<tr>
<td>7B. General Geological Studies</td>
<td>273</td>
</tr>
<tr>
<td>7C. Geochemistry-Petrology</td>
<td>276</td>
</tr>
<tr>
<td>7D. Geophysics-Structural Geology</td>
<td>282</td>
</tr>
<tr>
<td>7E. Historical Geology</td>
<td>292</td>
</tr>
<tr>
<td>7F. Paleontology</td>
<td>294</td>
</tr>
<tr>
<td>7G. Sedimentology-Stratigraphy</td>
<td>297</td>
</tr>
<tr>
<td>7H. Topography-Geomorphology</td>
<td>311</td>
</tr>
<tr>
<td>8. Engineering and Technology</td>
<td>313</td>
</tr>
<tr>
<td>8A. Aquaculture-Fish Guiding</td>
<td>313</td>
</tr>
<tr>
<td>8B. Biomedical Engineering-Life Support</td>
<td>315</td>
</tr>
<tr>
<td>8C. Cargo Handling</td>
<td>317</td>
</tr>
<tr>
<td>8D. Coastal Engineering</td>
<td>318</td>
</tr>
<tr>
<td>8E. General Ocean Engineering</td>
<td>320</td>
</tr>
<tr>
<td>8F. Instrumentation</td>
<td>321</td>
</tr>
<tr>
<td>8G. Equipment Design and Standards</td>
<td>330</td>
</tr>
<tr>
<td>8H. Power Systems</td>
<td>336</td>
</tr>
<tr>
<td>8I. Hydrodynamics</td>
<td>339</td>
</tr>
<tr>
<td>8J. Materials</td>
<td>343</td>
</tr>
<tr>
<td>8K. Mineral Sampling, Extraction and Processing</td>
<td>350</td>
</tr>
<tr>
<td>8L. Platform Design and Maintenance</td>
<td>352</td>
</tr>
<tr>
<td>8M. Sanitary Engineering</td>
<td>363</td>
</tr>
<tr>
<td>8N. Underwater Construction</td>
<td>364</td>
</tr>
<tr>
<td>9. Coastal Zone Management and Use</td>
<td>366</td>
</tr>
<tr>
<td>10. Legal Studies</td>
<td>370</td>
</tr>
<tr>
<td>11. Education and Training</td>
<td>371</td>
</tr>
<tr>
<td>12. Facilities</td>
<td>376</td>
</tr>
<tr>
<td>Subject Index</td>
<td>401</td>
</tr>
<tr>
<td>PRINCIPAL INVESTIGATOR INDEX</td>
<td>719</td>
</tr>
<tr>
<td>CONTRACTOR INDEX</td>
<td>731</td>
</tr>
<tr>
<td>SUPPORTING AGENCY INDEX</td>
<td>737</td>
</tr>
</tbody>
</table>
DESCRIPTIONS OF RESEARCH PROJECTS

1. PROPERTIES OF WATER

(Studies In-Situ and of Saline Water Systems in Laboratory)

1A. ACOUSTICAL PROPERTIES

(see Chapter 7g For Acoustical Properties of Sediments)

1.0001, ARCTIC ACOUSTIC RESEARCH
R.M. BUCK, General Motors Corporation, Goleta, California 93117 (NONR)

A long term study of the properties of the ambient noise in the deep Arctic Basin will be studied with special interest in the effects of anisotropic noise field on the degradation of equipment. Propagation studies will continue.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0002, TURBULENCE STRUCTURE AND NOISE STUDY
E.R. VANDRIEST, North Amer. Rockwell Corp., Long Beach, California 90803

The objective of this research project concerned the measurement of noise produced by turbulent flow as a function of flow projectories. The experiment utilized a pressure transducer located in the wall of a tubular fixture which was subjected to turbulent flow. The project also determined the reduction of such noise through the use of additives which were injected into the flow.

SUPPORTED BY North American Rockwell Corporation

1.0003, DETERMINANTS AND CONTROL OF UNDERWATER VOCALIZATIONS IN THE CALIFORNIA SEA LION
R.J. CHUSTERMAN, Stanford Research Institute, Menlo Park, California

The purpose of this project is a delineation of the factors influencing the underwater vocalizations of a member of the pinnipeds, Zalophus californianus, the California sea-lion. A determination will be made of the degree to which these vocalizations can be utilized to communicate information from visual displays, e.g. different shapes and sizes of objects and patterns. Both the 'naturally' occurring vocalizations encountered in free-swimming situations and controlled vocalizations utilized for information transfer.

While a great deal of scientific and training effort has been placed upon the cetaceans, particularly the dolphins and porpoises, the pinnipeds, or seals and sea-lions have received little attention as to their capabilities and general biology. This project is one part of a program to provide such information on this group of highly adaptable and potentially valuable animals. The Navy should be aware of the physical parameters and behavioral patterns involved in the pinniped contribution to the oceanic acoustic ambient and the feasibility of utilization of these intelligent animals in similar supportive roles to those now filled by the porpoises.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0004, OCEAN DYNAMICS - OCEANOGRAPHIC ANALYSES AND FORECASTING MODELS
T. LAEVASTU, U.S. Navy, Postgraduate School, Monterey, California 93941

OBJECTIVE: To determine those environmental factors affecting acoustical uses of the ocean. Categorize strategic areas into similar acoustical provinces for sonar operation. To provide scientific acoustical synoptic oceanographic analyses/forecasting models.

APPROACH: Extrapolate and interpolate the oceanographic and acoustic properties of known to unknown areas.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0005, OCEANOGRAPHIC RESEARCH
Y. IGARASHI, U.S. Navy, Undersea Warfare Center, Pasadena, California 91107

Technical Objectives: To conduct an oceanographic research program that will provide an understanding of the effects and limitations imposed by the marine environment on the performance of weapons and weapon systems and the discovery of information which may lead to new concepts.

Approach: An applied research program is being pursued, keying to acoustical problems in shallow waters. Two related areas are being investigated: (1) spatial dependence of temperature and sound velocity structures in water masses and (2) bottom characteristics at specific frequencies. To obtain basic data on temperature structure, a measurement program has been set up which requires simultaneous measurements at three stations using precision sensors. Physical measurements will be correlated with acoustic propagation tests; an improved theoretical model will be used to compute the intensities. A program has been formulated on the investigation of the relationship between bottom structures, and reflectivity and scattering at specific frequencies. Two reference areas having contrasting geological (and acoustic) properties were selected off the Southern California Coast for extensive oceanographic and supporting acoustic measurements.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0006, OCEANOMETRICS
E.R. ANDERSON, U.S. Navy, Undersea Warfare Center, San Diego, California 92140

Objective: To determine those environmental factors affecting acoustical uses of the ocean; to extrapolate and interpolate the oceanographic and acoustical properties of known to unknown areas; to develop theory for predicting the effects of variability of three layers of the sea; develop theory and models for predicting underwater sound propagation; develop statistical, physical and computer techniques.

Approach: Employ oceanographic, statistical, and computer concepts and techniques to develop new approaches for analyzing, summarizing, interpreting and extrapolating oceanographic data in ways meaningful to the scientist, engineer and officer dealing with underwater acoustic propagation research and equipment design and operation. Study the temporal and spatial variation of sound velocity and other pertinent oceanographic variables and their effect on sound propagation.

Make studies and investigations to describe space/time distributions of environmental factors; regional studies of same;
1. PROPERTIES OF WATER

verification of theoretical work in dynamic oceanography and statistics; computer programs; special support of laboratory problems.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0007. MEASUREMENT AND PREDICTIVE STATISTICS OF REVERBERATION

R.E. BATZLER, U.S. Navy, Undersea Warfare Center, San Diego, California 92140

Objective: To acquire and organize information on underwater acoustic reverberation and on the mechanisms controlling back-scattered sound.

Approach: The approach encompasses studies of all factors affecting reverberation. These include the sea surface, wind speed, structure and composition of ocean bottom, scattering layers, other biological scatterers, etc.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0008. MEASUREMENT AND THEORY OF SCATTERED UNDERWATER SOUND

L.R. DOREN, U.S. Navy, Undersea Warfare Center, San Diego, California 92140

Objective: To study and explain theoretically the reasons for reflection losses and other propagation phenomena in the ocean.

Approach: The approach will include both experiment and theory. Much of the experimental data will be acquired in connection with propagation studies.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0009. OCEANOGRAPHIC RESEARCH-INVESTIGATIONS IN SHALLOW WATER

O.S. LEE, U.S. Navy, Undersea Warfare Center, San Diego, California 92140

Objective: To determine those environmental factors affecting acoustical uses of the ocean; investigate factors in physical oceanography which pertain to underwater sound including physical properties such as thermal structure, water motion; and chemical properties such as salinity and oxygen.

Approach: By use of the NUWC Oceanographic Tower, SCUBA, buoys and bottom mounted equipment, and shallow submersibles: observe, measure, correlate those properties in the surface layers of the sea affecting underwater sound, particularly the marine physical chemical, biological and geological near-bottom properties. Develop environmental models for visibility, turbidity, conductivity, tidal and long shore currents, orbital motion, surface and internal waves, gas content and biological population, acoustical and chemical properties, bottom, beach and delta conditions, physical properties of sediments and microtopography; and instrumentation needed to obtain these models.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0010. DEEP OCEAN ACOUSTIC RESEARCH

K.V. MACKENZIE, U.S. Navy, Undersea Warfare Center, San Diego, California 92140

Objective: To determine those environmental factors affecting the acoustical uses of the ocean. Observe and develop theory and models for predicting underwater sound propagation using deep water paths, including near bottom phenomena; conduct underwater acoustic studies by utilizing deep manned submersibles.

Approach: Perform precision measurements on sound speed, temperature, salinity and pressure to study the in situ relationships, with particular emphasis on the pressure effects on sound speed. Temperature structures and sound velocity structures near the bottom and in the top layers of sediments will be investigated. Adiabatic compressibility anomalies computed from sound speed anomalies will be correlated with other measurements, emphasis will be also given to anomalies near the sea floor, sound speed micro-structure will be analyzed by turbulence theory with applications to underwater acoustic scattering and phase amplitude fluctuations affecting signal processing.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0011. PREDICTION OF SOUND FIELDS BY NORMAL MODE AND OTHER THEORY

M.A. PEDERSEN, U.S. Navy, Undersea Warfare Center, San Diego, California 92140

Objective: To predict propagation loss for a variety of oceanographic conditions in which the water medium itself, rather than the medium boundaries, is the controlling factor.

Approach: Modern high-speed electronic computers are used extensively and several basic theories of wave propagation in non-simple media are applied in the computer programs.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0012. UNDERWATER ACOUSTIC SIGNAL COHERENCE

G.O. PICKENS, U.S. Navy, Undersea Warfare Center, San Diego, California 92140

Objective: To conduct acoustic propagation and coherence studies.

Approach: Propagation is carefully analyzed for ray theory multipath conditions and for dominant propagation modes. Experiments are emphasized and are designed to determine the liability of existing acoustic models and means for improving them.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0013. AMBIENT SEA NOISE

G.M. WENZ, U.S. Navy, Undersea Warfare Center, San Diego, California 92140

Objective: To determine the sources, mechanism, statistical properties and other characteristics of ambient noise in the ocean as a function of temporal and spatial parameters.

Approach: Make continuous, or sustained periodic sampling, measurements at each of several sites, with as much geographic coverage as possible, supplemented by measurements using shipborne and buoy systems in more remote areas.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0014. MEASUREMENT OF UNDERWATER ACOUSTIC PROPAGATION

H. WESTFALL, U.S. Navy, Undersea Warfare Center, San Diego, California 92140

Objective: To check, verify, and determine the anomalies between predicted propagation and measurements at sea.

Approach: Measurements stress the accurate determination of sound fields at varying ranges and depths. Measure of pronounced variation in acoustic fields due to variation of a particular propagation factor are also emphasized so that computing methods can be improved and compared with data directly applicable. The general approach is one of verification of predictions leading to subsequent improvement of prediction.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0015. ENVIRONMENTAL SUPPORT OF SONAR DESIGN

R.D. WHEELER, U.S. Navy, Undersea Warfare Center, San Diego, California 92140

Objective: To obtain qualitative and quantitative data on acoustic propagation characteristics of various ocean areas.

Approach: Conduct world-wide research cruises utilizing surface and submerged vehicles to obtain simultaneous acoustic and oceanographic measurements in support of acoustic model development.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0016. OCEAN ACOUSTIC ENVIRONMENT

F.N. SPIESS, Univ. of California, Graduate School, San Diego - La Jolla, California 92038 (N00014-67-A-0190-0009)

This work unit is part of an overall effort to increase the body of knowledge of the marine acoustic environment. Reduction of data from at-sea experiments will represent a significant effort during the contract year. Reverberation spatial
and spectral measurement analyses will continue and a study of the ‘clumping’ of scatterers in the deep scattering layers will be conducted. Previously obtained ambient noise data will be analyzed with emphasis on the non-Gaussian general properties of the noise.

Technical Objectives: Short Term. 1. Determine the changes in the sound field which occur in various seasons in one selected location near Bermuda.

Long Term. 1. Extend the propagation loss measurement program to at least two other selected areas where considerable oceanographic differences occur. (This requires equipment development.) 2. Determine the need for extension of reverberation measurement programs and pursue this work if it appears necessary.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0017, ARCTIC PLANKTON ECOLOGY
UNKNOWN, McGill University, Graduate School, Montreal - Quebec, Canada

Certain relatively shallow under-ice water layers in the Arctic exhibit a pronounced seasonal interference to acoustic propagation. These studies are especially relevant to the development or improvement and utilization of underwater acoustic systems. Population studies aid in the identification of water masses of differing physical properties which are in themselves important to acoustic propagation. Organisms whether macroscopic or microscopic but present in large number per unit volume are potential sources of ambient noise and acoustic scatter. All acoustic applications require clear identification of causes of acoustic alterations as well as determination of corrective procedures.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0018, ACOUSTIC IMAGE INVESTIGATION
W.L. KONRAD, Raytheon Company, New London, Connecticut

Perform experimental studies in the MRL tank facility to determine acoustic image quality and characteristics independent of an image converter system. This was accomplished by forming an acoustic image of a known target with a parabolic reflection and then probing the image plane with a high resolution probe hydrophone. The amplitude and phase distribution over the image plane were determined by this technique. The results indicated that the quality of the image formed was in general agreement with the resolution capabilities of the reflector aperture.

SUPPORTED BY Raytheon Company

1.0019, ULTRASONICS
W.L. KONRAD, Raytheon Company, New London, Connecticut

This project investigated the finite amplitude effects in the mid frequency range (600 KHz). The effects of surface reflection, harmonic generation and difference frequency generation of finite amplitude waves were measured. The work was performed in the MRL tank facility. Additional work was performed at Seneca Lake, New York using the BQS-13.

Results pointed out several interesting application possibilities, including surface, ship bottom identification and source level determination through measurement of harmonic ratios.

SUPPORTED BY Raytheon Company

1.0020, SOUND TRANSMISSION IN THE SEA

This work deals with sound transmission in the sea. It includes: the development of theory; design, performance and analysis of supporting experiments; performance of appropriate surveys related to underwater sound; evaluation of experimental acoustic techniques and equipments; provision of consultant services in the above and related areas.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0021, INTERNAL WAVE STUDIES

Objective: To determine those environmental factors affecting acoustical uses of the ocean. To conduct studies of the effects of internal waves on the scattering and refraction of underwater sound.

Approach: Conduct theoretical studies and related scaled model measurements of the effects of internal waves on acoustical energy by constructing a model tank with scattering and refractions results with theory. Extend studies to a stationary sinusoidal interface between two fluids and continue these studies with a dynamic interface. Develop a program for intermediate and full scale ocean studies.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0022, BIOLOGICAL OCEANOGRAPHY

Objective: To determine those environmental factors affecting acoustical uses of the ocean. To investigate and identify organisms affecting acoustic reverberation and reflection, and ambient noise level. To study the acoustic characteristics and the spatial and temporal distribution of these organisms to develop a predictive capability of their migration habits and population density in areas of the Atlantic Ocean.

Approach: Conduct biological studies of the deep scattering layer in the North Atlantic. Using DRV’s, these studies are to consist of selective sampling via a biological sampler. Simultaneous acoustic backscattering studies will be made with available research instrumentation.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0023, AMBIENT NOISE RESEARCH STUDIES

Objective: Study the spectral, temporal, and spatial distribution of ambient noise. Develop suitable theoretical models and conduct necessary experiments to relate ambient noise to oceanographic, geometric and acoustic parameters.

Approach: Develop theory describing surface noise and its relationship to oceanographic parameters.

Continue experimental studies of ambient noise as a function of area to develop a general non-area dependent model for ambient noise.

Conduct measurements study first and second order noise characteristics in the deep ocean as a function of depth from near surface to below the deep sound channel. Study transient and spectral characteristics of biological noise.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0024, SIGNAL COHERENCE AND ARRAY DESIGN STUDIES

Objective: Study the temporal and spatial characteristics of underwater acoustic signals (time and space coherence and signal distortion) and relate these parameters to array gain and design and to expected and measured performance of various methods of signal processing.

Approach: Oceanographic studies are conducted in support of acoustic measurements to physically describe reflecting boundaries. Theoretical studies are undertaken to define distortion or change in waveform and develop criteria to evaluate the experimental results.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0025, BOTTOM-REFLECTED SONAR STUDIES
1. PROPERTIES OF WATER

Objective: To determine quantitatively and qualitatively the effects of surface, bottom, and volume backscattering on the propagation of acoustic energy in the ocean.

Approach: Conduct a series of acoustic measurements at sea, including system calibration tests, under a variety of environmental conditions.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0026, PHYSICAL OCEANOGRAPHY


Objective: To determine those environmental factors affecting acoustical uses of the ocean. Observe and develop theory models for predicting underwater sound propagation using deep ocean water paths; predict the effects of variability in properties of the sea surface, air and sea temperature structure related to acoustic propagation.

Approach: Using sea surface and environmental measuring systems installed on surface ships and Argus Island, make short and long term measurements of wave height and direction, wind velocity and turbulence, air and sea temperature structure in areas where acoustic studies are being conducted and integrate these measurements with acoustic programs. Relate all measurements to sound velocity and acoustic propagation and explore computer techniques.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0027, REVERBERATION RESEARCH STUDIES


Objective: Describe the spectral, temporal, and spatial distribution and coherence of reverberation as a function of frequency, transmitted signal characteristics and the environment, including both the oceanographic and geometric situation.

Approach: Conduct theoretical and at-sea experimental studies utilizing a variety of surface and deep research vehicles.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0028, ACOUSTIC SCATTERING STUDIES


Objective: Investigate scattering loss of acoustic signals upon reflection from the ocean boundaries as a function of frequency, grazing angle, signal characteristics and boundary characteristics and relate these results to prediction models.

Approach: Collect, process and analyze acoustic reflection data obtained from various geographic areas. Oceanographic measurements are conducted in support of acoustic measurements to physically describe the reflecting boundaries such that reflection loss may be related to boundary makeup.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0029, UNDERWATER SOUND PROPAGATION STUDIES


Objective: To study and report on underwater sound propagation in shallow and deep water as a function of frequency, environmental conditions and mode of propagation.

Approach: Determine the causes of propagation loss and attempt to resolve differences reported by various investigators. Increase the precision of knowledge concerning the attenuation coefficient. Investigate the temporal stability of shallow water propagation for improving correlation of shallow water propagation with environmental factors.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0030, SHALLOW WATER OCEANOGRAPHY


Objective: To determine those environmental factors affecting acoustical uses of the ocean. To investigate the oceanographic and meteorological properties of shallow water and continental shelf areas and the effects of these environmental parameters on underwater sound.

Approach: The Block Island Fishers Island oceanographic system will be installed between Block Island and Fishers Island. Oceanographic data will be obtained and related to acoustic shallow water propagation data obtained at the same time. This will be a continuing program (2-year period) such that long and short term relationships - acoustic oceanography - may be obtained.

Additional buoy emplantments and ships surveys are to be made on the seaward side of Block Island southeastward toward the clyonic shear region of the Gulf Stream system. This extension will provide information on the hydrodynamic forcing functions affecting Block Island Sound as well as internal waves and turbulence of the Continental Shelf.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0031. PHYSICAL ACOUSTICS AND THE PROPERTIES OF MATTER


Study of properties of matter by physical-acoustic techniques. (1) Acoustic cavitation. What variables are decisive and how those of nuclei interact with those intrinsic to liquid? What are natural nuclei and how are they stabilized? (2) Obtain accurate values for speed of sound in water as function of temperature and produce standard for calibration of velocimeters. (3) Possible anomalies in thermodynamic behavior of single crystal ice at low temperatures. Obtain most needed data, i.e., complete set of elastic constants. Relevance: properties of well-characterized substances and production of calibration standards.

(1) Remove naturally occurring nuclei, which are variable, and substitute reproducible ones using ionizing radiation. Devise techniques for absolute measurement of sound at 'threshold' and study as function of nucleus (neutron-recoil, alpha-recoil, fission) and liquid properties and temperature. (2) Develop instrument based on radiation theory; operating principle as different as possible from existing types. Simple, high speed conventional interferometer, but with progressive waves (simulated by long pulse) and with small baffled transducers for which far-field paraxial theory applies. (3) Elastic constants by refined pulse technique, modified for ice; L-waves and polarized S-waves, ice point to He temperatures.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

1.0032. RELIABLE ACOUSTIC PATH

C.L. BUCHANAN, U.S. Navy, Research Laboratory, Washington, District of Columbia

Technical Objectives: Short Term. 1. Determine the changes in the sound field which occur in various seasons in one selected location near Bermuda. 2. Determine the characteristics of the 'Deep Focus' region in a selected location near Bermuda at the first and second zones during 'winter' conditions.

Long Term. 1. Extend the propagation loss measurement program to at least two other selected areas where considerable oceanographic differences occur. (This requires equipment development). 2. Extend the study of the deep focusing region to different areas. 3. Determine the need for extension of reverberation measurements and pursue this work if it appears necessary.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0033. PREDICTIVE OCEAN ACOUSTICS

J. CYBULSKI, U.S. Navy, Research Laboratory, Washington, District of Columbia

Technical Objectives: The objective is to process and report all experimental data on mean horizontal speed of sound obtained in various ocean areas.

Approach: Determine by means of a theoretical and experimental program the effects of realistic variations in velocity profile, and other oceanographic parameters upon underwater acoustics, using values representative of ocean areas.
1. PROPERTIES OF WATER

Approaches: Conduct an extensive search, study, and analysis of all published results and conduct a thorough theoretical and experimental program to determine the relationship of signal characteristics to the ocean environment.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0039. ENVIRONMENTAL REVERBERATION STUDIES

Objective: To determine those environmental factors affecting acoustical uses of the ocean. To study the relation between particulate and microbubble distribution in the sea and acoustic volume scattering strengths in order to better understand the nature and cause of volume reverberation.

Approach: Obtain particle, bubble, optical and acoustic profiles at sea utilizing an in-situ particle analyzer and an in-situ microbubble analyzer. Relate data obtained to scattering theory and temperature, salinity and sound velocity. Analyze PARTICULATES using an electron microscope. Using a tank, conduct experiments to determine scattering strength and absorption of water containing known particulates and controlled microbubbles.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0040. SOUND SCATTERING IN THE OCEAN

Objective: Describe in mathematical terms the scattering of acoustic energy from the ocean bottom, volume and surface.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0041. BIOLOGICAL FALSE TARGETS AND RELATED ACOUSTIC CHARACTERISTICS

OBJECTIVE: In conjunction with the Department of the Interior, develop techniques for improving biological false target and fish detection, classification and prediction methods, and techniques of applying such predictions on a global basis in conjunction with Navy environmental prediction systems. In accordance with the Memorandum of Agreement between the Department of the Navy and the Department of the Interior, primary emphasis is placed on cooperation with the Department of the Interior and utilization of joint Navy-Interior capabilities in support of national goals.

APPROACH: In collaboration with the Department of the Interior, conduct investigations to determine the acoustic properties of marine organisms in order to identify potential biological false targets. Experiments will be conducted to determine target strengths and echo signatures of individual organisms and fish schools. Joint experiments will be conducted with the Bureau of Commercial Fisheries to detect, localize and classify marine organisms.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0042. SHALLOW WATER ACOUSTIC STUDIES

Objective: To provide fundamental information necessary to develop accurate acoustic prediction models for use in shallow water areas.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0043. MICROACOUSTICS

Objective: Increase the knowledge of the mechanisms of acoustic reflection and diffraction. To develop the capability of experimental determination of reflection from bodies not possible by analytical means. Establish realistic scaled thermal gradients in a water tank to determine their effect on echo characteristics.
1. PROPERTIES OF WATER

Approach: The reflection in water from less complicated bodies, (spheres, cylinders, spheroids) have been experimentally measured by several investigators seldom very extensively or in correspondence with a reliable theory. A group at DRL at the University of Texas have measured such reflection in a lake. Qualitative agreement with theory is available for some cases and quantitative agreement is within a factor of two or three in the best cases. Acoustic reflected and scattered fields must be measured with much more precision than heretofore and a correspondence with complete theory must be achieved for a limited number of specific cases sufficient to establish an experimental method with confidence.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0044, ACOUSTIC PROPAGATION STUDIES
L.C. RICALZONE, U.S. Navy, Research Laboratory, Washington, District of Columbia

Objective: Develop theory, design and develop oceanographic instrumentation, and conduct field experiments in support of acoustic propagation studies.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0045, ADVANCED TECHNOLOGY AND BOTTOM PREDICTIONS

Objective: Develop new and improve existing bottom acoustic data collection and analysis methods for improving NAVOCEANO's survey programs. Develop global bottom acoustic models and techniques for predicting the behavior of bottom influenced sound propagation to improve existing prediction methods for use by NAVOCEANO operational programs.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0046, CIRCULATION STUDIES
S. BRIDDA, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124 (NONR)

Objective: This effort is to improve our ability to predict environmental conditions influencing the operations of naval forces and the effective use of systems and equipment, especially those conditions affecting underwater sound.

Approach: Changes in the oceanographic conditions observed across the Florida Current are being correlated with simultaneously observed variations in acoustic transmissions across the current. The amplitude and phase fluctuations observed in low frequency (420 Hertz) acoustic signals transmitted across the Straits of Florida are being related to time series of temperature, salinity and current velocity obtained along the transmission path.

The influence of tides upon the current velocity structure and acoustic propagation conditions is being investigated. A two-week series of continuous oceanographic observations will be made to correlate tides and variations in the water masses of the Florida Current.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0047, BEHAVIOR AND SONIC ACTIVITY OF FISHES
A. MYRBERG, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124 (N00014-67-A-0201-0004)

Objective: The identification and prediction of the animal forms involved in the problem of biologically generated underwater sound is assuming increased importance. The design of this work unit, centering on the use of the unique Bimini Acoustic-Video System, is permitting direct and unequivocal observation of sound producers during a variety of activity patterns.

Approach: Utilizing the capability of the Acoustic-Video System located at the Lerner Marine Laboratory, Bimini, Bahamas, a correlation of the behavior and bioacoustic activity of the bicolored damselfish, Eupomacentrus partitus, will be made with the open environmental factors. Taped video and acoustic recordings of behavior will be analyzed and physical data on turbidity, light level, current speed and direction, and temperature will be integrated to reveal causal relationships. Acoustic playback experiments, using sounds of this and other sonic fishes will be completed, both in the field and in controlled laboratory conditions, as to behavioral reactions of the fish to the sound patterns.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0048, AMBIENT SEA NOISE INVESTIGATION
J.C. STEINBERG, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124

Objective: To determine the environmental factors affecting underwater uses of the ocean. Make time series measurements of ambient noise level related to concurrent wind/wave measurements.

Approach: Using an IBM 7040-1401 computer and applying time series techniques and standard statistical treatments to data obtained from Bimini, Bahamas during the period 10 Sept 66 to May 67, determine relationships between ambient noise levels and environmental parameters to develop a model in which a frequency dependent linear system of multiple inputs consisting of environmental parameters may be expected to determine a single output which would be ambient noise. Very narrow band noise measurements will be obtained. Real time analyses of the amplitude and phase characteristics of this narrow band noise will be performed. The distribution of pressure fluctuations of 1/3 octave band noise at selected frequencies during different environmental, bio-acoustical and shipping conditions will also be determined. LINC-8 data processors will be used for the high speed analogue-digital sampling and computation of this data.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0049, ACOUSTIC-VIDEO SYSTEM FOR AQUATIC BIOACOUSTICAL AND ETHOLOGICAL RESEARCH
J.C. STEINBERG, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124 (NONR)

Objective: The exigencies of Naval marine technology require that more detailed information be made available on biologically produced underwater sound. The Acoustic-Video System designed by Dr. Steinberg is providing direct and unequivocal observation and recording of sound producers in their natural environment.

Approach: The investigator and his staff will continue to operate, maintain, and modify, as requested by the biologists, the Acoustic Video System located in 20 meters of water off the NW Coast of Bimini in the Bahamas. This array will be used to permit bioacoustic behavioral studies on sonic animals in the field. Dr. Steinberg's team will continue to work closely with the biologists and expand the interdisciplinary approach to marine bioacoustical problems.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0050, SHALLOW-WATER ACOUSTICS
M. WEINSTEIN, Underwater Systems Inc., Silver Spring - Wheaton, Maryland 20910 (N00014-67-C-0480)

Review all literature pertinent to shallow-water acoustic transmission. Extract, collate, summarize, and annotate theoretical and experimental data. Visit facilities engaged in shallow-water acoustic studies to obtain unpublished information. Collate new material with original summary acoustic data (SAD) Report (1956) and issue revised and updated publication.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0051, SONAR ACCURACY
A.T. JAQUES, U.S. Navy, Ordnance Laboratory, Silver Spring - Web Oak, Maryland

To determine sonar bearing and ranging errors at long ranges.

Make acoustic propagation measurements with a stable research platform (SPAR).

SUPPORTED BY U.S. Dept. of Defense - Navy
1.0052. OCEANOGRAPHIC RESEARCH
UNKNOWN, U.S. Navy, Ordnance Laboratory, Silver Spring - White Oak, Maryland

To study the effect of ocean dynamics on the behavior of submerged moored bodies. To investigate the effect of shallow water and coast proximity on acoustic transmission properties. To develop the necessary instrumentation to carry out the above studies.

- Measure the current and the motion of a submerged body at selected locations. Determine how the two phenomena are related. Measure acoustic signals at selected coastal sites. Determine how the original signal is modified and identify the oceanographic parameters which contributed to the modification.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0053. ACOUSTIC AMBIENT NOISE
M. ARSOVE, Raytheon Company, Waltham, Massachusetts

Design, construction and operation of instrumentation to collect data relevant to determining the characteristic power spectra, amplitude distributions, directional properties, and relationship to ambient noise at depth of the near-surface acoustic ambient noise.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0054. BIOLOGICAL ASPECTS OF MIDDLE TERRAIN SOUND SCATTERING
R.H. BACKUS, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543

The long term goal is to understand the geographic distribution of mesopelagic fishes in the North Atlantic Ocean and adjacent seas. The investigators will include charting of the distribution of mesopelagic fishes by species in order to show principal distribution patterns, and to point to physical bases for the apparent patterns. Midwater trawl collections are to be accompanied with sound scattering observations in efforts to correlate echo soundings with possible causative organisms. With the development of adequate gear, attempts will be made to determine the relation of patterns of sound scattering to vertical distribution of mesopelagic fishes. Such collections would be accompanied by continuous echo soundings and by broad-band sound scattering observations. Refinement of such gear as midwater sampler, pneumotyt nets, and echo sounders are to be continued. Further observations are to be made on microbioluminescence in the sea and in Eel Pond at Woods Hole in order to understand something of the seasonal fluctuations in bioluminescence. Underway observations at sea will be made for studying geographic variations in such activity. Finally, dives are to be made in a deep-going submarine for the purpose of making direct observations of sound scatterers in deep scattering layers using echo sounders and sounding gear.

SUPPORTED BY U.S. National Science Foundation

1.0055. EASTERN ATLANTIC AND MEDITERRANEAN OCEANOGRAPHY
E.E. HAYS, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543 (NONR)

The purpose of this task is to support Woods Hole research scientists to participate with the UK scientists in a cooperative study of underwater sound experiments in the Eastern Atlantic and the Mediterranean Sea. Bathymetric and sounding measurements will be included. The task will also provide for analysis and interpretation of data.

This is part of a coordinated program to determine the oceanographic and acoustic structure of the Mediterranean. The WHOI scientists aboard the R/V CHAIN will participate in a joint cruise with a UK vessel.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0056. WOODS HOLE ENVIRONMENTAL STUDIES PHYSICAL OCEANOGRAPHY
E.E. HAYS, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543 (NONR)

Objective: Improved understanding of the oceanographic factors that affect acoustic systems (both current operations and for future designs). To relate the properties of the ocean environment to specific modes of acoustic transmission.

Approach: Obtain sound velocity profiles in terms directly related to specific acoustic experiments, and as a general oceanographic tool. Develop an on-line sound velocity profiling system using the shipboard computer. Use a STD (Salinity-Temperature-Depth) system to study oceanic fronts and gain information on the possible structure and movement of the water.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0057. WOODS HOLE ENVIRONMENTAL STUDIES OCEANIC ACOUSTICS
E.E. HAYS, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543 (NONR)

OBJECTIVE: Improved understanding of sound transmission and scattering in the ocean with a view toward providing equipment designers a description of opportunities and limitations they can use to define parameters which contribute to the ambient noise. Develop the necessary instrumentation to carry out the above studies.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0058. ACOUSTICS PHYSICS
W. HARDY, Hudson Laboratories Inc., Dobbs Ferry, New York (NONR)

Conduct studies of underwater acoustic transmission to provide the Navy with scientific and technical knowledge of underwater sound and related disciplines.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0059. THE PROPAGATION OF ACOUSTIC WAVES IN THE STRATIFIED ATMOSPHERES
W.L. DONN, Columbia University, Graduate School, New York, New York 10027

Technical Objective: Propagation parameters of pressure perturbation, vertical and horizontal motion, and kinetic energy along the vertical have been developed for gravity and acoustic gravity waves of long period (of the order of minutes). This study will be extended to pure acoustic waves of much shorter period (1 to 10 seconds).

Approach: The program consists of two aspects: (1) Theoretical analysis of acoustic wave propagation involving the application of the wave equations to the real atmosphere considered as being stratified in terms of both temperature and wind. (2) An experimental analysis of spectral characteristics of acoustic waves recorded by microphones.

SUPPORTED BY U.S. Dept. of Defense - Army

1.0060. BIOLOGIC SOUND SCATTERING
A.W. BE, Columbia University, Graduate School, Palisades, New York 10964 (N00014-67-A0108-0004)

This program is directed at measuring total volume reverberation levels in the ocean and correlating them with plankton-nekton standing crop. The newly initiated and specialized biological sampling program will be continued along with the concurrent acoustic measurements under controlled conditions using broadband and discrete sound sources. Correlation of biomass data and PDR records from past cruises will continue.

Volume reverberation is thought to result in part from sound scattering by biological organisms and varies in intensity with depth, geographic locality, season of the year, and sound frequency. The information on such variations and their interrelationships which will be provided by this program, should con-
1. PROPERTIES OF WATER

Siderably improve the Navy's ability to predict acoustic conditions as a function of time of day, time of year, and geographic location.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0061, OCEAN SOUND TRANSMISSION


A broad program of applied research is conducted on sound transmission in the ocean, and on phenomena controlling it.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0062, RESEARCH IN OCEANOGRAPHIC SPECIAL CHARTS

W.M. EWING, Columbia University, Graduate School, Palisades, New York 10964 (NONR)

Objective: To determine those environmental factors affecting acoustical uses of the ocean. To investigate and characterize the properties of the ocean bottom and sub-bottom including acoustic properties and to delineate physiographic provinces of the ocean bottom.

Approach: Extrapolate and interpolate the oceanographic and acoustic properties of known to unknown bottom areas and categorize areas into similar acoustical provinces. Observe and develop theory and models for predicting underwater sound propagation using deep ocean water paths including near bottom phenomena. Delineate and chart oceanic provinces on the basis of topography, sediment type, roughness, etc. and the accompanying acoustic properties of the bottom and the sub-bottom.

Refine these charts on the basis of reflectivity measurements and bottom and sub-bottom profile records.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0063, RESEARCH IN REGIONAL TOPOGRAPHIC ANALYSIS

W.M. EWING, Columbia University, Graduate School, Palisades, New York 10964 (NONR)

Objective: To determine those environmental factors affecting uses of the ocean. Extrapolate and interpolate the oceanographic properties of known to unknown bottom areas and categorize areas into similar provinces.

Approach: Study the statistical properties of the bottom topography including both slope and roughness and relate these properties to the physiographic province in the oceans. Develop suitable data presentation methods and analyses.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0064, BIOLOGICAL SOUND

M.P. FISH, Univ. of Rhode Island, Graduate School, Kingston, Rhode Island 02881 (NONR)

Objective: To determine those environmental factors affecting uses of the ocean. Extrapolate and interpolate the oceanographic properties of known to unknown bottom areas and categorize areas into similar provinces.

Approach: Study the statistical properties of the bottom topography including both slope and roughness and relate these properties to the physiographic province in the oceans. Develop suitable data presentation methods and analyses.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0065, SHALLOW WATER ACOUSTIC PROPAGATION STUDIES (SWAPS)


Technical Objective: Investigate some of the characteristics of sound propagation in shallow water and to relate these observations to the oceanographic environment.

Approach: Investigation will be conducted on the fluctuations of the level and relative phase of an acoustic signal propagated over a fixed range in shallow water and the regulation of the fluctuations to such oceanographic parameters as tide height, sound speed distribution, thermal microstructure, turbulent motion, and sea state. Upon selection of suitable sites, a detailed study of the bottom topography, the subbottom layering, and their acoustic properties will be undertaken. An indication of the acoustic field expected will be obtained from the geometry of the range, the properties of the bottom, and representative velocity profiles, using ray or normal mode techniques.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0066, EFFECTS OF THERMAL MICROSTRUCTURE ON ACOUSTIC TELEMETRY

D. BUGNOLO, Raytheon Company, Portsmouth, Rhode Island

Acoustic telemetry channels in the ocean environment will be affected by the relative motion of source and receiver and by the stochastic character of the medium. This study considers the effect of thermal microstructure on the phase and amplitude of an acoustic signal transmitted over the surface to bottom path, as in the case of a surface vessel to bottom mounted buoy. The phase and amplitude variations are related to the spectrum of the sound velocity variations. These in turn related to the thermal microstructure and currents in the medium. Examples are evaluated using a Kolmogoroff spectrum for the temperature variations, based on physical constraints. Further experimental effort including simultaneous oceanographic and acoustic measurements is required to verify the theoretical predictions.

SUPPORTED BY Raytheon Company

1.0067, BI-STATIC ECHO RANGING

E.L. DANIELS, Raytheon Company, Portsmouth, Rhode Island

Objective: To improve bi-static ranging techniques.

Approach: Collect bi-static echo ranging and reverberation data at sea in various propagation modes over a wide range of geometries.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0068, DEVELOPMENT OF ANALYSIS TECHNIQUES FOR CLASSIFYING TRANSIENT HYDROACOUSTIC SIGNALS

R. PLUTCHOK, Teledyne Incorporated, Garland, Texas

One part of a continuing effort to develop an operational system for classifying transient hydroacoustic signals was a study to define analytical methods for signal identification. To this end, signal analysis procedures were developed which were based both on in-house research and on the findings of other investigators in this and related fields.

These investigations were conducted by Earth Sciences, A Teledyne Company, at 314 Montgomery Street, Alexandria, Virginia.

SUPPORTED BY No Formal Support Reported

1.0069, ACOUSTIC SCATTERING

R.S. HAYRE, Univ. of Houston, Graduate School, Houston, Texas 77004 (NONR)

This task deals with the development and evaluation of models for scattering at the ocean surface and in its volume taking account of the effects of waves and entrained bubbles. Both analytic studies and model experiments in a tank will be performed and the results of the latter studies will be compared with sea data obtained by the University of Miami. It also includes the analysis of reflectivity data.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0070, DEVELOPMENT OF ANALYSIS TECHNIQUES AND EQUIPMENT FOR CLASSIFICATION OF TRANSIENT HYDROACOUSTIC SIGNALS

J.N. GRIFFIN, Teledyne Incorporated, Alexandria, Virginia
This project was undertaken to assemble an on-line hydroacoustic signal processing system implementing the findings of earlier research in methods for classifying transient signals, and to continue the development of robust methods for signal classification and identification.

SUPPORTED BY No Formal Support Reported

1.0071, HONEYWELL ACOUSTIC RESEARCH PROGRAM
P. MOOSE, Honeywell Incorporated, Seattle, Washington
The Honeywell Acoustic Research Program is an applied research project on the physics of acoustic reverberation in the sea. Reverberation, or clutter as it is called in radar, is a noise-like signal present to some degree in all active sonar sets. It is the superposition of many small echoes reflected or scattered from inhomogeneities in the medium and from the boundaries; but it excludes signal returns which have interacted with the target. (Those signals excluded are called the direct echo and attendant multi-path structure of the target.)

In order to accomplish target detection, estimation and/or classification problems with sonar, we need to establish certain statistical parameters of the reverberating structure. The first phase of the Honeywell Acoustic Research Program concentrated on theoretical models and formulations and upon preparation of special purpose instrumentation. The second phase, which is in progress, is to gather and process large amounts of data required in furthering this research.

Reverberation measurements will play an increasingly important role in oceanography and will help advance the state-of-the-art in marine physics and sonar.

SUPPORTED BY Honeywell Incorporated

13. CHEMICAL PROPERTIES

1.0072, CHEMICAL OCEANOGRAPHY
D.W. HOOD, Univ. of Alaska, Inst. of Marine Sciences, College, Alaska 99773
Arctic water masses will be characterized by detailed analyses of inorganic and organic components. These, with selected organic and trace metal analyses, and determination of isotopic gradients beneath the ice, will provide basic data for the understanding of water movement and mixing, and provide insight into biogeochemical processes. Certain organic compounds will be used as specific tracers to provide quantitative data on water source and time-averaged currents. Large samples of dissolved organic material uniquely obtainable due to the slow drift of T-3 will be dated by 14C and time-averaged currents will be calculated for knowledge of the age distribution of the tracer. Terrestrial and marine sources of water will be determined by study of 13C/12C rating of organic matter. Emphasis will be placed upon processes and mechanisms of cycling of organic carbon.

These studies contribute to basic knowledge of chemistry of marine waters. The physico-chemical structure of sea water has an important bearing upon all of man's uses of the sea. Processes of basic reactions and chemical cycling of the sea, especially organic carbon cycling, are of greatest relevance and the understanding of these for each of the layered water masses provide relevant data on the dynamic processes of water movement and mixing and the interchange of mass and energy with the other oceans.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0073, MARINE INTERFACE CHEMISTRY
D.W. HOOD, Univ. of Alaska, Inst. of Marine Sciences, College, Alaska 99773 (NONR)
The objectives of this task are to understand the processes responsible for observed concentrations and gradients at the air-sea interface, and to determine if detectable gradients exist at other marine interfaces such as fresh-salt water, and between different water masses. The sampling at the air-sea interface will be accomplished using a screen, and the gradients in the first meter by use of a special float-supported tube with intakes at closely spaced intervals. Chemical measurements will include plant nutrients, dissolved and particulate organic matter, lipids and a number of inorganic ions.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0074, GEOCHEMISTRY OF SAN FRANCISCO BAY
J.R. KRAMER, U.S. Dept. of Interior, Water Resources Division, Menlo Park, California
Purpose: To determine abundance, distribution, and clay mineralogy of suspended sediment in San Francisco Bay and their influence on the overall quality of bay waters.

Methods: Study of the composition of selected geochemical constituents with depth in sediment to relate source. Plot distribution and occurrence of trace minerals in bay sediment and waters.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

1.0075, ORGANIC GEOCHEMISTRY OF SAN FRANCISCO BAY WATERS AND SEDIMENTS
D.H. PETERSON, U.S. Dept. of Interior, Water Resources Division, Menlo Park, California
Purpose: To increase our limited knowledge of the factors which control the abundance, distribution, and composition of organic matter in coastal waters and sediment.

Methods: 1) Determine the relative abundance, distribution and clay mineralogy of suspended sediment in San Francisco Bay waters in relation to source and waters, such as the distribution of saline water. 2) Survey the abundance and distribution of organic carbon in San Francisco Bay waters and sediment in relation to season, source and differences in depositional environment such as the distribution of NO3 and oxygen dissolved in the waters. 3) Study the distribution of specific trace elements in relation to the distribution of organic matter. 4) Survey the distribution of pesticides in sediment in relation to depositional environment and depth in sediment. 5) Study abundance and composition of organic matter thought to be of prime importance in the engineering properties of sediment. 6) Study the composition of selected geochemical constituents with depth in sediment in relation to source and subsequent alteration of organic matter.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

1.0076, SEA WATER CHEMISTRY
T.J. CHOW, Univ. of California, Scripps Inst. of Oceanography, San Diego - La Jolla, California 92038 (NONR)
Techniques for separating and identifying trace materials in sea water, snow, and atmospheric aerosols will be developed and applied to the determination of the distribution of rare earths, indium, molybdenum, potassium, and calcium. Mass spectrometry will be applied to the detection of relative amounts of lead and to determination of isotope ratios for identification of the origins of these lead traces.

Knowledge of the natural and industrial background values for concentration of lead in sea and atmospheric is important in establishing levels above which possible higher concentrations may exist. The present main sources of industrial lead are probably insecticides and motor exhausts.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0077, LIGHT ISOTOPE STUDIES
H. CRAIG, Univ. of California, Scripps Inst. of Oceanography, San Diego - La Jolla, California 92038 (NONR)
A study of fractionation of hydrogen isotopes (deuterium) and oxygen isotopes in sea waters, sea ice, and atmospheric precipitation will continue and will be interpreted in terms of mixing rates and kinetics of evaporation and gas exchange at interfaces. The recent discovery that the oxygen in sulfate and in sea water exchanges very slowly with oxygen in water molecules will be exploited as a means of investigating past oceanic temperatures, residence times of sulfate in the sea, and the kinetics of the sulfate-sulfide reactions in sediments and stagnant basins.
1. PROPERTIES OF WATER

The slow and complex nature of mixing processes in the deep ocean makes it mandatory that all possible parameters be investigated for their contribution to the overall understanding of oceanic circulation. The study of isotopic variations provides an important addition to the chemical and physical methods of examining large-scale ocean mixing processes.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0078, EFFECT OF PRESSURE ON CONDUCTIVITY OF SOLUTIONS
F.H. FISHER, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

The physical chemistry of electrolytes such as magnesium sulfate and its effect on the conductivity and acoustical properties of sea water has been the subject of recent dispute. Minute amounts of salts such as magnesium sulfate in sea water produce a sound absorption of thirty times that exhibited in fresh water. Not only is this of fundamental interest to the physical chemist concerned with reaction kinetics but it is of primary concern to the oceanographer who must interpret conductivity versus pressure data. The problem of the complex relationship between conductivity, temperature, pressure, and specificity of salt content of sea water has been intensified by the introduction of conductivity meters to determine "salinity" which in turn is converted by an arbitrary relationship to density.

The principal investigator will make precise measurements on the electrical conductivity of sulfate aqueous solutions as a function of temperature and pressure using data on dielectric constants, viscosity and density. The addition of pressure to the systems should give more realistic values on the shifts in conductivity and acoustical properties of sea water.

SUPPORTED BY U.S. National Science Foundation

1.0079, EFFECT OF PRESSURE ON CONDUCTIVITY OF SOLUTIONS
F.H. FISHER, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

Plans are for continuation of the study of the effect of pressure on conductivity of electrolyte solutions, in particular 2-2 sulfates, started under NSF Grant GP-4748. The 2-2 electrolytes exhibit unusual acoustic absorption properties which have been investigated at atmosphere pressure by ultrasonic relaxation spectroscopy techniques. Wide variations in acoustic properties related specifically to the cation have been discovered which contrast with the great similarities in such properties as activity coefficients and equilibrium constants. The physical chemistry of these salts is difficult and a subject of dispute. Recent work has led to the concept of a four-state dissociation model which is used to account quantitatively for the unusual acoustic absorption in these solutions in terms of simultaneous pressure-dependent chemical reactions.

SUPPORTED BY U.S. National Science Foundation

1.0080, STUDY OF THE DISTRIBUTION OF RADIONUCLIDES IN THE OCEAN DETAILED EXPLORATION OF Cs137 IN THE OCEAN
T.R. FOLSOV, Univ. of California, Graduate School, San Diego - La Jolla, California 92038 (AT(11-1)-34, PROJECT 071)

1967 Objective: Collecting detailed distribution of fallout especially in upper layers of the N. Pacific to indicate mixing and circulation rates and the behavior of elemental cesium in the ocean.

Background: Several years work has culminated in a successful means for rapidly surveying Cs137 in the ocean by concentrating in situ on absorbers at any depth. Previous work has led to the concept of a four-state dissociation model which is used to account quantitatively for the unusual acoustic absorption in these solutions in terms of simultaneous pressure-dependent chemical reactions.

1.0081, STUDY OF THE EXCHANGE OF CARBON DIOXIDE BETWEEN THE ATMOSPHERE AND THE OCEANS
C.D. KEELING, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

1967 Proposal: 1. Intercepting a concentration front believed advancing south of Hawaii to further determine transport and diffusion rates. 2. Detailed cesium section of N. Pacific Current near 170 degrees W to confirm suspected upwelling. 3. More detailed subsurface measurements near 30 degrees N, 150 degrees E and 30 degrees N, 140 degrees W to estimate the advance of intermediate waters southward. 4. Detailed reinspection of Cs133 anomalies discovered near Samoan and California shores. 5. Further refinements in Cs133 and Cs137 collecting and analytical techniques. 6. Summarizing Cs137 findings to date correlated with other data in oceanographic reports.

SUPPORTED BY U.S. Atomic Energy Commission

1.0082, PHYSICAL CHEMISTRY OF BUBBLES
F. MACINTYRE, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

This project, now completed, investigated certain physicochemical hydrodynamic features of breaking bubbles and also the effects of capillary ripples upon interfacial gas exchange. More detailed accounts may be found in MacIntyre, J. Phys. Chem. 72, 589 (1968) 'Bubbles: A Boundary-Layer Micromote for Micron-Thick Samples of a Liquid Surface', and in MacIntyre (submitted to J. Fluid Mech.) 'Enhancement of Interfacial Gas Transfer by Capillary Ripples'.

SUPPORTED BY Amer. Chemical Society

1.0083, DETERMINATION OF TRITIUM IN NATURAL WATERS
H.E. SUESS, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

The long-range goal of this oceanic investigation is to describe the mechanism of the exchange of CO2 between the oceans and the atmosphere. Towards attainment of this goal it is proposed to: (1) conduct a seasonal study of horizontal and vertical variations of all of the determinative chemical species related to CO2 gas, and (2) to continue laboratory investigations of the chemistry of inorganic carbon in ocean water, and (3) to automate additional phases of data processing both at sea and in the laboratory.

SUPPORTED BY U.S. National Science Foundation

1.0084, NATURAL RADIOCARBON MEASUREMENTS
H.E. SUESS, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

This grant provides support for the continued operation of the principal investigator's radiocarbon dating laboratory. Radiocarbon determinations are being carried out in connection with the following lines of research: 1. Distribution of natural radiocarbon in bicarbonate of the deep oceans for the investigation of movement of deep ocean water masses. 2. Distribution of artificial radiocarbon in the surface water of the Pacific Ocean for the purpose of investigating mixing through the thermocline. 3. Determination of carbon-14 dates in connection with other
research carried out at the Scripps Institution of Oceanography and by the Earth Sciences Department.

SUPPORTED BY U.S. National Science Foundation

1.0085, TRACE ELEMENTS IN SEA WATER
K.K. TUREKIAN, Yale University, Graduate School, New Haven, Connecticut 06520

During the next year we propose the following program to continue our studies of the marine geochemistries of the trace elements. It is hoped that knowledge of the behavior of the naturally occurring and pollution contributed trace elements in natural waters will also assist in the understanding of the behavior of radioactive nuclides from reactors and other potential sources of radioactive waste.

Long Island Sound studies: We will complete the neutron activation analysis for Long Island Sound water profiles for cobalt, nickel and silver. An attempt will be made to make a material balance for as many elements as possible in Long Island Sound using stream, sea water and sediment data. This is of importance not only because of the imminent construction of nuclear reactors in the state of Connecticut but also as a general model of the behavior of trace elements for analogous areas around the world.

Analytical methods: We shall continue in the development of neutron activation analytical techniques for the analysis of stream waters. With the use of sodium carbonate carrier and freeze-drying in addition to Co, Ni and Ag we expect to develop techniques for the determination of the following elements from the processing of a single 100 ml aliquot of water: Hg, Se, Sb, Cr, Rb, Cs, Au, Zr, Hf, Ta, Zn, Fe, Sc, Ba, Sr, Te, Mo.

Techniques for the accurate determination of uranium and molybdenum will be developed. Uranium will be determined by neutron activation and alpha spectrometry and molybdenum will be determined by mass spectrometric isotope dilution and possibly by neutron activation. These elements are of interest not only because of their peculiar geochemical properties but also if found to be constant in concentration in sea water as indicated by some workers, for use as monitors in the sponge adsorption experiments.

SUPPORTED BY U.S. Atomic Energy Commission

1.0086, HEAVY METAL GEOCHEMISTRY OF ANTARCTIC SEA WATER AND MARINE SEDIMENTS
K.K. TUREKIAN, Yale University, Graduate School, New Haven, Connecticut 06520

This award continues a study of variations in the content of heavy metallic elements in the Antarctic Ocean. Previous support was under GA-110, GA-183, and GA-275. Deepwater samples were collected on Eltanin Cruises 11 and 22. These are being analyzed chemically and radiometrically for Ag, Cu, Ni, U234, U238, and the alkaline-earth metals (Ba, Sr and Ca). Siliceous sediments from deep-sea cores in the same areas were analyzed for Sr2, C14, and the uranium-decay series. These determinations were analyzed to relate the variations of the different elements to biological activity and to the rate of mixing of the ocean water masses. It is proposed to continue the analyses of Eltanin samples and of the data. Strontium in untreated sea water will be determined by atomic absorption spectrophotometry. Results to be compared with analyses obtained by mass-spectrometric, isotopic-dilution techniques. The same water samples to be analyzed for specific alkalinity. These two sets of data will be used to understand both the oceanic circulation around the Antarctic regions, and the geochemical properties of Antarctic water. Analyses already made on isotopes of Si, C, and the uranium-decay series will be compared for a determination of the rates of sediment accumulation in Antarctic deep-sea sediment cores. These rates will be compared with the barium content of the cores and of the water for a further check on the flow rates between the Antarctic Ocean and the other major oceans.

SUPPORTED BY U.S. National Science Foundation

1.0087, PH STANDARD REFERENCE MATERIALS FOR USE IN SEA WATER

Technological Objectives: The hydrogen ion activity (pH) is an important parameter in chemical and biological processes. Over the years a pH scale in sea water has been developed at the National Bureau of Standards augmented by a series of standard reference materials. As work is extended to other systems (deuterium oxide, sea water, non-aqueous solvents), a parallel activity scale and a series of standard reference materials must be developed. The increasing interest in oceanography has made the development of a pH scale in sea water most pressing. The present work at NBS to define a pH scale in sea water and develop standard reference materials will fill the need in this area.

Approach: A 'standard' sea water for this work is being developed and a pH scale is being defined in this medium. Accompanying this is a study of the deviations in pH with changes in salinity. Once the scale is established, work will begin to prepare and standardize a group of defining standard reference materials.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

1.0088, TRACE ELEMENT EQUILIBRIUM STUDIES
J.D. GASSAWAY, U.S. Navy, Oceanographic Office, Washington, District of Columbia

Objective: To investigate equilibrium distribution coefficients and uptake rates of elements and suites of elements on ion-exchange resins containing various organic complexing and precipitating agents.

Approach: The initial effort will be directed at establishing the optimum conditions for adsorbing and/or absorbing organic complexing agents onto ion exchange resins. Immediate attention will be given to dithizone, 1-nitroso-2-naphthol, dimethylglyoxime, 8 hydroxyquinoline, and ammonium pyrrolidine dithiocarbamate on Dowex 1 of varying mesh sizes. Using appropriate radioactive tracers (e.g. zinc, cobalt, copper, nickel, antimony, manganese, iron, chromium and the rare earths), studies will be made of: (i) their equilibrium distribution coefficients in a sea water matrix with a pH ranging from 2 to 9 under controlled conditions; (ii) elution characteristics of the exchangers employing various eluants (both organic and inorganic); (iii) trace element recoveries from large volumes of sea water; and (iv) factors affecting recoveries.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0089, OCEAN RADIOACTIVITY
J.T. HOOVER, U.S. Navy, Research Laboratory, Washington, District of Columbia

Objectives: To make measurements of the neutron intensity as a function of depth. To increase our knowledge of the neutron distribution in the ocean.

Approach: The experimental approach is to utilize currently available, highly sensitive counters to detect the neutron component in the ocean.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0090, ISOTOPIC OCEANOGRAPHY

OBJECTIVE: Develop capabilities for the measurement and utilization of radioisotopes and stable isotopes in the sea to provide NAVOCEANO survey forces the ability to rapidly and selectively collect marine radiochemical and trace element samples for use in studying oceanographic phenomena and to respond rapidly to oceanic disasters involving nuclear material. Provide the capabilities for survey measurement, prediction and search capabilities for radiotopes at low levels and stable trace constituents at levels of 1 ppm or less.

APPROACH: Collection and radiochemical analysis of sea water, bottom sediment and plankton, samples from selected Arctic areas. The data are studied with other physical and chemical oceanographic parameters to determine the manner in which the
1. PROPERTIES OF WATER

Spatial and temporal isotope distributions reflect environmental features. Chemical, geological, and biological considerations are to be made of Arctic and Tropical areas to fully evaluate controlling factors on stable and non-stable isotopic distributions. The radiocarbon levels observed will be used to provide background levels for reference for future measurements in the Arctic and/or other areas of interest. Results will be used as a guideline in determining the feasibility of future isotopic surveillance efforts and for modifying sample collection and laboratory analytical techniques for more efficient and rapid data procurement. Utilize injection sources, such as nuclear reactors, to study the properties of introduced pollutants and their relationships to oceanographic variables present.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0091, SHIPBOARD METHODS OF CHEMICAL ANALYSIS
J.W. SWINNERTON, U.S. Navy, Research Laboratory, Washington, District of Columbia

1. To make shipboard evaluation of method for determining dissolved light hydrocarbons and carbon monoxide in seawater by gas chromatography. (2) To adapt method for determining low-molecular weight hydrocarbons and CO in air over the ocean.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0092, PRECISION MEASUREMENTS OF DISSOLVED OXYGEN, NITROGEN AND ARGON IN SEAWATER
D.E. CARRITT, Nova University, Graduate School, Fort Lauderdale, Florida (N00014-67-A-0386-0001)

The Navy needs to know the rate of ventilation of subsurface waters as it is pertinent to corrosion of structures; availability of 02 for isolated, long-term, undersea human habitation; and general ocean circulation. Gas exchange across sea surface has relevance to sea-air interaction and gas-membrane exchange phenomena.

The objectives are to obtain measures of the distribution of dissolved 02, N2 and Ar in the ocean by newly developed techniques which eliminate both systematic and accidental errors present in existing methods, and to use these measures as the basis for (1) describing the distribution of 02, N2, and Ar in the ocean; (2) establishing the departure (if any) of the gas solubility from predicted thermodynamic equilibrium; (3) elucidating the physical processes by which matter is transferred across the sea-air interface and (4) estimating the rate of ventilation of subsurface parts of the ocean. The system for gas measurements utilizes a sample bottle which captures a measured volume of sample in situ and upon recovery is attached directly to the analysis instrument. Analysis is with a gas chromatograph containing a 30-foot molecular sieve column, thermal conductivity detectors and built-in calibration systems based upon (a) coulometric generation of 02 or N2 and (b) injection of air or standard gas mixtures. Measurements will be made using Nova's research vessel and ships of opportunity for studies away from the U. S. East Coast.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0093, CHEMICAL METHODOLOGY - APPLICATIONS OF NITRATE SPECIFIC ELECTRODE TO CHEMICAL OCEANOGRAPHY

Objective: To study and evaluate various methods for reducing or nullifying chloride interference on the nitrate specific ion electrode, thus making a useful analytical tool available to chemical oceanography.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

1.0094, DETERMINATION OF VOLATILE ORGANICS IN SEA WATER
J.F. CORWIN, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124

Preliminary work by this investigator (1959-1963) has shown the feasibility of the use of Gas Chromatography for the separation and identification of volatile organic compounds in sea water. The principal problems encountered were sensitivity of the instrumentation, suitable stationary phases of the columns and a suitable method of removing the volatile materials from the water. Improvements in instrument manufacture, development of a new stationary phase by U. P. Schlunegger (1965) and the headgas method of sample treatment indicates that the time is right for devising a good procedure for the analysis of low molecular weight organic content of sea water.

It is proposed to devote one year (sabbatical 1967-1968) to this problem. The success of this year will dictate the extent of effort to be devoted to the program in the future (after July 1, 1968). Dr. Corwin has been appointed Adjunct Professor by the Institute of Marine Sciences and has been offered space for the work.

SUPPORTED BY U.S. National Science Foundation

1.0095, THE GEOCHEMISTRY OF RADIOACTIVE ELEMENTS IN THE MARINE ENVIRONMENT - THE GEOCHEMISTRY OF LANDLOCKED SEAS
E. RONA, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124 (AT(40-1)2411)

The geochemistry of natural radioactive elements has been studied for several years at this Institute and elsewhere. Considerable contributions have been made in the use of radioisotopes for age determination and in the study of the geochemical conditions during and after the sedimentation process. Methods have been invented and some have been further developed. We are of the opinion that specific areas of investigation will result in answers to some of the remaining questions.

Ocean sediments and sea water may, in principle, be dated by the radiochemical determination of certain members of the naturally radioactive disintegration series. Thus, Th-230/Pa-231 ratios may be used for dating ocean sediments and radium concentrations for sea water. The purely technical problems of measuring the activities of the actual isotopes are considered to be reasonably well solved. Despite quite extensive previous research, the assignment of age values on the basis of activity measurements is, however, badly hampered by lack of knowledge of the geochemistry of these isotopes, e.g., their chemical distribution at zero, the possible chemical and physical processes that could affect the distribution at a later time.

We therefore propose to try a different approach to these problems by investigating the geochemistry of the elements of the natural uranium-thorium series in landlocked seas where chemical conditions will differ, in some case extremely, from those in the open seas. In this connection, we also propose to extend the study to include barium, since its chemistry is similar to radium. Also included will be a comparison between C-14 ages and the uranium-series ages of some of the materials.

SUPPORTED BY U.S. Atomic Energy Commission

1.0096, THE EXTRACTION OF POTASSIUM FROM FRESH AND SALINE WATERS BY CLAY MINERALS
C.E. WEAVER, Georgia Inst. of Technology, Water Resources Center, Atlanta, Georgia 30332

The general objective is to determine how and to what extent the chemistry (particularly potassium) of fresh and saline waters is controlled by clay minerals and gels, both in the laboratory and in natural environments. Using waters of various compositions, the ability of a variety of clay minerals to extract specific cations will be determined and the mean free bonding energies of the cations calculated. The release of interlayer clay water to the fluid will be measured and the factors controlling the return of adsorbed cations to the fluid phase as the chemistry of the water changes will be determined.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rech Georgia Institute of Technology
1. PROPERTIES OF WATER

1.0100. EXTENT OF BRACKISH WATER IN TIDAL RIVERS, MARYLAND

S.G. HEIDEL, U.S. Dept. of Interior, Water Resources Division, Baltimore - Towson, Maryland

This research is a part of the program of water resources investigations conducted by the U.S. Geological Survey in cooperation with the State of Maryland.

Purpose: To delineate the boundary zone between brackish and fresh water and provide information to permit maximum utilization of the water in the tidal portions of Maryland rivers.

Methods: Location of the saline water front in all the inland tidal areas of Maryland at varying conditions of tide and runoff and different seasons of the year will be determined through use of continuous conductivity recorders, periodic spot measurements of chloride concentrations and determination of river profiles of salinities. A comprehensive report will be prepared on the extent and variation of the salt water encroachment in surface waters on the basis of these field observations and available supplementary information.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey Maryland State Government

1.0101. MASS SPECTROMETRIC AND MANOMETRIC STUDIES OF THE OCEANS AND THE ATMOSPHERE

B.B. BENSON, Amherst College, Graduate School, Amherst, Massachusetts 01002

This research is a continuation of studies of dissolved gases which have great potential for the study of air-sea exchange phenomena, for the elucidation of processes occurring within the oceans, and for the determination of the past history of ocean waters. For this type of work very accurate dissolved gas measurements are required, and very accurate values for the solubilities of the gases must be known. Because the emphasis is on accuracy, the experimental procedures are described in detail.

During the first year, major activity will be focused on the determinations of the distilled and sea water solubilities of nitrogen, oxygen, and the five noble gases, since these are necessary for the correct interpretation of ocean data. At the same time, however, it is planned to complete and test sampling, processing and analytical equipment for the ocean measurements. The solubility work will be continued in the second year, but the emphasis will be shifted toward studies of the atmosphere and the oceans.

SUPPORTED BY U.S. National Science Foundation

1.0102. GEOCHEMICAL OCEANOGRAPHY

M. BLUMER, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543 (N00014-66-CD-0043)

Work will continue on isolation and structural identification of organic compounds of marine organisms, whose production appears to be controlled by environmental factors, using a combined mass spectrometer-gas chromatograph. The movement of these compounds through the food chain and into the water masses will be studied.

Knowledge of the natural background occurrence of organic compounds in the sea is fundamental to development of means of detecting changes resulting from operations such as occupation of underwater habitats.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0103. ORGANIC COMPOUNDS IN THE SEA AND IN MARINE SEDIMENTS

M. BLUMER, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543

Investigations will continue on the origin and fate of organic compounds in the sea and in marine sediments. Using techniques developed under an earlier grant, compounds of biochemical origin will be isolated from all components of the marine environment. Identification will be carried out by combined mass chromatography-mass spectrometry, and by nuclear magnetic resonance and infrared spectroscopy. Special emphasis will be placed on the study of biogenic hydrocarbons, lipids and selected polar compounds. The type and concentration of these comp-
1. PROPERTIES OF WATER

Pounds vary with the comparison of the plankton present in the water, with the time of the year, with the climate and with the history of the water mass. Thus, they should provide suitable tracers for the of dynamic processes in the ocean.

Selected derivatives of biochemical compounds will be isolated from deep marine, recent and ancient sediments. The structural constraints on these compounds and their eventual conversion products will provide insight into the molecular processes in the subsurface.

SUPPORTED BY U.S. National Science Foundation

1.0104, RADIOELEMENT STUDIES IN THE OCEANS - LANGHANDES IN SEA WATER AND THEIR INTERACTIONS WITH MARINE SEDIMENTS AND SUSPENSOIDS

V.T. BOWEN, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543 (AT(30-11))

Using activation analysis, individual lanthanides have been analysed in N. Atlantic sea water. Samples of N. Atlantic Deep Water (11), of Antarctic Bottom Water (3) and of Antarctic Intermediate Water (6) showed each water mass to have a characteristic and distinct profile of relative lanthanide element concentrations. Reported ACS Miami meeting 1967, and in press.

Carrier-free radioisotope studies show La, Y and Ce to react with standard clay minerals, marine sediments and open ocean suspensoids to give measurable and distinct F/C ratios on a gram per gram basis ranging from 1 to 100 for APS standard clay, from 20 to 100 for open ocean sediments, and from less than 20 to 40 for open ocean suspensoids. Analysis of geochemical and oceanographic implications of this data is in process.

SUPPORTED BY U.S. Atomic Energy Commission

1.0105, SIGNIFICANCE OF FLUORIDE VARIATIONS IN SEA WATER

P.G. BREWER, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543

Recent literature has indicated the presence of abnormally high fluoride/chlorinity ratios at depth in several stations in the North and South Atlantic Ocean. The source of the high fluoride has been tentatively assigned to volcanic activity associated with the Mid-Atlantic ridge. The research described in this proposal is intended to define the source of the fluoride and to determine its importance in understanding deep sea phenomena. We propose to develop a device to measure the fluoride/chlorinity activity ratio in situ and thus obtain a continuous record of the ratio with depth. During the Summer of 1968 the R/V CHAIN will make two crossings of the North Atlantic and the R/V ATLANTIS II a crossing of the South Atlantic. On each of these cruises we intend to obtain several profiles of the F/C ratio from the surface to the ocean bottom. The data obtained from these profiles will provide us with a measure of the extent of the fluoride enrichment with depth. Is this a localized phenomenon that may be associated with volcanic activity, or localized outcrops of fluorine rich minerals, or is it more widespread and possibly associated with the dissolution of particulate matter at depth? We also hope to obtain some indication of the value of the F/C ratio in tracing oceanic circulation at depth.

SUPPORTED BY U.S. National Science Foundation

1.0106, STABLE ISOTOPE STUDIES ON COEXISTING MINERALS IN MARINE SEDIMENTS

W.G. DEUSER, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543

A study will be made of the distribution of the stable isotopes of oxygen and hydrogen among coexisting minerals in marine sediments and of the fractionation between the minerals and the interstitial and overlying waters. Samples to be investigated include those collected in and around the ATLANTIS and DISCOVERY deeps of the central Red Sea which are characterized by high salinities and temperatures ranging from 40 to 60 degrees C. Cores taken contain numerous biologically identified minerals including various carbonates, oxides, sulfides and silicates, all of which appear to have formed syngenetically. Determination of the oxygen-isotope ratios in the different minerals and in the water samples coupled with the temperature measurements taken during sampling should reveal data on the mode of formation of the minerals. Knowledge of the water chemistry will aid in this effort. A comparison with the samples collected outside the hot deeps should reveal information on paleotemperatures and also on calcite-dolomite relationships at 20 degrees C. Additional determination of hydrogen-isotope ratios in hydrated minerals will serve as a further check on mode of formation and diagenetic changes of the minerals. A general study of hydrogen and oxygen isotope distribution as a function of depth in sediments will be made for individual minerals and mineral groups to determine the effect of diagenetic processes on isotope ratios.

SUPPORTED BY U.S. National Science Foundation

1.0107, ELECTROLYTE-NON-ELECTROLYTE INTERACTIONS IN SEA WATER AND RELATED SOLUTIONS

J.E. GORDON, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543

This is a continuing program in which the firm base provided by the thermodynamic measurements on simple salt mixtures is used to extend investigation of thermodynamic properties of dissolved organic non-electrolytes to more complex systems, approaching marine phenomena more specifically. These extensions require measurement on polar non-electrolytes, which represent the bulk of organic constituents of sea water and of compounds of biological interest. They also require a deeper study of solubilization phenomena. The proposed plan of research includes these studies, but places emphasis on the second topic of the original proposal, marine chemical applications of proton magnetic resonance spectroscopy. Results on this half of the program are not as far advanced as the thermodynamic work, due principally to time invested in establishment of the experimental proton magnetic resonance facility. Detailed plans for pursuing the proton magnetic resonance investigation of water in mixed salt solutions, of organic non-electrolytes in salt solution, and of aspects of the solubilization phenomenon, as well as employing the instrument in structure studies on organic compounds isolated from sea water—all with increased efficiency—are presented. One new topic of investigation is proposed—evaluation of the marine chemical potentialities of the formation of insoluble complexes of alkalai and alkaline earth metal salts on treatment of their aqueous solutions with liquid CBr2(CN)2. Suggested applications are removal or fractionation of sea salt and use in trace element determination.

SUPPORTED BY U.S. National Science Foundation

1.0108, STABLE ISOTOPES

J.M. HUNT, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543 (N00014-66-C0241)

Profiles will be made across the North Atlantic and South Atlantic, and C13/C12 ratios will be measured in both the dissolved organic carbon (DOC) and inorganic carbon (CO2). The DOC will be photo-oxidized by UV irradiation and the CO2 produced caught for analysis in the mass spectrometer. C13/C12 ratios in DOC will be compared with values already established for various components of marine life. Knowledge of distribution of natural variations of isotope ratios in sea water is an important prerequisite to evaluation of man-made variations resulting from test or employment of weapons or operations of vehicles. Program also contributes to overall understanding of mixing rates and turbulence in the ocean.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0109, DISTRIBUTION OF CARBON AND RADIUM IN THE ANTARCTIC WATERS

T. KU, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543

Woods Hole Oceanographic Institution will collect and analyze water samples from the southern oceans for several dissolved elements and gases. Samples will be taken on Eltanin
Crust 35 in the South Australia Basin of the Indian Ocean at 10 stations. Each station sample series will consist of ten 20-liter Niskin bottle samples, one from the surface and nine from predetermined depths. The concentration and isotopic composition of the dissolved inorganic carbon, and the partial pressure of carbon dioxide will help to identify surface water, as distinguished from Antarctic bottom water. The method using an infrared gas analyzer has been shown to be more accurate and sensitive as compared to the pH and alkalinity methods employed previously on other research projects. The determination of dissolved oxygen, and the ratio of carbon-12 to carbon-13 of the dissolved inorganic carbon, will help to better understand the oxidative processes of the organic compounds present. The heavy radioactive metals, radium and uranium, will also be determined for various depths in order to evaluate the role played by the biota in the vertical distribution of heavy elements in the water column.

The shipboard collecting and analyses will be carried out by a marine geochemist from Lamont Geological Observatory. No personnel from WHOI will be on board the Eltanin during Crust 35.

SUPPORTED BY U.S. National Science Foundation

1.0110, ANALYSIS OF SEA WATER BY DIFFERENCE CHROMATOGRAPHY
P.C. MANGELSDORF, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543 (AT(30-1)3838)

The objective of this research is to use the method of ion exchange difference chromatography to study slight variations in the proportions of major elements in sea water. The method in its present form has been shown to be sensitive to differences in the K plus/Na plus and Cs plus/Na plus ratios in sea water of the order of one part in 10 to 5th power. We will attempt to increase the sensitivity by a factor of 10 in the expectation that well-defined reproducible variations of these and other ratios can be found in water samples from various sources. In particular we are interested in the vertical variations of composition in the deep sea water column, in the effects of run-off on the salt composition of coastal waters, and in the composition in interstitial waters trapped in recent sediments.

SUPPORTED BY U.S. Atomic Energy Commission

1.0111, ORGANIC MATTER
D.W. MENZEL, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543 (N00014-66-C0251)

Water will be sampled on a cruise from North to South Atlantic and then across the South Atlantic to determine relationships between dissolved organic carbon (DOC) and oxygen depletion in the water masses. Samples will be closely spaced (50 m.) in regions of oxygen and salinity minima. Nitrate and phosphate will also be determined. Significance of dissolved oxygen as a conservative property will be evaluated.

A study to be made of the origin, distribution, composition and fate of the particulate matter in the sea, with emphasis on the non-living organic material (i.e., detritus). Major emphasis will be placed on determining the flux of this material through the marine ecosystem by investigating its relationship to primary and secondary organic production, its rate of decomposition, its seasonal, geographical, and vertical distribution in the sea, and its rate of sinking and decomposition on the bottom. The ecological significance of the particulate matter will also be investigated with respect to its ability to scavenge dissolved organic matter by surface adsorption, its role in providing a surface for bacterial growth, and its value as food, both directly and indirectly through the use of organic matter adsorbed to or growing on its surface. The possibility that detritus in the deep-sea represents a stable, refractory, and neutrally buoyant reservoir of organic matter, as indicated by recent evidence, will be examined in detail through intensive distributional studies, laboratory experimentation, and isotopic dating techniques.

SUPPORTED BY U.S. Atomic Energy Commission

1.0113, ELEMENT CHEMISTRY
D. SPENCER, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543

The purpose of this task is to determine the distribution and concentration of dissolved metals in the oceans. The work involves careful sampling from ships, to avoid contamination, and subsequent analysis in the laboratory using atomic absorption spectroscope.

Knowledge of the natural background levels of concentrations of metallic ions in sea water masses is fundamental to the development of means of monitoring man-made changes in these levels through military or industrial activity.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0114, HETEROOTROPHIC ACTIVITY AND PRIMARY REGENERATION IN THE OCEAN
R.F. FACINARO, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543

The amount of surface oriented dissolved organic carbon in the ocean is relatively large in terms of the remainder of the water column and varies according to the rate of biological recycling. Within photic depths both labile and refractory forms of carbon are prominent since organic reproduction and degradation proceed simultaneously. At intermediate depths further decomposition may occur following sinking and the advective transport of particulate organic residues but ultimately throughout the remaining and deeper portions of the water column dissolved organic carbon remains remarkably constant. Inability in the part to demonstrate significant biochemical oxidation within the deep ocean suggests that most of the organic material is present in a refractory form capable of prolonged resistance to biological decomposition.

The bulk of this deep refractory organic carbon appears in the form of macromolecules believed to be structured on linkages provided by polyphenols, quinones or amino acids. In this regard our current efforts include a shipboard application of charcoal adsorption designed to fractionate and quantitatively evaluate the importance of residual carbon in the ocean. Observations so far completed include a transtlantic crossing from Barbados to the Cape Verde Islands as well as sampling in the deep and shallow waters of the Gulf of Mexico proximal to the Yucatan Peninsula. The pattern emerging is that between 70 to 90 percent of the deep dissolved organic carbon at midoceanic locations is present as organic condensates which appear to occupy a quasi-terminal position in the organic cycle of the sea. At river outlets, in coastal waters, and in adjacent seas such as the Gulf of Mexico, the fraction of residual organic material is significantly less.

SUPPORTED BY U.S. National Science Foundation

1.0115, CHEMISTRY OF THE HYPOLIMNION OF LAKE ERIE
H.E. ALLEN, U.S. Dept. of Interior, Biological Laboratory, Ann Arbor, Michigan

During the period of summer stratification much of the hypolimnetic water in Lake Erie experiences severe oxygen depletion. Concurrent large changes occur in the concentration of nitrate, ammonia, phosphate, iron, manganese, and sulfide. Our objectives include describing the magnitude and rate of these changes, determining the chemical processes involved and determining the effects of these changes on the ecosystem. Subsequent to fall overturn concentrations of these materials return...
1. PROPERTIES OF WATER

To those concentrations existing prior to stratification. Field studies are being made to determine the concentrations of these and other substances in the waters. Laboratory studies are being conducted to determine the oxidation-reduction potential at which materials are released from the sediments and to determine the kinetics of their buildup in the water. The chemical composition of materials precipitated upon overturn is being investigated. Various sediments are being investigated to determine the substances responsible for oxygen depletion.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

1.0116, CHEMICAL CHARACTERISTICS OF THE GREAT LAKES
J. F. CARR, U.S. Dept. of Interior, Biological Laboratory, Ann Arbor, Michigan

The long-range objectives are to gain an understanding of the cycles of the major nutrients in the Great Lakes and connecting waters and their influences on the productivity of the lakes. Objectives are to demonstrate the vertical, horizontal, and seasonal variations in water quality in various habitats of the lakes. Routine determinations are being made on a variety of Great Lakes waters for sodium, calcium, magnesium, potassium, sulfate, chloride, silica, alkalinity, pH, dissolved oxygen, and total phosphorus.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

1.0117, MINERAL-WATER CHEMISTRY, GREAT LAKES
J. R. KRAMER, Univ. of Michigan, Great Lakes Research Division, Ann Arbor, Michigan

Great Lakes chemistry, relative to major ions, is evolved from a time independent invariant chemical equilibrium model(s). The ability to rigorously define these models rests upon knowing free energy expressions for the specific minerals and aqueous ligands, the crystallography and stoichiometry of the minerals, and the in situ chemistry of the Great Lakes.

Solution equilibrium among end member solid phases permits determination of free energy of formation of the common minerals. This procedure is applied to synthetic simple composition minerals and naturally occurring minerals. Equilibration is considered attained when identical results are achieved for different paths of equilibration.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol.Ctl

1.0118, MINERALOGICAL CONTROLS ON THE CHEMICAL COMPOSITION OF OCEAN WATER
H. L. HOLLAND, Princeton University, Graduate School, Princeton, New Jersey 08540

Although it is almost certain now that the chemical composition of ocean water is strongly influenced by reactions of ocean water with silicate minerals, the nature and the geography of these reactions are very inadequately known. This grant is for the study of the interaction of clays with ocean water in the field and in the laboratory.

Preliminary work in the vicinity of Puerto Vallarta, on the Pacific Coast of Mexico, has shown that a good deal of the area is underlain by rhyolites and andesites and that essentially none of the clays in soils and in the rivers is inherited. It is intended to study the mineralogy of soils in this area, the chemistry of at least one of the rivers from its source to its estuary, the mineralogy of river sediments, and the mineralogy of sediments in estuaries and just offshore.

At the same time it is planned to do some exploratory work on the fate of iron which is brought to the Atlantic Ocean in great abundance by a number of New Jersey rivers. There is some evidence that Fe2O3.nH2O reacts to form silicates containing abundant Fe3+ during the diagenesis of marine sediments, which makes it desirable to see how much and how rapidly iron-rich clay is formed in near-shore environments.

SUPPORTED BY U.S. National Science Foundation

1.0119, OXYGEN RESOURCES OF TIDAL WATERS
J. P. BARLOW, State University of New York, Agricultural Experiment Sta., Ithaca, New York 14850

The objective of this project is to evaluate the potential sources of oxygen in tidal waters which may be subjected to organism pollution. The study is presently concerned principally with regions in which horizontal exchanges are so restricted that the ocean is a relatively minor source compared with plant photosynthesis and atmospheric reaeration. Photosynthetic production of oxygen will be evaluated by means of direct experimental methods, and atmospheric reaeration from an analysis of time-changes in concentration effected by diurnal changes in biological processes. It is hoped thereby to obtain some understanding of the influence or hydrographic and biological factors on the reaeration of these regions.

SUPPORTED BY New York State Government

1.0120, INVESTIGATIONS OF URANIUM AND THORIUM SERIES ISOPTOE DISEQUILIBRIUM IN THE OCEAN AND IN PLEISTOCENE SEDIMENTS
W. S. BROECKER, Columbia University, Graduate School, Palisades, New York 10964 (AT(30-1)3139)

This research is primarily a study of the conditions which bring about disequilibrium among the isotopes of the U and Th series in nature with an eye toward developing methods of age determination. Thus we are trying to date water masses by studying the distribution of Ra-226, Th-228, Pb-210, Po-210 and Ra-226, oceanic sediments by measuring Th-230 and Pa-231 and plutonium lake salts and volcanic ashes by measuring Th-230, Th-232 and uranium. At the same time, these studies lead to a better understanding of the geochemical behavior of these elements. By applying these methods we are trying to answer the following questions of importance to earth science: 1) what is the source of the high concentration of unsupported Ra-226 in ocean water? 2) is the distribution of Pb-210 surface ocean water controlled by the input of atmospheric Pb-210? 3) do the times of the sharp cold to warm climate changes as seen in deep sea sediments support the astronomical theory of glaciation? 4) how is the timing of pluviation related to the time of glaciation?

SUPPORTED BY U.S. Atomic Energy Commission

1.0121, GEOCHEMICAL STUDIES OF CONTINENTAL WATERS
W. S. BROECKER, Columbia University, Graduate School, Palisades, New York 10964 (AT(30-1)2495)

The purpose of this research is to gain an understanding of the factors controlling the major element chemistry of continental waters. We are contrasting the chemistry of three closed basin saline lakes, a sulfate-rich meromictic lake, and its associated ground waters, two fresh water lakes, lake within active volcanic regions and subsurface waters in an island coral cap. Measurements of the major elements, pH, and pCO2 are being made on the lake waters, river and ground waters supplying the lakes, and pore waters extracted from the lake sediments. Stable and radioisotopes (C-14, C-13, Sr-90, Cs-137, Rn-222, ... ) provide useful means of tracing sources and determining residence times. The origin of the detrital and authigenic phases in the sediments is also being studi

A report regarding our study of Green Lake is in press (Limnology and Oceanography). Preliminary reports on our saline lake studies appear in this years Project Report.

SUPPORTED BY U.S. Atomic Energy Commission
1.0122. MINERALOGICAL STUDIES OF PARTICULATE MATTER SUSPENDED IN SEA WATER

RCOGS, Columbia University, Graduate School, Palisades, New York 10964

The purpose of this study is to establish the mineralogical and chemical nature of particulate matter suspended in sea water. A world-wide sampling program was carried out in its second year. The differences have produced surface and deep sea water samples of suspended particulate matter, along with samples of corresponding bottom sediment. X-ray diffraction and spectrographic techniques will constitute the principal analytical procedures to yield mineralogical and chemical data for suspended particulate matter in ocean water.

Little is known about the nature of the mineral particles suspended in sea water; even quantitative information of the most basic nature is wanting. Although most of the mineral content of suspended particulate matter has been derived from the weathering of land masses, there is a possibility that an authigenic component of significant magnitude forms within the sea. It is significant to understand the relative importance of these two components. Also, information is needed regarding the changes the land-derived minerals undergo in sea water, as well as their settling times. A widespread layer of cloudy water near the ocean bottom has been discovered, and there is a possibility that this represents an additional means of transport for large quantities of sediment.

SUPPORTED BY U.S. National Science Foundation

1.0123. DISSOLVED ORGANIC PHOSPHORUS IN NATURAL WATERS

EJ. KUENZLER, Univ. of North Carolina, School of Public Health, Chapel Hill, North Carolina 27514 (AT(40-1))

The objectives of this proposal are to continue seeking techniques for identification of the major components of the dissolved organic phosphorus (DOP) pool in natural waters, to investigate the seasonal distribution of DOP compounds, and to examine the nature of the DOP eliminated into the medium by cultures of planktonic algae. The geographical and seasonal changes in total DOP are partially known but the chemical compounds making up these pools are completely unknown. Prior work has shown that the DOP present in natural sea waters consists of several important components. The DOP eliminated by healthy algae in pure culture also consists of several components but it is not yet known whether these are the same as occur in natural waters. This project began in 1965 and should be completed in 1970. To date methods have been developed for concentrating, purifying, and separating organic phosphorus compounds from natural waters and from unalgal cultures. Radioactive phosphate in culture media is taken up by algae and partially eliminated as labeled DOP. This permits measurement of rates of DOP elimination under various environmental conditions. The next steps are the final identification of these compounds, the delineation of their spatial and seasonal distributions, and investigation of their ecological significance.

SUPPORTED BY U.S. Atomic Energy Commission

1.0124. STRONTIUM ISOTOPE COMPOSITION AND TRACE ELEMENT CONCENTRATIONS IN LAKE HURON AND ITS PRINCIPAL TRIBUTARIES

G. FAURE, Ohio State University, Graduate School, Columbus, Ohio 43210

Concentrations of the major cations: Na, K, Ca, and Mg and Sr were determined for 64 samples of surface water from Lake Huron and for 17 of its major tributary rivers. For addition, isotopic compositions of strontium were measured for 30 samples of lake water and for 13 of the tributary rivers. Concentrations of dissolved iron and total phosphorus were determined for a small suite of lake and river water. The data documents important differences in the chemical composition of water discharged into Lake Huron by Lake Superior, Lake Michigan and tributary rivers. These differences are related to differences in the chemical and mineralogical composition of the bedrock underlying the Great Lakes drainage basin.

1. PROPERTIES OF WATER

The strontium contributed to Lake Huron by water draining the Canadian Shield along its northern shore is enriched in radiogenic Sr87. The average Sr87/Sr86 ratio is 0.718. The rivers draining sedimentary rocks of Michigan and southwestern Ontario contribute strontium whose isotope composition is similar to that in the modern oceans and has a Sr87/Sr86 ratio of 0.710.

A geochemical model is presented which attempts to represent the chemical composition of water in Lake Huron as a mixture of the different types of water discharged by different sources.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rch Ohio State University

1.0125. CHEMICAL FEATURES OF THE SUBARCTIC BOUNDARY IN THE NORTHERN PACIFIC OCEAN

K. PARK, Oregon State University, Graduate School, Corvallis, Oregon 97331

It is proposed to study the chemical features of the unique oceanographic phenomenon in the North Pacific, the confluence of Subarctic and Subtropic waters. The four specific objectives are: (1) Chemistry of the subarctic boundary - to investigate the chemical make-up and history of the Subtropic and Subarctic waters near the Subarctic Boundary. The data arising will help to understand the nature and mixing of the two water masses as they move eastward from near Japan. (2) Deep-sea chemical properties near the Subarctic Boundary - to study the deep-sea gas nutrient interrelationships underneath the Subarctic Boundary. (3) CO2 Sink near the Subarctic boundary - to learn about the air-sea exchange of CO2 over both the Subarctic and Subtropic regions. (4) Chemical reference for hydrochemical data from the Subarctic boundary - to establish a reference to intercompare the hydrochemical of Japan, U.S.S.R., Canada, and the U.S. already obtained from the Subarctic boundary region. Three cruises are planned for the study. The first cruise is for a study of the microstructure of the boundary; the second to establish a chemical-conditions reference for winter; and the third is for an intensive study of the entire Subarctic boundary region from near the west coast of the U.S. to Japan. These studies will contribute to the national oceanographic program by providing important information for an understanding of the complex features of the North Pacific.

SUPPORTED BY U.S. National Science Foundation

1.0126. CHEMICAL PROPERTIES OF SEA WATER AND THEIR USE IN STUDIES OF WATER MASSES AND MIXING

R. PYTKOWICZ, Oregon State University, Graduate School, Corvallis, Oregon 97331

Objective: The increasing use by the Navy of relatively permanent surface, subsurface, and bottom-mounted installations in both its R&D and its operational activities requires a better understanding of the chemically corrosive environment in which these activities occur. This research is providing fundamental information on the chemical properties of sea water in the NE Pacific, on the variability of these properties in space and time, and on the chemical changes across the air-water and water-sediment interfaces. In addition, this same information is being used in studies of water mass movements, and diffusion and mixing processes.

Approach: Shipboard field-observation programs will be carried out to determine the distributions and concentrations of carbon dioxide, oxygen, phosphates, nitrates, and silicates during the winter months when upwelling is absent and again during the spring and summer when upwelling is present. The amount of dissolved gas in the upwelled water mass should be a distinctive property and will be used to trace the downward and seaward motion of this water mass after it leaves the upwelling area.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0127. RESEARCH ON THE PHYSICAL CHEMISTRY OF CHEMICAL REACTIONS IN SEA WATER

R.M. PYTKOWICZ, Oregon State University, Graduate School, Corvallis, Oregon 97331
I. PROPERTIES OF WATER

A study will be made of the application of the newly determined apparent dissociation constants of phosphoric acid in seawater to revise existing data on the solubility of apatites and to compare these data with ionic products in the oceans.

The determination of the apparent dissociation constants of carbonic and boric acids will be extended to 1,000 atmospheres and 0 degrees C.

A study will be made of the solubility and rates of solution of foraminifers in sea water as a function of pressure to verify earlier data on simpler solid phases and to better understand the compensation depth.

Complexes formed by ions in seawater will be studied over ranges of temperature and pressure that reproduce conditions found in the oceans. Initial emphasis will be on sulphate complexes and, if time permits, bicarbonate and carbonate complexes will also be studied.

SUPPORTED BY U.S. National Science Foundation

1.0128, MARINE BIOLOGY PROGRAM
F.G. LOWMAN, Univ. of Puerto Rico, U.S. Aec Pu. Ri. Nucl. Ctr., Mayaguez, Puerto Rico

In this program, begun at PRNC in Jan. 1962, the distribution and movements of trace elements is being studied in restricted but complete ecological and biogeochemical systems in river basins and offshore along the western coast of Puerto Rico. The program is concerned with coordinated investigations of selected trace elements, with analyses; concentration factors in selected organisms for particular radionuclides; the marine ecosystem; biological productivity; studies of the physical, chemical, and geological oceanography of the west coast of Puerto Rico, and distribution patterns of rare earths in the Anasco River watershed, the neighboring marine waters, the organisms and sediments.

Published results include papers on stable scandium as determined in sediments, soils and minerals by neutron activation analysis; distribution of trace elements in the marine environment; effects of river outflow on the distribution pattern of fallout radionuclides in marine organisms; distribution and partitioning of Fe, Zn, Se, and Sm within the benthic community of Anasco Bay. P.R.; trace element composition in inshore and offshore populations; uptake of Zn65 by marine algae, etc.

SUPPORTED BY U.S. Atomic Energy Commission

1.0129, CHEMICAL OCEANOGRAPHY
J.T. CORLESS, Univ. of Rhode Island, Graduate School, Kingston, Rhode Island 02881 (NONR)

This task involves studies in the following areas of chemical oceanography: (1) rare earth geochemistry to provide insight into mechanisms of sea floor evolution; (2) trace elements content of seawater and phytoplankton; (3) organic phosphate substances in sediments and biochemical equilibrium of allicine; (4) effect of pressure on biochemical processes. Trace element concentrations in seawater give promise as a tool for understanding the circulation and dispersion of materials in the oceans. The fraction of these elements in inorganic and in bound forms needs to be understood if full advantage is to be taken of this tool as a water mass tracer. The pressure effects on biochemical processes are pertinent to the Navy's saturated diving programs such as 'Man-in-the-Sea.'

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0130, AN INVESTIGATION OF TRITIUM IN RAINWATER
E. ERIKSSON, Stockholms Universitet, Stockholm, Sweden (AT(30-1)2458)

The objective of the proposed work is to continue the study of the meteorological factors which influence the distribution in time and space of tritium in rainwater and in atmospheric moisture.

The scientific background to this problem is the observed fact that the distribution of tritium in precipitation differs substantially from that of Sr90 although at present their sources are common. This difference can be expected because tritium appears as a part of the water molecule and may be taken advantage of as an aid in understanding certain parts of the circulation of water in nature.

The procedure to be adapted is to collect all available data and study their geographical distribution at various times and further, if possible, to relate this distribution to the transport pattern of atmospheric water vapor. Further, to aid the interpretation, studies of the vertical distribution of tritium in atmospheric moisture will also be carried out, both in continental environment and in maritime environment.

So far, it has been concluded from past years' studies that a considerable transfer of tritium from the atmosphere to the oceans takes place through mass exchange between the sea surface and the atmosphere and that this transport is about two times larger than the transport by precipitation. This mass exchange which does not apply to e.g. Sr90 explains in a qualitative way the present geographical pattern of tritium in precipitation.

SUPPORTED BY U.S. Atomic Energy Commission

1.0131, CHEMICAL OCEANOGRAPHY
E.R. IBERT, Texas A & M University System, Graduate School, College Station, Texas 77843 (NONR)

This task involves studies into the methods of recovery, analysis, and age dating of dissolved and particulate, organic matter in the Gulf of Mexico and Caribbean, leading to determinations of its origin, distribution, and fate. Efforts include the extraction of organic carbon from seawater aboard ship in quantities sufficient for carbon-14 age determinations.

Organic materials in sea water are responsible for surface films and it is becoming evident that these compounds have a finite influence on many of the inorganic chemical reactions taking place in the oceans. This program will provide basic information necessary to the understanding of these phenomena.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0132, STABLE CARBON AND OXYGEN ISOTOPE RATIO VARIATIONS IN THE FLOW TO CARBON AND OXYGEN THROUGH NORMAL AND POLLUTED AQUATIC SYSTEMS
P.L. PARKER, Univ. of Texas, Graduate School, Port Aransas, Texas 78373

The main goal of the proposed research is to develop ways to use measured variations in stable carbon and oxygen isotope ratios to solve problems concerning the flow of these elements in aquatic systems. By investigating both normal and polluted systems a better understanding of both will result. Rivers, lakes and marine bays are aquatic systems which would be studied. However, single species of organisms, sewage systems and industrial plants also have a flow of carbon and oxygen and would be suitable for study.

In addition to the stable isotope studies the total amount of dissolved and particulate organic matter in area waters will be investigated. The organic geochemical studies which have been conducted here for the past three years will be continued.

SUPPORTED BY U.S. National Science Foundation

1.0133, PHYSICAL AND RADIOLOGICAL CHEMISTRY OF OCEAN SOLUTIONS
R.W. PERKINS, Battelle Memorial Institute, Richland, Washington 99352

The many radionuclides from fallout, cosmic ray spallation, reactor waste disposal and natural sources, although at extremely low concentrations, are excellent tracers for physical studies of the oceans. Hanford techniques of sufficient sensitivity are available. When combined with neutron activation analysis, these make possible studies of the tracers present in oceans and the reactions in which they participate. The chemical processes in the oceans, the existing chemical equilibria, and the reaction rates and mechanisms will be studied. The behavior of fallout material and of low level radioactive tracers will be clarified. The various forms - ionic, colloidal, chelate, particulate, or incorporated into...
biological material will be determined. Automatic equipment will be installed and used on oceanographic research ships.

Studies of radionuclide and trace element concentrations, physical and chemical forms were made on the Oregon coast and across to Hawaii, Mn-54, Co-60, Ru-106, Cs-137 and Ce-144 increased two-to threefold in the first half of the voyage then decreased to about one-half of the west coast concentration at Hawaii. Cs-137 up to 500 miles off the California coast showed relatively uniform surface concentrations dropping to 2 to 3% at 300 meters. A study of contamination associated with sampling led to improved techniques; an all-plastic sampler was built. Trace elements were simultaneously determined in organisms by neutron activation and multidimensional gamma-ray spectrometry. Squid and lantern fish concentrate Ag. Neutron activation proved useful for trace elements in deep sea sediment.

SUPPORTED BY U.S. Atomic Energy Commission

1.0134, CHEMICAL OCEANOGRAPHY
T. JOYNER, U.S. Dept. of Interior, Biological Laboratory, Seattle, Washington 98102
Phase I. Development and evaluation of techniques for the measurement of trace elements in sea water and marine organisms.

Phase II. Application of trace element measurements to the detection of heterogeneity in water masses and the determination of the patterns of circulation and mixing in coastal and oceanic waters.

Phase III. Evaluation of the effects of variations in environmental proportions of trace elements on the production and ecological organization of marine life. This will be based upon (1) controlled experimentation in laboratory cultures and (2) direct observations made at sea.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

1.0135, STUDIES OF OXYGEN-FREE, SULFIDE-BEARING MARINE ENVIRONMENTS
F.A. RICHARDS, Univ. of Washington, Graduate School, Seattle, Washington 98122
The observations will be designed to elucidate the following unique features of anoxic environments: (1) Denitrification, with the removal of nitrate and nitrate ions and the production of N2; (2) Sulfate reduction, with the production of sulfides and other reduced forms of sulfur and the occurrence of low redox potentials; (3) Anoxic fermentation with the production of methane and possibly other hydrocarbons and hydrogen; (4) Extraordinarily large concentrations of carbonates in solution, high alkalinity values and low pH values; (5) The accumulation and preservation of relatively large concentrations of organic matter in the sediments, which are not reworked because benthic organisms are eliminated by the sulfides; and (6) The maintenance in solution or the authigenic precipitation of metals and metal sulfides.

Laboratory studies will be carried out to investigate (1) A stoichiometric model for the decomposition of organic matter in the sea in general and especially in anoxic environments; (2) A mathematical model for the vertical distribution of organic decomposition products, of sulfides, and dissolved oxygen which accounts for interactions between sulfides and oxygen; (3) The effects of the conditions in these environments on the alkaline components; (4) The kinetics of reactions between solutions of oxygen and sulfides, and (5) The effects of sulfides and low oxidation-reduction potentials on the solubility of metals and their solid phases.

SUPPORTED BY U.S. National Science Foundation

1.0136, CHEMICAL STUDIES OF THE OCEANIC ENVIRONMENT
F.A. RICHARDS, Univ. of Washington, Graduate School, Seattle, Washington 98122 (NONR)
Objective: The Navy's man-in-the-sea activities and underwater development of systems and equipment require fundamental knowledge of the occurrence in the sea of reducing substances, toxic gases and trace metals in order to be able to understand and predict their effects on both man and objects. This investigation of the chemistry of the Pacific Ocean includes the chemical tracing of water masses; the chemical control on the biological regime and its effects on plankton and other sound scattering organisms; the chemistry of oxygen-deficient environments; and the chemistry of trace metals observed in a variety of environmental influences.

Approach: This is a field and laboratory investigation to determine and explain the distributions of the chemical constituents of sea water. Both quantitative and qualitative analyses are being made of water samples collected from different oceanic areas. Comparisons are being made of the waters off the Washington and Oregon coasts where the Columbia outflow and upwelling occurs and in contrasting biologically poor and rich ocean regions of the North America and Peru. The study of water in the Peru Trench and Mexican Trough is being measured as a means of determining age, transport, rate of replenishment and exchange of these waters.

SUPPORTED BY U.S. Dept. of Defense - Navy

1. PROPERTIES OF WATER

periods, thereby providing measurements of one key environmental parameter.

This work is concerned with the interpretation of measurements of electric and magnetic signals which are caused by oceanic flow. The effort mainly consists of a series of related field experiments in order to obtain continuous information about the flow between widely spaced current meters, electrodes are being developed for attachment to the same moorings as the current meters. The potential difference between electrodes gives a measure of the volume of water flowing between them. Using electrodes attached to a submarine cable crossing the Florida Straits, sure of the volume of water flowing between widely spaced current meters, electrodes are being experiments. In order to obtain continuous information about the oceanic flow. The effort mainly consists of a series of related field measurements of electric and magnetic signals which are caused by periods, thereby providing measurements of one key environmental parameter.

It is expected that this information will aid developing a predictive model of this flow.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0140. CRITICAL TABLES ON THE ELECTROCHEMICAL PROPERTIES OF INTERFACES

J. LYKLEMA, Landbouwhogeschool, Wageningen, Netherlands

The properties covered in this project are the capacitance or charge of the electrical double layer, electrocapillarity curves, electrokinetic properties such as electrophoretic mobilities, streaming potentials and electroosmosis; c) points of zero charge. The data will be critical reference data of wide use in the study of natural and manufactured colloidal systems and of interfaces in electrolytic solutions such as seawater.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

1D. GENERAL AND MISCELLANEOUS PROPERTIES

1.0141. OCEAN DYNAMICS IN THE STRAITS OF GIBRALTAR AND ADJACENT AREAS

T. LAVASTU, U.S. Navy, Postgraduate School, Monterey, California 93941

To determine those environmental factors affecting acoustical uses of the ocean; to categorize strategic areas into similar acoustical provinces. To provide scientific background knowledge for improvement of synthetic oceanographic analyses/forecasting models which provide environmental support to submarine and anti-submarine warfare forces. Study tidal, synoptic, seasonal and secular changes in oceanographic conditions in the Strait of Gibraltar and adjacent seas and make a dynamic computerized model. Procure all available hydrographic data from the area in cooperation with the Spanish Oceanographic Institute (SOI) and analyze at FNWF using existing computer programs. To monitor the flow into and out of the Mediterranean by measuring the potentials in telephone cables across the Strait.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0142. OCEANOGRAPHIC RESEARCH

E.C. LAFOUD, U.S. Navy, Undersea Warfare Center, San Diego, California 92140

Objective: To determine those environmental factors affecting acoustical uses of the ocean; to predict the effects of variability in properties of the surface layers of the sea affecting salinity, sound speed, microbubbles, gas content. Chemical and Biological (except sound scattering) factors, water motion (orbital, tidal, turbulence, internal waves) and other dynamic processes; to observe acoustically and modulate underwater sound propagation using deep ocean water paths including near-bottom phenomena.

Approach: Collect physical oceanographic data over depth-time and space using the NUWC Oceanographic tower, buoys, ships, airplanes, deep submersibles and bottom mounted equipment to investigate the nature of changes in thermal structure, water density, velocity and motion as related to underwater acoustics; obtain descriptive and statistical relations between thermistor chain data and geographic location, depth of water, tide currents, upwelling, island wakes, water masses, storms, seasonal and biological growth data; conduct deep sea expeditions and joint investigations with other nations.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0143. OCEANOGRAPHIC RESEARCH - INVESTIGATIONS WITH THERMISTOR CHAIN

O.S. LEE, U.S. Navy, Undersea Warfare Center, San Diego, California 92140

Objective: To determine those environmental factors affecting acoustical uses of the ocean. Observe and develop theory models for predicting underwater sound propagation using deep ocean water paths. Develop theory to predict water motion, especially internal waves in the deep ocean.

Approach: Obtain descriptive and statistical relations between thermistor chain data and geographic location, depth of water, tide, currents, upwelling, island wakes, water masses, storms, season and biological data; conduct deep sea expeditions and joint investigations with other nations and activities.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0144. SEAWATER/SEDIMENT/BIOLOGY MONITORING PROGRAM

W.A. ANIKOUCHINE, Oceanographic Services Inc., Santa Barbara, California 93105

0ONO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY Continental Oil Company

1.0145. DETERMINATION OF EQUATION OF STATE, VISCOSITY AND COMPRESSIBILITY OF SEA WATER

W. DROSTHANSEN, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124 (NONR)

Objective: A fundamental understanding of the physical chemistry of sea water and its physical properties is necessary to support the development and use of oceanographic instruments in Navy surveys, in more accurately determining ocean current structure from mass distributions, in understanding acoustic propagation influencing detection and communication systems, and operating machinery and equipment in naval underwater facilities. The aim of this project is to develop an accurate equation of state for sea water and obtain a better understanding of the structure of sea water mixtures.

Approach: The viscosity and isothermal compressibility of sea water are being measured as functions of temperature and salinity. Laboratory experiments are being conducted covering a range of temperature from 0 to 40 degrees centigrade; salinity from 0 to 40 parts per thousand; and pressure from One to 50 atmospheres. Artificial sea water of varied salinity is being investigated first, followed by actual sea water samples from a variety of geographic regions.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0146. SHALLOW WATER OCEANOGRAPHY (SEALAB III)

G.B. DOWLING, U.S. Navy, Mine Defense Laboratory, Panama City, Florida 32401

Objective: To determine those environmental factors affecting undersea uses of the ocean. Investigate shallow water parameters affecting MAIN-IN-THE-SEA including SEALAB support.

Approach: Conduct physical oceanographic experiments with an inhabitant of SEALAB III. Emphasis is placed on use of instrumentation and the recording of useful quantitative data utilizing the judgment and flexibility provided by an in-situ scientist.
1.0147. HYDROGRAPHY OF APPALACHEE BAY
K. Warsh, Florida State University, Graduate School, Tallahassee, Florida 32306

Measurement of the physical environment of the Florida State University Marine Laboratory on Appalachee Bay. Monitoring of currents and salinity and temperature changes in the bay, winds, rainfall, tides, and solar radiation.

SUPPORTED BY Florida State University

1.0148. STUDY OF THE UPPER CHESAPEAKE BAY
G.R. Seckel, U.S. Dept. of Interior, Bureau of Commercial Fisheries, Honolulu, Hawaii 96812

Theory shows that processes which determine the temperature and salinity, directly affect their rate of change. At any location, the annual variation of these processes, the net heat exchange across the sea surface and processes associated with water motion (advection and diffusion), is characteristic of that location. Hence, at such a location the rate of change of temperature and salinity also varies in a characteristic manner during the year.

A first approximation of the processes which determine the temperature and salinity in the Hawaiian Islands area has been made (Seckel, 1962, Fish. Bull. 193). It is therefore possible to interpret variations in the rate of change of temperature and salinity at Koko Head, Oahu, in terms of changes in the annually repeating processes which are characteristic of Hawaii.

To refine this method, the seasonal variations of water types, defined by temperature and salinity, are monitored on a continuing basis and will be linked with results of project 131.8G, 'Analyze and publish basic data from pilot study (analytic studies).'

On the basis of the first order approximation, temperatures and salinities monitored at Koko Head, Oahu, are used to predict a favorable or unfavorable environment for skipjack fishing in Hawaii.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

1.0149. PHYSICAL PROPERTIES OF SEA WATER AT PRESSURE
E.M. Stanley, U.S. Navy, Ship Research & Dev. Center, Annapolis, Maryland

Objective: To determine those environmental factors affecting undersea uses of the ocean. Investigate pressure effects on the physical properties of sea water for use in design of heat exchangers, submersible motors, speed reducers, and in deep submergence problems.

Approach: Investigate the physical properties of seawater including viscosity and thermal conductivity as affected by pressure. Special equipment and the Laboratory's high pressure facility will be used, for instance a rolling ball viscosimeter has been adapted for operation under pressure pending completion of the high pressure facility.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

1.0150. PHYSICAL AND CHEMICAL CHARACTERISTICS OF THE UPPER CHESAPEAKE BAY
W.N. Shaw, U.S. Dept. of Interior, Biological Laboratory, Oxford, Maryland

Physical characteristics (temperature, current speed and direction, tidal fluctuations, exchange rates and volumes) of local waters and in large man-made salt water ponds are being and will be determined. Chemical characteristics (salinity, oxygen, phosphate, nitrate, etc.) of local waters and in artificial ponds are being and will be determined. Chemical and physical factors of bottom sediments in natural waters and in artificial ponds will also be determined. Information provides baselines to evaluate effects of environmental extremes on commercial shellfish in natural waters and in laboratory experiments.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

1.0151. OCEANOGRAPHIC RESEARCH
A.T. Jaques, U.S. Navy, Ordnance Laboratory, Silver Spring - White Oak, Maryland

To study the oceanographic environment and its effects on naval systems. Assist in adaptation of sonobuoys to the measurement of underwater sound reverberation and background.

Investigate fluctuation of shallow water sound propagation and look for causative factors. Measure seismic signatures of ships. Measure pressure background on the bottom in various geographic areas.

Study optical transmission, scattering and background in representative oceanic areas. Study effect of ocean currents on submerged bodies.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0152. FORMATION OF ANTARCTIC BOTTOM WATERS
H.M. Stommel, Mass. Inst. of Technology, Graduate School, Cambridge, Massachusetts 02139

Massachusetts Institute of Technology proposes to investigate the temperature, salinity, and dynamics of water, particularly bottom water, in the Weddell Sea Antarctica. Almost all temperature changes in the oceans occurred at the air-water boundary. Cold ocean water must form only in the polar regions, as surface waters elsewhere have temperatures above the world oceans' potential temperature of about 3.5 degrees C. The Weddell Sea area has been suggested as a major source of the cold bottom water of the world oceans. MIT, in cooperation with the Institute of Geophysics, University of Bergen, Norway, would employ four submerge buoys instrumented for measurements of currents and temperatures on the sea bottom during January 1968. Multiple sea-water samplers would also be placed on two of the submerged systems to obtain a series of water samples during the Antarctic winter. The data that would be obtained from successful recovery of these instruments in January 1969 would help to determine when and at what intervals cold bottom water is formed, and at what critical density, temperature-salinity relationships the sinking of surface water is initiated.

No MIT personnel will go to the Weddell Sea. Two Norwegian scientists will be on the U.S. icebreaker Glacier.

SUPPORTED BY U.S. National Science Foundation

1.0153. PROPERTIES OF SEA WATER
A.L. Bradshaw, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543 (N00014-66-C0241)

Work under this task is being directed towards more accurate determination of the basic physical properties of sea water, thermal expansion and volume compressibility. This work is in part intended to support the future development of techniques of field measurements by providing accurate and complete measurements of basic properties. A device to measure the microstructure of conductivity and temperature in the ocean is being developed.

More precise knowledge of these physical parameters in the ocean are vital to several Naval activities including large scale surveys.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0154. GREAT LAKES RESEARCH - CHARACTERISTICS OF LAKE WATER
A.P. Pinsak, U.S. Army, Lake Survey, Detroit, Michigan 48226

The research involves collection, analysis, and interpretation of data pertaining to physical and chemical characteristics of the fresh water in the Great Lakes, including radiological contamination and sound propagation; definition of those water properties which may be utilized as indices of water characteristics and quality; and installation of permanent automatic monitoring stations. The broad objectives are to investigate short term variations in water quality and properties, including the factors causing these variations, and to determine and monitor the long term trends. Energy budgets and chemical budgets will be developed to explain evaporation, lake currents and other physical variables.
1. PROPERTIES OF WATER

Systematic collection of data on physical and chemical water characteristics, bottom sediments, meteorological parameters, and wave observations was performed during summer and fall 1965 in Lake Erie and in Lake Huron during the open water season 1966. A similar program will be carried out in the eastern basin of Lake Superior during the 1966 open water season. Reduction, analysis and publication of data from Lakes Erie and Huron is in progress.

SUPPORTED BY U.S. Dept. of Defense - Army

1.0155. (A) ANNUAL SUPPLY OF PARTICULATE MATTER IN THE GREAT BAY ESTUARY (B) LATE PLEISTOCENE HISTORY OF THE GREAT BAY 
F. F. ANDERSON, Univ. of New Hampshire, Graduate School, Durham, New Hampshire 03824

(A) Sea water samples have been collected on a bi-monthly basis from the Great Bay Estuary since December, 1967. Total particulate matter, particulate carbon, salinity, temperature, and current velocities have been obtained. These data are being related to the factors that affect the particulate matter in estuaries.

(B) Sixty Gravity Columns have been collected from the Great Bay Estuary, New Hampshire and are being processed for texture, composition and Foraminifera. These data, in conjunction with selected C14 dates should enable the investigator to interpret the Pleistocene evolution of the estuarine system.

SUPPORTED BY University of New Hampshire

1.0156. PHYSICAL AND CHEMICAL PROPERTIES OF THE SHELF AND SLOPE WATERS OFF NORTH CAROLINA
U. STEFANSSON, Duke University, Graduate School, Durham, North Carolina 27706

This is for the continuation and completion of studies now in progress of the physical and chemical properties of the waters on the continental shelf and in the slope region off North Carolina. The continuing research includes: (1) examination of the acquired data in relation to oceanographic factors and processes affecting the renewal of the shelf waters, (2) study of biochemical relationships in Gulf Stream waters and deep bottom waters of the Hatteras Basin, and (3) investigations of organic and particulate phosphorus and particulate aluminum and iron in the shelf area for studying the distribution of runoff water.

SUPPORTED BY U.S. National Science Foundation

1.0157. PHYSICOCHEMICAL AND ACOUSTIC PROPERTIES OF SEA WATER
D. N. CONNORS, U.S. Navy, Underwater Weap. Res. & Eng., Newport, Rhode Island 02844

Technical Objective: (1) Determination of the heat of mixing in sea water between minus 2 degrees C and 25 to 30 C and estimate its effect on thermal structure of upper layers of the ocean. (2) Develop techniques and instrumentation for measuring partial conductance of salts in sea water and another comparable solution. (3) Measurement of the partial conductances of sodium and potassium chlorides and sulphates and salts of the divalent cations magnesium and calcium in sea water and comparable solution, as a function of pressure and temperature. (4) Estimate specific and nonspecific interactions of the above salts and their effect on velocity of sound in sea water as a function of pressure and temperature. (5) Determination of in situ density anomaly from conductance measurements for nonconstancy of composition in sea water.

Approach: Measurements will be conducted on the heat of mixing at approximately 0 degrees C, as a function of concentration, and on two selected concentrations, measurements of heat of mixing from approximately 0 degrees C to 25-30 degrees C. Evaluations will be made of several high pressure set-ups. Preliminary work will be done on the design and fabrication conductance cells.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0158. BIOLOGICAL AND CHEMICAL STUDY OF VIRGINIA'S ESTUARIES
M. L. BREHMER, Virginia Inst. of Marine Sci., Gloucester, Virginia

Virginia's three major estuarine systems—the James, the York, and the Rappahannock—exhibit different biological characteristics both within and between years. These differences have been noted in phytoplankton populations; in shellfish reproduction, growth, and condition; and in finfish populations. This study will compare the biological, chemical, and physical characteristics of the three systems. Stations will be occupied at 5% intervals from 25 to less than 0.5% in each river at slack before flood tide. Water samples will be collected at 2 m intervals from surface to bottom and the water column described by temperature, salinity, dissolved oxygen, pH, alkalinity, chlorophyll, suspended solids (loss on ignition and fixed residue), transparency, phosphorus (soluble reactive, soluble unreactive, particulate reactive, and particulate unreactive), and nitrogen (soluble organic, ammonia, nitrite, nitrate, and particulate organic). Primary productivity levels will be determined.

Nutrient levels and turn-over rates, phytoplankton standing crop and productivity, and the dependent and independent physical and chemical characteristics of the three systems will be compared. Data collected by the shellfish and finfish departments at the Institute will be utilized to complete the analyses.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Reh

1.0159. INTERNATIONAL NORTH PACIFIC FISHERIES COMMISSION SUBARCTIC OCEANOGRAPHY
F. FAVORITE, U.S. Dept. of Interior, Biological Laboratory, Seattle, Washington 98102

Oceanographic measurements of temperature and salinity versus depth and ocean currents are made in the subarctic region of the North Pacific Ocean from the BCF research vessels George B. Kelez and Miller Freeman. Interrelationships among the physical water properties, ocean currents, and sockeye salmon distribution are investigated and reported to the International North Pacific Fisheries Commission. Local coastal areas are surveyed to establish criterion that will permit prediction of environmental conditions. Participation in cooperative oceanographic surveys is scheduled with other BCF laboratories, universities, and national and international agencies.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

1.0160. PHYSICAL OCEANOGRAPHY
W. B. MCALISTER, U.S. Dept. of Interior, Biological Laboratory, Seattle, Washington 98102

Work in physical oceanography consists of two subprojects: 1. Physical and mathematical models of the oceanic processes in the North Pacific Ocean are constructed and examined to obtain insight into the dynamic response of the ocean to the forces acting upon it. Both long term response, and short term departures from average conditions are examined. II. Instrumented field observations and model tests are designed and performed. This has included design and operation of buoy platforms instrumented with oceanographic sensors, telemetry and data recovery and data logging systems including satellite positioning and satellite data relay.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

1.0161. OCEANOGRAPHIC RESEARCH
T. EWART, Univ. of Washington, Graduate School, Seattle, Washington 98122

Objective: Provide essential data for design and development of Naval systems and develop techniques for optimum performance and effectiveness of such systems. Investigate the horizontal variations of oceanographic parameters, with particular emphasis on temperature, as related to the ocean's acoustic properties. Relate these variations to gross environmental features which Navy presently has some capability for predicting in an effort to extend the prediction capability.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
1. PROPERTIES OF WATER

1.0165, BIOLUMINESCENCE
W.D. MCELROY, Johns Hopkins University, Graduate School, Baltimore, Maryland 21218
A thorough ecological study of a small phosphorescent bay in Jamaica is being conducted with emphasis on the influence of environmental factors on the physiology, especially photosynthesis and luminescence of the phytoplankton. The bay chosen is in almost constant bloom and provides opportunity for continuous monitoring of temperature, salinity, tide, fresh water influx, and flushing rates, as well as chemical parameters for experimental purposes.
SUPPORTED BY U.S. Atomic Energy Commission

1.0166, SEA WATER OPTICS STUDIES
J. WILLIAMS, Johns Hopkins University, Graduate School, Baltimore, Maryland 21218 (NONR)

The goal is to develop relationships whereby the significant optical properties of sea water could be computed from knowledge of the concentration size distribution and physical character of the suspended matter and vice versa. During the coming year the results to date will be summarized and reported and this task terminated.
Further knowledge of specific optical properties of sea water is required for design improvements of systems which require visibility underwater. The techniques for utilizing optical methods that may evolve from this task should aid in determining optical and particulate characteristics of estuarine environments.
SUPPORTED BY U.S. Dept. of Defense - Navy

1.0167, OCEANOGRAPHIC RESEARCH
D.E. MATLACK, U.S. Navy, Ordnance Laboratory, Silver Spring - White Oak, Maryland

Objective: Measure optical properties of deep ocean.
Approach: Utilize self-contained submersible cable suspended instrument package to measure spectral absorption, scatter and background visible light for all depths at specific ocean sites. Utilize results to predict utility of optical techniques.
SUPPORTED BY U.S. Dept. of Defense - Navy

1.0168, LIGHT IN THE SEA
H.G. HOUGHTON, Mass. Inst. of Technology, Graduate School, Cambridge, Massachusetts 02139 (NONR)

This project is directed towards developing techniques for the detection, counting and sizing of oceanic particulates through the measurement of the light scattering by the particulates. It may also be possible to deduce the degree of sphericity of the particles through estimation of their optical index of refraction. Both laboratory and field studies are planned. Observations will be made on the optical transmission of light through the water at various wave lengths. Also to be examined are the polarization and angular distribution of the light scattering.
Potential applications of the results of this study are (1) the use of properties of the scatterers as tracers of water motion, (2) predictions of the distribution of solar or artificial light in the sea, (3) possible chemical and biological implications.
SUPPORTED BY U.S. Dept. of Defense - Navy

1.0169, FACTORS INFLUENCING THE INTENSITY OF BIOLUMINESCENCE
F.H. JOHNSON, Princeton University, Graduate School, Princeton, New Jersey 08540 (NONR)

1.0162, MID-DEPTH BIOLUMINESCENCE
B. BODEN, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

Bioluminescence at sea has been studied for many years, but no standardized, quantitative methodology had been developed until very recently. This investigator is utilizing the new approach which involves the simultaneous use of two photometers and which operates with a minimum of disturbance to the organisms. He observes and measures the characteristic patterns of the natural flashing and determines the relationship of these patterns to the environmental conditions under which light is produced. He will also continue his studies of the physiological mechanisms in crustaceans and other luminescing forms which produce and receive light.

This research will contribute to our knowledge of the oceanic environment and will relate especially to the causes and mechanisms of the distribution of light production in the sea, particularly among the populations which make diurnal vertical migrations.
SUPPORTED BY U.S. Dept. of Defense - Navy

1.0163, OPTICAL OCEANOGRAPHY IN FLORIDA BAY, FLORIDA STRAITS AND BAHAMA BANK
A. IVANOFF, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124

This research concerns the study of oceanographic phenomena through the application of optical methods.
The first objective is a study of the relationship between the particle load of a water mass in shallow water and the dynamics of wind-stirred waters. The total surface of particles and their size of distribution will be determined by light-scattering methods. The areas of research for this objective will be west of Abaco Island and in Biscayne Bay.
The second objective is a study of the sediment transport from these shallow-water areas to the deeper oceanic area. Long time series will be necessary. However, knowledge of an established relationship in a well-studied area will make it possible to estimate the year-round transport on the basis of wind observations. The research will be carried out at Bear Cut and in the area between Bimini and Cat Cay.
The third objective is the study of the mixing of Biscayne Bay water with the Florida Current. The attenuation meter will be utilized to demonstrate the difference of absorption of coastal waters and oceanic waters. In the course of these studies the 'black screen' attenuation meter will be refined by using photomultipliers.
SUPPORTED BY U.S. National Science Foundation

1.0164, MECHANISM STUDIES ON BIOLUMINESCENT REACTIONS WITH EMPHASIS ON ENERGY TRANSFER PROBLEMS
M.J. CORMIER, Univ. of Georgia, Graduate School, Athens, Georgia 30602 (AT(40-1)741)

The mechanism by which chemical energy is converted to light energy is being investigated in several in vitro bioluminescent systems. These include luminous bacteria, sea pansies (Calli), luminous earthworms, and luminous marine fish. Attempts are being made to isolate the enzymes (luciferases) involved so that their properties may be studied. In addition, at-
1. PROPERTIES OF WATER

The investigator is analyzing the chemical and physical factors influencing or controlling the brightness of biologically produced light by two interrelated approaches: the analysis of variations in light intensity under the influence of temperature, hydrostatic pressure, chemical inhibitory or activating substances, concentration of essential reactants, etc., and the isolation and determination of the properties of the reactants of the biological systems for interpretation in kinetic studies.

Bioluminescence is important in operations where visual search or concealment are critical factors. The light producing action of many organisms serves also as a means for detection of certain trace elements required for luminescence in many processes which occur at the ocean bottom; (2) to investigate the light scattering properties in the ocean; and (3) to make bottom current measurements. A multipurpose instrument package will replace individual instruments if tests presently underway are successful. This package will provide bottom photographs, bottom current information, water and sediment temperatures, light transmission and light scattering data at up to 20 separate locations on a single lowering.

1.0170, OPTICAL MEASUREMENTS

W. M. EWING, Columbia University, Graduate School, Palisades, New York 10964 (N00014-67-A0108-0004)

The objectives of this program are: (1) to study, by means of bottom photographs, the biological and physical properties of and processes which occur at the ocean bottom; (2) to investigate the light scattering properties in the ocean; and (3) to make bottom current measurements. A multipurpose instrument package will replace individual instruments if tests presently underway are successful. This package will provide bottom photographs, bottom current information, water and sediment temperatures, light transmission and light scattering data at up to 20 separate locations on a single lowering.

Naval operations can be made more effective as the nature of the water-sediment interface at the ocean bottom is understood. In support of the need for such knowledge, this program will provide information on the benthos, texture, and strength of the ocean-bottom and on the currents and light-transmissivity in the waters just above the ocean bottom.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0171, STUDY OF STABILITY AND SHEAR IN THE TOP 500 METERS OF THE OCEAN

W. S. WOOSTER, Univ. of California, Graduate School, San Diego, La Jolla, California 92038

The purpose of this study is to measure and describe the dynamic stability in the upper 500 meters of the ocean at several locations in the California Current. The measurement program is to be carried out by use of a continuous recording in-situ salinometer (STD) and a set of current sensors. The STD records permit calculation of the density profile as a continuous function of depth, while the current sensors determine the vertical shear of velocity. The combination of these two measurements will determine the dynamic stability and permit a quantative description of the flow regime in and immediately adjacent to the thermocline. This description will be of value in assessing vertical energy transport, leading to a better understanding of the mixing and diffusion processes in the vicinity of the thermocline.

SUPPORTED BY U.S. National Science Foundation

1.0172, SHALLOW WATER OCEANOGRAPHY

G. B. AUSTIN, U.S. Navy, Mine Defense Laboratory, Panama City, Florida 32401

Objective: To determine those environmental factors affecting undersea uses of the ocean. To relate ocean wave power and directional spectra in the near-shore to causative factors, and formulate means of predicting environmentally caused pressure fluctuations.

Approach: Investigate pressure spectra using in-situ measurements on the ocean bottom and tanks. Investigate waves by means of sensors at two offshore platforms near Panama City, Florida, measuring the interannual and interdecadal time-scale variation in surface wave and bottom pressure and extracting such information as (1) directional spectra, (2) low frequency coherent line spectra, and (3) the effects of fetch on the sea spectrum within a well-defined continental shelf area. Use and extend techniques for investigating the oceans' wave spectra at low frequencies. Investigate the environment selectively in time and space.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0173, OCEAN PRESSURE RESEARCH

W. P. CHRISTOPH, U.S. Navy, Ordnance Laboratory, Silver Spring - White Oak, Maryland

Gather and analyze oceanographic data in connection with pressure sensitive equipment.

Record pressure background data at selected places in the Atlantic and Pacific Oceans. Analyze the data such that results are applicable to equipment placed in the sea. Selected locations: Frying Pan Shoal, N.C.; Buzzard Bay, Mass.; Argus Island, Bermuda; off Vancouver Island, Canada (oil drilling rig).

SUPPORTED BY U.S. Dept. of Defense - Navy

1G. THERMAL PROPERTIES

1.0174, THERMAL WAVE STUDIES

E. F. FLINT, North Amer. Rockwell Corp., Anaheim, California

Objective: Investigate the thermal discontinuities associated with internal waves and turbulent wakes of submerged bodies.

Approach: Utilize and advanced underwater research instrument previously developed under this effort to measure and analyze the frequency, amplitude, persistence and statistical properties of thermal discontinuities in the ocean.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0175, PACIFIC COASTAL ENVIRONMENT AS RELATED TO DISTRIBUTION AND ABUNDANCE OF GAME SPECIES -- SEA SURFACE TEMPERATURE MEASUREMENTS

G. B. TALBOT, U.S. Dept. of Interior, Tiburon Marine Lab., Belvedere - Tiburon, California 94920

Objective: To determine the sea surface temperature gradients in selected areas of the eastern Pacific Continental Shelf. Survey to be conducted in cooperation with the United States Coast Guard, using an airborne infrared radiometer to provide a near instantaneous isotherm picture of the coastal sea surface temperature structure.

To develop detailed synoptic information on one important physical parameter of the marine environment for correlation with available marine fish catch/effort information.

Procedure: Three sectors of the eastern Pacific Continental Shelf covering the areas from Cape Flattery, Wash., to Tillamook Head, Ore.; Pt. Arena to Pt. Sur, California; and Pt. Conception to San Diego, California, with an infrared radiometer mounted in a U.S. Coast Guard aircraft. Sectors to be surveyed monthly with tracks of 700 to 900 nautical miles in length. Sea surface temperature data will be published immediately after each survey in the form of isotherm charts. Observers will also note and record air temperature, visual changes in water color, the extent and direction of convergence lines, location and observed abundance of marine life (fish and mammals). Survey to be conducted once each month for an indefinite period.

In FY 1963 experiments were conducted with an airborne infrared radiometer on accuracy and repeatability. Airborne water temperature surveys were made of coastal inshore area from Mexico to Cape Flattery.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0176, MONITORING SURVEY AND TIME-SERIES ANALYSIS OF SUBSURFACE TEMPERATURE IN THE NORTH PACIFIC OCEAN

J. F. SAUR, U.S. Dept. of Interior, Biological Laboratory, Palo Alto - Stanford, California

Understanding and prediction of the effects of environmental conditions on the abundance and distribution of fish requires knowledge of the distribution of properties beneath, as well as at, the water surface and the processes by which changes in these
properties occur. A glaring obstacle in such research is that subsurface data having both time and space continuity are practically nonexistent.

It is impractical because of time, cost, and number of ships required to attempt to obtain such data with oceanographic research and survey vessels. However, the use of expendable in situ systems aboard ships of opportunity, that is, merchant and other ships whose operating costs are already covered, offers the possibility of obtaining highly useful data at a reasonable cost. Use of this method should be begun as soon as possible.

There is no precedent for collecting the subsurface temperature data on a time-series basis as proposed here. The specific data to be collected are needed for research by the BCF Biological Laboratory, Stanford. It is equally important, however, that the feasibility of collecting such data from ships of opportunity be demonstrated and a particular system be tested on an operational basis with the data also feeding into the Navy operational forecasting system.

The objectives are to determine quantitatively the variations in thermal structure of the upper layers of the water column and the relationship of oceanographic conditions, such as currents, and to the local energy exchange at the sea surface; and at the same time to pioneer a joint BCF-Navy effort for producing mutually needed ocean information. The initial step in this is to establish a pilot study for the collection of time-series subsurface temperature data using ships of opportunity. Such a pilot project was started in June 1966 aboard the Matson Navigation Co. ship SS CALIFORNIAN. Temperature observations to 1500 ft. depth and at spacing of 100 naut. miles are being obtained about twice a month from Honolulu to San Francisco.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

1.0177. THERMAL PROPERTIES OF SEA WATER AT LOW TEMPERATURE AND HIGH PRESSURE

D.R. CALDWELL, Univ. of California, Graduate School, San Diego - La Jolla, California 92038 (NONR)

The objective of this task is to obtain precise measurements of the coefficient of thermal expansion, the specific heat, and the thermal conductivity of sea water at low temperature and high pressure, such as occur in deep water and to apply these to investigation of processes affecting heat and mass exchanges in the water layers close to the sea floor. Both laboratory and field measurements are being made. Measurements of water flow at the bottom involve heated thermistor anemometers mounted on the Snodgrass-Munk deep sea tide recorders.

There is a recognized need for better fundamental values of the physical and chemical properties of sea water. Such information will contribute to the accurate determination of the speed of sound in deep water. It will also provide basic engineering knowledge to support naval systems operating at great depths or on the sea floor.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0178. BATHYTHERMOGRAPH ANALYSIS

M.K. ROBINSON, Univ. of California, Scripps Inst. of Oceanography, San Diego - La Jolla, California 92038 (NONR)

The objective of this task is to provide descriptions and models of the surface and near-surface temperature structure of the ocean, as derived from the analysis of bathytelermograms achieved at Scripps, Woods Hole and the National Oceanographic Data Center. Objective analytical techniques have been developed and the results of analyses of data from the Pacific, Atlantic and Indian Ocean are being prepared for publication in atlas format by the U. S. Naval Oceanographic Office. A preliminary analysis of Indian Ocean hydrographic stations and BT data is being prepared for publication and analyses of the salinity structure of the upper layers of the oceans is to be undertaken based upon hydrographic station data.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0179. HISTORICAL CHARTS AND INTERPRETATION OF CHANGES IN SEA SURFACE TEMPERATURE IN THE NORTH PACIFIC OCEAN

L.F. EBER, U.S. Dept. of Interior, Ocean Research Lab., Stanford, California

Sea surface temperatures (intake or injection temperature observations taken by surface ships) provide the only ocean-wide data with satisfactory long-term continuity from which to infer historical changes that have taken place in the circulation of the ocean. The construction of monthly sea surface temperature (SST) charts is thus a necessary step towards understanding the interrelationship between atmospheric and oceanographic environments and their effects upon commercial fisheries, following which the changes in SST between different years can be analyzed with relation to changes in other environmental conditions.

The objective is to provide basic data for research on changes in oceanographic conditions by developing and publishing an atlas of mean sea surface temperature for the North Pacific Ocean and of anomalies from a suitable mean period, month by month for the period 1949-1962, during which suitable data are known to exist. The year 1956 and 1957 were selected for initial study. Data for each of the 24 months were plotted and analyzed, and the resulting set of charts were published in the spring of 1962. It was determined that the preparation of charts for additional years would be accomplished more quickly and with improved quality, by switching from manual to machine processing of the data. This change made feasible the inclusion of refined editing procedures too lengthy to carry out by hand. The entire program involves several stages, ending with machine analysis and charting, using programs developed at the U.S. Navy Fleet Numerical Weather Facility, Monterey.

Publication of the 14-year series of charts is expected by the summer of 1968. Continuing work includes the preparation of monthly normal charts based on the 14-year period of reference and of anomaly charts for each month of each year. Charts depicting within-month and year-to-year variation also will be prepared.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

1.0180. EVALUATION OF LOW LEVEL TEMPERATURE GRADIENTS OVER THE LINE ISLANDS NEAR THE EQUATOR

W. GRAY, Colorado State University, Graduate School, Fort Collins, Colorado 80521

The purpose of this proposed work is to study the sea-surface and sub-cloud layer temperature gradients in the vicinity of the intertropical zone during the Line Island Experiment in early 1967.

Measurements will be made using two radiometers mounted on the Woods Hole Oceanographic Institution's C-540 aircraft. An aerosol counter will be placed on the aircraft also to help determine the effect of a hazy environment on the radiometric measurements. The sea surface temperature will be mapped in the vicinity of the Line Islands. Values will be checked with other measurements made by other groups and using different techniques. It is hoped to correlate the measurements with other available synoptic and meso-scale observations to help determine the cause of observed satellite 'cloud blobs'.

SUPPORTED BY U.S. National Science Foundation

1.0181. MILLSTONE POINT TEMPERATURE SURVEY

W. OWEN, Raytheon Company, New London, Connecticut

A 12 hour temperature and salinity survey was conducted at Millstone Point, Connecticut to document the temperature distribution of temperature and salinity at each of three stations before the world's largest atomic power plant goes into operation next year.

A similar survey will again be conducted in March 1969.

SUPPORTED BY North East Utilities Service Company

1.0182. MONTVILLE STATION TEMPERATURE SURVEY (THAMES RIVER)

W. OWEN, Raytheon Company, New London, Connecticut
1. PROPERTIES OF WATER

The non-consumptive use of water for cooling the condensers of thermal power stations requires a knowledge of the distribution of temperature in the body of water used for the purpose.

In August, September, and November of 1968, MRL conducted a temperature survey of the Thames River Estuary in the vicinity of an operating thermal power plant. An average of 130 continuous temperature profiles were made over a 12 hour period on each of the eight survey days. In addition, meteorological measurements, tide measurements, salinity determinations, and bathymetric measurements were made.

The data from the survey was presented to the funding agency in the form of 184 cross section contour maps and 30 planner contour maps of the temperature data.

SUPPORTED BY Bechtel Corporation

1.0183. THE CONTRIBUTION OF ADEVDION AND LOCAL HEATING TO THE MAINTENANCE OF THE THERMAL STRUCTURE IN THE NORTH PACIFIC OCEAN

K. WYRTKI, Univ. of Hawaii, Graduate School, Honolulu, Hawaii 96822

The thermal structure and the distribution of sea surface temperature within the mixed surface layer is maintained by the combined action of heat exchange at the sea surface and of ocean circulation. The heat exchange changes the temperature locally, while the circulation by the processes of advection and mixing redistributes the heat. Since 1948, monthly charts of sea surface temperature and of the anomaly of sea surface temperature from the long-term mean have been published for the North Pacific Ocean, but the interpretation of the origin, redistribution and of the decay of such temperatures anomalies has not advanced beyond speculations.

Under this grant, investigations will be made on the interaction between the field of heat exchange, circulation and tempertature distribution, to establish firm quantitative relations between these factors and to develop instrumentation suitable for the calculation of the behavior of anomalies of these fields, and to compare such results with actual observed situations.

SUPPORTED BY U.S. National Science Foundation

1.0184. THERMAL STRUCTURE

E. SCHROEDER, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543 (N00014-66-CO-241)

This program calls for the systematic collection of data from an oceanographic station off Bermuda that has been occupied approximately fortnightly since 1954 and for the analysis of the time series in terms of fluctuations in temperature, salinity and steric sea level. Analysis of North Atlantic thermal data is a continuing program. An atlas of smoothed average temperatures at five levels is being prepared in cooperation with Naval Ocean and Scripps.

The results from this task should provide a better understanding of long-term changes in the ocean in the vicinity of existing heat flow measurements at sea. These data should be on a time series basis in order to assist in the planning of Naval operations and in the development of design criteria. Work from this task has contributed to the program at the Naval Numerical Weather Facility, Monterey.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0185. GREAT LAKES RESEARCH - MONITORING OF WATER CHARACTERISTICS

A.P. PINSK, U.S. Army, Lake Survey, Detroit, Michigan 48226

A system of permanent automatic monitor stations will be developed to continuously measure and record geophysical processes that affect or are influenced by the Great Lakes and their environment and to program observations for timely use in forecasts and control. As a first phase in this program continuous automatic water temperature recorders have been installed at 10 sites along the periphery of the U. S. portion of the Great Lakes. These stations will be removed as the comprehensive monitoring program develops.

Hourly water temperatures, daily and monthly mean temperatures at each of the ten sites are published regularly.

SUPPORTED BY U.S. Dept. of Defense - Army

1.0186. CALORIC - AN INVESTIGATION OF HEAT RELEASE PATTERNS ASSOCIATED WITH PRESENT AND PLANNED LAKESHORE ELECTRICAL POWER PLANTS

G.J. NEUMAER, Cornell Aeronautical Lab. Inc., Buffalo, New York 14221

The objective of this program is to investigate the thermal pattern in the vicinity of an existing electrical power station and to develop a theoretical model for predicting the thermal pattern that will prevail during the operation of a planned nuclear facility near an existing plant. This program will provide information for assessing the influence of the future power discharge from the nuclear plant on lake ecology and for determining the preferred locations of the intake and discharge tunnels of that plant.

The program consists of three tasks: (1) the development of a theoretical model of the lake thermal characteristics, (2) measurement of the surface water temperature distribution using an airborne infrared radiometer, and (3) the design, fabrication, and installation and routine maintenance of lake temperature and current instrumentation.

SUPPORTED BY United Engineers & Constructors Inc.

1.0187. COLLECTION AND INTERPRETATION OF OCEANIC THERMAL GRADIENTS

M.G. LANGSETH, Columbia University, Graduate School, New York, New York 10027

The object of this investigation is to continue regular heat flow measurements from the R/V Vema and R/V Conrad in an attempt to delineate large areas where the heat flow is low, normal, or high. In addition, it is hoped that certain areas such as the East Pacific Rise and the Sigsbee Knolls area of the Gulf of Mexico can be thoroughly investigated with the use of satellite navigation or anchored buoys to determine the nature of large heat flow variations over relatively short distances.

A temperature-measuring instrument, the thermogradi, developed at Lamont Geological Observatory, allows the continuous measurement of water temperature from close to the surface to the ocean bottom and also the thermal gradient of the sediment. To date, many hundreds of measurements have been made using this device. Recent results in the East Pacific Ocean show high heat flow over the East Pacific Rise between Panama and Hawaii, low heat flow in the Guatamala Basin, and a high heat flow close to Hawaii. Other results in the same area show high heat flow off the coast of Washington State and a surprisingly uniform heat flow south of the Mendocino Fracture Zone in a line between Victoria, British Columbia, and Midway Island.

SUPPORTED BY U.S. National Science Foundation

1.0188. TEMPERATURE MICROSTRUCTURE AT THE OCEAN FLOOR

G. BODWATERSON, Oregon State University, Graduate School, Corvallis, Oregon 97331

This is a renewal of GP-4642 to make temperature measurements at the bottom of the ocean in both the water and the bottom sediments for extended periods of time. Two analog recording thermistor probe instruments have been assembled and calibrated. The instrument package has been operated at a depth of 1500-1700 fathoms for a period as long as 22 hours. Techniques have been developed to measure temperature gradients for a period of several weeks, using a buoy. Heat flow measurements have been made in two areas off the coast of Oregon and a number of theoretical studies have been made.

It is proposed to develop the instrument package to arrive at observation periods of three to six months. The data will be studied with regard to the stability of the bottom boundary layer. The importance of the evaluation of existing heat flow measurements at sea is obvious. Theoretical studies will be continued.

SUPPORTED BY U.S. National Science Foundation

1.0189. A STUDY OF THE TEMPERATURE MICROSTRUCTURE AND EDDY TRANSPORT IN THE OCEAN FLOOR BOUNDARY LAYER

G. BODWATERSON, Oregon State University, Graduate School, Corvallis, Oregon 97331

26
Under previous NSF support three analog recording thermoprobe instruments have been assembled, calibrated and field tested. Each probe carries eight thermistor sensors and a sediment sampler. The probes furnish data on the temperature up to 3.3 meters above and down to two meters below the ocean floor as well as on the heat flow through the bottom interface. They have operated successfully in 3,000 meters of water for periods up to 22 hours. The temperature measurements can be made with a resolution of plus and minus 0.004 degree centigrade. Two of the probes were lost during field operations, but a fourth one is now being assembled.

A fifth temperature probe for longer period temperature recording is partially finished. This unit has the capability of scanning ten sensors and converting the input to a digital format for storage by a magnetic tape recorder. The total storage capability of the tape unit will extend the in situ recording time to three months.

The objective of the presently proposed research is to make further improvement of the temperature probing equipment and to continue the experimental program on the temperature structure and heat transport in the lowest section of the ocean floor boundary layer.

SUPPORTED BY U.S. National Science Foundation

1.0190. AIRBORNE SEA SURFACE MEASUREMENTS IN THE EQUATORIAL PACIFIC
R.A. RAGOTZKIE, Univ. of Wisconsin, Graduate School, Madison, Wisconsin

The objectives of the proposed research are to map the surface temperature field of the ocean by airborne infrared radiometry and then interpret the results in terms of related atmospheric and oceanic phenomena.

A Barnes (IT-3-) infrared radiometer will be mounted in the NCAR aircraft and converted to the ARIS data acquisition system aboard the plane. The radiometer will be used in fixed and tilted modes so both the sea surface temperatures and the amount of water vapor in the atmosphere can be measured.

It is anticipated that the variability in time and space of the sea surface temperature can be documented, that the effect of storms can be accentuated, currents can be delineated and oceanic fronts observed. All of these observations will be of great use in understanding better the interaction between the ocean surface and the overlying atmosphere.

SUPPORTED BY U.S. National Science Foundation

2. WATER MOTION
(see Also Air-sea Interaction in Chapter 3a and Hydrodynamics, Chapter 8i)

2.0001. RADIOISOTOPE TRACERS IN OCEANOGRAPHIC RESEARCH

Objective: Investigate radioactivity and measure fallout isotopes in the ocean that are useful in tracing vertical migration and circulation of water and concentration of water properties. To establish methodologies for determining the distributions of naturally occurring and man-introduced radioactivity in the oceans and to develop research instrumentation as required.

Approach: Develop in-situ gamma radiation detectors for employment on submersibles and for more general use from surface vessels. Evaluate the capabilities of such detection systems as oceanic radioactivity probes. Map the known present oceanic inventory of fission products, induced radioactivity and special fuels; locate and account for future injections from oceanic, atmospheric, and terrestrial sources; define the trace elements of interest and their physical and chemical states in sea water; define their interactions with the bio-mass; develop isolation techniques for gamma spectrometric measurements of micro trace quantities; initiate a program for sampling the surface waters of the world from ships of opportunity; and schedule specific cruises in the North Pacific Ocean for the determination of vertical profiles. Apply data analysis, with the aid of sophisticated computer programs, to the extension of present theories and the development of new theories on the circulation, mixing and turbulent diffusive processes extant.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0002. OCEAN CIRCULATION
R.S. ARTHUR, Univ. of California, Graduate School, San Diego - La Jolla, California 92038 (NONR)

The purpose of this investigation is to advance qualitatively, through the development of analytical and numerical models, an understanding of features of both oceanic and near-shore circulation to the point where circulation behavior can be predicted. Wind-driven circulation near-shore and over submarine canyons is being studied to obtain a model of water and sediment transports in rip currents and in the circulation over canyons. Attention also is being given to the eastern boundary current off California in order to establish a dynamic model for the mean flow in this region and help in planning mesoscale arrays of buoys.

Forecasting the movement of ocean water, or deducing such movements, from available oceanographic and meteorological observations depends on adequate theoretical understanding of the processes and dynamics of oceanic systems. This work is making substantial improvements in such theory.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0003. STUDY OF OCEAN CURRENTS AT SEA FLOOR AND THEIR SPATIAL CORRELATION
C.S. COX, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

A continuing effort is underway to obtain the very long time series of ocean current observations necessary to reliably distinguish between the various possible types of water motion having periods longer than tidal periods. It is not planned to measure currents throughout an entire water column, but rather to undertake a variety of measurements using instruments which rest solidly on the sea floor.

The first set of measurements involves operating current meter stations on the sea floor for extended periods of time. The current meters, commercially available, are mounted rigidly in a tripod so as to record at about one meter above sea floor and are recoverable by means of a line attached to a surface float. The meter-buoy station may be left unattended for about six weeks, after which the current meter is retrieved, serviced, and replaced on the bottom.

In conjunction with the current meter observations, measurements of the electric field at the bottom of the sea will be attempted. The measurements of electric field will permit estimation of the barotropic component of water flow. This will complement the bottom current measurements which, of course, make no distinction between barotropic and baroclinic components of the flow.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0004. BOTTOM CURRENTS AND DEEP SEA TIDES
M.C. HENDERSHOTT, Univ. of California, Graduate School, San Diego - La Jolla, California 92038 (NONR)

The purpose of this task is to develop an understanding of long period waves and currents in the ocean, including tides, through theoretical and observational investigations. The theoretical work consists of devising computational methods capable of representing long period gravity and planetary wave oscillations in deep basins. Observational work consists of measurements of water flow in deep water within a few meters of the bottom where the effects of friction are evident. During the coming year, it is proposed to use finite difference calculations for solving the deep-sea tide problem, on a model which has boundary conditions simulating the effects of energy dissipation and trapping near coasts. Current meters are to be developed to measure the directional components of current velocity in the boundary layer immediately above the ocean floor in the deep sea.
2. WATER MOTION

The Navy is embarked on a deep ocean technology program designed to improve man's capability to work and install equipment on the ocean floor. In addition, sound propagation is affected by physical variations in the deep ocean waters. This task will provide knowledge of the variations and causes of such variations pertinent to these Navy problems.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0005, A STUDY OF THE DEEP CIRCULATION AND DEEP FISH POPULATIONS IN THE PACIFIC OCEAN

J.D. ISAACS, Univ. of California, Graduate School, San Diego - La Jolla, California 92038 (AT(11-1)-127)

Until this last year the deep currents in the oceans have been only rarely measured, although many aspects of the circulation have been theorized from models and from the evidences of various physical and chemical variables such as temperature, salinity, oxygen, carbon 14, etc. During the last year 15 direct current records (3 meters off the bottom) have been obtained at about 4 km in depth, 400-800 km off the West Coast of northern Baja California, Mexico. The direct measurements in this area show a coherent net transport of about 2.2 cm per sec in a southeasterly direction; a semidiurnal fluctuation of an rms amplitude of about 1.7 cm per sec., rotating counterclockwise; and with the phase coherent with the dominant component (the semi-diurnal lunar component) of the tides at La Jolla, California. This extent of coherency greatly increases the possible significance of widely-spaced observations, and it now appears that such measurements can be highly significant in elucidating the deep circulation and tides over the entire basin.

The plan is to conduct a widespread study of deep currents and related features in the Pacific Ocean during the next year for the purpose of elucidating the nature of the deep circulation and the fluctuating currents.

In one year we will not have gathered a large number of deep measurements but we will have measurements broadly spread in the Pacific Ocean. This information should yield great insight into the nature of the deep currents, and permit the design of an optimum study of currents in the entire basin.

Other measurements that are planned at some current stations are free vehicles with a camera and a fish trap; temperature and salinity to the bottom; and opening and closing net tows in the deeper layers.

SUPPORTED BY U.S. Atomic Energy Commission

2.0006, STUDY OF DEEP PACIFIC CIRCULATION USING SILICON-32

H.W. MENARD, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

The research program proposal aims towards an understanding of the nature of circulation in the deep Pacific Ocean using cosmic ray produced Si 32 as a tracer. Whereas several radioactive techniques have recently been employed to invigorate the characteristics of circulation of water in the oceans, they are at best primarily suited for evaluating the gross features of circulation, viz., the turnover time of oceans. Extensive studies of cosmic ray produced C 14 in sea water and of another cosmic ray produced radioisotope, Si 32, in surface marine waters have provided useful information in this direction. The available measurements on the specific activity of C 14 in the biocarbonate of deep Pacific waters show that the horizontal and vertical gradients that exist in its specific concentration are often small compared to the precision of measurement and, furthermore, close in magnitude to the effect produced by the dissolution of gravitationally settling skeletons which results in a direct in situ addition of carbon of higher specific activity. In view of the above, the C 14 data lead only to a box-model type analysis with most of the deep oceans being considered as a well mixed reservoir.

SUPPORTED BY U.S. National Science Foundation

2.0007, CIRCULATION OF THE PACIFIC

J.L. REID, Univ. of California, Scripps Inst. of Oceanography, San Diego - La Jolla, California 92038 (NONR)

The objective is to chart and understand the overall large scale circulation of the northwest Pacific and the origin of the deep waters of the major ocean basins. The approach is to examine along with other physical and chemical properties potential density as an indicator of flow, and to measure bottom currents at great depths. During the coming year, data from 10,000 deep water stations spread over the world ocean are to be analyzed. Bottom current meter observations are to be made around the Central Pacific Basin to obtain details of the water exchange between the North and South Pacific.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0008, NATURE AND VELOCITY OF CURRENTS AND OTHER FLOWS IN SUBMARINE CANYONS

F.P. SHEPARD, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

Thorough study will be made of the various currents and sediment flows in submarine canyons where they are particularly amenable to study since the location is predictable. Working together with scientists of the Navy Electronics Laboratory, San Diego, and the local branch of the U.S. Geological Survey, extensive current meter studies in the canyons near Scripps Institution are planned. This would be supplemented by the planting of event recording devices within the canyons, which would be released and rise to the surface after a strong flow down the canyon floors, and would provide us records of the transient flow velocities. In addition, attempts would be made to set off flows in the canyons with the help of the best available information on soil mechanics. The movement of traceable sands and other recognizable objects down the canyon floors would be followed. The work would also involve supplementary studies of upwelling, downwelling, and the sedimentation taking place in the canyon heads. This work would be coordinated with observational studies made by scuba divers and deep diving vehicles presently studying the canyons.

The investigation should provide much needed information on the true nature of turbidity currents, and also should determine to what extent ordinary currents and powerful flows, other than turbidity currents, are contributing to the phenomena that are generally considered the work of turbidity currents. Information coming from this project should prove valuable, not only in interpreting such features as submarine canyons and great sea fans, but could also provide helpful information for man's rapidly expanding utilization of the sea floor.

SUPPORTED BY U.S. National Science Foundation

2.0009, DESCRIPTIVE OCEANOGRAPHY/PACIFIC

B. TAFT, Univ. of California, Graduate School, San Diego - La Jolla, California 92038 (NONR)

The purpose is to understand the air-sea interactions involved in large ocean currents. Attention is being focused on the equatorial system using data collected largely on operation EAS-TROPAC. Physical data from continuous recording devices and time series from buoys are being examined by computation for information on the interaction between the changing atmospheric circulation and the current system.

The results of the analysis from this work are expected to contribute significantly to the understanding of a major portion of the eastern Pacific Ocean. Such knowledge will be useful for planning of naval operations and furthering our ability to describe and predict large scale changes which the atmosphere may induce in the oceans.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0010, CIRCULATION AROUND OCEANIC ISLANDS

W.G. VANDORN, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

Objective: To study the character and mechanisms of circulation around oceanic islands. Initial exploratory work will be done on the islands in dynamically stable regions where a deep thermocline and steady trade winds prevail. Such regions comprise most oceanic areas between latitudes 30N-30S, and might be termed 'oceanic deserts,' because vertical mixing is strongly opposed by a
streets as the result of perturbed flow around an island. (2) Unstable density structure, and the surface waters are consequently ocean. Field work at sea on the thermal structure of the mixed processes the theoretical ocean by the evaporation of sea water at the surface. Another vective Connecticut 06520 (N00014-66-C0171-A01) supported by u.s. national science foundation. (3) Enhancement and breaking of internal waves on mixing. These include: (1) The formation of vortices and vortex streets as the result of perturbed flow around an island. (2) Upwell and downwelling as a result of differential wind stress and convection. (3) Inertial and tidal frequencies, is expected to yield significant in-...APPROACH: The vertical and horizontal variability of kinematic features of the ocean over synoptic (100-1000km) and meso (10-100km) scales and over temporal scales of one month to one season will be studied. The spectral energy content of currents, particularly the relative amplitude of peaks which appear at inertial and tidal frequencies, is expected to yield significant informa-...2.0016, ocean current transport W.S. Richardson, Nova University, Graduate School, Fort Lauderdale, Florida (N00014-67-A-0386-0001) This is a combined field and theoretical study of the structure and variability of ocean currents. Special emphasis is given to measurements of velocity field in vertical cross-sections across the Gulf Stream along the E. Florida coast using freedrop instru-...2.0017, studies of the transport of the Florida current W.S. Richardson, Nova University, Graduate School, Fort Lauderdale, Florida The Principal Investigator has recently developed a technique for the rapid measurement of vector transport which...
2. WATER MOTION

permits the measurement of total flow of a large current with
good accuracy. The method consists of dropping a free instru-
ment at a known point from which it falls to the bottom, releases
weights and returns to the surface under its own buoyancy. The
instrument contains internal recording of pressure versus time
and is accurately fixed when it surfaces.

This method requires the availability of a precise navigation
system. By increasing the transmitted power of the presently
available HIFiX system, it will be possible to provide navigational
accuracy of plus or minus 2 meters throughout the Straits of
Florida, Northeast and Northwest Providence Channels and to
the North and East of Little Bahama Bank (range of 250 miles).
With this increase in coverage it should be possible to determine
the transport through the Little Bahama Bank-Palm Beach sec-
tion and the flow out of Northwest Providence Channel, as well
as the transport through the Miami-Bimini section. In this way, the
contribution of the channels to the Gulf Stream can be deter-
mained.

In all of these sections, the vertical and horizontal distribu-
tion of transport will be determined and efforts will be made to
calculate these with geostrophic determinations made from
hydrographic stations. In addition to transport measurements of
the above type, current meter installations will be made both at
the shorelines and in deep water to determine the shape of the
tidal wave in the straits and associated channels.

SUPPORTED BY U.S. National Science Foundation

2.0018, RESIDENCE TIMES OF WATERS BEHIND BAR-
RIE ISLANDS
K.G. DEAN, Univ. of Florida, School of Engineering, Gainesville,
Florida 32601

The proposed research comprises the development and
evaluation of a numerical model to calculate the residence times
of the waters in lagoons behind barrier islands and in intercon-
ected bay systems. The numerical model will be based on the
governing differential equations of motion and continuity includ-
ing all nonlinearities. Wind stresses, precipitation and tidal dis-
placements at the openings to the water system under considera-
tion will be included as 'input' to the numerical model. The model
'output' includes predictions of water velocity and elevation as
functions of time and position in the water system. The 'output' is
generated by representing the water area as a grid system and
solving the governing difference equations with the prescribed spa-
tial and temporal distributions of the input functions. To assess
the validity of the model, a field program will be conducted to
measure the input and output functions for at least two different
water systems. Simulations of the model will be based on a comparison of measured water elevations and velocities
with those determined from the numerical model.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rch
University of Florida

2.0019, SEA SURFACE SURVEILLANCE
Miami, Florida

Objectives: 1. To obtain data concerning the variation of prop-
erties of surface water entering the Caribbean Sea to test the
relationship of the spatial and temporal distribution of tuna
schools to variations in the circulation. 2. To contribute to the un-
derstanding of the oceanography of the Caribbean Sea and
western tropical Atlantic Ocean. 3. To establish effective sam-
ping procedures to be used at shore stations and on ships of op-
portunity in this and other areas of investigations.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

2.0020, WATER MASS TRACERS
C.H. OPPENHEIMER, Florida State University, Graduate
School, Tallahassee, Florida 32306

The objective of this task is to determine the role of plank-
tonic Foraminifera as biological tracer organisms in identifying
major currents and water mass distribution patterns. Specifically,
the research will determine the limits of precision of this method
and further develop its application. During the coming year the
effort will be devoted primarily to analyzing the several thousand
samples which have been collected in the eastern Equatorial
Pacific and are being collected in the tropical Atlantic. These
analysis will be compared to other physical and chemical mea-
surements.

Sound propagation in the ocean is affected by the density
structure as well as water velocity and biological concentrations.
The distribution of these properties is dependent upon circulation
patterns which are not understood. This task should provide a
powerful tool for studies of oceanic circulation.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0021, HAWAIIAN OCEANOGRAPHY
K. WYRTKI, Univ. of Hawaii, Hawaii Inst. of Geophysics, Honolu-
u, Hawaii 96822 (NONR)

The effect of the Hawaiian Islands on the North Equatorial
Current is being investigated to determine the influence of an
island chain in mid-ocean on the structure and dynamics of a
larger permanent ocean current. The investigation is concerned
with the study of the North Equatorial Current, its modification
during flow through the various channels between the islands and
the development of eddies behind the island chain. Particular
emphasis is on the formation, the duration and the decay of ed-
dies; the correlation of sea-level differences between islands with
the flow through channels and development of eddies; and the
tidal current pattern in the Hawaiian Islands region and in the
open ocean away from the Islands.

This study should result in information on the disturbance of
the oceanic structure in the vicinity of a mid-ocean island chain,
the variations in time and space of the thickness of the mixed
surface layer, of the depth and intensity of the thermocline and of
the surface and subsurface circulation in channels between the
Hawaiian Islands. Since naval operations take place in the vicinity
of these islands, the knowledge of these oceanic parameters and
their fluctuations are of importance to the Navy.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0022, CIRCULATION IN THE GULF OF MEXICO
K. DRENNAN, Gulf South Research Institute, Baton Rouge,
Louisiana (N00014-67-C-0514)

The purpose of this investigation is to study the circulation of
the northeastern and central portions of the Gulf of Mexico.
Emphasis is on the circulation of shelf water in the northeast Gulf,
particularly the effects induced by the Mississippi outflow and the
Loop Current. Both hydrographic data and airborne IRT observa-
tions are being used to determine eddy flow patterns. The
surface circulation features of the Yucatan and Loop Currents in
the Central Gulf also are being studied by airborne IRT in an at-
tempt to correlate observed patterns with circulation features
derived from standard oceanographic observations.

This task is part of the Navy's broad basic research program
in oceanography to provide a better understanding of the Navy's
operating environment. Results from this task are expected to
contribute to operations by furthering the understanding of the
circulation and water structuring of such regions.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0023, THEORETICAL AND LABORATORY MODEL
STUDIES OF LARGE-SCALE OCEAN CIRCULATION
A.R. ROBINSON, Harvard University, Graduate School, Cam-
bridge, Massachusetts 02138 (NONR 00014-67-A-0298-0011)

Objective: The accomplishment of many operational Navy
objectives such as prediction of subsurface currents during deep-
sea operations, is contingent upon knowledge of water move-
ments and the associated physical property distributions. In turn,
the goal of predicting three-dimensional configurations of ocean
currents depends in large measure on improved understanding of
the fundamental processes involved. This research is a successful
example of the application of basic fluid mechanics to understand
motions in the rotating fluid envelope which is the real ocean.
2. WATER MOTION

Approach: Experimental and theoretical model studies of the motions, associated forces and energy of fundamental processes in ocean circulation constitute most of the work. Quantitative comparison of theory with the results of experiments performed with a rotating model of a curved sea will continue to provide critical tests for many aspects of the general ocean circulation. Numerical modeling of time-dependent, intense, jet-like currents will continue. A predictive model of the variation in Gulf Stream path will be tested by a field experiment during summer of 1969. The study of processes involved in the subsurface equatorial current system and in the large-scale interaction between ocean and sea will continue. Field tests will be made on an instrument designed to measure small pressure fluctuations at great depth in an effort to sense very large wave-like disturbances of ocean currents.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0024, (U) OCEAN CIRCULATION MODELS
R.C. BEARDSLEY, Mass. Inst. of Technology, Graduate School, Cambridge, Massachusetts 02139

A rotating laboratory model which models the dynamics of the large scale wind driven ocean circulation will be used to investigate the interaction of Rossby waves with the mean interior and western boundary layer flow in an enclosed basin. The amplitude, wavelength and response functions will be measured as the relative mean and oscillatory components of the applied stress are varied. A numerical study of the model equations for a steady stress will be compared with experimental results previously obtained to help understand the nature of the flow instability observed.

Many operations in the ocean are contingent upon knowledge of water movements and the associated physical property distributions. In turn, the goal of predicting three-dimensional configurations of ocean currents depends on large measure on improved understanding of fundamental processes involved.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0025, LONG RANGE SOFAR FLOATS
H.M. STOMMEL, Mass. Inst. of Technology, Graduate School, Cambridge, Massachusetts 02139 (NONR)

This is a field experiment concerned with measuring water motions at subsurface depths. Measurements will be made of long period and large scale ocean currents by acoustically tracking neutrally buoyant floats in the SOFAR channel. Fixed hydrophones in the sound channel will be used to locate and track the floats and to determine the ambient temperature at the float via transmitted CW pulses. These floats are large, expensive and recoverable. The second type of expendable floats, which is under design. The deployment of relatively many of these inexpensive floats would yield information regarding vertical shear and horizontal coherence of subsurface motions.

This is an important step towards understanding the large scale and long period motions of the oceans in the mid-depth range. It is also significant in that it fully recognizes the potential of the permanent sound channel for information telemetering.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0026, EASTERN BOUNDARY CURRENTS
I. SCHELL, Ocean Atmospheric Res. Inst., Cambridge, Massachusetts 02138 (N00014-67-C-0334)

The objective of this task is to determine the influence of large-scale atmospheric conditions, such as pressure and wind field patterns, upon the Benguela Current and associate upwelling in the eastern South Atlantic Ocean. From the distribution of atmospheric pressure over the South Atlantic Ocean, indices of atmospheric circulation are being developed to describe the intensity of this circulation. These indices are then being correlated with both surface temperature conditions off southwest Africa and subsurface temperature, salinity and oxygen content for sections which extend seaward from areas of upwelling along the coast.

This is part of the Navy’s basic research program intended to provide a better understanding of the operating environment of the Navy. The results from this study should contribute to the understanding of macro-scale air-sea interactions, and, in particular, the influence of large-scale atmospheric systems upon the dynamics and structure of the oceans which relate to acoustical propagation characteristics. From such better understanding of the large-scale influences of the atmosphere upon the oceans should develop improved environmental forecasts.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0027, CIRCULATION ON THE CONTINENTAL SHELF
D.F. BUMPUS, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543

This investigator has endeavored to delineate the horizontal motions in the circulatory system of the continental shelf of the east coast of the United States. With the generalized pattern in hand we are trying to work out the secular changes in the circulation and their causes. We will use a Lagrangian technique with drift bottles at the surface and sea-bed drifters at the bottom and make use of all the physical oceanographic, hydrological, climatic and meteorological data and theory to elucidate these motions.

SUPPORTED BY U.S. Dept. of Hith. Ed. & Wel. - P.H.S.

2.0028, GULF STREAM EDDIES
P.C. FUGLISTER, Woods Hole Oceanicographic Inst., Woods Hole, Massachusetts 02543 (N00014-66-C-0241)

This is a continuing study of the Gulf Stream system in the region following its departure from the continental shelf off and east of Cape Hatteras. The objective is to gain a better understanding of the structure, behavior and frequency of occurrence of large-scale, cold-water eddies formed by the meandering Gulf Stream. This year emphasis is upon the analyses and interpretation of data from recent cruises concerned with the detailed documentation of the life cycle of a single eddy. This includes both descriptive aspects and the development of numerical models. A series of cruises also will be mounted to search for and tag both old and new eddies to determine the role these large-scale features play in the water mass structure of the northwestern North Atlantic.

It is essential to obtain a detailed quantitative description of the oceanic circulation on both a large and a small scale in order to establish a sound basis for predictions of oceanic structure and to isolate the physical, chemical, biological, and geological processes responsible for the ocean’s behavior. The results from this study should assist the development of forecasting methods.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0029, GULF STREAM TRANSPORT
P.C. MANOLE, SIDOR, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543

It has been found that navigation methods now available can provide average surface current measurements between successive hydrographic stations precise enough to be combined with the calculated geostrophic shear to yield true total transport. A cruise of R/V CRAWFORD is scheduled for August 1969 which is planned to use this method to measure the total transport of the Gulf Stream system across two different sections extending from the Continental Slope to the Bermuda Rise. This grant provides funds for equipment and scientific personnel for this cruise, and for subsequent data processing.

SUPPORTED BY U.S. National Science Foundation

2.0030, INVESTIGATION OF SHALLOW CURRENT STRUCTURE IN THE WESTERN TROPICAL ATLANTIC OCEAN
W.G. METCHALF, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543

Further studies of the circulation in the shallow layers of the Western Equatorial Atlantic are proposed. The classical view of the current pattern shows that water of South Atlantic origin flows northward across the equator and enters the Caribbean Sea (and the North Atlantic circulation) by way of the Guiana Current.

31
2. WATER MOTION

Direct current measurements and a study of the hydrographic data in this area indicate that that portion of the water column between 13 to 24C, of South Atlantic origin, does not contribute to the circulation of the North Atlantic. In particular the oxygen concentration in the South Atlantic water is higher than in North Atlantic water through the same temperature range.

Sections of hydrographic stations and direct current measurements are planned to determine the circulation pattern between the mouth of the Amazon River and the Antilles Arc. Special emphasis will be placed in obtaining closely spaced samples through the upper 300 to 500 meters of the water column. Direct current measurements will be made using parachute drogues and a current meter designed to be lowered from the ship.

SUPPORTED BY U.S. National Science Foundation

2.0031, NORTH ATLANTIC CIRCULATION

L.V. WORTHINGTON, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543 (N00014-66-C0241)

This task is concerned with the general circulation and water mass distributions of the ocean. It includes both the description of large oceanic features such as current systems and the study of the causes with which changes in them. Particular emphasis will be placed upon the measurement of the volume transport of the Gulf Stream south of New England using free drop instrument techniques. The validity of the hypothesis that sloping bottom topography controls meanders also is being re-examined using new bathymetric data. A water budget of volume transport and actual volumes of different water masses is being developed for the North Atlantic and the distribution of water mass properties in the Somali Basin are being determined.

This study should provide the understanding of the physical nature of oceanic circulation which has a bearing upon numerous problems in effective use of the oceans for military operations. It will provide the proper input to theoretical models of the circulation which are needed for the long-term goal of prediction of oceanic variables and further our ability to describe and predict the properties of the oceans.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0032, AN INVESTIGATION OF THE OVERFLOW OF NORWEGIAN SEA WATER INTO THE NORTH ATLANTIC THROUGH DENMARK STRAIT

L.V. WORTHINGTON, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543

Observations made during the International Geophysical Year have indicated that the Norwegian Sea overflows are major sources of deep water in the North Atlantic. Past measurements have shown that the overflow between Iceland and the Faroes amounts to about 5 x 10^3 to the 6th power cubic meters/sec. The amount of the Denmark Strait overflow has not been determined.

This research proposal is for a detailed examination of this overflow using both hydrographic measurements and current meters. The staff of the Bedford Institute of Oceanography have agreed to cooperate in this effort and the work will be performed aboard the Canadian Research Ship HUDDSON.

SUPPORTED BY U.S. National Science Foundation

2.0033, VERTICAL CURRENT STRUCTURE IN THE GREAT LAKES

V.E. NOBLE, Univ. of Michigan, Great Lakes Research Division, Ann Arbor, Michigan

The objective of this program is to use the wind and current data from the buoy system established in the Great Lakes by the Public Health Service to gain an understanding of the dynamics of the current structure in the Great Lakes. These data are continuous, and have been obtained over a full-year period in Lakes Michigan, Ontario, and Erie. The buoy stations were placed so as to cover the entire basin of each lake. The buoy stations will be in Lake Huron during 1966, and will be moved to Lake Superior in 1967.

Preliminary analysis has shown a seasonal progression of the current patterns in Lake Michigan. This progression of patterns seems to reflect the change in the effectiveness of the air-sea coupling as a result of the air-sea temperature structure.

A detailed analysis of the available data will help to provide the conceptual framework for the development of a theoretical model which will accurately predict the current patterns observed in the Great Lakes.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

2.0034, OCEAN CIRCULATION AND CONTROLLING FACTORS FOR PREDICTION

G. NEUMANN, New York University, Graduate School, New York, New York 10003 (NONR)

Objective: The Navy needs for oceanic environmental information, to plan and execute operations and to install fixed subsurface systems requires knowledge of the movements of water mass and currents as well as a capability to predict changes in them. This research is to determine the factors controlling organic circulation, both large-scale current systems and local upwelling phenomena. By providing a better understanding of the meteorological and oceanographic conditions controlling oceanic circulation, improved environmental prediction techniques may be developed to support naval operations.

Approach: The fresh water discharge of the Amazon River and differences in precipitation and evaporation are being evaluated as causes for the large salinity variations observed in the upper strata of the Tropical Atlantic. Physical oceanographic data obtained from EQUA1ANT cruises in the area are being analyzed to determine seasonal variability. Oceanographic and meteorological data also are being collected, analyzed and correlated to determine the causes of anomalous temperatures frequently encountered in the waters off New Jersey.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0035, STUDY OF INFLUENCE OF STRATIFICATION ON CURRENT STRUCTURE

G. NEUMANN, New York University, School of Engineering, New York, New York 10003

This research proposal is concerned with the study of the circulation of Lake Michigan. Rotary currents with the local inertial period have been found to be very prominent in the data and frequently mask other long and short term current variations. In order to obtain more definitive clues as to their nature, it is proposed to separate these currents from the data by a least squares technique. This will enable us to study not only the vertical and horizontal structure of these rotary currents but also the residual circulation that remains after the rotary current has been subtracted.

SUPPORTED BY U.S. National Science Foundation

2.0036, VERTICAL OCEAN CIRCULATION

P.K. WEYLE, State University of New York, Graduate School, Stony Brook, New York 11790

The basic goal of this research is to increase the level of knowledge regarding convective processes within the ocean. Such knowledge will yield better understanding of how the ocean stabilizes our climate and how climatic distributions affect subsurface circulation in the sea. The first objective is to identify ocean areas capable of producing long-term effects on the subsurface circulation through the formation of distinct water types and to estimate the formation and mixing rates of such waters. During this year, the objective will be attacked by the development of a statistical, dynamic model involving knowledge of the distribution of all ocean waters on the basis of some measure of depth, as well as temperature and salinity. Only existing data will be used. (Preliminary studies indicate that the model will be more sophisticated than was expected because of complex equation of state of sea water).

SUPPORTED BY U.S. Dept. of Defense - Navy

32
2.0037. CURRENT STUDY ON THE NEUSE RIVER AND ESTUARY

W.J. WOODS, Univ. of North Carolina, Institute of Marine Science, Morehead City, North Carolina 28557

A study will be made of water movements in the Neuse River and Estuary. Data obtained will be used to determine flushing rate and circulation patterns. This is the second phase of a study which it is hoped will ultimately determine flushing rates and circulation patterns in the Pamlico Sound complex. Pamlico Sound is a shallow, bar-built estuary in North Carolina.

Fluorescent dye (Rhodamine B or Rhodamine WT) will be added to the river and its distribution traced by boats equipped to pump water continuously through a "umer Fluorimeter." The record of concentrations on successive days, as long as the dye is detectable, will be used to determine the rate and direction of water movement and the effect of wind and tidal action.


2.0038. TIME DEPENDENT VARIATIONS IN SURFACE OCEANIC CIRCULATION

R.G. DOUGLAS, Case Western Reserve Univ., Graduate School, Cleveland, Ohio 44106 (AT(11-1-1796)

It is apparent that in the future demands will be made upon the marine environment for many of the resources which are now available on land. These demands will take many forms, but probably the most important will be the increasing use of the oceans for: 1) waste disposal and, 2) food production. If the exploitation of the terrestrial environment can be taken as a guide (and present indications suggest that it can), increasing use of the oceans will significantly alter the marine environment, probably irreversibly. Before this occurs it is imperative that a comprehensive understanding of the phenomena which control the major physical characteristics of the marine realm be obtained. Since 1880, for example, the North Atlantic has experienced an average sea-surface temperature change of up to 3 degrees Centigrade, presumably due to changes in ocean currents resulting from minor climatic fluctuations. Such changes bear on the ultimate fate of wastes deposited in the sea and on the productivity of the world's fisheries which originate and are maintained largely through a delicately balanced combination of currents and temperature.

Because the oceans undergo time-dependent change, the prediction of oceanographic conditions -- necessary for intelligent utilization of the ocean as a resource -- can only partially be derived from study of the modern situation. To this must be added a historical perspective. It is necessary to know the direction and magnitude of changes which have occurred in the past and may be expected to recur. The necessary models of past conditions can be derived from detailed geological investigation of materials preserved in the sedimentary record on the sea floor. We propose to make an investigation which relates to the development of models which can be used for dynamic calculations. Such changes bear on the ultimate fate of wastes deposited in the sea and on the productivity of the world's fisheries which originate and are maintained largely through a delicately balanced combination of currents and temperature.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0039. TIME FLUCTUATIONS IN OCEAN CURRENTS

M.S. LONGUETHGIGINS, Oregon State University, Graduate School, Corvallis, Oregon 97331

Two related approaches will be taken towards the study of time-fluctuations in ocean currents having periods of the order of a few pendulum-days.

Theoretical studies - (a) Calculation of the normal-mode oscillations in ocean basins of ideal shape and of a rotating sphere. The computations will take account of horizontal divergence and will span the whole range of Lamb's parameter. (b) Numerical evaluation of new types of wave motion associated with bottom topography, including (particularly the double Kelvin waves propagated along a straight discontinuity.

2. Model experiments - Experiments will be made with a rotating fluid shell contained between two concentric spheres. The initial aim is to set up the shells in such a way that the zero radial velocity and related wave motions.

SUPPORTED BY U.S. National Science Foundation

2.0040. OCEAN CIRCULATION STUDIES

W.J. WOODS, Univ. of Rhode Island, Graduate School, Kingston, Rhode Island 02881 (NONR)

Two related approaches will be taken towards understanding of ocean circulation.

(a) Calculation of the normal-mode oscillations in ocean basins of ideal shape and of a rotating sphere. The computations will take account of horizontal divergence and will span the whole range of Lamb's parameter. (b) Numerical evaluation of new types of wave motion associated with bottom topography, including (particularly the double Kelvin waves propagated along a straight discontinuity.

2. Model experiments - Experiments will be made with a rotating fluid shell contained between two concentric spheres. The initial aim is to set up the shells in such a way that the zero radial velocity and related wave motions.

SUPPORTED BY U.S. National Science Foundation

2.0041. CURRENTS AND WATER MASSES IN THE SOUTHWEST ATLANTIC

L.R. CAPURRO, Texas A & M University System, Graduate School, College Station, Texas 77843

This work is concentrated in the area of the Blake Plateau where the Gulf Stream appears to cross the deep western boundary current and along the continental slope off New England. (2) fluid dynamics relations to non-linear mechanics, in particular the application of statistical mechanics to equilibrium phenomena. (3) the transfer of energy across the frequency spectrums of internal waves.


2.0042. CIRCULATION STUDIES

J.D. COCHRANE, Texas A & M University System, Graduate School, College Station, Texas 77843 (NONR)

This task is concerned with the study of ocean circulation in three distinct regions: (1) the eastern Gulf of Mexico and Yucatan Sea, (2) the western tropical Atlantic, and (3) the eastern tropical Pacific Ocean. A cruise is scheduled to study the Yucatan Current to determine the onset of western intensification in the current as well as evidence of convergence and divergence patterns on the west side of the Campeche Bank. Ongoing analyses of other, previously-collected data are concerned with the origin and downstream modification of the Atlantic Equatorial Undercurrent and the eastern termination of the Pacific Equatorial Undercurrent.

The results from this study should provide a better understanding of the dynamics of the oceans in these little-known areas and assist in planning any future more-detailed surveys in these areas. Through a better understanding of the dynamics of the oceans also can evolve better methods for predicting current behavior.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0043. BOTTOM ENVIRONMENT--GULF OF MEXICO

W.E. PEQUEGNAT, Texas A & M University System, Graduate School, College Station, Texas 77843 (NONR)

The environment at the bottom is being studied in the deep waters of the Gulf of Mexico, where the depth exceeds 1700
2. WATER MOTION

The objective is to understand the forces affecting bottom properties. To this end deep sea photography combined with current meters, dredges and other sampling devices are used to relate biological populations, water motion, and chemical content to the observed physical properties of the bottom.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0044. CIRCULATION STUDIES

R.O. REID, Texas A & M University System, Graduate School, College Station, Texas 77843 (NONR)

This task includes both theoretical and field studies of ocean circulation with emphasis on the Gulf of Mexico. Theoretical models of the Gulf circulation will be treated as will the more general problem of western boundary currents in a layered ocean. A major effort is being directed towards the development of a 3-dimensional numerical model for describing the circulation and associated thermal structure of the Gulf. An observation program also is being mounted to monitor the inflow into the Gulf from the Yucatan Current for use in the numerical model. Another study is investigating the response of a stratified ocean system and overturning stationary hurricane.

The results of this task should provide a better understanding of the circulation of the Gulf and the cause of spatial and temporal variations. Some generalization to other regions should be possible for forecasting purposes.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0045. CIRCULATION DYNAMICS (GULF OCEANOGRAPHY PROGRAM)

R.S. ARMSTRONG, U.S. Dept. of Interior, Biological Laboratory, Fort Crockett - Galveston, Texas

Studies have shown that variations in shrimp catches in the Gulf of Mexico are regional rather than local. This wide-spread effect suggests an influence corresponding to deviations from the normal oceanic environment.

Project goals involve (1) describing the stratification, currents, circulations, and distribution of properties as observed during pertinent periods; (2) defining deviations from the normal, and the rates of changes in climatic variations, seasonal fluctuations, and shorter time variations; and (3) relating the sea and the variations to the driving forces of wind-driven circulations, changes in the water budget, primarily by the volume transport through the Yucatan Straits, and energy associated with heat budget.

The ultimate goal will be to develop usable, routine techniques for predicting the state and character of the waters at any locale in the Gulf.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

2.0046. FINE STRUCTURE FEATURES OF TEMPERATURE AND SALINITY AT WATER MASS BOUNDARIES IN PACIFIC

G.I. RODEN, Univ. of Washington, Graduate School, Seattle, Washington 98122 (NONR)

Objective: An understanding of the temperature and salinity small-scale variation in the transition zone between the subarctic and subtropical water masses of the North Pacific is important to the Navy for sound propagation and prediction of oceanographic and meteorological conditions that influence naval operations. This research is to better understand the circulation patterns and their relationship to the fine structure of temperature and salinity observed at the boundary of these water masses which extends from Japan to Mexico between 31 and 43 degrees north latitude.

Approach: A detailed observational and theoretical study of the eastern part of the transition zone between 145 degrees west longitude and the American mainland will be made. The fine detailed temperature-salinity structure and oceanic circulation will be investigated. Temperature, salinity, dissolved oxygen and nutrients will be measured. The processes leading to the formation of the transition zone and detailed temperature-salinity structure will be theoretically investigated. The time variability of temperature and salinity in the zone also will be assessed from meteorological and oceanographic information collected on Ocean Weather Station NOVEMBER.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0047. BOTTOM CURRENTS AND THE MOVEMENT OF SEDIMENT ACROSS THE CONTINENTAL SHELF

R.W. STERNBERG, Univ. of Washington, Graduate School, Seattle, Washington 98122 (AT(45-1)1752)

Field, experimental, and theoretical work is proposed in several areas as part of the initial stages of an investigation of sediment transport on the continental shelf. In order to relate the general physical oceanography of the shelf to the bed load sediment transport, procedures for accurate calculation of the boundary shear stress must be available. In general, this requires an understanding of non-uniform and unstable boundary layer mechanics. Such boundary layers are to be studied in the field using a marine Preston tube in conjunction with a bottom mounted array of rapid response current meters. These two systems give three nearly independent ways of evaluating the boundary shear stress in quasi-uniform quasi-steady flows providing a check on the method presently being used as well as permitting extension of our experimental capabilities to flows hitherto precluded by instrumental limitations. Theoretical and laboratory work on this problem and the related sand wave problem will continue. In addition, field measurements of bed load transport and boundary shear stress will be used to check the validity of the standard bed load equations in the marine environment.

Moreover, the boundary shear stress at which sediment motion is initiated and the nature of sand waves will be investigated more thoroughly using the underwater television system, the stereo cameras, and the marine Preston tube. Theoretical work on these sediment transport aspects of the problem will continue. Field work will be carried out in Puget Sound and in the Columbia River during the next contract year. However, in the subsequent year a major part of the offshore work is expected to begin.

Results to Date: In the past few years considerable data has been accumulated on the variation of the drag coefficient relating the boundary shear stress to the flow one meter from the bed with flow conditions and bottom configuration. Information which confirms the use of the Shields' initial motion criterion in the marine environments has also been obtained. Recent results obtained by this project include successful flume measurements of the shear stress and velocity distributions over model sand waves, measurements of Reynolds stress in a tidal channel, measurements of the structure of the tidal flow near slack water, and measurements of boundary shear stress with a marine Preston tube.

SUPPORTED BY U.S. Atomic Energy Commission

2.0048. INVESTIGATION OF THE CIRCULATION OF LAKE SUPERIOR

R.A. RAGOTZKIE, Univ. of Wisconsin, Graduate School, Madison, Wisconsin

The overall goal is to describe and explain the general circulation of Lake Superior throughout the year. Studies have revealed that there are persistent cold cells in Superior, at least until early August, and a nearshore surface current flowing northeast along the Keweenaw Peninsula.

Gradient currents calculated from temperature cross-sections in the nearshore region north of the Keweenaw Peninsula indicate currents velocities excess of 1 knot flowing in a northeast direction. Current measurements from buoys confirm these calculated currents. This boundary current flows from mid-June until at least early September.

Theoretical studies have shown that for a stratified fluid in an enclosed basin the size of Lake Superior, the natural free mode of circulation includes high velocity boundary currents in a cylinronic direction. These may also occur in Lakes Huron and Ontario.

Circulation studies in a rotating laboratory model of Lake Superior also suggest this circulation in the epilimnion. Further analysis of field observations and laboratory experiments is continuing. Additional airborne infrared temperature mapping and in situ current measurements are planned.
2. CONVECTION-MIXING-UPWELLING

2.0049, TRACERS STUDIES IN ALASKAN HARBORS
D.L. WORF, Univ. of Alaska, U.S.D.I. Alaska Water Lab., College, Alaska 99701
Tidal flushing and estuarine water flowing into harbors are the primary means for diluting the industrial and community pollutants discharged into these harbors. The mechanics of this dilution is complex and not well known. The objective of this proposal is to use tracers (dyes and radioisotopes) to measure the rates of dilution at various points in the channel. Variables are seasonal fluctuations in fresh water flow, temperature, amount of natural and man-made wastes discharged into harbors.


2.0050, DISPERSION PROCESSES IN ESTUARIES AND RIVERS
H.B. FISCHER, U.S. Dept. of Interior, Water Resources Division, Menlo Park, California
Purpose: To determine the mechanics of the dispersion process in streams and estuaries chiefly by the use of previously derived and newly developed analytical and numerical theories and to suggest modifications and more effective methods of analysis.

Methods: Rhodamine WT and Rhodamine B dyes are being used to study longitudinal and lateral dispersion on bays, estuaries, and large streams. Hydraulic models will be constructed to ascertain differences in the models and prototype streams selected for comparative purposes.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0051, DISPERSION IN HYDROLOGIC AND COASTAL ENVIRONMENTS
N.H. BROOKS, Calif. Inst. of Technology, School of Engineering, Pasadena, California 91109
Hydrodynamics problems of dispersion in hydrologic and coastal environments will be studied theoretically, in the laboratory, and in some instances in the field. The various areas and problems to be considered are:

Turbulent diffusion and density-stratified flow phenomena are common to several areas above.

Work will not be conducted in all areas simultaneously but rather a continuing program at a modest level will be developed.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ct

2.0052, BIG EDDIES AND MIXING PROCESSES IN THE GREAT LAKES
G.T. CANADY, Univ. of Waterloo, School of Engineering, Waterloo - Ontario, Canada
Disposal of domestic and industrial waste in the Great Lakes requires a knowledge of the mixing processes involved. Previous work of the principal investigator and his collaborators has shown that mixing in the vertical depends critically on the supply of relatively large eddies, occurring in a more or less organized pattern, and often giving rise to a streaky appearance of the lake surface. The physical mechanism causing such 'streaming' is not known (although several speculative explanations have been proposed), nor is it clear what eddy structure would be set up in a wind driven current or in a gradient current, or how such structure would be modified by convective effects due to surface cooling. The object of the present project is to investigate the eddy structure of the surface layers of the Great Lakes, particularly as regards big eddies (which are known to determine mixing processes in turbulent flow) and relate this to observable diffusive properties of lake currents.


2.0053, TRITIUM AS A TRACER FOR MIXING PROCESSES
G.H. OSLUND, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124
This is a continuing study of the distribution of tritium in the Equatorial Atlantic. Combined with salinity distribution the tritium data have yielded insight into the relative roles of horizontal and vertical mixing. Cruises in 1965 and 1967 have collected some 320 samples from the Equatorial Atlantic Current System and it is proposed to complete these analyses. The implications of these data will be investigated, relative to mixing processes, origins and time scales of components of the current system, etc.


2.0054, MIXING PROCESSES INFLUENCING THE OCEANIC ENVIRONMENT
C. ROOTH, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124 (NONR)
Objective: The prediction of oceanic environmental conditions influencing naval operations and the effectiveness of control systems and equipment requires an understanding of the physical processes causing changes within the environment. The aim of this research is to determine the nature of mixing processes such as those in the surface layer that influence the thermal structure, and those at the seabed influencing the operation of underwater facilities.

Approach: Analyses are being made of material from previous laboratory experiments and field studies on entrainment effects and turbulence penetration in pycnolines and on oceanic velocity spectra obtained from moored current-meter arrays. They are to be the basis for the formulation of a mixing theory for the interior of the oceans. The effects of density-modifying processes acting at the lateral boundaries of a basin (frictional mixing and geothermal heat flow) also are being studied with a number of theoretical and laboratory models.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0055, STUDY OF OCEANIC TURBULENCE
B. GALLAGHER, Univ. of Hawaii, Graduate School, Honolulu, Hawaii 96822
Increased knowledge of the structure of oceanic turbulence is necessary to further understanding of the dynamics and transport processes in the sea. It is proposed to begin measurements of this structure in a deep ocean location where the spatial nature of the turbulence is expected to be least complex. The measurements are designed to reveal the spatial structure of the motion in a form to which turbulence theories can be applied. Values for parameters of energy dissipation and vertical diffusion will be found.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0056, TURBULENT DIFFUSION STUDY
D.W. PRITCHARD, Johns Hopkins University, Graduate School, Baltimore, Maryland 21218 (NONR)
The aim is to study turbulent diffusion in estuarine and coastal waters. Emphasis during the coming year is upon the effects of tidal mixing and the velocity field on the shape and concentration distribution of a cloud introduced as an instantaneous local source. A field experiment will be conducted in Chesapeake Bay to obtain data on the relationship between the local shear in the horizontal velocity field and the shape, during early stages of dispersion of a nearly instantaneous source. Other field studies include the study of vertical diffusion through the pycnocline in a tidal estuary and the study of large scale advective and diffusive processes which control the longitudinal distribution of salinity in an estuary.
2. WATER MOTION

This study will contribute to understanding short-term small-scale fluctuations in temperature in shallow water and estuarine areas as well as to the fate of contaminants introduced deliberately or accidentally.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0057, EXPERIMENTAL AND THEORETICAL STUDY OF THE HYDRODYNAMICS OF DISPERSION IN RIVERS AND ESTUARIES
M.P. TULIN, Hydromatics Incorporated, Laurel, Maryland

The general aims of the proposed research are: 1. To improve understanding of river hydraulics insasmuch as it has a bearing on dispersion. 2. To develop methods enabling the calculation of the velocity distribution in streams, which may be used to determine the dispersion coefficient, and to provide systematic experimental evaluation of the results. 3. To provide experimentally verified, quantitative results relating to dispersion in channels with varying aspect ratio and boundary roughness distribution. 4. To develop quantitative verified theories relating components of the dispersion tensor to the mean flow characteristics. 5. To provide useful and verified information and procedures relating to the scaling and model testing of dispersion in streams.


2.0058, RESEARCH ON TURBULENT CONVECTION
E. MOLLOCHRISTENS, Mass. Inst. of Technology, Graduate School, Cambridge, Massachusetts 02139

Turbulent convection is one of the important processes in atmospheric fluid mechanics. The research was for the purpose of obtaining more information about the phenomenon from laboratory experiments performed under controlled conditions. The experiments involved observations of statistical measures of the turbulent fluctuations, such as spatial covariance, time and space intermittency, spectra in frequency and wave number. Turbulent convection in a stratified medium was also investigated.

SUPPORTED BY U.S. Dept. of Defense - Air Force

2.0059, RESEARCH IN OCEANIC PHYSICS
H. MEYER STONE, Mass. Inst. of Technology, Graduate School, Cambridge, Massachusetts 02139

The program centers about a field study of the small-scale structures and mixing processes within the main thermocline of the subtropical North Atlantic. Various new forms of instrumentation will be used to measure shear, density stability, and the history of laminae on vertical scales of less than ten meters. The field study is scheduled for the Research Vessel ATLANTIS II on August 25 - September 19, 1968, southeast of Bermuda.

Theoretical study of the Ekman layer in the presence of strong heating and application to the Trade wind region of the ocean is contemplated. Also a laboratory model-study and theoretical study of density tongues in rotating density-stratified fluids is being pursued: with the hope of eventual application to interpretation of the spreading of water-masses at depth.

During the Spring of 1969 an attempt will be made to locate, identify, and intensively survey a region of active bottom -water formation in the Ligurian Sea. A continuous monitoring of the cold-upwelling region off Somalia, associated with the Monsoon-induced Somali Current is also in progress in the hope of providing definite information on the time of response of an ocean current to variable wind-stress. The latter investigations are meant to be part of the U.S.-Italy Cooperative Science Program.

SUPPORTED BY U.S. National Science Foundation

2.0060, VERTICAL MOTIONS
A.D. VOORHIS, Woods Hole Oceanographic ' · Woods Hole, Massachusetts 02543 (N00014-66-C0241)

Experiments are being carried out to measure vertical motion and vorticity in depths ranging from 300 to 3000 meters of water in the northwest North Atlantic. Neutral buoyant floats with vanes that cause rotation as water moves vertically past them are being used. Rotation is measured acoustically to the tendency ship. An experiment is to be carried out in the vicinity of a moored array of current meters to study the partition of kinetic and potential energy in the oceans. Other measurements also will be made at the edge of the Gulf Stream where turbulence is high.

Litt. is known about the vertical movement of water in the oceans. This program is attempting to measure such movement. It influences the displacement and deployment of naval systems in deep water. Therefore, the magnitude of such motions should be known and sufficiently understood to predict them.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0061, SALINITY INTRUSION AND RELATED PHENOMENA
H.B. SIMMONS, U.S. Army, Waterways Experiment Sta., Vicksburg, Mississippi

The objective of this project is to determine, for conditions of open channels subject to tidal water intrusion and tidal oscillations from the sea, the factors which control the extent of salinity intrusion, the degree of vertical mixing of salt and fresh water, the magnitudes and durations of current velocities at all depths, and the movement and deposition of sediments as influenced by density effects.

SUPPORTED BY U.S. Dept. of Defense - Army

2.0062, CHARACTERISTICS, CAUSES, AND PREDICTION OF UPWELLING WATER MASSESS OFF OREGON
R. SMITH, Oregon State University, Graduate School, Corvallis, Oregon 97331

Objective: The efficiency of search and rescue, underwater construction and other operations can be strongly influenced by the character and motion of water masses in the operating area. One commonly occurring and very distinct water mass off the west coast of the U. S. results from an intermittent upwelling of deep cold water into the near surface water. A thorough understanding of this upwelling process and the associated changes in horizontal currents and water properties should allow their prediction both in the study area and in similar areas elsewhere in the world.

Approach: Interrelationships between upwelling, tides, local weather, water properties and currents are being studied using concurrent measurements of sea level, atmospheric pressure, and the temperature, salinity, and oxygen content of water. In addition, information on currents is being obtained both from tracking drogues which drift with the currents and from fixed current meters anchored above the continental shelf. A team of qualified researchers, mostly advanced graduate students, is carrying out detailed but coordinated studies on various aspects of the program. As the interrelationships become more clearly defined, predictive models will be constructed and tested.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0063, CATALYSIS AND KINETICS OF MANGANOUS ION OXIDATION IN AQUEOUS SOLUTION AND ADSORBED ON THE SURFACES OF SOLID OXIDES
R.W. COUGHLIN, Lehigh University, School of Engineering, Bethlehem, Pennsylvania 18015

In view of the several mechanisms which have been proposed for the formation of manganese nodules, and because of the need for further quantitative data on manganese chemistry, this proposal sets forth a program which would: 1. Study the adsorption of soluble manganese from aqueous solution on the surfaces of various solid oxides (especially those of manganese and iron) with the goal of obtaining information about the nature of adsorption and double-layer formation. It will be of special importance to investigate the effects on these processes of foreign ions, complexing molecules, etc. 2. Study kinetics and mechanisms for the oxidation of manganous ions both in aqueous solution and at oxide surfaces (especially those of manganese and iron). The possible catalytic action of these surfaces will be of special interest.

SUPPORTED BY U.S. National Science Foundation

36
2.0064, HORIZONTAL DISPERSION IN SHALLOW ESTUARIES OF IRREGULAR SHAPE
F.D. MASCH, Univ. of Texas, School of Engineering, Austin, Texas 78712

This proposed research involves the development and verification of a numerical model to evaluate transport characteristics in shallow, vertically-mixed estuaries of irregular shape. The model is intended to assist in developing water quality requirements and evaluating the assimilative capacities of the shallow irregular estuaries found along the Gulf Coast of the United States.

The study includes the following three phases: 1. Adaptation of an explicit numerical model of the two-dimensional convective dispersion equation to the irregularly-shaped estuary. 2. Evaluation of the dispersion coefficients from graphical and analytical considerations. An attempt is made to relate conditions found with causative oceanographic and meteorological factors, decay of the lobe of river water throughout the year and unique the Columbia River water and its load of materials in the dispersion equation to the irregularly-shaped estuary. 3. Verification of Phases 1 and 2 in a hydraulic model and then in the field.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rch
University of Texas

2.0065, COLUMBIA RIVER EFFECTS IN THE NORTHEAST PACIFIC
C.A. BARNES, Univ. of Washington, Graduate School, Seattle, Washington 98122 (AT(45-1)-1725)

This study, started in 1961, aims to describe quantitatively the Columbia River water and its load of materials in the Northeast Pacific, stressing the movement, mixing, growth, and decay of the lobe of river water throughout the year and unique physical, chemical, biologic, and geological properties that identify these waters. An attempt is made to relate conditions found with causative oceanographic and meteorological factors, to explain pertinent processes, and to establish a base for predicting general behavior at sea of river water and its transported load.

Analysis and interpretation continue of conventional oceanographic measurements and collections made on 60 cruises, covering 165,000 kilometers in 825 days at sea and providing 154,000 water samples; 14,900 productivity measurements; 8200 phytoplankton, 2500 zooplankton, 2400 sediment samples; in situ gamma-activity measurements; seabed drifter movement; and miscellaneous samples and observations.

Columbia River effluent moves in response to wind and current, north in winter and south in summer. Nutrients and dissolved oxygen have been correlated with mass properties and with the productivity and distribution of phytoplankton. Phytoplankton studies include productivity-chlorophyll ratios, taxonomic composition, size distribution, seasonal and diurnal variations, and response to light. Preliminary attention has been given to zooplankton speciation and abundance and to benthos. The bathymetry 500 km seaward from Washington and Oregon has been described, and initial reflection studies made of the shelf and slope. Mineral types, mechanical characteristics, chemical nature, microorganisms, radioactivity, and movement of the sediments have been described in part, and lower river reservoirs have been examined for characteristics, configuration and movement of bottom sediments. Detailed observations currently are being made near the river mouth, at the edge of the river plume, and of water and sediment movement near bottom. Coordination is maintained with pertinent ONR, NSF, ESSA, USGS, other AEC projects and with local Pacific coast groups, including Canadian.

SUPPORTED BY U.S. Atomic Energy Commission

2.0066, UNSTEADY FLOW AND SALINE INTRUSION IN ESTUARIES

It is of fundamental importance to recognize that flow in natural channels is basically unsteady flow. To be sure, the degree of its unsteadiness is often of such minor significance that, with sound reason, such flow can be assumed to be steady flow, thereby taking advantage of greatly simplified analytic representation. Nevertheless, proper and thorough understanding of the mechanics of unsteady flow is important per se in determining the discharge of regulated streams, in flood routing, in determining flows in tidal reaches of homogeneous density, and, in fact, in any situation where open-channel flow cannot be assumed to be steady flow. Moreover, an understanding of the mechanics of unsteady flow is fundamental to improving the understanding of saline intrusion and diffusion in estuaries.

The ultimate objective of this investigation is the development of mathematical models representing unsteady open-channel flow, particularly as associated with estuarine channels. These models, hopefully, could then be used to predict flow using certain field obtained parameters — to determine such quantities as outflow, saline intrusion, and effects of channel changes upon flow.

A thorough appraisal of present knowledge of unsteady, open-channel flow is being conducted, including categorization of flow types and their required mathematical representation. Mathematical models will be derived and evaluated utilizing various solution techniques employing both analog and high-speed digital computers. Selected field data will be employed in the evaluation process.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

2.0067, HYDROLOGY OF UPPER OLD TAMPA BAY, FLORIDA
J.A. MANN, U.S. Dept. of Interior, Water Resources Division, Tallahassee, Florida

This research is part of the program of water resources investigations conducted by the U.S. Geological Survey in cooperation with the State of Florida.

Purpose: To provide data for evaluating the hydrological effects of conversion of the bay into a fresh water lake and information by which to judge the feasibility of similar plans in other areas of the State.

Methods: The study will include the area of the proposed lake and an additional 25 to 35 square miles of land adjacent to the lake in Hillsborough and Pinellas Counties. The quantity and quality of surface and ground-water inflow into the bay will be determined. Continuous conductivity and stage gages will be installed on the lake and the bay, and on selected wells in the area to determine the degree of interconnection between the aquifers and the fresh water lake. Conductivity traverses will be made of the upper part of the bay, supplemented by sampling sites, to determine ground-water discharge into the bay. An evaluation will be made of existing geologic and hydrologic data to determine the relationship between changes in water quality and groundwater storage. The areal extent, thickness, and permeability of clay beds underlying much of the area will be determined. The fresh water-salt water interstage will be monitored continuously.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

Florida State Government

2.0068, STUDY OF LOW FREQUENCY SURFACE WAVES IN THE PACIFIC OCEAN
G.W. GROVES, Univ. of Hawaii, Graduate School, Honolulu, Hawaii 96822

Movement of water in the ocean is related to vertical movement of the sea surface, but in a way which is not yet clear. As soon as a relation is established, it will be possible to use tide gauge records to study historical variations in oceanic water movement and their long-term statistical properties. The object of this present work is to study movement of the sea surface and to try to account for the observed activity in terms of local weather, planetary waves, turbulence, etc. Long series of tide-gauge and weather data at Pacific Islands will be used. Cross spectra and other statistical properties of sea level and weather at one location, as well as at different locations, will be studied. Existing theories, especially the planetary wave theories of Longuet-Higgins, will be found compatible or incompatible with the results.

SUPPORTED BY U.S. National Science Foundation

2. WATER MOTION

2C. GENERAL WATER MOTION
2. WATER MOTION

2.0069. OCEAN KINEMATICS DYNAMICS
D.W. PRITCHARD, Johns Hopkins University, Graduate School,
Baltimore, Maryland 21218 (NONR)

The purpose of this study is: (1) to measure the turbulent velocities in estuaries and coastal waters corresponding to eddy scales of the order of centimeters to 100 meters (2) to determine the statistical character of the turbulent velocity fluctuation in this scale range; (3) compare turbulent velocity spectra with theory; and (4) determine influences of boundaries, stability and wave induced motion on velocity spectra in this scale range. During the coming year, analyses of data from a field program in June 1967 will be completed and a field program in a Chesapeake Bay tributary will be undertaken to study spatial coherence and boundary effects upon turbulent eddies.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0070. THEORY OF LARGE-SCALE ATMOSPHERIC AND OCEANIC PROCESSES
JG. CHARNEY, Mass. Inst. of Technology, Graduate School,
Cambridge, Massachusetts 02139

The objective of this work is to continue to apply analytic, computational and experimental methods to the study of a large-scale atmospheric and oceanic processes with the intent of incorporating these methods into mathematical models of the general circulation. The work is subdivided into several parts: (1) tropical circulations - includes the development of a two-level numerical model for studying the symmetric Hadley ITC circulation and its interaction with the sea surface, wave-circulations at higher latitudes, problems of the growth of disturbances in the ITC, and the relation of cumulus convection to the large scale field of convergence in the boundary layer; (2) equatorial jets - includes work on a theory; and (4) determine influences of boundaries, stability and wave induced motion on velocity spectra in this scale range. During the coming year, analyses of data from a field program in June 1967 will be completed and a field program in a Chesapeake Bay tributary will be undertaken to study spatial coherence and boundary effects upon turbulent eddies.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0071. OCEAN DYNAMICS EXPERIMENTS
N.P. FOFONOFF, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543 (N00014-66-C0241)

This is primarily a program of field observations and experiments. Its objective is to continue to apply analytic, computational and experimental methods to the study of the symmetric Hadley ITC circulation and its interaction with the sea surface, wave-circulations at higher latitudes, problems of the growth of disturbances in the ITC, and the relation of cumulus convection to the large scale field of convergence in the boundary layer; (2) equatorial jets - includes work on a theory; and (4) determine influences of boundaries, stability and wave induced motion on velocity spectra in this scale range. During the coming year, analyses of data from a field program in June 1967 will be completed and a field program in a Chesapeake Bay tributary will be undertaken to study spatial coherence and boundary effects upon turbulent eddies.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0072. OCEAN DYNAMICS EXPERIMENTS
N.P. FOFONOFF, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543 (N00014-66-C0241)

The objectives are: (1) to process and analyze data collected from field work in the Indian Ocean during the International Indian Ocean Expedition with respect to problems of physical oceanography; (2) to determine the circulation of the Western Indian Ocean in whole and in its parts, from the data at hand; (3) to make use of and extend the capabilities of computer techniques with respect to problems of physical oceanography; (4) to make use of and extend the capabilities of computer techniques with respect to problems of physical oceanography; (5) to perform analyses of data from previous expeditions and provide results in a form suitable for use by other research vessels such as the DISCOVERY, METEOR, DIAMANTINA and KISTNA. Data will be shared with other participants of the Expedition as they are processed and become available.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0073. STUDIES IN THE INDIAN OCEAN
A.R. MILLER, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543

The objectives are: (1) to process and analyze data collected from field work in the Indian Ocean during the International Indian Ocean Expedition with respect to problems of physical oceanography; (2) to determine the circulation of the Western Indian Ocean in whole and in its parts, from the data at hand; (3) to make use of and extend the capabilities of computer techniques with respect to problems of physical oceanography; (4) to make use of and extend the capabilities of computer techniques with respect to problems of physical oceanography; (5) to perform analyses of data from previous expeditions and provide results in a form suitable for use by other research vessels such as the DISCOVERY, METEOR, DIAMANTINA and KISTNA. Data will be shared with other participants of the Expedition as they are processed and become available.

SUPPORTED BY U.S. National Science Foundation

2.0074. GREAT LAKES RESEARCH - HARBOR CURRENTS
J.G. HOUSLEY, U.S. Army, Lake Survey, Detroit, Michigan 48226

Objective is to acquire data on winds, currents, waves, water-level fluctuations, atmospheric pressure variations, and lake currents in the vicinity of harbors in order to determine their effect on currents in harbors, and pollution hazards engendered by the lack of currents. Mathematical equations or models will be derived relating currents in harbors with their causative forces and harbor geometry. Flushing rates will be established. The results are applicable to the design or redesign of new and existing harbors, including approach channels. Currents were measured: 1964 in Calument, Racine, Muskegon, and Sturgeon Bay harbors; 1965 in Muskegon, and Buffalo harbors; and 1966 in Harbor Beach and Toledo harbors. Data and analysis of currents and associated variables in Little Lake Harbor, Lake Superior, was published in 1966. During FY 69 analysis of the data will be continued, and preparation of reports for the various harbors will be continued.

SUPPORTED BY U.S. National Science Foundation
2.0075, FLOW AND SALINITY IN THE HUDSON ESTUARY, NEW YORK

This research is part of the program of water resources investigations conducted by the U.S. Geological Survey in cooperation with the State of New York.

Purpose: To define the physical and chemical characteristics of the water in the estuary in order to provide a basis for management of this resource.

Method: River stage at each end of a reach (Poughkeepsie to Clinton) is continuously recorded. These time-synchronized stages are used with the power series method developed by Baltzer and Lai to compute tidal volumes. Water conductivity and temperature are continuously recorded at Poughkeepsie, Beacon, Peekskill and Peekmont. The conductivity data (a measure of salinity) will be related to tidal volume and movement and to fresh-water inflow as measured by several gaging stations on tributaries to the estuary.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey New York State Government

2.0076, PHYSICAL OCEANOGRAPHY IN OREGON SHELF AND SLOPE WATERS
J.G. PATULIO, Oregon State University, Graduate School, Corvallis, Oregon 97331

Study of the dynamics and the physical properties of the water over the continental shelf and slope off Oregon will be continued. Competence in using moored recording current meters and thermographs on the continental shelf and in the analysis of the time-series obtained has been acquired during the past two years.

It is proposed that the measurement program on the shelf be continued and expanded to allow 3-dimensional arrays of instrument strings to be used. This expanded program will allow determinations of the spatial scale of the upwelling phenomenon, temperature inversions, inertial current flow, etc. The static and the dynamic stabilities which influence mixing will be studied, particularly in the region of the temperature inversion. It is further proposed to extend the measurement program offshore to study the water above the continental slope. The continental shelf and slope waters are dynamically interesting because the upwelled water moving offshore meets oceanic water to form a front. The slope region is also where we expect the subsurface poleward flow that many workers think characteristic of a coastal upwelling region.

The longer time-series records will allow investigation of the response of the coastal regime to longer period atmospheric systems. Detailed descriptive statistical analyses will be made of all data. The feasibility of prediction will be studied. Construction of a numerical model for prediction will be made based on the vertical transfer functions obtained from the time-series measurements.

SUPPORTED BY U.S. National Science Foundation

2D. TIDES-SEA LEVELS-SEA STATES

2.0077, GRAVITY AND EARTH TIDES

Attempts to determine the difference, in amplitude and phase angle, between observed and theoretical earth tides will be made. Measurements of the long-period fortnightly tide and the earth's free vibrations will be obtained in Antarctica where undesirable noise from perturbations in the earth's rotation is minimal.

The research is of basic importance in determining (1) the physical nature of the materials forming the solid earth, and (2) the response of the solid earth to tidal forces. Such information has direct bearing on seismic wave propagation, tides in the open ocean, and the deformation of continental margins by ocean tides.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0078, INTERRELATIONS WITHIN THE PHYSICAL ENVIRONMENT
J.F. SAUR, U.S. Dept. of Interior, Biological Laboratory, Palo Alto - Stanford, California

The ultimate objective of the Ocean Research Program is to attain the capability of predicting the abundance and distribution of commercial fishes and thereby increase the efficiency of their harvest. This requires not only information on the state of oceanographic conditions, but also on the physical processes that bring about changes of the state of conditions as they occur with the passage of time. The interacting processes involved in a chain of events will determine the magnitude, time lags and persistence, all of which are pertinent to prediction. Knowledge of the processes leading to the event will also provide insight as to their effect on the biotic community supporting the fish population. For instance, the temperature of a region may be changed either by incursion of a different water mass or by an alteration of heat exchange across the air-sea interface. In the one case a new plankton community will be brought into the region and in the other a new set of conditions would be imposed on plankton community already populating the region.

The objectives of this project are to describe and to reach an understanding of the nature of the interrelationships occurring between parameters of the physical environment, that is, the magnitude and duration of changes, the time lags between changes in the parameters, and the interdependence between parameters. Primary effort under the project at this time is a study of variations of monthly mean sea levels and their relation to atmospheric conditions and density structure of the ocean.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

2.0079, A GLOBAL DIRECTORY OF TIDAL CONSTANTS
M.C. HENDERSHOTT, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

All available tidal constants derived from observations at coastal and island stations are being collected into an updateable directory written on magnetic tape, from which the constants over an arbitrary coastal on island arc may be extracted in the form needed in constructing cotidal maps.

SUPPORTED BY Alfred P. Sloan Foundation

2.0080, OCEAN WAVES AND TIDES
W.H. MUNK, Univ. of California, Graduate School, San Diego - La Jolla, California 92038 (NON)

The objective of this investigation is to study tides in the open ocean and concurrently, temperature variations and water motion near the sea bed. The program includes the development of instrumentation and field measurements. During the coming year, a field experiment will be conducted to determine the horizontal coherence of tidal currents and long waves immediately above the bottom in deep water. The thermal and velocity structure of the benthic boundary layer also will be investigated and methods for analyzing time series will be improved.

The Navy is embarked upon a deep ocean technology program designed to improve man's capability to work and install equipment on the ocean floor. In addition, sound propagation is affected by physical variations in the deep ocean waters. This effort will provide knowledge of the variations and causes of such variations pertinent to these problems.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0081, STUDIES OF BARACLINIC TIDAL MOTIONS ON THE CONTINENTAL SHELF OF THE EASTERN UNITED STATES
P.P. NILER, Nova University, Graduate School, Fort Lauderdale, Florida

Large baroclinic tidal motions occur in the Florida Straits and there is evidence for their existence also on the Blake Plateau. It is proposed to carry out a theoretical and experimental analysis to explain their nature and cause. The theories will be related to existing field measurements and new experiments will be designed to test the theories in a critical manner.

SUPPORTED BY U.S. Dept. of Defense - Navy
2. WATER MOTION

SUPPORTED BY U.S. National Science Foundation

2.0082, THE NET EFFECT OF WIND ON RECREATIONAL TIDAL STREAMS IN FLORIDA
D.H. MOREAU, Univ. of Florida, School of Engineering, Gainesville, Florida 32601

Wind stress acting upon the surface of these shallow tidal rivers and their embayments along portions of the Gulf coast of Florida at times other than during storms can bring about water level changes as great as those resulting from the periodic tide products. The development of a method for determining the net effect of wind and astronomical tides upon water levels in these tidal rivers is becoming increasingly important with respect to their influence upon recreational use of the river and upon the aquatic environment of the rivers and their estuaries.

The basic data for this correlation study will be that which has been recorded at Cedar Key, Florida for the period July 1, 1963 through June 30, 1964.

It is proposed that the data be subjected to a time-series analysis consisting of the resolution of the data into two components: (1) an oscillatory series representing astronomical tidal action, and (2) a residual series representing the effect of wind and possibly the interaction of wind and astronomical tidal action.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rch
University of Florida

2.0083, SPECTRAL ANALYSIS OF TIDAL CURRENTS
V. GRAEFE, Univ. of Hawaii, Hawaii Inst. of Geophysics, Honolulu, Hawaii 96822

Current data that had been collected under the direction of K. Wyrtki near the Hawaiian Islands were analyzed to determine the direction from which the diurnal and semidiurnal tides approach Hawaii. Fifteen series of current data, each covering a period of three to four weeks, had been obtained at ten locations near the Hawaiian Islands, and two series near Palmyra Island. The data of each series were first subjected to a linear filter that rejected all frequencies lower than 1 cph or higher than 2 cph, and then a Fourier analysis was performed. The diurnal and semidiurnal Fourier components were used to compute idealized current ellipses for the two frequencies, and the phase differences between the Fourier components of the current and the corresponding Fourier components of the sea level were also determined.

The tentative results of this study are as follows for the Hawaiian Islands: (1) the diurnal tide approaches the islands from a northeasterly direction; (2) the semidiurnal tide from a southwesterly direction. The general flow pattern of the tidal currents between the islands can be determined with a fair degree of accuracy; at certain times, however, the pattern seems to be widely distorted, probably by superimposed long-period currents (perhaps eddies caused by the North Equatorial current).

The results for Palmyra are inconclusive, probably because various diurnal and semidiurnal tidal waves, from different directions, arrive with slightly different frequencies at Palmyra. The available time series are too short to permit discrimination between the various diurnal or semidiurnal constituents, hence the method will give conclusive results only if all major diurnal and all major semidiurnal waves arrive from approximately the same direction.

SUPPORTED BY University of Hawaii

2.0084, USE OF TIDAL POWER AND OTHER OCEAN ENERGY SOURCES
R.H. CHARLIER, Northeastern Ill. State Coll., Graduate School, Chicago, Illinois 60625

Survey all likeable sites for harnessing tidal power. Establish feasibility (engineering, financial costs, productivity, inclusion in national grid, consumers market) of various geographical locations. Examine potential of other energy sources from ocean.

*Only support received was a French Francs 500 grant for library research from the Institut Oceanographique de Monaco (J. Y. Cousteau, Director) in May 1968.

SUPPORTED BY No Formal Support Reported

2.0085, LONG-PERIOD WAVES
H.M. STOMMEL, Mass. Inst. of Technology, Graduate School, Cambridge, Massachusetts 02139 (NONR)

This is a field operation to be carried out near Bermuda. Using newly available differential pressure sensing devices mounted on bottom, it is expected that instantaneous sea level will be resolvable to better than one centimeter at depths exceeding 3000 meters. Bottom-mounting of arrays in relatively shallow water should yield spatial information about propagating periodic surface disturbances of periods less than the semi-diurnal tidal period. Statistical techniques should permit amplitude resolution to better than one millimeter. Immediate goals include in-house sensor evaluation, development of suitable control and recording equipment, packaging, and field testing.

Understanding, based on field measurements, of the spatial distribution and frequency of occurrence of propagating long-period surface fluctuations is fundamental to our knowledge of variability in the ocean.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0086, GREAT LAKES RESEARCH - WATER-LEVEL DISTURBANCES
J.G. HOUSLEY, U.S. Army, Lake Survey, Detroit, Michigan 48226

Water-level disturbances are caused by various forces, including astronomical tides, wind tides, surges, and seiches. Research investigates the formation of these water-level disturbances, their patterns and distribution over the lakes, and their effects on water levels in harbors and in rivers. The derived mathematical models of water motion and its relationship with causative forces are used to develop methods of forecasting dangerous long-period waves and currents, and changes in depths and quantities of water.

A set of 16 water-level recorders was in operation on Lake Michigan in 1964. The data have been reduced, and spectral analysis is in progress. Data from 22 water-level gages in Lake Erie will be used to investigate three-dimensional oscillations of Lake Erie in FY 65.

A contract for theoretical investigation of three-dimensional seiches in Lake Erie is in progress.

SUPPORTED BY U.S. Dept. of Defense - Army

2.0087, TIDAL FLOWS IN RIVERS AND HARBORS
J.B. TIFFANY, U.S. Army, Waterways Experiment Sta., Vicksburg, Mississippi

The committee known as the Committee on Tidal Hydraulic Research has been established consisting of civilian employees in various Corps of Engineers Division Offices, District offices, and laboratories who are familiar with tidal theories and tidal problems. The objectives of the Committee are to recommend programs of study, investigation, and research designed to provide the knowledge necessary to arrive at adequate solutions for the engineering problems associated with tidal phenomena, and to render such consultations and advice on specific problems in tidal waters as may be requested by various offices of the Corps of Engineers.

SUPPORTED BY U.S. Dept. of Defense - Army

2.0088, TIDAL DISCHARGE RESEARCH, NEW JERSEY
A.C. LENNO, U.S. Dept. of Interior, Water Resources Division, Trenton, New Jersey

This research is part of the program of water resources investigations conducted by the U.S. Geological Survey in cooperation with the State of New Jersey, the Corps of Engineers, and the Federal Water Pollution Control Administration.

Purpose: To develop and improve techniques for the collection of tidal stage, discharge, quality of water, and sediment data.

Methods: Synchronous records of tidal stage have been collected by digital recorders at estuary stations, computer programs used to compile these records. Discharge equations have also been programmed and calibration has been based on observed
2. WATER MOTION

for investigating correlations between fluctuations in scattering and the seasonal variability of the oceanographic environment off the coast of Oregon.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0092, DIRECT AND INDIRECT DETERMINATION OF OCEANIC WATER MASS MOTION ON ALL SCALES
J. FATTULLO, Oregon State University, Graduate School, Corvallis, Oregon 97331

Objective: The efficiency of search and rescue, underwater construction and other operations can be strongly influenced by the character and motion of water masses in the operating area. This research seeks to know and understand water mass movements in the ocean from small-scale and short-lived turbulence to large-scale and steady-state ocean currents in the NE Pacific. Such knowledge and understanding is an important step (i) in learning to predict conditions at a given time and place, and (ii) in the future development of new operational systems, vehicles, or platforms.

Approach: Ships and buoys will be used to continue a detailed description of temperature, salinity, and current conditions and their variations with time off the NW coast of the U.S. Current meter data obtained from bottom moored current meters, from dye diffusion field experiments, and from tracking drogues which drift with the currents. The collection and analysis of these data will be improved by the development of an increased hydrographic capability and by the use of modern techniques of signal analysis and statistics. In addition, free-diving deep current meters and a newly designed spar buoy for collecting marine meteorological data will be developed and tested.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0093, DYNAMICS OF INTERNAL WAVES AND TURBULENCE IN THE THERMOCLINE
G. M. CORCOS, Univ. of California, School of Engineering, Berkeley, California 94720

To elucidate the dynamics of the processes in the ocean which result in the transfer of the energy originating in larger scale motion to smaller scale agitation and which intensify and propagate vertically the gradients of salinity and of density found in thermoclines.

Propose to start with the study of elementary flows related to these processes and to carry out these studies by creating stratified flows in a heated tank.

A satisfactory scheme for producing a density stratification qualitatively typical of a thermocline and a shear distribution typical of a shear zone between two currents on either side of a thermocline has been devised for which the Richardson number range is appropriate for the study of infinitesimal and finite instabilities.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

2.0094, WATER WAVE DOCUMENTATION
J. E. McNIEL, General Motors Corporation, Goleta, California 93017

This contract requires AC-DRL to perform oceanographic research tasks as specified. The AEC sent to AC-DRL in FY 1968 45 Data Logging Systems (individual units for measuring wave heights) with their associated computer and data reduction system for over haul, storage and maintenance. At some future time AC-DRL may be called upon to emulate these units at various Pacific Ocean locations and to operate the data recording network. In April and May 1968 12 of these units were emplaced off Catalina Island as a practice operation. In June several practise emplantments of the large buoy and anchor were made from a Navy ship in 4000 feet of water using special launching gear developed at AC-DRL.

SUPPORTED BY U.S. Atomic Energy Commission
2. WATER MOTION

2.0095, GENERATION, PROPAGATION, AND COASTAL EFFECTS OF TSUNAMIS
V.A. YANOBI, Calif. Inst. of Technology, Graduate School, Pasadena, California 91109

This research will be concerned with the experimental and theoretical study of the generation, propagation, amplification of tsunamis (earthquake generated sea waves) and resulting effects on the coastline. The program will involve theoretical and experimental studies which will be concurrent and lend support to each other. Specific areas to be initially examined are:

Experimental - (a) The propagation of tsunamis and the resultant run-up on beaches of small slope and on shore-structures with steep faces. (b) The transient response of harbors to tsunamis.

Theoretical - (a) Generation of tsunamis due to displacements of the ocean bottom for several typical modes of the bottom motion. (b) Propagation of two- and three-dimensional tsunamis through an ocean of arbitrary bottom configuration. (c) Steepening of waves in water of decreasing depth and width variations, including the final stage of run-up on beaches. (d) The wave forces experienced by bodies of simple shapes, both floating and submerged, as well as fixed obstacles.

SUPPORTED BY U.S. National Science Foundation

2.0096, INTERNAL WAVE RESEARCH
O.S. LEE, U.S. Navy, Undersea Warfare Center, San Diego, California 92140

Objective: To determine those environmental factors affecting the acoustical uses of the ocean; to observe, define and develop theory to predict the effects of variability in properties of the ocean surface layers affecting sound speed, water motion (orbital, tidal turbulence, internal waves) and other dynamic processes; to investigate experimental developments and theory of internal waves in the ocean.

Approach: Make current reviews of progress in internal wave research; establish criteria for experimentation and analyze data in the light of wave theory and plausible models of the medium; record time-series observations at fixed points in space and at different geographical locations by use of a retrievable buoyed data system; invite capable scientists to participate in analyses of data.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0097, WAVES
W. KRAUSS, Univ. of California, Graduate School, San Diego - La Jolla, California 92038 (NONR)

This investigation is intended to study the nonlinear interaction of surface and internal waves and the effect of this process upon oceanic temperature structure. An experiment is to be undertaken to verify a previously developed theory of nonlinear interaction. A theoretical study also is to be undertaken to explain the existence of domes observed in isothermal surfaces by thermistor chain data in the North Pacific.

This is part of the Navy's oceanography program aimed at obtaining fundamental knowledge of the oceanic environment for the needs of naval forces and should provide information that will contribute to the development of thermal structure and environmental forecasts.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0098, WAVE AND SURGE ACTION STUDY FOR LOS ANGELES-LONG BEACH HARBORS
B.W. WILSON, Science Engineering Assoc. Inc, San Marino, California

This study reviews the phenomenon of surge action in San Pedro Bay, California, and in the basins of Los Angeles and Long Beach Harbors. It considers all observations, measurements and analyses made in previous studies and supplements them with new analyses of both past and recent wave recordings. In general these analyses are intended to document new wave frequencies and amplitudes of long period wave activity. Ship behavior and surge damage to wharves and shipping are correlated with the disturbances. The natural oscillating characteristics (eigen frequencies and mode shapes) of the continental shelf and oceanic basins offshore, of San Pedro Bay within the break-water and of the harbor basins are determined by solution of hydrodynamic equations for both mathematical and semi-exact numerical models. These procedures are extended to proposed new harbor basins. Necessary requirements of hydraulic models to simulate the conditions are considered. Finally, the report deals with an instrumentation system design for securing additional field data on long wave heights and currents throughout the harbors.

SUPPORTED BY U.S. Dept. of Defense - Army

2.0099, INTERNAL WAVE STUDY
C.A. GRISCOM, General Dynamics Corporation, Groton, Connecticut

This empirical study will investigate the relationships between internal waves and tidal motions over a continental shelf and the relationship of such motions to the temperature structure. Analyses will be made of existing data from an area southeast of Long Island collected by NavOceanO in 1959 and 1960. This work is expected to yield information on: (1) tidal motions and non-tidal drift at Texas Tower NO. 4; (2) tidal phase lag between Texas Tower NO. inshore station, the Scotland Lightship, and (3) relationship between state of tide and variance (including internal wave effects) in the temperature structure observed at Texas Tower No. 4.

The results from this study should contribute to the understanding of tidal and internal wave influences upon the thermal structure and, in turn, sound conditions in shelf areas.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0100, MECHANICS OF WAVE ACTION IN DEEP AND SHALLOW WATER

Studies are made in both laboratory and field to determine the characteristics of all types of waves (tsunamis, standing waves, harbor surges, etc., as well as normal ocean gravity waves), and the change in these characteristics as the waves approach shore over a shoaling bottom of varied characteristics, and finally break. Study also involves such phenomena as wave set-up and longshore currents which are generated by wave action. The mechanics and kinematics of these waves are also studied. Breakers and surf, and the reforming of waves after breaking are included in this study.

SUPPORTED BY U.S. Dept. of Defense - Army

2.0101, WAVE RECORDING AND ANALYSIS

A cooperative surf observation program with U. S. Coast Guard collects visual data on surf height, period, direction, and type of breaker at 16 U. S. Coast Guard stations. Statistical compilation is planned.

Recorded wave data are also collected at a number of locations along U. S. Coasts, and an automated system is under development.

Work is on a wave direction gage using a rotating sonic current meter as the indicator and a damped Rayleigh disc is underway.

Pressures are also planned for observation at a station at 70' and 30' directly under the present relay type gage to obtain data on changes in pressure as related to the depth of the gage and period of the waves.

Standardized analytical methods for engineering use are being developed. New types of gages (such as radar, sonar, and laser) are being studied.

SUPPORTED BY U.S. Dept. of Defense - Army

2.0102, FUNDAMENTAL PROBLEMS IN HYDRODYNAMICS
2. WATER MOTION

This study is part of a cooperative field experiment to be carried out in the North Sea during August and September of 1968. The groups involved in the experiment include National Institute of Oceanography in England and the Univ. of Kiel, German Sea-Watcr Service and German Hydographic Office in Germany. The experimental goals are to investigate: (1) the growth of wind waves; (2) interaction between wave-atmospheric fields; (3) processes involved in establishing a fully-developed wave spectrum; and (4) the loss of wave energy due to bottom friction. Measurements of atmospheric parameters and two dimensional wave spectra will be made with aid of buoys, ships and bottom-mounted sensors. Specific objectives of this work unit include obtaining measurements of wave spectra for different wind speeds, participation in overall analysis and interpretation, and documentation of the experiment and results.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0106, OCEAN WAVES AND STRUCTURE


This task involves the following investigations: (1) a small field program designed to interconciple ocean wave spectral data measured by the ONR telemetering oceanographic buoy and prototype type floating wave meter; (2) analysis of data collected by the principal investigator during the past five years at Texas A&M and under ONR contract. Specifically, the data will be analyzed to determine the characteristics of oceanic stratification from continuous temperature and salinity profiles.

A thorough knowledge of surface waves on the ocean is important to Naval operations. The internal structure of the ocean volume has important implications to the propagation of underwater sound.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0107, WAVE, CURRENT AND STORM SURGE RESPONSE TO EXTREME WIND CONDITIONS

R.G. DEAN, Univ. of Florida, School of Engineering, Gainesville, Florida 32601

This research will involve analytical investigations and field measurements to improve the general understanding of effects of extreme wind systems in causing waves, currents and storm surges in the near coastal waters.

The program will include a comparison of measured field quantities with predictions based on realistic numerical models. On the basis of differences between measured and predicted quantities, the relationships governing the generation of waves, currents and storm surges will be refined and re-evaluated by subsequent sets of measurement-prediction tests. Special purpose laboratory investigations may be conducted in an existing wind-wave tank if deemed advisable.

SUPPORTED BY U.S. National Science Foundation

2.0108, LONG PERIOD WAVES

J.A. PURPURA, Univ. of Florida, School of Engineering, Gainesville, Florida 32601 (NONR)

The purpose of this study is to investigate the penetration into narrow fjords of long period waves, having periods ranging from minutes to hours. It is a cooperative program with the Icelandic Government, which has installed and maintains sea level recorders in Eyafjordur. A selected set of recorded data is to be examined to determine auto- spectra and cross-spectra and the results interpreted hydrodynamically in terms of reflection, transmission, amplification, etc.

These studies are important to shore installations which are subject to storm tides and waves and to damage from tsunamis. An understanding of the effect of harbor shapes and sizes on altering wave shapes and sizes will help in selecting building sites and in predicting storm damage.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0103, WAVE GENERATION

P.S. DELEONIBUS, U.S. Navy, Oceanographic Office, Washington, District of Columbia

Objective: To construct a turbulent wind wave generation model based on simultaneous measurements of surface shearing stresses and the directional wave spectrum. Such simultaneous measurements will attempt to provide experimental background required to reconcile proposed wave generation theories with observed turbulent transfer of momentum.

Approach: Surface shearing stresses and wind profiles will be measured from an outrigger probe at Argus Island 'tower' by 'eddy correlation' and will be augmented by AGOR ship estimating stress downwind from the tower by 'dissipation' techniques. Directional wave spectra will be recovered from surface wave profile data obtained by 'star flight' patterns flown over the sea surface using an airborne wave profiling device. All three component measurements will be made simultaneously during steady state, high wave conditions, preferably after the passage of a well-developed cold front. Wind stress estimates through 'dissipation' will be used during BOMEX.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0104, NUMERICAL WAVE PREDICTION

P.S. DELEONIBUS, U.S. Navy, Oceanographic Office, Washington, District of Columbia

Objective: Develop deep and shallow water wave models to provide automatic forecasts of wave height and directional spectrum in the North Atlantic, North Pacific and for the South China Sea.

Approach: Recent advances in numerical deep water wave prediction technique indicate a militarily useful extension of these models into shallow water and coastal regions. Two approaches are being considered: a linear model developed by NYU and a non-linear model which employs radiative transfer equations are being extended into shallow water. Wave sensors for use aboard ships, aircraft, towers, and in shallow water areas are being developed for use in verifying these models. The sensors and techniques would also be used operationally to input wave data into forecasting models.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0105, OCEAN WIND WAVE GENERATION AND DISSIPATION


To conduct investigations on problems such as (1) Internal waves produced by a body of revolution moving in density-stratified liquid to a source or sink impulse; (2) Interaction between long waves and superposed short waves; (3) Damping of shallow-water wave—summary of available information; and (4) Mixing effect of raindrop impingement on a water surface. Problems (1), (2) and (4) are primarily experimental.

Quantitative information on problem (3) already exists but there is considerable need for collection, re-analysis and re-evaluation. a. Problem (1) has specific application to underwater ordnance and atmospheric waves; problems (2) and (3) can be applied to wave ass surf forecasts; and problem (4) is useful in several areas, particularly reservoir hydraulics. This project continues NBS work on the development and application of various measurement techniques to the solution of important hydrodynamic problems.

Problem (1) involves the measurement of internal waves generated by moving bodies and other impulses. Additionally, it is necessary to develop the corresponding theory, which has proved difficult, particularly in the case of problem (1). In problem (2), theory is developed in literature, but our measurements on complex wave behavior under controlled conditions have never been made. Problem (3) involves extensive literature search and information evaluation, while problem (4) will involve primarily photographic observations along with some analytical treatment.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.
2. WATER MOTION

2.0109, WAVE MEASUREMENT IN THE OPEN OCEAN
K. WARSH, Florida State University, Graduate School, Tallahassee, Florida 32306

Measurement, digitization and magnetic recording of a directional wave spectra in the open ocean from a spar buoy by means of resistance wire waves and accelerometers. The same buoy is also used to measure, digitize and record wind profiles.

SUPPORTED BY Florida State University
U.S. Dept. of Commerce - E.S.A.

2.0110, AN ANALYTICAL AND EXPERIMENTAL STUDY OF THE EFFECTS OF INTERNAL WAVES
M. C. RSTEN'S, Georgia Inst. of Technology, School of Engineering, Atlanta, Georgia 30332

The development of, the geometry of, and the drag exerted by bed forms (dunes) which occur on the sea bed under first-order Stokian waves has been studied experimentally in an oscillatory-flow water tunnel. Three series of runs were performed with a different bed material in each series—0.297 mm glass beads, 0.585 mm Ottawa sand, and 0.185 mm Ottawa sand. Total amplitude of the oscillating water was constant during each run and was varied throughout the range from 0.25 ft. to 3.0 ft. for each series of runs. A final report for Contract DA-49-055-CNV-1821 (Georgia Institute of Technology) was issued in September 1967. Publication as a Technical Memorandum of the Coastal Engineering Research Center, U. S. Army Corps of Engineers is pending.

SUPPORTED BY U.S. Dept. of Defense - Army

2.0111, TSUNAMI RUNUP EXPERIMENTS ON A SCALE MODEL OF OAHU
W.M. ADAMS, Univ. of Hawaii, Hawaii Inst. of Geophysics, Honolulu, Hawaii 96822

This research will experimentally determine the relationship between wave height and ramp at the shore to save heights at distances offshore for the entire island periphery under different tsunami approach directions. This data will be compared to theoretical predictions and past records to develop a more accurate forecast system thus ensuring more positive cooperation of the public with authorities in the event of major tsunamis.

SUPPORTED BY U.S. National Science Foundation

2.0112, MEASUREMENT OF SURGING IN KUHIO BAY, HILO HAWAII
W.M. ADAMS, Univ. of Hawaii, Hawaii Inst. of Geophysics, Honolulu, Hawaii 96822

Pressure gauges have been installed at a depth of about 20 feet on pilings of the piers 1 and 2 adjacent to the turning basin in Kuhio Bay. The purpose of this field instrumentation is to permit measurement of the pressure waves for estimating the water motion in the period ranges 8 to 30 seconds for one gage per pier 1 and period range 3 seconds to 2 minutes at 2 gages under pier 1. These pressure recordings are only made during periods of surging and occasional background control time intervals. Recording is for 12 hour duration on a digital tape transport and, for the high frequency trace, real time analog chart. The digital records are filtered and played back on a computer facility using IBM 7040, IBM 360 model 50, and IBM 1401. The results of the filtered digitized data will be presented on a computer plotter.

These data are supplied to the Army Corps of Engineers.

Conjointive study has developed the procedure which predicts the occurrence of surge, as defined by historical notes of the harbor master, and is based on correlation of the harbor master records with meteorological weather maps.

SUPPORTED BY U.S. Dept. of Defense - Army

2.0113, HIGH FREQUENCY WAVES
L.F. MCGLDREDK, Univ. of Chicago, Graduate School, Chicago, Illinois 60637 (NONR)

This research is concerned with theoretical and experimental investigations of phenomena associated with high frequency (large wave number) random wave spectra. The work is concentrated on (a) wave spectra at high frequencies; (b) interaction between surface waves and turbulence in the water itself; (c) resonant surface wave interactions resulting in energy transfer; and (d) development and refinement of wave measuring apparatus. During the coming year, experimental measurements of resonant interactions are expected to be completed and spectral measurements of a random high frequency wave system are to be made.

This project is part of the Navy's broad program in oceanography being supported to better understand its operating environment. Knowledge from this project should aid the development of better wave forecasting methods required to support a variety of fleet operations.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0114, AIR/SEA INTERACTION STUDY
B. KINSMAN, Johns Hopkins University, Graduate School, Baltimore, Maryland 21218 (NONR)

Research under this task is concerned with: (1) the generation and growth of wind waves; (b) the interaction of opposing wind waves and swell; (c) convective effects of wave spectrum transformation; (d) the effect of waves on the near surface, vertical wind profile, and (e) the erosion of the thermocline by motion associated with wind waves. The program during the coming year includes laboratory studies of the processes involved in energy and momentum transfer to short surface waves and the detailed nature of entrainment processes in the turbulent mix layer of the ocean; it also includes the development of instrumentation and data analyses techniques for use in field programs on the study of wind wave generation.

Knowledge of the mechanism of wave generation would permit computation of two dimensional spectra of short crested seas. Forecasting of mixed layer depth would be helped by understanding the mechanisms of thermocline formation.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0115, OCEANIC INTERNAL MOTIONS AFFECTING OPERATIONS
C.I. WUNSCH, Mass. Inst. of Technology, Graduate School, Cambridge, Massachusetts 02139 (NONR)

This task is directed toward understanding density variations in the oceans and the subsequent effect of those variations on operations. In addition to the benefits derived from a better understanding of effects of internal waves, this work should provide engineering knowledge of motions of deep-sea cable arrays. Such information has direct applicability to many naval missions involving long-term deployment of buoyed cables.

This is principally a field experiment designed to sense and record internal waves in order to obtain a better understanding of the role played by these waves in ocean variability. A fixed horizontal cable array will be deployed at mid-depth near Bermuda. Cable motions will be measured, analyzed, and compared with simulated cable motions obtained by numerical modeling. From this cable, time series measurements of temperature will be used using thermistors; supplementary velocity measurements will be made with internally recording current meters suspended from taut-wire buoy systems. The data will provide a first step in measuring directly the horizontal coherence, directionality and spectral distribution of internal waves. Supporting engineering studies and modeling of internal waves will be carried out.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0116, ISLAND-CURRENT INTERACTIONS
C.I. WUNSCH, Mass. Inst. of Technology, Graduate School, Cambridge, Massachusetts 02139 (NONR)

This is a study of large-scale steady or periodic motions of the ocean. It will involve use of the large rotating tank at WHOI for experimental work and the analysis of existing observational data. Specifically, this study is intended to try to understand the interaction of an island with its environment. The field of motion around an isolated oceanic island is an extremely complicated

44
function of time undergoing large-amplitude time variations on
many scales. The first effort will be to understand how typical of
mid-oceanic conditions are those in the vicinity of an island.

This study is intended to gain an understanding of the
changes of oceanic structure due to islands, which are, of course,
prime operational sites. Such understanding might aid in predic-
tion of the sound propagation field as well as the time changes of
major currents in the vicinity of islands.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0117. PROPAGATION AND REFRACTION OF OCEAN
WAVES IN NEAR SHORE REGIONS
J.G. HOUSLEY, U.S. Army, Lake Survey, Detroit, Michigan 48226

Objective: Predictions of ocean wave conditions are needed
by naval forces in the conduct of logistics and salvage and rescue
operations in nearshore regions. This theoretical investigation of
the study of ocean wave propagation in water of variable depth
should further the present knowledge of the modification of
ocean waves as they progress from deep water to the shore. Such
knowledge should contribute particularly to the improvement of
methods for predicting wave conditions in the nearshore regions.

Approach: Mathematical methods will be employed to
develop theories to explain the propagation of finite amplitude
waves in water of variable depth and also provide a means for cal-
culating the height of waves at any given location and time. A
non-linear ray theory is to be synthesized from an improved ver-
sion of ray theory for variable depth effects and from non-linear
mechanics methods used for determining finite amplitude effects.
The analytical work is to be supplemented by numerical calcula-
tions.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0118. GREAT LAKES RESEARCH - LAKE WAVES
J.G. HOUSLEY, U.S. Army, Lake Survey, Detroit, Michigan 48226

The generation, propagation, and decay of waves in the
Great Lakes are being investigated and correlated with wind
speed and resulting wind stress, wind direction, and lake
geometry. The characteristics of waves, including the expected
maximum height given locations, will be established; wave cli-

45

2. WATER MOTION

A better understanding of energy regimes and correlated
changes in shore conditions will improve the reliability of predic-
tions of coastal environmental properties.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0120. WHITECAPPING
E.C. MONAHAN, Hobart & William Smith College, Graduate
School, Geneva, New York 14456

The purpose of this study is to investigate the onset of
whitecapping as a function of wind speed, atmospheric stability,
and water temperature and determine the growth rate of whitecap
concentration as a function of these parameters. During the com-
ing year, an observational program of whitecaps will be con-
ducted in the North Atlantic from research vessels and fixed plat-
forms. The reduction of whitecap photographs and their analysis
with respect to observed meteorological conditions is to be un-
tertaken. A laboratory tank experiment simulating salt water
whitecaps is to be undertaken to compare salt water and fresh
water characteristics.

Knowledge from this basic study of the air-sea interface is ex-
pected to further the understanding of the transfer of energy and
matter across the interface and also further the development of
wave forecasting for a variety of operational needs.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0121. HIGH FREQUENCY OCEAN WAVES
W. MARKS, Oceanics Incorporated, Hicksville - Plainview, New
York 11803 (NONR)

High frequency wind generated ocean waves are being stu-
died with respect to their role in the generation of wind waves and
also radar backscatter characteristics of the sea surface. Their
directional spectra are being derived from stereo-photographs and
correlations are being established between statistics of these
waves and of the radar sea return recorded simultaneously by
aircraft.

The results from this task should contribute to the improve-
ment of operational wave forecasts.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0122. THEORETICAL STUDIES OF TSUNAMI
PROPROPAGATION
A. CLARK, Univ. of Rochester, School of Engineering, Rochester,
New York 14627

The object of the work is to learn more about the effects of
variable ocean depth on the propagation of tsunamis. The plan of
procedure includes a two-fold theoretical attack on the problem:
(i) the development and application of a valid statistical theory,
and (ii) the detailed calculation of individual scattering events for
certain simple bottom topographies. The ultimate aim of much
tsunami work is to increase predictive capabilities, especially with
regard to wave amplitude. From this point of view, the sig-
nificance of the present work would lie in its contribution to an
understanding of diffraction of wave energy due to variable
depth. The work may also have significance from the point of
view of random wave theory, since it appears that present statisti-
cal theories will have to be improved if they are to cover the range
of parameters of interest in the tsunami problem.

SUPPORTED BY U.S. National Science Foundation

2.0123. EXPERIMENTAL STUDY OF THE INTERRELATION-
ATIONS BETWEEN WIND-WAVE PROPERTIES
G.F. BEARDSLEY, Oregon State University, Graduate School,
Corvallis, Oregon 97331

A preliminary investigation of the relative importance of tur-
bulence and wave motion as mixing agents will be made in the
upper ocean. A secondary outcome of this program will result
from the simultaneous measurement of the pressure and velocity
fields under a random sea. From these data, it is hoped to deter-
mine the degree to which these fields and their statistics can be
calculated using a knowledge of the surface wave height and
linear and second order wave theory.

SUPPORTED BY U.S. National Science Foundation

45
2. WATER MOTION

2.0124, AN OPTICAL METHOD OF MEASURING THE FORM OF THE FREE SURFACE OF A FLUID
H. SCHENCK, Univ. of Rhode Island, School of Engineering, Kingston, Rhode Island 02881

This research will deal with the development of a method of studying the speed, form, and character of waves and other disturbances on the surface of a fluid by detecting the angle of refraction of a collimated beam of light at the surface using one or more submerged photocells. It is anticipated that the developed method will have applications in many areas of fluid science including physical oceanography, theoretical hydrodynamics, ship motion, estuarine, stream and river morphology, and other related fields. The theoretical basis for the method is discussed in a July 1957 Optical Society of America Journal, 'On the Focusing of Sunlight by Ocean Waves.'

SUPPORTED BY U.S. National Science Foundation

2.0125, FIELD DETECTION AND MEASUREMENT OF INTERNAL WAVES
M. RATTRAY, Univ. of Washington, Graduate School, Seattle, Washington 98122 (NONR)

Objective: It is desired to predict the propagation of sound in the ocean, the operational Navy has need of quantitative descriptions of physical processes which affect the density distribution and thereby the sound speed distribution. In support of that need, this research has as its scientific goal the fuller understanding of waves (called internal waves) propagating within the ocean which disturb the density distribution. For internal waves generated by tidal forces near the continental shelf edge and propagating out to sea: (1) the distribution of motions (and thus energy) with depth will be measured, and (2) the adequacy of present theories to predict the propagation of internal waves will be tested.

Approach: Using digital computers to simulate the expected behavior of waves within the ocean the site for a field experiment will be selected. At the locations chosen observations of temperature versus depth will be repeated at closely spaced intervals (order of one minute) for a period of about 15 days duration. These data will be stored and analyzed with the aid of digital computers. Available analysis techniques should enable the investigators to extract from the temperature variations the associated velocity and energy variations.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0126, THEORETICAL ACOUSTIC-GRAVITY WAVE PROPAGATION
D.G. HARKRIDER, Brown University, Graduate School, Providence, Rhode Island 02912

Objective: Four research projects will be investigated to understand the propagation of acoustic-gravity waves in the atmosphere. The first project will determine the quantitative relations between over-pressure and yield at various source and detector altitudes in the frequency and time domain for a wide range of source yields for various sources and detector altitudes will be calculated. The second project will evaluate the necessity for a more complicated source by comparing the simple-point source to the observed direct wave at close-in distances to a nuclear explosions. The closed form of the green function will enable one to calculate by fourier synthesis the far field pressure pulse generated by nuclear explosions and the direct wave in the region surrounding the source. The third project will investigate the epicenter displacement hypothesis as a source mechanism for some of the detectable air waves associated with seismic events. Surface sources of this type can be used to model volcanic eruptions and sudden vertical surface motion associated with earthquakes and underground nuclear explosions. The fourth project will make use of the previously developed source excitation theory of acoustic-gravity waves to investigate the generation of sea-waves by atmospheric disturbances and the formation of tsunamis by oceanic earthquakes.

SUPPORTED BY U.S. Dept. of Defense - Air Force

3. METEOROLOGY

3.0001, ANALYSIS OF THE MARINE LAYER - A MESO METEOROLOGICAL STUDY
S.R. FRANK, Aerometric Research Foundation, Goleta, California

The project's specific aim is to define and model the Marine Layer of the atmosphere in terms of its dispersion and transport characteristics. In order to do this a systematic network of weather observers has been established in the Santa Barbara Channel Area through the cooperation of Federal, State, and private organizations. Using these observations for basic flow analysis of the area, a program has been established for the determination of heat sources and sinks of the ocean surface. The consideration for surface thermal modification of the overlying Marine Layer plus the distortion of flow due to orographic influences, has resulted in an integrated attack on the problem of potential dissipivity of the atmosphere. The program will involve utilizing a mobile 'turbulence sensor' (a portable tower) with wind and temperature stations, for fine scale determination of turbulence at specific locations during critical meteorological conditions. It is anticipated that use of this 'sensor' will result in quantitative definitions of orographic contributions to turbulence in the Marine Layer.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

3.0002, OCEAN DYNAMICS SEA AIR INTERACTION MODELS-MEDITERRANEAN
T. LAEVASTU, U.S. Navy, Postgraduate School, Monterey, California 93941

To determine those environmental factors affecting acoustical uses of the ocean; to categorize strategic areas into similar acoustical provinces; provide a foundation for medium and long range forecasting, incorporating correct sea-air interaction models which emphasize the dynamics of the surface layers. Study the sea-air exchange in the Mediterranean in relation to changes in the overlying air masses; to improve computation of exchange and establish physically correct numerical feedback models; investigate synoptic and seasonal behavior of oceanic fronts and their temperature and salinity structure; study the possible similarity of Moroccan and California regions, especially with respect to their response to driving forces (surface wind).

SUPPORTED BY U.S. Dept. of Defense - Navy

3.0003, TRANSPORT PROCESSES ACROSS AN AIR-WATER INTERFACE
R.L. STREET, Stanford University, School of Engineering, Palo Alto - Stanford, California 94305

The objective of this study is to verify or refute present interface process hypothesis and to discover additional facts about the air-water interface phenomena. It is proposed to make the following studies: (1) direct measurements of the mass, momentum and energy transfers across an air-water interface; (2) a comparison of measured results with estimates from theoretical and empirical formulae; (3) measurements and analyses of the statistical properties of the fluctuating flow properties in the surface boundary layer; and (4) an attempt to provide new descriptive concepts for the interface transfer as suggested by the above measurements and analyses.

The experimental measurements will be made in the wind, water wave research facility located at Stanford University. The facility is equipped with a centrifugal fan that causes a flow of air over a body of water and a mechanical wave generator.

SUPPORTED BY U.S. National Science Foundation

3.0004, OCEAN WAVES
C.S. COX, Univ. of California, Scripps Inst. of Oceanography, San Diego - La Jolla, California 92038 (NONR)

This task is concerned both with surface wind waves and with internal waves and associated causes of temperature variations in the ocean. The relationship between eddy stresses in an overlying
wind field, the average wind profile, the growth of wind waves and the partition of momentum between waves and currents is being studied in a laboratory wind-wave channel. The study of internal waves concerns the energy distribution according to frequency and also the vertical distribution of this energy. The layered fine scale of temperature structure in the oceans is being examined in order to interpret measurements of temperature fluctuations resulting from internal waves.

Improvements in the theory of wind-wave interaction are expected to contribute to improvements in the prediction of wave conditions. Studies of turbulence (including internal waves) in the ocean contribute directly to understanding time and space variations in sound propagation.

SUPPORTED BY U.S. Dept. of Defense - Navy

3.0005, OCEAN-ATMOSPHERE STUDIES WITH STABLE ISOTOPES AND DISSOLVED GASES
H. CRAIG, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

This research will cover the following areas of investigation: (1) The formation and mixing of deep and intermediate water masses, using deuterium, oxygen 18, and dissolved gases as additional oceanographic parameters together with salinity and temperature to characterize water masses and mixing process; (2) the exchange of water between the atmosphere and sea, using the variations in deuterium and oxygen 18 content of atmospheric water vapor and surface seawater over the oceans; (3) Experimental studies of the nature of the air-sea interface, based on equilibrium and kinetic isotopic fractionation effects in the transport and exchange of water across the interface; and (4) The carbon dioxide-dissolved oxygen system in the ocean, using gas chromatography at sea to measure concentrations and using the carbon and oxygen isotope ratios of these components as additional parameters.

SUPPORTED BY U.S. National Science Foundation

3.0006, LARGE-SCALE INTERACTIONS
J. ISAACS, Univ. of California, Graduate School, San Diego - La Jolla, California 92038 (NONR)

The purpose of this task is to investigate the nature of large-scale variations in oceanographic and meteorological conditions in the North Pacific and the interrelationships of the variations. Deep moored, unmanned instrumented oceanographic and meteorological stations will be used in arrays as the principal means of obtaining the necessary environmental data. During the coming year, two buoy clusters will be deployed north of Hawaii as a pilot study for the larger experiment. The collection and analysis of existing data for the North Pacific will continue and will be used both in the design of the overall experiment and in the interpretation of the resulting data.

Reliable prediction of environmental conditions at sea have long been a necessity for naval operations. The results of this task hold great promise for providing information and understanding of the environmental processes which control the changes in the oceans. This knowledge is necessary to the reliable prediction systems required.

SUPPORTED BY U.S. Dept. of Defense - Navy

3.0007, TOTAL HEAT FLUX MEASUREMENT WITH A TWO-WAVELENGTH RADIOMETER
E.D. MCALISTER, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

The objective of this work is to continue an investigation of the total heat flux measurement in the air overlying the ocean surface using a two-wavelength radiometer. It is anticipated that measurements accurate to within 5% of a known heat loss can be accomplished on the open sea.

The study will be divided into three major parts: (1) a laboratory study of factors determining heat flow; (2) a study of the relationship between the heat flow at sea and meteorological elements; and (3) a study of the variations of heat flow.

SUPPORTED BY U.S. National Science Foundation

3. METEOROLOGY

The laboratory study will establish the accuracy of the two wavelength radiometer (4.45 to 5.1 microns). It will offer a wealth of information upon which can be built an understanding of the mechanisms involved in heat transfer. It is recognized that it will be difficult to correlate the heat flow measurements with meteorological measurements due to the inability to measure meteorological variables accurately over the open sea. The varia
tional studies are aimed at determining differences in surface temperature due to distance from the shoreline and due to the diurnal cycle.

SUPPORTED BY U.S. National Science Foundation

3.0008, WAVE GENERATION BY THE TURBULENT WIND FIELD OVER THE SEA
R.W. BURLING, Univ. of British Columbia, Graduate School, Vancouver - British Columbia, Canada (NONR)

Sea surface conditions induced by local winds affect a variety of natural operations such as evaporation, sensible and latent heat exchange, and wave generation. The development of a capability to produce accurate predictions of wave generation processes and supplement the wind velocity measurements.

SUPPORTED BY U.S. Dept. of Defense - Navy

3.0009, ATMOSPHERIC-OCEANIC-GLACIOLOGIC INTERACTIONS IN THE ANTARCTIC
W.S. WEYANT, U.S. Dept. of Commerce, Research Lab., Boulder, Colorado 80302

The Polar Meteorology Group of the Air Resources Laboratory at ESSA will perform researches which are directed at providing a further description and explanation of the physical processes which occur in the Antarctic atmosphere. This will be accomplished through studies of 1) the nature and magnitude of energy and water exchange between the atmosphere and the underlying snow, ice or water surface; 2) the heat and mass budgets of the atmosphere -snow-ocean system which controls the Antarctic heat budget; 3) how the Antarctic heat budget is related to the overall terrestrial heat budget; and 4) the relationship of the general high latitude atmosphere circulation to the total planetary circulation. The data used in these studies will be recovered from the International Antarctic Meteorological Experiment at Melbourne, Victoria, Australia, the National Weather Records Center in Asheville, North Carolina, or direct from the records of any station, ship, or satellite engaged in high southern latitude meteorology.

As time permits special attention may be give to studies of 1) radiation balance and the net vertical and horizontal transport of sensible and latent heat, 2) ozone concentrations and the atmospheric circulation model, 3) circulation at all levels up through the stratosphere, and 4) temperature, humidity and wind profiles in the regions of the Antarctic convergence to learn about the effects of the convergence on the boundary layer of air masses.

SUPPORTED BY U.S. National Science Foundation
3. METEOROLOGY

3.0010, DEVELOPMENT OF PHYSICAL-NUMERICAL MODELS FOR STUDIES OF THE ATMOSPHERE-OCEAN PLANETARY BOUNDARY LAYER
J.P. PANDOLFO, Travelers Research Center Inc., Hartford, Connecticut

The present model represents a complex local theory for the study of the vertical structure, and temporal changes, characteristics of the atmosphere-ocean planetary boundary layer. The combined effects of boundary layer turbulence in stratified (humidity and salinity dependent) flow, advection by the mean velocity, mixing due to wind generated waves on the interface, and cloud-dependent radiative heating, are calculated iteratively in the mixed initial-boundary value problem represented by the model equations.

Experimental objectives during the past year included model evaluation and climatological supplement calculations for a region of the tropical oceans to be intensively observed next year. The model behavior successfully simulates some already measured characteristics of this region. The model also successfully simulates some recently observed general characteristics of this layer.

The models are now being generalized to include investigation of the horizontal structure of the boundary layer on several scales. Future work will make use of the intensive observational data to be obtained next year in these analyses. The series of projects began in FY '66, and is expected to end in FY '71.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

3.0011, MISCELLANEOUS SERVICES FOR FEDERAL AVIATION AGENCY (VISUAL RANGE)

To furnish measurement of the characteristics of fogs during the testing of visibility meters. To obtain data on fog variability, air-sea interface, for example. To furnish technical advice and assistance on problems related to the determination of visibility conditions at airports. This is assistance to other agencies utilizing facilities and knowledge not available elsewhere, NBS Mission Component 1.6.

Measurements of fog density and its variation with time and place will be made as required at the NBS Field Laboratory, Arcata, California. Technical advice and assistance will be supplied as requested.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

3.0012, EVAPORATION OF WATER

The principal objective of this project is to make a study of the feasibility and probable value of performing laboratory or other types of research for investigating the physical processes of evaporation. This project falls within the mission of NBS to conduct research on basic measurement techniques and instrumentation. It should lead to improved methods of measuring water vapor flux and evaporation, which in turn should assist meteorologists and hydrologists in measuring and predicting water losses due to evaporation over land and water.

The study will include: survey of technical literature, visits to laboratory and field facilities where evaporation research is being pursued, development of recommendations for suitable research programs and proposals for equipment and instrumentation.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

3.0013, EXCHANGE METEOROLOGIST WITH JAPANESE ANTARCTIC RESEARCH EXPEDITION

A study of the atmospheric boundary layer over the Antarctic Ocean will be conducted aboard the Japanese icebreaker, Fuji, by Mr. Weyant. Sponholz, the U.S. Exchange Scientist with the Japanese. The investigations will include (1) an examination of the effect of the Antarctic Convergence and the ocean-sea ice boundary on the overlying atmosphere, and (2) a comparison of the data for the lower 1000 feet of the atmosphere over the ocean, over the sea-ice and along the coast, with similar information obtained inland at Plateau Station (elevation 11,690'). The data will be obtained from sensors suspended from four kyosons towed from the stern of the ship. A modified radiosonde will transmit pressure, humidity, wind speed and temperature observations at a height of 1000 feet from the sensors to the ship.

SUPPORTED BY U.S. National Science Foundation

3.0014, RESEARCH AND COMPUTATIONS ON THE THERMODYNAMIC PROPERTIES OF AIR AND RELATED GASSE

XXA computer program for the NBS UNIVAC for the calculation of thermodynamic properties for a gas mixture such as air or hydrogen with other gases of up to tritium molecules has been prepared (except for general degassing) by modification and merging of two previous 5794 programs. A capability of free energy minimization as composition is changed by chemical reaction is provided. Transport property estimates with Enskog type density corrections can also be made. For polar gas pairs, a collisional integral increment between Lennard-Jones and Stockmayer values is used. Non-polar values are based on the exp-6 potential with alpha read in or based on the close approach behavior from theory, with the 1-exp-6 potential. The program has provision for up to six terms in a polynomial in the density representing ln(PV/RT) for each of the constituents. The temperature dependence is by series compatible with the Stockmayer potential. The constants required may be obtained via another program under development for fitting isotherm data. It fits second virial with 1, 1-2, 6 potential and extrapolates to high temperatures with rigid sphere relations for higher virials. Accepted critical constants can be fitted; provision is also made for later use of a singularity function in the critical region to fit liquid-vapor equilibrium data in using the main thermodynamic property program. In the absence of newly fitted PVT constants, it is possible to use old constants such as were used for B and C for some gases in NBS Circular 564 if their densities or molar fractions are low. Inter-intercic effects have been coded for another program and can be added here also. New theoretical estimates for negative ion effects have been derived. Spectroscopic constants for diatomic constituents have been studied with the view of improvement for high temperature calculations. New procedures for the theoretical analysis of spectroscopic constants for diatomic molecules have been devised.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

3.0015, BARBADOS OCEANOGRAPHIC AND METEOROLOGICAL EXPERIMENT
R. MORSE, U.S. Dept. of Transportation, Oceanographic Unit, Washington, District of Columbia

The Barbados Oceanographic Meteorological Experiment (BARBEX) is a comprehensive synoptic meteorological and air-sea interaction study to be conducted in the vicinity of Barbados Island during the summer of 1969.

Evaluation of momentum transfer, sinks and sources of vapor in the atmospheric system, wind system at sea and measurements of standard oceanographic variables, salinity and temperatures, as a function of depth will be made. The U.S. Coast Guard Cutter ROCKAWAY (WAGO 377) will participate in the program.

Other agencies participating are the Environmental Science Services Administration, Atomic Energy Commission, Bureau of Commercial Fisheries, National Aeronautics and Space Administration, National Center for Atmospheric Research, National Oceanographic Data Center and the National Science Foundation.

SUPPORTED BY U.S. Dept. of Transportation - Coast Guard
3.0016. AIR-SEA INTERACTION (WAVES)  
R.L. SNYDER, Nova University, Graduate School, Fort Lauderdale, Florida (N00014-67-A-0586-0001)  
This is research into processes of energy exchange between wind and ocean waves. It involves field measurement program at an experimental site in the Bight of Abaco. Three interrelated activities are involved: (1) studies of white caps as a possible mechanism for dissipation of energy put into the sea by wind; (2) measurement of wave induced pressure fluctuations in an effort to explain growth rates of wind waves; and (3) instrumentation of Abaco site for measurements of turbulent fluctuations in the water and interpretation of such measurements.  
An improved understanding of wind generation and decay of ocean waves will assist in the development of improved wave forecasting conditions. Improved knowledge of sea state conditions assists many naval operations.  
SUPPORTED BY U.S. Dept. of Defense - Navy

3.0017. EXPERIMENTS IN AIR-SEA INTERACTION INVOLVING SURFACE PRESSURE MEASUREMENTS  
E.B. KRAUS, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124  
The objective of this work is to carry out two separate but related experiments using the same location and instrumentation of internal waves in the lower atmosphere and the second deals with the measurement of the geostrophic and actual surface winds as a method of computing the stress at the air-sea interface.  
The first experiment is designed to test Bretherton's theoretical concept that wave groups and their propagation can be used to describe gravity waves that travel in the lower atmosphere associated with low level inversions. It is hoped that measurements of travelling perturbations of the surface pressure and the surface wind can be used to express the group velocity and the wave energy of the group. These quantities can be expressed as a function of the absolute frequency, the horizontal wave number components, the wind velocity and the local Brunt-Vaisala frequency. From the mean temperature and wind and temperature from nearby radiosonde stations as well as the records from the array of surface pressure transducers, information about the energy, frequency, and propagation of the wave groups in the atmosphere will be obtained.  
The second experiment is designed to clarify the observation that there is a wide divergence between the actual wind and the geostrophic wind near the sea surface. It is hoped that systematic, simultaneous recording of actual and geostrophic surface winds over the water will permit a derivation of a frequency-dependent empirical transfer function between the two vectors.  
SUPPORTED BY U.S. National Science Foundation

3.0018. TRITIUM IN HURRICANES  
G. OSTlund, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124  
The objective of this research is to study the air-sea exchange of water in hurricanes and in the region of the trade winds by measurement of the water and water vapor in the oceans, rain, clouds and air. Hurricanes and tropical storms in various stages of development have been studied in an effort to establish a connection between the intensity of air-sea exchange and the development of the tropical disturbance.  
It is planned to achieve the above objective by sampling the rain, clouds and air in and around hurricanes. Aircraft from ES' SA's Aircraft Flight Facility will be the sensor platforms. Sea water will be sampled by ships and small boats from the Institute of Marine Science. In addition samples of water vapor will be obtained during the non hurricane season in the trade wind flow that moves off the African continent and travels across the Atlantic to the Lesser Antilles. It is hoped that such information might be instructive in studying the modification of the air by the sea. The collection of data will be supported by U.S. Atomic Energy Commission.  
An emphasis will be made to bring more interested atmospheric scientists into this work to interpret the chemical data collected and analyzed by Dr. Ostlund. This aspect will become a major effort under NSF support. An effort will be made to measure other tracers such as the tritium component in the normally occurring hydrogen gas in the air and develop techniques for instantaneous analysis of the tritium.  
SUPPORTED BY U.S. Atomic Energy Commission

3.0019. STUDY ASSOCIATION BETWEEN TRADE WIND SYSTEM AND NORTH PACIFIC OCEANOGRAPHIC CLIMATE  
The objective of the investigation is to develop a model for air-sea interactions. The most important of these concerns the linkage between the trade wind system and surface water motion. The Hawaiian oceanographic climate, the seasonal changes in temperature and salinity, are largely determined by changes in the location of the boundaries and changes in the speed of the California Current extension, or surface water movement. A project to make preliminary investigations concerning surface water motion as reflected by the Hawaiian Oceanographic climate and associated changes in the trade wind system, are an important part of the initial phase of the experiment.  
SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

3.0020. ATMOSPHERIC TURBULENCE FIELD STUDIES  
P. FRENZEN, Argonne National Laboratory, Argonne - Lemont, Illinois  
The structure of small-scale turbulence in the lowest 10 meters of the atmosphere is being investigated with the object of developing operational methods for the routine measurement of energy exchange at the surface of the earth. Turbulent fluctuations of wind speed and temperature are recorded under conditions in which the vertical flux is invariant with height, using specially developed instruments mounted on portable towers over selected, uniform sites. A recent theoretical method for determining the turbulence dissipation rate (and, subsequently, the vertical flux of momentum) from reductions in variance effects by averaging wind records over successively larger intervals (Frenzen, Quart. J. Roy. Meteor. Soc., 91 (1965); 28-34) has been verified in the field using data collected by a fast-response wind measuring system constructed for the purpose. A similar theoretical treatment of thermal fluctuations has been prepared (Frenzen, Radiol. Phys. Div. Ann Rep., July '64 - June '65, ANL-7060; Argonne National Lab.; 140-133) and a temperature system designed to utilize this result for the measurement of vertical heat flux is being completed. Because of the relative simplicity of the instrumentation required and an inherent freedom from longer period disturbances such as those caused by waves rocking an instrumented platform, these 'variance reduction' methods appear to be especially suited to the problem of measuring vertical eddy transfer over large bodies of water.  
Apparatus is currently being constructed for the direct measurement and computation of vertical fluxes in the field by an eddy-correlation method. Unlike most devices of this kind previously used in micrometeorological investigations, the present equipment will employ digital rather than analogue computation procedures.  
SUPPORTED BY U.S. Energy Commission

3.0021. EXPERIMENTAL FLUID DYNAMICS  
A.J. FALLER, Univ. of Maryland, School of Engineering, College Park, Maryland  
The objective of this proposal is to continue the studies of boundary layer instability in rotating systems, of oscillatory circulations due to the tilt of the rotation axis, of the generation of wind waves, and of the stability of a barotropic geostrophic jet on a 'beta' plane. It is further proposed to initiate an experimental study of thermally-driven circulations that are designed to simulate the general circulation of the atmosphere.  
The problems will be approached in the following manner:  
(1) Boundary layer instability and transitions - numerical integrations for combined shear flow and thermal convection will be undertaken. Boundary layers with both stable and unstable stratifications will be studied. (2) Oscillations in a tilted rotating tank -
3. METEOROLOGY

The tilted axis will be processed to allow various combinations of tidal and rotation frequencies. Regions of resonance will be investigated theoretically and experimentally. (3) Analogues of the general circulation of the atmosphere - thermally-driven circulations will be generated by heating and cooling by large cylindrical rotating tanks. Statistics of the flow will be measured directly. The resulting numerical models will compare statistical features with corresponding statistical measurements of the experiment. (4) Wind-generated waves and small-scale air-sea interactions - studies will include the determination of velocity profiles in both air and water, the turbulence level in air and water and the effects of surface films.

SUPPORTED BY U.S. National Science Foundation

3.0022. DYNAMICS OF AIR-SEA INTERACTION
E.L. MOLLOCHRISTENS, Mass. Inst. of Technology, Graduate School, Cambridge, Massachusetts 02139

The objective of this work is to continue studies of the dynamics of air-sea interaction. The ultimate goal is to obtain quantitative measures of the vertical fluxes of heat, moisture and momentum across the sea surface as a function of time history, scale, and atmospheric and oceanographic parameters. The emphasis will be on understanding the details of the small scale dynamical processes such as the processes of generation of turbulence and the structure of the turbulent field over the sea surface.

Problems related to the small scale processes are being investigated in laboratory experiments. These studies include investigations of stratified shear flow stability and turbulence, the structure of the turbulent Ekman layer, and phenomena involving stratification and rotation.

Field studies are being conducted also so the full scale range of parameters can be obtained as well as the full complexity of the natural processes. These studies include measurements in the boundary layer over the sea surface of the spatial and temporal structure of the velocity and temperature field under known mean conditions of wind profile, temperature profile, current, water temperature structure and surface wave field.

This program is supported jointly by the Office of Naval Research and the National Science Foundation.

SUPPORTED BY U.S. National Science Foundation

3.0023. AIR-SEA INTERACTION
E.L. MOLLOCHRISTENS, Mass. Inst. of Technology, Graduate School, Cambridge, Massachusetts 02139

This task is concerned with the dynamics of small scale air-sea interaction processes within the boundary layers of the ocean and atmosphere, with particular emphasis on fluctuations in velocity, temperature and salinity to determine the turbulent flux of momentum, salinity and heat throughout the surface layer of the ocean. It is primarily a field program with experiments being conducted from a buoy system set in Buzzards Bay, Massachusetts.

The results from this task are expected to further our understanding of the environmental processes influencing wave generation and the thermal structure of the ocean. From this understanding may result improved forecasting methodology to support marine operations.

SUPPORTED BY U.S. Dept. of Defense - Navy

3.0024. LARGE-SCALE INERTIAL OCEAN-ATMOSPHERE RELATIONSHIPS
I.I. SCHELL, Ocean Atmosphere Res. Inst., Cambridge, Massachusetts 02138

The objective of the work is to conduct an investigation into the nature of large-scale inertial ocean-atmosphere relationships involving the equatorward extent of ice and the contemporary and subsequent large time-scale monthly and seasonal sea surface temperatures and weather as a basis for possible long-range forecasting.

To accomplish the above objective it is planned to analyze synoptically and statistically the southerly ice limit in the Greenland Sea and the Okhotsk Sea and compare them with charts of sea level and upper level pressure distributions, winds and jet streams, sea temperatures, etc. Indices of circulation are to be developed from an analysis of the correlation of ice limits and sea temperatures with subsequent weather as a basis for long range forecasting of the sea surface temperatures of the northeastern Atlantic and the weather of northwestern Europe as well as the sea surface temperatures of the northwestern Pacific and the weather of northern Japan, the Aleutians and Alaska.

SUPPORTED BY U.S. National Science Foundation

3.0025. INTERACTIONS BETWEEN TURBULENCE, CLOUDS, SEA TEMPERATURE
A.F. BUNKER, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543

The objective of the proposed work is to analyze, evaluate and interpret the vast body of meteorological data obtained by the WHOI C-54Q aircraft during the Inte national Indian Ocean Expedition (1963-65) and the Line Island Experiment (1967).

The Indian Ocean work will include vertical cross-sections of clouds collated with streamlines, temperature cross-sections and photographs from satellites and the aircraft. Turbulence and turbulent flux measurements in clear and cloudy air above the frictional level will be studied in detail to find their relation to sea surface temperatures, wind fields and gradients, the conditional instability of the air in the southwest monsoon, the stability of the air in the northeast monsoon, and the convective activity in the equatorial trough.

The Line Islands work will include making cloud cross sections and relating the cloud types and heights to the thermal, water vapor and wind fields of the atmosphere in the equatorial region. Turbulence measurements and turbulent flux computations made in the moist layer between 6 degrees S and 21 degrees N will be studied to determine their relation to the sea-surface temperature and the thermal and kinetic fields that were observed at the same time.

SUPPORTED BY U.S. National Science Foundation

3.0026. AIR-SEA EXCHANGE
P. SAUNDERS, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543 (N00014-66-0005)

The objectives of this task are to improve our knowledge and understanding of the short wave isolation reaching the surface layers of the ocean and to improve the accuracy and usefulness of measurements of sea surface temperature using remote techniques. The relationship between bulk water and interface temperatures and the exchange of energy and momentum from air to sea is to be examined by observations obtained from a tower in Buzzards Bay. Measurements also are to be made of the albedo of the ocean for both diffuse and direct insolation, and the apparent surface temperature observed from infrared radiation measurements are being examined as a function of the height of the sensor.

The results from this work are expected to provide basic understanding of the radiative processes which heat and cool the surface layers of the oceans, thereby affecting the thermal and sound velocity structures. Such knowledge is required to develop meaningful models from which forecasting methods can be developed.

SUPPORTED BY U.S. Dept. of Defense - Navy

3.027. TURBULENCE OVER WAVES
D.J. PORTMAN, Univ. of Michigan, School of Engineering, Ann Arbor, Michigan (N00014-67-A-0180-0005)

The objective of this task is to investigate the structure of turbulence and of the turbulent fluxes of momentum and heat in the atmospheric boundary layer immediately over the sea surface. An experimental investigation will be made of the three-dimensional structure of turbulence and of the spectral characteristics of temperature fluctuations. Analyses will include determination of the Reynolds' fluxes of heat and momentum over water waves. Measurements will be made from a fixed tower or buoy and also a low-flying aircraft.
The results from this task are expected to contribute to the understanding of the nature of the wind field immediately above the sea surface. Better knowledge of its characteristics are needed to improve wave forecasts for naval operations and to assist aircraft operations at low altitudes and landings at sea. Improved understanding of heat flux should aid in improving forecasts of thermal structure as well as meteorological forecasts over oceanic areas.

SUPPORTED BY U.S. Dept. of Defense - Navy

3.0028, AIR-SEA INTERACTION PROCESS
A.C. WHINNEIS, Univ. of Michigan, School of Engineering, Ann Arbor, Michigan

Since the wind is the chief driving force of the lake, specification of the wind in the layer of air just above the water surface is of fundamental importance. To obtain wind fields over the lake on a routine basis, parameters must be chosen which a) are themselves routinely available, b) uniquely define the wind profile near the surface or the wind at some significant level and c) are representatives of large portions of the lake.

On the other side of the air-lake interface the problem of specifying the possible modes of response of the Lake arises. To provide information of water flow a relatively dense network of instrument buoys was placed in Lakes Michigan, Ontario and Erie by the Great Lakes-Illinois River Basins Project of the Division of Water Supply and Pollution Control, U.S. Public Health Service.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

3.0029, GREAT LAKES RESEARCH - ENERGY TRANSFER AT THE AIR-WATER INTERFACE
J.G. HOUSLEY, U.S. Army, Lake Survey, Detroit, Michigan 48226

The direct contact between water and air at their interface produces an exchange of energy and mass. Analysis of the interface activity will establish the mechanism by which energy and mass transfers, both air to water and water to air, are accomplished. These transfers are in the form of heat energy, such as radiation, conduction, convection, condensation, and evaporation; kinetic energy as in wind tides and waves; mass as in absorption of gases and solids by water; and electric charge transfer. Results will lead to improved methods of predicting waves, currents, wind tides, water; s, and modification of regional climate by the lakes.

Under contract with the University of Michigan, data are being obtained at an instrumented tower about one mile offshore, near Muskegon in Lake Michigan. The tower was in operation for the seasons 1963, 1964, and 1965, and 1967. Reduction and analysis of the data will continue in FY 69; the instrumented tower was reestablished in May 1968. Development of equipment for wind-stress measurements on a continuous basis is underway.

SUPPORTED BY U.S. Dept. of Defense - Army

3.0030, SURFACE TENSION
J.J. JASPER, Wayne State University, Graduate School, Detroit, Michigan 48202

The data on surface tension of pure liquids at ordinary temperatures will be compiled from the literature and critically evaluated. The surface tensions of liquids are needed for an understanding of all processes of liquid-liquid extraction, wetting of solids, adhesion and many meteorological processes. This project is in accord with the reference data mission of NBS.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

3.0031, PROJECT EVAPORATION
C.C. EASTERBROOK, Cornell Aeronautical Lab. Inc., Buffalo, New York 14221

The main objective of this project is to determine the effect of wave action on the rate of evaporation from a free water surface. Experiments carried out in an enclosed wave-tank as part of the initial contract showed that evaporation was actually reduced from 30% to 40% by well developed waves on the surface. Subsequent study of air flow across the waves indicated that this flow was modified in such a way as to retard the upward transport of water vapor.

The extension to the evaporation project carried the study into the real world where measurements were made in the free atmosphere over the surface of Lake Hehner in Oklahoma. This data was recorded on magnetic tape by a cooperating group from ESSA in Boulder, Colorado. The data is currently being analyzed and results will be reported in the final report.

SUPPORTED BY U.S. Dept. of Interior - Bu. Reclamation

3.0032, RADIANT ENERGY FLUX ACROSS THE AIR-SEA INTERFACE AND HEAT BUDGET OF THE OCEANS
R. HOLLMAN, New York University, School of Engineering, New York, New York 10003 (NONR)

Objective: The needs for environmental predictions of ocean thermal structure require knowledge of the factors controlling the heat budget of the surface layers of the ocean. The heat budget is controlled by radiation directly from the sun and indirectly from the sky as well as that radiated back to the atmosphere from the oceans. This research on the exchange of radiant energy at the sea surface is aimed to contribute to naval oceanographic forecasting services as well as marine meteorological forecasts.

Approach: The flux of radiant energy at the sea surface is being measured as a function of solar evaluation and cloud conditions in order to determine the coefficient of reflectivity for sky radiation. The results are being used to derive prediction equations for the downward flux density of radiation under varying cloud amounts and types of air-masses. Infrared measurement techniques from spacecraft, aircraft and surface ships also being studied to determine the reliability to which the longwave back radiation from the sea surface can be determined.

SUPPORTED BY U.S. Dept. of Defense - Navy

3.0033, TURBULENT PROCESSES AT AIR-SEA AND BOTTOM BOUNDARIES OF THE OCEAN
A.D. KIRWIN, New York University, School of Engineering, New York, New York 10003 (NONR)

Objective: The Navy requires knowledge of turbulent processes in the oceans in order to describe and predict the oceanic environment for the planning and execution of operations. A better understanding of the turbulent regime at the air-sea and bottom boundaries bears upon the prediction of thermal structure; on bottom currents and their variability affecting deep rescue vehicle operations; on deep water and the determination of loading forces on fixed underwater structures; and on surface wave and wind forecasts affecting the operations of surface ships.

Approach: Both theoretical and field experimental work on turbulence is being conducted. Earlier theoretical work by Eringen is being extended and applied to flow between plates. Field measurements of the structure of turbulence in the lower levels of the atmosphere immediately above the sea surface are being made from ARGUS Island off Bermuda. The effects of sea surface roughness, the fetch of the wind field and the stability of the atmosphere on the transfer of energy from the atmosphere to the ocean is being determined. The program is being conducted jointly with NavOceanO. A paralleling study of the turbulence in the bottom boundary layer of the ocean is being conducted in a tidal channel off Long Island, N. Y., to determine the nature of the velocity field next to the bottom.

SUPPORTED BY U.S. Dept. of Defense - Navy

3.0034, PHYSICAL OCEANOGRAPHY
T. ICHIYE, Columbia University, Graduate School, Palisades, New York 10964 (N00014-67-A0108-0004)

This task is concerned with air-sea interactions and diffusion processes within the upper ocean, and with the micro-thermohaline structure of the oceans. The relationships between
3. METEOROLOGY

Langmuir type cellular convection in the surface layer and environmental factors such as surface currents and their shear, winds, and waves, are being investigated. Information on the heat exchange between sea and atmosphere also is being obtained using airborne thermal infrared thermometer and humidity sensors. A joint program with the University of Hawaii using STD's is to be undertaken to determine the horizontal scales of the thermaline microstructure present in the region of the Pacific immediately north of Hawaii.

Surface layer parameters and the ability to forecast them are important in fleet operations and in the dispersal of waste and contaminants. Observations of thermal structure and its space and time variations strongly affect acoustic propagation. Naval capabilities in these areas will benefit from the results of this research program.

SUPPORTED BY U.S. Dept. of Defense - Navy

3.0035. RESEARCH IN AIR-ENERGY EXCHANGE

W. V. BURT, Oregon State University, Graduate School, Corvallis, Oregon 97331

The emphasis to date has been on measurement of radiation; short-wave radiation has been measured at sea and on port. These measurements will be critically examined with future concurrent measurements at the Marine Science Lab and at sea. Equipment is being prepared to separate diffuse from direct short wave radiation at the Marine Science Lab, and a pyranometer has been installed to be used with filters to study the spectral variation of incident solar radiation. An inverted pyrheliometer will be used at sea to measure reflected short wave radiation, and a specially vented radiometer has been built for measurement of long wave radiation at sea.

Heat stored in the waters is under intensive study; comparison will be made between the surface budget and the observed storage. Efforts will be made to explain the differences and then design direct sampling programs to test for the advective transport. Direct measurement of light in the sea has been begun in cooperation with biological phenomena. More effort will be expended on this part of the work. Experiments with lasers and other artificial light sources will be added in order to learn more about turbidity and other factors affecting light transmission in both sea and atmosphere. Preliminary studies of atmometers for estimating evaporation at sea have been made, and if these prove feasible, they will be used in conjunction with the mass transfer computations to study the evaporation from the sea off Oregon.

SUPPORTED BY U.S. National Science Foundation

3.0036. ATMOSPHERIC EFFECTS ON INCOMING SOLAR RADIATION OVER TROPICAL OCEANS

W. V. BURT, Oregon State University, Graduate School, Corvallis, Oregon 97331

The objectives of this research are threefold: (1) to obtain a comprehensive understanding of atmospheric effects on incoming solar radiation over the tropical Pacific Ocean; (2) to develop suitable equations for computing incoming solar radiation over tropical oceans based on meteorological data; and (3) to compute incoming solar radiation over the tropical Pacific based on findings and equations developed.

To accomplish the above objectives it will be necessary to investigate the cloud distribution by type and amount at 5 selected sites (Canton Island, Wake Island, Johnstown Island, Majuro Atoll and Kwajalein Atoll); to determine the effect of various amounts of atmospheric water vapor and clouds on incoming solar radiation; to determine the moist layer thickness at all locations during both disturbed and undisturbed weather conditions; to find suitable correlations between daily predicted and direct sun data and between significant weather disturbances at the sites; to determine the effect of weather conditions and incoming radiation in the vicinity of the equatorial trough; to determine the most suitable cloud parameters to use in computing incoming radiation in the equatorial trough and trade wind regions; and to determine what other parameters are essential to formulae for computing incoming solar radiation; to use Air Force and Navy summaries to extend study results in space and time; and to develop suitable formulae for computing incoming solar radiation over the tropical oceans through use of hourly atmospheric and radiation data in conjunction with computer programs.

SUPPORTED BY U.S. National Science Foundation

3.0037. FLUXES OF DISSOLVED GASES AND NUTRIENTS RELATING TO BIOCHEMICAL AND AERATION PROCESSES OFF THE OREGON COAST

K. PARK, Oregon State University, Graduate School, Corvallis, Oregon 97331

Research to date has been on the synoptics of the various chemical parameters in spatial and temporal coordinates. The parameters being investigated are salinity, oxygen, pH, alkalinity, phosphate, and less frequently, silicate and total carbon dioxide. Development of chemical techniques that can be used at sea, such as conductometric alkalinity analysis, gas-chromatographic determination of dissolved gases, and the reliability of conductometrically determined salinity has been studied.

It is proposed to study the air-sea exchange in different seasons of inert gases (argon and, for first approximation, nitrogen) and biologically active gases (oxygen and carbon dioxide). Such studies are essential to understand the mechanism of aeration in natural oceanic conditions, and it is quite feasible in this region, because a large annual surface temperature fluctuation, over 8 degrees C at 500 km, occurs off Newport, Oregon.

Quantities of the nutrient matters supplied to the euphotic zone of the ocean by Columbia River outflow and by the process of upwelling will be measured. It is calculated that each of these sources adds approximately one billion moles of phosphate to the euphotic zone off Oregon. The rate of addition of the nutrient by these sources affects the fertility of the euphotic zone.

SUPPORTED BY U.S. National Science Foundation

3.0038. HEAT AND MOMENTUM EXCHANGE PROCESSES BETWEEN THE OCEAN AND THE ATMOSPHERE

G. S. POND, Oregon State University, Graduate School, Corvallis, Oregon 97331

Objective: Improvements in forecasting marine weather and sea conditions are extremely important to operation at sea. Such improvements will require a more accurate knowledge of the transfer of heat and momentum between the ocean and the atmosphere. This research, by providing a better understanding of the energy exchange processes, will help determine more accurate ways of estimating these exchanges from incomplete environmental data.

Approach: A field experiment using an instrumented tower located about one mile off the Oregon Coast will be carried out. Water vapor concentration, temperatures, wind velocities, and the vertical gradients of each of these variables will be made in the atmosphere immediately above the sea surface. From these data determinations will be made of (i) the amount of heat exchanged between the atmosphere and the ocean, (ii) the similarities and differences between the several physical mechanisms by which heat and momentum are transferred, and (iii) the relations between the amount of heat exchanged and the prevailing meteorological and oceanographic conditions.

SUPPORTED BY U.S. Dept. of Defense - Navy

3.0039. SEA-AIR INTERACTION RESEARCH


Technical Objective: (1) Establish a working knowledge of the mean conditions and the variables involved in the dynamics of small scale processes in the air-sea interaction. (2) Make meaningful observations of the fluxes of momentum, heat, and salt in the air-sea interface region, and correlate the dynamics of the sea surface with the generation of ambient sea state noise at the air-sea interface.

Approach: One or possibly two tower-type, spar satellite buoys will be implanted near the Buzzards Bay entrance light sta-
tion. Instrumentation and appropriate sensors will be installed to measure mean air-sea conditions, including air temperature, wind velocity, water temperature, current velocity, wave conditions, and ambient noise. Measurements will be made of the space-time correlation structure and spectrum of the wind speed above the air-sea interface and the ambient noise records. Studies will be conducted in the laboratory on turbulent convection in a stably stratified fluid heated from below.

**SUPPORTED BY U.S. Dept. of Defense - Navy**

### 3.0040. SEA BREEZE INVESTIGATION

**K.H. JEHN,** Univ. of Texas, School of Engineering, Austin, Texas 78712

This work covers the third and final year of an investigation of the sea breeze along the Gulf Coast of Texas. The objectives of this year’s work are to analyze and interpret the meso-scale observational data that have been collected during the summers of 1966 and 1967 and to make selected measurements during the summer of 1968. The meso-scale analysis will center around the objective analysis program that has been made operational on the NCAR CDC-6600 computer. A study of the energy budget associated with the sea breeze will be started. A wind tunnel study and calibration of the liquid water content device used in cloud observations will be completed. In June 1968 a small field effort will be mounted for the purpose of evaluating the surface input of energy into a sea breeze circulation. Measurements in the boundary layer will be made from several towers. In addition an airborne radiometer will be flown on an NCAR aircraft to determine the surface temperatures over the land and water. Extensive laboratory testing will be required of the instrumentation before going into the field in June.

**SUPPORTED BY U.S. National Science Foundation**

### 3.0041. AIR-SEA INTERACTION

**G.A. FRANCESCHINI,** Texas A & M University System, Graduate School, College Station, Texas 77843 (NONR)

The goal of this effort is to develop methods of predicting changes in conditions within the boundary layers of the sea and atmosphere from routinely available data. Of immediate concern is the exchange of sensible and latent heat and its relation to near surface gradients of temperature and humidity. An observational program is being planned and associate equipment designed and field site selected during the coming year. This study would improve our knowledge of spatial and temporal variations of temperature in the ocean and thus work toward eventual systems for predicting environmental conditions.

**SUPPORTED BY U.S. Dept. of Defense - Navy**

### 3.0042. AIR-SEA INTERACTION

**D.F. LEIPPER,** Texas A & M University System, Graduate School, College Station, Texas 77843 (NONR)

The objective of this task is to develop accurate forecasting methods for oceanic phenomena which are dependent upon air-sea interactions using tools of synoptic oceanography. Particular attention is being paid to the currents and thermal structure in the eastern Gulf of Mexico and the ways in which they change seasonally and in response to weather conditions. It is expected that these studies will contribute to the development of oceanic forecasting methods particularly the influence of large-scale weather systems upon ocean temperature.

**SUPPORTED BY U.S. Dept. of Defense - Navy**

### 3.0043. HYDROSPHERE-ATMOSPHERE RADIOCHEMICAL MEASUREMENTS

**A.W. FAIRHALL,** Univ. of Washington, Graduate School, Seattle, Washington 98122

The excess carbon-14 introduced into the northern hemisphere stratosphere during the 1961-1962 USSR and US nuclear weapons tests provides a useful tracer for the study of atmospher-

### 3. METEOROLOGY

#### 3.0044. ENERGY TRANSFER NEAR THE EARTHSURFACE

**R.G. FLEAGLE,** Univ. of Washington, Graduate School, Seattle, Washington 98122

The principal objective of this proposal is to complete the development of the capability for making reasonably accurate measurements of vertical turbulent flux. It is anticipated that during the period of time involved objectives will be formulated to take advantage of and contribute to the developing national and international programs involving energy transfer in the atmospheric boundary layer.

To complete the development work, it is planned to hold several comparative experiments between instruments for measuring turbulence statistics. Studies will be made analyzing the motions of the MENTOR buoy, measuring the vertical fluxes of heat and momentum simultaneously over different surfaces, determining the spectra of the fluxes and establishing the Kolmogoroff constant for momentum and temperature.

**SUPPORTED BY U.S. National Science Foundation**

### 3B. HURRICANES-STORMS

#### 3.0045. ATMOSPHERIC CONDITIONS ASSOCIATED WITH CUMULUS CONVECTION

**W.M. GRAY,** Colorado State University, School of Engineering, Fort Collins, Colorado 80521

To continue investigation of the wind speed, vertical shear, and baroclinicity in the inner areas of tropical storms and develop a model to fit the observed cumulus convection. To continue a statistical study of fractional turning of wind in the sub-cloud layers over the tropical oceans. Most of the work will utilize RFF flight data since much of the area under study is over tropical oceans. In addition, large quantities of data supplied by Asheville, and special tower observations will be utilized.

During the period of previous support results indicated that most tropical disturbances from which storms form are generated from an environment in which a horizontal shearing zonal trade wind current is present with minimum tropospheric vertical shear.

**SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.**

#### 3.0046. HURRICANES AND OTHER TROPICAL

**METEOROLOGICAL PROBLEMS**

**R.C. GENTRY,** Univ. of Miami, National Hurricane Res. Lab., Miami - Coral Gables, Florida 33124

The scientific objectives of NHRl are to acquire greater knowledge of tropical cyclones and their environment; to develop improved techniques for forecasting hurricane motion, formation, dissipation, and intensification; and to develop and/or evaluate hypotheses of tropical cyclone modification. Specially equipped research aircraft, weather satellites, and conventional surface and upper air networks will be used to obtain data to study the structure, dynamics, and high energy processes of the tropical cyclone. These data will also be used to determine interactions between the tropical cyclone and its environment in efforts to determine what are the factors involved in hurricane formation, intensification, dissipation, and movement. Tropical cyclonegenesis and maintenance are being studied by the development of dynamical-numerical models of tropical circulations. Efforts to continue modification experiments on hurricanes...
3. METEOROLOGY

will be intensified. Primary emphasis will be placed on the experiment to conduct multiple seedings of the eye wall of a mature hurricane. Second priority will be given to modification experiments on the rainband of a hurricane.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

3.0047, TRITIUM IN HURRICANES
H.G. OSTLUND, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124

To use the radioactive hydrogen isotope tritium, T, as a tool in air/sea interaction studies. Since the exchange of molecules at the interface is closely related to the flow of latent and sensible heat, the results could give experimental verification to hitherto only vaguely known exchange coefficients, and the energy budget of the system.

Using aircraft, take separate samples of liquid water and water vapor for analysis of tritium content. Relating points where samples were taken to positions in the hurricane or tropical storm. From the analysis, the total exchange of water at the air/sea interface may be deduced.

Some preliminary experiments were conducted in 1964, 1965, 1966. These experiments indicate that the total exchange of water at the air/sea interface is intense. Also the radial distribution of inflow into a hurricane was deduced, along with the air/sea exchange coefficients for water vapor.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

3.0048, TROPICAL STORM INVESTIGATIONS IN THE ATLANTIC, CARIBBEAN, AND GULF OF MEXICO
N.E. LASEUR, Florida State University, Graduate School, Tallahassee, Florida 32306

Objective - Lack of conventional meteorological data has hindered a complete analysis of disturbances in the tropical oceans during the course of a typical season. Project objectives are: (a) to produce a sequence of analyses tropical oceanic areas extending from the Gulf of Mexico eastward to 10 degrees E., and investigate characteristic features of waves, anticyclonic centers, major convergent lines and other significant systems. (b) The development, extension and testing of hypotheses based on comparisons of satellite pictures. Approach - All data are being incorporated into complete analyses using both forward and backward time continuity. Wave and vortex structures will be tracked to gain information on size, intensity and speed of motion. During periods of concurrent coverage, satellite pictures will be used to investigate the intensity of disturbances and their vertical motion field.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

3.0049, TROPOSPHERE METEOROLOGY IN THE TROPICAL ATLANTIC AREA
N.E. LASEUR, Florida State University, Graduate School, Tallahassee, Florida 32306

It is intended that the work remaining in the preparation and analysis of derived quantities (divergence, vorticity, deformation) and auxiliary fields (clouds and precipitation) will soon be completed. The problems of anomalous anticyclone gradient balance between the wind and pressure fields will be pursued.

The approach will be to solve the balance equation in its usual elliptic form in regions of cyclonic flow and normal anticyclonic gradient balance plus the solution of the hyperbolic form of this equation in regions of anomalous anticyclonic gradient balance.

Analysis of surface and upper tropospheric changes over the Tropical Atlantic region has been carried out over the past five years. In addition analyses have been made of cloud and precipitation information collected for the IGY period. Work continues on the problem of anomalous wind cases associated with subtropical westerly and easterly jet-streams.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

3.0050, RESEARCH ON DYNAMICS OF LOW LATITUDE CIRCULATIONS
H.L. KUO, Univ. of Chicago, Graduate School, Chicago, Illinois 60637

Objective - At low latitudes, particularly over the oceans, conventional meteorological observations are scarce and atmospheric circulations are poorly understood. Project objective is to continue theoretical studies currently underway directed primarily to the formation of easterly waves and hurricanes. This involves the development of numerical models to simulate hurricane formation, and includes theoretical investigation of convection and low latitude wave perturbations.

Approach - Increasingly more complex and complete models will be designed to study hurricane formation. Effects of diurnal heating and vertical wind shear will be incorporated in the studies of convection motions. Results will be described in a comprehensive Final Report.

Progress (to June 30, 1967): Little progress this period because of problems with the multi-level hurricane model. Grant has been extended six months.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

3.0051, DYNAMIC STUDY OF THE TEMPORAL
A.J. PALLMAN, Saint Louis University, School of Engineering, Saint Louis, Missouri 63103

Technical Objective: To continue the study of the 'temporal' in terms of a dynamic-energetic model incorporating earlier findings to establish the important characteristics of the temporal at maturity as well as at its formation. Comparison to major tropical storm characteristics will then be possible.

APPROACH: By use of Nimbus II radiation data, AVCS photographs and conventional data, another 'temporal' case of June 20-27, 1966 will be studied. Results will be presented in a written report.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

3.0052, LAKE EFFECT SNOWSTORM STUDY
V.J. SCHAFFER, State University of New York, Atmospheric Sciences Res. Ctr., Albany, New York 12203

The primary objective of this research is to conduct studies on the effects that the Great Lakes have on lee side snow fall.

The approach will be focused on continuous monitoring of atmospheric nuclei and of snow crystal types during the snowstorms which occur and relate these to snow fall, wind direction and related phenomena. In addition, patterns of convergence, generation of clouds, snow distribution will be studied. Until these features are well established, it will be difficult to develop an engineering design to properly modify these storms.

Orographic phenomena also will be studied.

Work accomplished under the grant has been the establishment of a mesoscale observation network downwind of both Lakes Erie and Ontario.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

3.0053, HURRICANE DYNAMICS FOR ARTIFICIAL MODIFICATION STUDY
K. OYAMA, New York University, School of Engineering, New York, New York 10003

This grant provides support for the third and final year of research carried out formerly under GP-5192 and GA-623 on the activities of K. Oyama in studying the structure and behavior of hurricanes using mathematical models on high speed electronic computers. The first objective of the project to construct a simple model of a hurricane to understand the basic hurricane dynamics has now been achieved. This extension will permit work to be initiated on a numerical model which would be accurate enough to predict the behavior of real hurricanes. The restrictive assumptions in the present model, such as gradient wind balance and axisymmetry, will have to be replaced by more realistic boundary conditions.

SUPPORTED BY U.S. National Science Foundation
3.0054, SEVERE STORM CLIMATOLOGY

To investigate the spatial and temporal variations in 1) the synoptic patterns associated with the subsequent development as well as non-development of tropical cyclones; 2) the contribution of the storms to the precipitation distribution patterns over specific land areas; and 3) the low-level meteorological phenomena associated with severe frontal passages and to relate satellite cloud photos to time and degree of recurvature of hurricanes, Climatological models will be developed to provide the probable distribution of significant parameters such as wind and moisture.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

3C. GENERAL METEOROLOGY-CLIMATOLOGY

3.0055, AN EXPERIMENTAL AND THEORETICAL STUDY OF THE MARINE AND CONTINENTAL CLIMATES OF POINT CONCEPTION TO THE MORRO BAY REGION OF CALIFORNIA
J.A. ROBERTS, Meteorology Research Inc., Altadena, California

Technical Objective: An improved scientific understanding of the marine elements of coastal climates and of the effects of topography on micrometeorology of the coast and a more complete basis for predicting environmental conditions affecting military landing and beach clearance operations.

Approach: Micrometeorological and marine data on the California coast from Point Conception to Morrow Bay will be collected and analyzed. This portion of the coast has been classified as a single climatic type and contains a variety of coastal land forms. Data will be collected from three instrument ranges, eleven coastal reporting stations, and a series of seasonal aircraft operations. The data will be reduced and analyzed with respect to the synoptic situation and related to seasonal climatic conditions.

Progress: Three mechanical weather stations were sited around each of the three headlands, Pt. Arguello, Pt. Sal and Pt. Buchon, for a total of nine installations. Each station consists of wind direction and speed, air temperature and precipitation gauges. Atmospheric soundings are made by an MRI aircraft instrumented to take continuous measurements of temperature, humidity and turbulence as a function of elevation. Intensive field observations were conducted during two periods, 31 May to 3 June and during the week of 22 August, including special measurements of wind and observations of cloud cover, in addition to wind data being measured by the network of mechanical weather stations.

SUPPORTED BY U.S. Dept. of Defense - Army

3.0056, MESO WIND PATTERNS IN THE CENTRAL CALIFORNIA VALLEY
W.E. YATES, Univ. of California, School of Agriculture, Davis, California 95616

The proposed research has emerged from studies on: drift of herbicides and insecticides, air pollution, and wind erosion. Exploratory surveys on a modest scale in parts of the Central Valley of California resulted in the discovery of some peculiar wind patterns in the lower Sacramento and lower San Joaquin Valleys. Spraying schedules in parts of this area could be established for agricultural aircraft operators, and suitable wind protection devices could be designed in another part.

The study is carried out by establishing several portable climate recorders that include wind registering in various sites of the Valley. A further observation tool is a 1,500 ft. TV tower, which was equipped also with six or three recorders at various heights. Furthermore, pibal observations and airplane cruises are employed. The data will permit obtaining basic knowledge of the particular wind patterns, and generally about the interaction of the phenomena of sea breeze and continental pressure systems about 100 miles from the coast.

SUPPORTED BY U.S. Dept. of Hith. Ed. & Wel. - P.H.S.

3.0057, PACIFIC OCEAN INFLUENCE UPON CALIFORNIA RAINFALL
J. BIERNKES, Univ. of California, Graduate School, Los Angeles — U.C.L.A., California 90024

In project research for the National Science Foundation carried on by the principal investigator it has been found that the Pacific Ocean temperature varies more from year to year near the equator than it does in adjacent areas to the north and south. It has also been demonstrated that the inter-annual variation in heat and moisture input from the equatorial belt of the Pacific Ocean, the few instances investigated does influence the global pattern of the atmospheric circulation. On the basis of this experience it is tentatively assumed that the variation of rainfall from year to year in California, and other areas around the Pacific Ocean, primarily results from the variability of the water temperature at the equator.

It is planned to test this hypothesis by assembling maps of the atmospheric circulation for all winter seasons during which equatorial water temperature measurements were carried out. Next, the map types will be correlated on the one hand with equatorial water temperatures and on the other with the historical rainfall record in California.

The problem of estimating the yield of a rainy season on the basis of atmosphere and ocean data, available before the rains start, will be investigated.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rech University of California

3.0058, CLIMATE CHANGE OVER THE POLAR OCEAN
S. ORVIG, Mcgill University, Graduate School, Montreal - Quebec, Canada

The project proposes to continue studies of climatic effects resulting from heat transfer processes in the Arctic. The objective is to attain numerical values for all the terms in the heat balance equation for the surface and atmosphere over the polar ocean. The work will supplement the U.S. work by making available to the large numerical projects, hand computed input values of areal values of conditions, radiative energy fluxes, cloud conditions, etc.

SUPPORTED BY U.S. National Science Foundation

3.0059, ATMOSPHERIC PROCESSES IN THE TROPICS
W.M. GRAY, Colorado State University, School of Engineering, Fort Collins, Colorado 80521

The objective of this research is to study the tropical atmosphere through a continuation of observational studies of atmospheric processes using data collected from satellites, aircraft, surface ships and conventional synoptic observations.

The objective is to be achieved by studying three primary physical processes. They are: (1) the mutual variation of wind, shear and baroclinicity in tropical storms and disturbances; (2) a statistical treatment of the Ekman or frictional turning of the wind in the sub-cloud layer within the tropics; and (3) the association, movement and conservation of the satellite-observed 'cloud blob' areas in and surrounding the Inter-Tropical Convergence Zone for a better understanding of the dynamics of this system.

The proposed work is part of a continuing mutual research effort with Professor Yanai of the Department of Geophysics at the University of Tokyo. All of this work is related directly to the Tropical Meteorological Experiment (TROMEX) to be carried out in the early 1970's and to the Global Atmospheric Research Project (GARP) to be carried out in the mid or late 1970's.

SUPPORTED BY U.S. National Science Foundation

3.0060, WEATHER PROGRAM - STATION T-3
V. ROCKNEY, U.S. Dept. of Commerce, Weather Bureau, Washington, District of Columbia

Standard Weather Bureau methods are utilized to provide a program of surface and upper-air weather observations on Drift Station T-3, an ice island research station in the Arctic Ocean Basin. Surface observations are made on a minimum of 6-hour basis and Rawinsonde probes of the upper atmosphere are made two times daily.
3. METEOROLOGY

Routine standard weather observations contribute to a climatology of the Arctic and will provide background for all future Navy operations in Arctic seas. Daily observations and forecasts are necessary for air support of the drifting station itself as well as international aviation. Upper air data are of special importance to investigations of the Arctic Ocean energy balance which is studied on a continuing basis on T-3. It is especially important that the polar atmospheric circulation be known in detail and that its relation to world weather and ice distribution and behavior be better understood.

SUPPORTED BY U.S. Dept. of Defense - Navy

3.0061, TROPICAL ANALYSIS AND FORECASTING

The primary objective of this research is to conduct studies which will lead ultimately to the construction of a model of convective scale systems in Maritime tropical atmospheres. This model will be developed both theoretically and by extensive observations in the field.

The approach will be based on a computer model of the heated island, determining the characteristics of the velocity field over a heated island, and extensive field experiment to test the model and hypothesis.

Work accomplished under the grant has been the near completion of a numerical (computer) model of the heated island and the development of instrumentation necessary to gain the above objectives.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

3.0062, MESO AND CONVECTIVE SCALE SYSTEMS IN THE MARITIME TROPICAL ATMOSPHERE
M. GARSTANG, Florida State University, Graduate School, Tallahassee, Florida 32306

The objective of this work is twofold: (1) to collect and process observations made during the Line Island Experiment for use by all participants in the experiment and any other interested parties; (2) to investigate synoptic and sub-synoptic weather processes and climatology in the region of the Line Islands during the approach.

To accomplish the first objective all routine weather observations made over the Pacific (130 degrees E-80 degrees W and 40 degrees S) during the Line Island Experiment will be collected, processed, plotted, analyzed and listed in a publication put out by the University of Hawaii.

The second objective will be accomplished by independent investigations under the following topics: LaGrangian dynamics, ocean-atmospheric momentum exchange, climatology of the Line Islands, Line Islands weather in the context of the total tropical, and atmospheric tides.

SUPPORTED BY U.S. National Science Foundation

3.0064, MESOSCALE WIND SYSTEMS AROUND THE GREAT LAKES
E.W. HEWSON, Univ. of Michigan, School of Engineering, Ann Arbor, Michigan

The research to be undertaken is concerned with the structure and dynamics of lake and land breeze systems around Lake Michigan. The field program will conduct measurements during May and June near the eastern shore of Lake Michigan between Holland and Muskegon. The field measurements are several pilot balloon observations of winds aloft to be taken along a line extending eastward from the shore, and at distances of 0, 5, 10, and 15 miles from it. Pilot balloons will also be taken from a vessel over the lake. Lapse rate measurements of temperature and moisture will be obtained over land and lake using an instrumented manned aircraft.

The above measurements will be used for comparison with a theoretical model of a lake-land breeze system. Numerical analysis using a digital computer will be employed to achieve the required solutions.

The results will be of substantial value in the analysis and control of interstate air pollution problems.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

3.0065, GREAT LAKES RESEARCH - LAKE PRECIPITATION
J.A. DERECKI, U.S. Army, Lake Survey, Detroit, Michigan 48226

Purpose is to determine the precipitation over the large water areas of the Great Lakes and to derive methods to calculate the overwater precipitation from the overland records.

In cooperation with U.S. Weather Bureau, the lake precipitation is being recorded on selected small islands. In Lake Michigan precipitation recording started October 1963 on South Manitou, North Manitou, South Fox, Beaver and Ile aux Gallets Islands. In Lake Erie precipitation recorders were placed on West Sister and East Sister islands during May 1964. Field program will continue through October 1968. Hourly precipitation data are available in tables and on punch cards.

SUPPORTED BY U.S. Dept. of Defense - Army

3.0066, EQUATORIAL CIRCULATIONS IN THE STRATOSPHERE
A.D. BELMONT, Control Data Corporation, Minneapolis, Minnesota (AT(11-1))

The object of this study is to help understand the nature of the field of motion in the tropical stratosphere. The results will be applicable to problems of atmospheric transport in this region.

As a continuation of earlier studies, selected aspects of the tropical stratospheric wind flow patterns from January 1961 - December 1964 as functions of height, latitude and longitude, will be described. Emphasis will be placed on estimating cross-equatorial flow both on a planetary scale and on the local scale at selected stations. As the winds at these base levels in tropical latitudes do not follow normal seasonal or monthly patterns, but are mainly dependent on the regular quasi-biennial oscillation, multi-year mean monthly or seasonal statistics are of no significance, and all data must be presented for individual months and years. Studies of the diurnal variation of the meridional wind and its effect on computations of cross-equatorial transport will also be made.

SUPPORTED BY U.S. Atomic Energy Commission

3.0067, THREE-DIMENSIONAL GLOBAL CLIMATOLOGY

To determine: 1) the static structure of the atmosphere from the surface to as great height as is feasible; 2) the dynamic structure of the atmosphere by spectral analysis which is expected to provide preferred modes of motion in the atmosphere in the three dimensions, latitude, longitude, and altitude; and 3) the various time scales indicated to be important by the spectral analysis.
To study geophysical data generally with respect to accuracy and representativeness and with a view to practical applications of these disciplines singly or in combinations.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

3D. SEA ICE-GLACIOLOGY

3.0068, CARBON MONOXIDE CONTENT OF GLACIAL ICE AND THE NATURAL ATMOSPHERE
R.C. ROBBINS, Stanford Research Institute, Menlo Park, California

Carbon monoxide is one of the gases found in trace amounts in the earth's atmosphere. A very approximate estimate of the background concentration of carbon monoxide, based on information available to date, is 0.2 ppb or less. The total global emissions in automobile exhaust and other combustion processes is so large that carbon monoxide lifetime in the atmosphere cannot be more than a few years. The object of this research is to study the travel, distribution, and fate of atmospheric carbon monoxide by determining concentrations in remote areas having no combustion sources. Carbon monoxide concentrations in the Atlantic and Pacific, and in the northern and southern hemispheres will be measured. Examination of the concentration data will provide a much more comprehensive estimate of carbon monoxide lifetime in the atmosphere as well as improved ideas regarding the principal sinks or sinks.

The assistance of Military Sea Transport Service will be requested to carry our CO analyzer with a technician on Atlantic and Pacific Ocean crossings. Also, we plan to make airborne measurements of CO concentration from an aircraft to an altitude of 25,000 feet in the vicinity of the California coast to obtain vertical carbon monoxide concentration profiles.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

3.0069, MEASUREMENT OF COMMON LEAD IN THE EARTH'S HYDROSHERE
C.C. PATTERSON, Calif. Inst. of Technology, Graduate School, Pasadena, California 91109

The purpose of this investigation is to determine the change as a function of time in the concentration of lead in snow from polar regions. In order to understand the significance of the observed lead concentrations, it is necessary to determine the concentration of some other elements as well, such as chloride, sulphate, sodium, potassium, silicon, vanadium, calcium, magnesium and aluminum. It is hoped that we can detect lead originating from industrial sources, and those other elements can be used as indices for lead originating from both industrial and non-industrial sources. Sodium and potassium can be used as an index for the contribution from sea salts, for example, while chlorine can be used to estimate contributions from volcanic contaminants. Silica and aluminum can be used to estimate contributions from soil dusts. Sulphate, when combined with sulphur isotopic analyses, can be used to estimate the possible extent of industrial contributions.

During 1965 summer field season, a large number of snow samples were collected from Greenland. The analyses of these samples for lead and the other elements listed above will involve approximately 880 determinations using the following techniques; isotope dilution, flame spectrophotometry, atomic emission spectrophotometry, colorimetry and nephelometry. The amount of work involved here is extensive and it is expected that these investigations will extend through 1967.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

3.0070, ARCTIC UNDERSEAS RESEARCH, PHYSICAL AND CHEMICAL PROPERTIES OF SEA ICE
W.K. LYON, U.S. Navy, Undersea Warfare Center, San Diego, California 92140

Objective: To determine environmental factors affecting undersea uses of the ocean in Arctic areas. To determine the physical and chemical properties of sea ice. To model sea ice growth and break-up in the Laboratory Arctic Research Pool.

3.0071, ARCTIC UNDERSEAS RESEARCH, JOINT USA-CANADIAN HEAT BUDGET STUDY
W.K. LYON, U.S. Navy, Undersea Warfare Center, San Diego, California 92140

Objective: To determine environmental factors affecting undersea uses of the ocean in Arctic areas; determine and test theory of heat exchange adjusted to climatological observations.

Approach: Fundamental to ocean-cryological processes, is an understanding of energy transfer between the atmosphere, sea ice and sea beneath. Very large capacity, high-speed data logging systems and many new, precise sensors are required and have been designed to permit direct processing of field data by computer. Precise measurements are made of temperature, wind speed and direction, turbulence, heat flow, water vapor, water transport, radiation, etc. The system includes cabling, buoys, towers, generators. After check-out of circuitry and calibration, as a joint USA-Canadian research project, the two barges and shore equipment will be installed in Jesse Harbor on Banks Island of the Canadian Arctic Archipelago. Installation is planned for FY 1969 if preliminary buoy installations last out the winter.

SUPPORTED BY U.S. Dept. of Defense - Navy

3.0072, ELECTRICAL PROPERTIES OF ICE
E.R. POUNDER, McGill University, Graduate School, Montreal - Quebec, Canada

Systematic investigations are to be extended to include the electrical parameters of saline ice with salinity typical of natural sea ice at selected audio frequencies in the temperature range minus 20 degrees C to minus 100 degrees C to look for the effect of the phase changes in the composition of sea ice. These are expected to have significant results only at relatively low audio frequencies. To carry out similar measurements at a single temperature (minus 20 degrees C) over the frequency range 40 to 3000 Hz.

This task will contribute to the ice reconnaissance operations employing radar and other electromagnetic techniques, as well as a greater understanding of propagation phenomena associated with radio communications, under, through and over sea ice.

SUPPORTED BY U.S. Dept. of Defense - Navy

3.0073, HF AUDIO ABSORPTION IN ICE
E.R. POUNDER, McGill University, Graduate School, Montreal - Quebec, Canada (NONR)

An experimental study of high frequency audio absorption in ice to investigate systematically the acoustic attenuation of sea ice as a function of frequency and salinity; to make reverberation measurements on sea ice at selected frequencies (100, 200, 500, 1000 KC); to measure reflection coefficients of sound waves incident from the water on the ice-water interface at selected frequencies and for a wide range of angles of incidence.

SUPPORTED BY U.S. Dept. of Defense - Navy

3.0074, ARCTIC SUB-ICE STUDY
R.C. FAYLOR, Arctic Inst of North America, Washington, District of Columbia

The contractor will provide coordination, liaison and focal point for the conduct of a multidisciplinary, milliagency program of under-ice acoustic, marine biological and sea ice investigations from the deep submersible vehicle PISCES. A series of dives throughout the Arctic Archipelago and Arctic Ocean under ice will be made to investigate marine biology, marine mammal acoustics, sub-ice acoustic regime and sub-ice oceanography.
3. METEOROLOGY

Investigations supported by this task provide the Navy with new information on sub-ice underwater sound.

SUPPORTED BY U.S. Dept. of Defense - Navy

3.0075, SATELLITE SEA ICE STUDIES USING HRIR

OBJECTIVE: To determine the usefulness of HRIR data in the 3.5-4.1 micron water vapor 'windows' region for Arctic sea ice surveillance.

PROBLEM ADDRESSED BY STUDY: Knowledge of polar ice distribution and characteristic is essential for understanding large-scale, long-range climatic changes in the atmosphere. In addition, flight operations, shipping interests, exploratory petroleum-drilling efforts, and eventually manned space activities, all require knowledge of sea ice conditions in polar regions, particularly as these conditions affect, or are affected by, weather conditions. Very little definite knowledge of sea ice conditions in the polar regions is now available, as the time of acquiring such knowledge is enormous if attempted by surface or near-surface observation.

This study is aimed at determining the extent to which satellite HRIR data may be applied to determine sea ice characteristics in the Arctic Ocean and environs.

APPROACH: Nimbus I and II HRIR pictorial and digital data will be compiled and examined to determine the amount and quality of sea ice information which can be extracted. Ice covered areas will be identified and differentiated from clouds primarily through recognition of terrestrial features. Ice boundaries and open water areas will be delineated. The frequency with which useful IR observations can be obtained will be estimated. A comparison of data obtained from both satellites will be made to determine whether the higher resolution (because of the lower altitude) of Nimbus I results in a significant improvement in the capability of the system for ice surveillance.

PROGRESS: Several studies have been made of the uses of Nimbus NRIR data for observing terrestrial features. Popham and Samuelson found that the HRIR could detect considerable detail over the polar regions, with cracks in the pack ice of the Weddell Sea being readily apparent. However, no detailed studies of HRIR observations over ice areas have been conducted.

BENEFITS: This study will determine the feasibility of using satellite IR observations for ice and weather surveillance in the Arctic regions.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

3.0076, ICEBERG DRIFT AND DETERIORATION
M.J. MOYNIHAN, U.S. Dept. of Transportation, Oceanographic Unit, Washington, District of Columbia

The U.S. Coast Guard is continuing to improve the capability and effectiveness of its International Ice Patrol Mission. Data on iceberg drift and deterioration has been routinely collected by the Ice Patrol now more than fifty years. Since 1964, special observations of icebergs by drogue and current meter measurements and by photo mapping techniques have been conducted in order to develop an iceberg model to support the iceberg drift prediction mission of the Ice Patrol Service. These measurements will be correlated with hydrographic data collected at the same time.

The special data collection phase of this project has been terminated. This final report will be published by the U.S. Coast Guard in the Oceanographic Report Series (CG-373).

SUPPORTED BY U.S. Dept. of Transportation - Coast Guard

3.0077, WEST GREENLAND GLACIER SURVEY
M.J. MOYNIHAN, U.S. Dept. of Transportation, Oceanographic Unit, Washington, District of Columbia

In July 1968, the U.S. Coast Guard conducted a comprehensive oceanographic and geological expedition to twelve tidewater glaciers of West Greenland. The purpose of these expeditions was to study the source of the iceberg menace to the North Atlantic. This was the first year in this area by the International Ice Patrol since 1940 and it constitutes the first phase of a three year project to study the productivity patterns of these glaciers, which are estimated to discharge annually 5400 icebergs.

The objectives of this series of annual expeditions are: (a) To determine the present number of icebergs calved from the major West Greenland iceberg producers. (b) To survey the glacier fronts and compare these data with earlier records to ascertain the advance, or recession, of the glacier termini. (c) To study the environmental conditions affecting the discharge and drift seaward of icebergs from the parent glacier.

Observations include an inventory of iceberg size, type, distribution, and movement. Glacier fronts were charted and bench marks established wherever possible to aid future surveys. Oceanographic observations are made at selected sites within the fjords and in the offshore waters. Photography of fjord bottoms, and significant marine life with an underwater camera and of major glacier fronts from camera equipped Coast Guard aircraft are planned.

The scientific results of this expedition with contributions from invited scientists will be published by the U.S. Coast Guard in the Oceanographic Report (Series CG-373).

SUPPORTED BY U.S. Dept. of Transportation - Coast Guard

3.0078, PREDICTION OF POLAR ICE BEHAVIOR AND DISTRIBUTION

Objective: Expand and improve sea ice data collection, prediction, and dissemination services. Special emphasis is on prediction of underice ridges and dynamics of water features and ice features. As a corollary objective, these studies improve estimates of the global mass budget of ice and consequently global weather prediction.

Approach: Continue collection of ice information on an Arctic Ocean wide basis for a bank of statistical data concerning distributions, sizes, and frequencies of water openings, ice ridges, stages of ice development and other variables affecting operations. Implement a program involving coincident observation and measurement, over a wide ice covered region (i.e., 10,000 nm²), of ice-water stresses, air-ice stresses, ice motions and deformations. This program will use airborne remote sensor support.

SUPPORTED BY U.S. Dept. of Defense - Navy

3.0079, ARCTIC AND COLD WEATHER SUPPORTING TECHNOLOGY
M.M. KLEIMERMAN, U.S. Navy, Ordnance Laboratory, Silver Spring - White Oak, Maryland

Approach: This effort comprises a series of studies and field experiments conducted in-house, by U.S. and Canadian activities, and by industrial activities. There is no underice range in existence at the present time. Naval Ordnance Laboratory, Naval Underwater Research and Engineering Station, and Canadian DRI are engaged in a cooperative effort for establishment of such a range in Nova Scotia, Canada. Stevens Institute is conducting mode tank studies of bottom pressure fluctuations under an ice cover. Acoustics of the ice-water interface are being investigated by McGill, Seismic acoustic transmission through ice is being developed by General Motors.

SUPPORTED BY U.S. Dept. of Defense - Navy

3.0080, ARCTIC SUPPORT
H.M. KLEIMERMAN, U.S. Navy, Ordnance Laboratory, Silver Spring - White Oak, Maryland

Approach: This task area, with the Naval Ordnance Laboratory, White Oak, Maryland laboratory, consists of several basic studies of the effect of high-latitude environment on systems and the ways and means of coping with difficulties imposed by sea ice and cold weather. These studies consist of analytic approaches, laboratory experiments, and field measurements. Included are ice impact and penetration dynamics and remote sensing of ice thickness.

SUPPORTED BY U.S. Dept. of Defense - Navy
3.0081. GREAT LAKES RESEARCH - RIVER ICE JAMS
S.J. BOLSenga, U.S. Army, Lake Survey, Detroit, Michigan 48226

The causes of ice jams in rivers and methods of possible elimination of destructive jams or reduction of their power are being studied.

In the first step of the study pertinent manuscripts from all areas of the world have been collected, examined, and summarized. Foreign language manuscripts account for a significant portion of the items and were translated as required. Report acquisition was through standard library sources, translation agencies, and by direct contact with investigators in the field.

The final results of the survey will be a narrative summary and selected bibliography prepared from the reports. Completion will be in June 1968.

SUPPORTED BY U.S. Dept. of Defense - Army

3.0082. GREAT LAKES RESEARCH - ICE CHARACTERISTICS
E.W. MARSHALL, U.S. Army, Lake Survey, Detroit, Michigan 48226

The investigation seeks to determine the physical characteristics of ice cover in the Great Lakes by field measurements and laboratory analysis of samples from representative localities.

Field investigations are conducted during the 1965-66 and 66-67 winters in the Whitefish Bay area of Lake Superior. Among the factors investigated were: ice thickness, structure, crystal size and orientation, floe characteristics, pressure ridge configuration and ice foot formation. Aerial photomapping provided control for selection of ice samples and a permanent record for additional investigations. Micrometeorological measurements were taken at Whitefish Point during the 1966-67 season with particular emphasis on global radiation in four spectral bands. Petrographic studies of the ice samples collected in the field are conducted in the laboratory.

During the 1967-68 winter season studies will be continued in Whitefish Bay and extended to other areas on and near Lake Superior.

SUPPORTED BY U.S. Dept. of Defense - Army

3.0083. GREAT LAKES RESEARCH - ICE COVER DISTRIBUTION
E.W. MARSHALL, U.S. Army, Lake Survey, Detroit, Michigan 48226

This investigation seeks to determine the changes that take place in the areal distribution, structure, and imagery of the Great Lakes ice cover throughout the winter.

Currently three methods and levels are employed: low level visual reconnaissance, up to 8,000 feet, medium altitude aerial photography, 23,000 feet, and high level satellite imagery, 400 to 800 nautical miles.

The visual aerial reconnaissance program provides the extent and relative concentration of ice. These observations are coordinated with those of the Canadian Department of Transportation which covers the Canadian portions of the Great Lakes. These observations provide a general synoptic view of ice conditions at 10-15 day intervals.

Aerial photomapping of the ice cover at the scale of 1:46,000 is carried out over eleven areas critical to Great Lakes shipping. Weather satellite imagery is monitored to aid in determining ice distribution and program planning.

SUPPORTED BY U.S. Dept. of Defense - Army

3.0084. GREAT LAKES RESEARCH - GREAT LAKES DE-ICING
E.W. MARSHALL, U.S. Army, Lake Survey, Detroit, Michigan 48226

This investigation will prepare three reports (1) Annotated bibliography based on the world's literature on the natural conditions of the formation and decay of freshwater ice on lakes, harbors, rivers and locks as well as scientific and engineering information on techniques used to aid the delay of ice formation and to accelerate the ice in both fresh and marine environments. (2) A summary of the pertinent papers identified in the above and (3) A summary of information developed by the in-house projects of the Research Center on Great Lakes ice characteristics and areal distribution.

SUPPORTED BY U.S. Dept. of Defense - Army

3.0085. PHASE RELATIONS OF THE HYDRATED CARBONATES OF CALCIUM AND MAGNESIUM
D.L. GRAF, Univ. of Minnesota, Graduate School, Minneapolis, Minnesota 55455

The project is concerned with determining the equilibrium phase relations and crystal structures of the carbonates of calcium and magnesium. A knowledge of these phase relations will help one to understand the effect of surface rejections and solution structure upon the kinetics of nucleation, growth, and solution of both hydrated and anhydrous Ca and Mg carbonates in aqueous solutions. The broad understanding of interactions between carbonate solids and water afforded by the total program would be particularly relevant to the formation of dolomite and to the physical properties of sea ice.

SUPPORTED BY U.S. National Science Foundation

3.0086. SPECIALIZED RESEARCH EQUIPMENT FOR SEA ICE STUDIES
K.O. BENNINGTON, Univ. of Washington, Graduate School, Seattle, Washington 98122

The proposed research by the University of Washington will allow for the purchase of specialized equipment for a study of different pressure and internal stresses that develop in sea ice as it freezes during the polar winter. The data that may be gained from this research is basically an understanding of the driving forces that are instrumental in the escape of brine from sea ice. A correlation will be attempted between temperature waves, the resulted pressure waves, and associated compositional changes during the formation and aging of sea ice. Such a correlation has not previously been made. This research project by the University of Washington was begun during the winter of 1966-67, and the equipment that is proposed to be acquired would allow the expansion in both data obtained and in the sophistication of the research. The study of sea ice is an interdisciplinary field between oceanography, glaciology, meteorology, and physics that is essentially restricted to the polar areas. It is expected that the results of this research will contribute to an understanding of one of the major surface features of both the Antarctic and the Arctic regions.

SUPPORTED BY U.S. National Science Foundation

3.0087. SEA ICE MOVEMENT DYNAMICS
N. UATERSTEINER, Univ. of Washington, Graduate School, Seattle, Washington 98122

Evaluation of an existing mathematical model of sea ice movement with special emphasis on the term in the equation of motion representing the eddy viscosity of ice, and an elaboration of a plan to obtain empirical data necessary for a basic improvement of the model.

This project will aid in developing knowledge of the environmental factors that affect the polar ice fields and that is necessary for ice and topographic charting; ice predictions and alluded purposes. The application of the model in forecasting ice concentration and movement showing open leads and pressure ridges will assist in routing of ships.

SUPPORTED BY U.S. Dept. of Defense - Navy

3.0088. ARCTIC AIR, SEA AND ICE
N. UATERSTEINER, Univ. of Washington, Graduate School, Seattle, Washington 98122

Coordinated micrometeorological investigations on shore at Barrow, Alaska, and on drifting stations establish qualitative and quantitative relationships of climate to the physical and biological phenomena it controls. Variables investigated are thermal, moisture and wind gradients, net radiation exchange and carbon
3. METEOROLOGY

dioxide of the atmosphere. Atmosphere and oceanographic factors are studied in their inter-relationships with the annual energy budget of ice, rate of ice formation and distribution information and drift and crystallographic structure.

This task contributes to knowledge of world-wide climatic circulation and specially to climatic patterns in the Arctic. Significant knowledge accrues on the earth's energy balance and the relationship of energy flux at water and atmospheric interfaces of ice to the growth, behavior and wastage of sea ice. Knowledge of total Arctic environments provide criteria for all Navy Arctic operations either by air, surface or water-ice approaches; safety

3E. WEATHER MODIFICATION

3.0089, ION CLOUDS IN THE UPPER ATMOSPHERE  

Chemical seeding of the upper atmosphere with materials which form ion clouds has important military applications. The project aim is, as part of a cooperative effort involving scientists from a number of other installations, both in government and industry, (a) to investigate the feasibility of various proposals which have or are being made for chemical seeding and (b) to divide what areas of research and development are most likely to effectively improve the efficiency of chemical seeding processes. Both of these goals must be approached with specific applications in mind.

Work on this project consists mainly of maintaining a close contact with researchers who are actively engaged in chemical seeding technology or in closely related fields as well as those workers who intend to use such releases for specific applications. Detailed work consists in trying to determine what mechanisms are responsible for ionization in previously performed or proposed chemical releases.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

3.0090, PROJECT FOG DROPS  
W.C. KOCMOND, Cornell Aeronautical Lab. Inc., Buffalo, New York 14221

The purpose of Project Fog Drops is to investigate natural warm fog properties and dynamics and to suggest and evaluate concepts for modification of warm fogs. The principal accomplishments to date are summarized below.

A generalized fog classification system has been evolved. Structural models have been established for the micro- and macroscopic properties of advection and radiation fogs and for sea fog. A fog climatology has been established for the Continental United States.

Measurements made with the thermal diffusion chamber indicate that the maximum supersaturation achieved in urban fogs is substantially less than 0.1 percent and that sources of atmospheric pollution are not the major contributors to the fog nucleus concentration.

Theoretical and experimental investigations have shown that the growth rate of droplets can be decreased by treatment of the droplets with rain surface active monolayers. Ionic surfactants were shown to inhibit rather than promote coalescence.

We have demonstrated in the laboratory that it is impractical to attempt to modify fog by placing electrical charge on the fog droplets. A procedure is currently being tested in the field for suppressing dense natural fog. Experiments in a 600 cubic meter cloud chamber have demonstrated that visibility in warm fog can be improved by a factor of up to 10 by seeding with hygroscopic nuclei of carefully controlled sizes.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

4. SURVEY AND PREDICTION

4A. DATA NETWORKS

4.0001, SATELLITE COMMUNICATION TESTS  
R.F. DEVEREUX, General Dynamics Corporation, San Diego, California (NONR)

The purpose of this task is to evaluate the use of synchronous satellite communication for telemetering oceanographic and meteorological data from moored oceanographic buoys, and to compare the method with the high frequency radio telemetry system now in use aboard the ONR monster buoys. To accomplish this a VHF system will be installed as an additional communication link aboard an existing monster buoy which will be anchored in the middle of the North Pacific in the summer of 1968. The data collected by the oceanographic and meteorological sensors will be stored in the buoy and transmitted, on command, from shore, by both VHF and HF radio links. Interrogation will be made from San Diego, California.

The capability of the Navy to make reliable predictions of the ocean environment for operations will depend in large part on synoptic ocean-wide networks of data collecting buoys. This task will provide experimental data important to the communication links necessary to such systems.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0002, OCEAN SYSTEM TELEMETRY STUDY  
R.F. DEVEREUX, General Dynamics Corporation, San Diego, California (NONR)

A comparative engineering and economic analysis will be made of the use of moored surface buoy/radio links and ocean floor cabled systems for telemetering at remote locations both near and far from land masses. Applicable modulation, coding, data compaction transmission frequencies, subsurface cable characteristics, mooring techniques, reliability and costs are included in the study.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0003, NATIONAL DATA PROGRAM FOR THE MARINE ENVIRONMENT  
J. SINGLETON, System Development Corporation, Santa Monica, California

This is a comprehensive ocean data management study intended to identify, formulate, and evaluate problems of information and data management associated with a national program for the development of the potential of the marine environment. The study should provide overall delineation of a preferred National Marine Data Program, including policy and operational arrangements and specific priority steps for implementation.

Phase 1 of the task, completed in November 1967, was a 5-month project definition phase to determine the scope and structure of marine environmental data activities in the Federal and State governments, industry and universities. The 14-month Phase II will evaluate marine data and means for handling it; and design plans for a National Data Program for the Marine Environment.

U.S. Natl. Aero. & Space Adm.
U.S. National Science Foundation
U.S. Atomic Energy Commission
U.S. Dept. of Defense - Army
U.S. Dept. of Treasury
U.S. Dept. of Defense - Navy
U.S. Dept. of Interior
U.S. Dept. of Commerce
U.S. Dept. of Hlth. Ed. & Wel.
4.0004, STANDARD MONITORING SECTIONS (ATLANTIC AND PACIFIC OCEAN)

The oceanographic program on the Standard Monitoring Sections consists of the occupation (monthly and/or seasonal) of a line of oceanographic stations which are normal to a major current system. These sections, 7 in the Atlantic and 6 in the Pacific, were selected to include the most dynamic areas possible consistent with the normal tracks of the Ocean Station Vessels. The sections in the North Atlantic will provide considerable information about the Labrador and North Atlantic current systems. The North Pacific sections will provide information about the Kuroshio, North Pacific and California currents.

Serial observations are made of temperature and salinity to a depth of 1500 meters or to near bottom when the water depth is less than 1500 meters at each station and stations are taken at intervals that vary from 10 to 60 miles. Observations of temperature and salinity from each Nansen cast station are transmitted by radio teletype to the U.S. Coast Guard Oceanographic Unit for real-time processing, quality control and dissemination to users. During FY 69, the In Situ Salinity/ Temperature/Depth electronic measuring system (STD) is being introduced aboard the Atlantic and Pacific Ocean Station Vessels. This instrument will produce a continuous record of salinity and temperature versus depth and will be calibrated with simultaneous Nansen bottle data.

Data from these cruises are available at the National Oceanographic Data Center approximately two months following the cruise. These data with analyses will be published by the U.S. Coast Guard in the Oceanographic Report Series (CG-373).

SUPPORTED BY U.S. Dept. of Transportation - Coast Guard

4.0005, TIME-SERIES OBSERVATIONS OF TEMPERATURE AND SALINITY (NORTH ATLANTIC AND NORTH PACIFIC OCEAN STATIONS)

The oceanographic program on the Ocean Stations consists of time-series observations of temperature and salinity. Nansen casts are made daily to 1500 meters in depth and once during the cruise. These data with analyses are also transmitted by radio teletype to the U.S. Coast Guard Oceanographic Unit for real-time processing, quality control, and dissemination to users. Salinities are determined at sea by the use of inductive salinometers. Salinity data are also transmitted by radio to the U.S. Coast Guard Oceanographic Unit for quality control. Occasionally, other observations are made by the OSVs, upon request, including biological sampling, collection of samples for chemical analyses, bathymetry, wave height measurements and other observations.

During FY 69, the use of an electronic measuring system was initiated on the Atlantic Ocean Stations. This instrument, the In Situ Salinity/ Temperature/Depth Measuring System (STD), produced a continuous record of temperature and salinity versus depth. Observations are made to 1500 meters in depth four times daily. The STD observations are calibrated by simultaneous Nansen bottle observations. By the end of FY 69, it is expected that 75% of the Ocean Station Patrols in the Atlantic will be made using the STD system. Also the Pacific OSVs will be phasing in the STD instrument by this time.

Data from these cruises are available at the National Oceanographic Data Center approximately two months following the cruise. These data with analyses will be published by the U.S. Coast Guard in the Oceanographic Report Series (CG-373).

SUPPORTED BY U.S. Dept. of Transportation - Coast Guard

4.0006, COAST GUARDS COASTAL OCEANOGRAPHIC MONITORING NETWORK
M. LIGHT, U.S. Dept. of Transportation, Oceanographic Unit, Washington, District of Columbia.

The Coast Guard presently maintains seven off-shore lightships along the East Coast. Eventually all of the remaining 13 lightships will also be replaced by fixed aids-to-navigation. These fixed aids-to-navigation stations proved unique facilities for the continuous monitoring of the ocean environment. During the past 12 years the lightships and the fixed light stations have been used to monitor water temperatures and salinities with relatively uninstrumented stations.

A prototype automatic oceanographic sensing and recording system was installed aboard the SCOTLAND Large Navigational Sea Buoy off Sandy Hook. The oceanographic transducer package is located approximately 5 feet below the water surface and measures the same parameters as the Buzzards Bay system. Its meteorological system measures air temperature, wind speed, wind direction, and barometric pressure. Digitized data arc telemetered over the remote control and monitoring system for the on-board navigational equipment. The data are recorded automatically at Coast Guard Station, Sandy Hook on an incremental tape recorder. Tywritten printouts for real-time monitoring of data are also obtained on command.

The U. of Rhode Island Institute of Ocean Technology has a contract to provide for high order processing, analysis, and interpretation of data from both systems.

Data tapes produced by the Coastal Oceanographic Monitoring Network will be lodged with National Oceanographic Data Center. Monthly data reports will also be made available to the oceanographic community when these systems become operational.

SUPPORTED BY U.S. Dept. of Transportation - Coast Guard

4.0007, ENVIRONMENTAL MEASURING EQUIPMENT

Objective: Develop environmental measuring equipment which will operate over extended periods and under adverse conditions to provide meteorological and oceanographic data over the new data-sparse polar and ocean areas. This equipment is designed to provide high order processing and interpretation of data from both systems.

Approach: Reduce the environment into arbitrary functional areas, such as: (1) Surface data for island and polar stations; (2) limited surface and subsurface data for marine stations; (3) full-range surface and subsurface data for marine stations, and (4) limited upper-air data for 2 and 3 above. Establish a basic platform or mix of platforms for each functional area. Acquire, equip and test the platforms; and refine the various subsystems as necessary to show finite overall progress. Establish the best arrangement of marine platforms into a geographical array with the goal of achieving and operational network capable of acquiring and disseminating all of the environmental data affecting naval operations. Author: coordinated with the USCG National Buoy Study.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0008, DEVELOPMENT EXPERIMENTAL SYSTEM FOR AIR SEA INTERACTIONS
M. GARTANG, Florida State University, Graduate School, Tallahassee, Florida 32306.

Over a planned three-year period, Florida State University, with major support from SAIL, is developing a buoy system for measurement of meteorological and oceanic parameters. With ESSA ship and SAIL staff support, field investigations will be made over extended time periods in the vicinity of Barbados.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.
4. SURVEY AND PREDICTION

4.0009, ANALYSIS AND INTERPRETATION OF SATELLITE RADIATION DATA
UNKNOT, U.S. Natl. Aero. & Space Adm., Greenbelt, Maryland

Technical Objective: To investigate the physical processes of the Earth-atmosphere system which affect the outgoing radiation over the parts of the spectrum sensed by the TIROS, Nimbus, and ATS radiation experiments, leading to methods of interpreting the data to consolidate the results of the experiments with theoretical concepts of atmospheric processes.

Approach: Analytical methods to determine the transfer of infrared and visible radiation in the atmosphere, through clouds, and at the Earth's surface are developed and applied to radiation measurements from meteorological satellites. These measurements are then interpreted in terms of the composition of the atmosphere, the global heat balance, and the general atmospheric circulation. In accomplishing these studies approximately five National Academy of Sciences - National Research Council Post-doctoral Resident Research Associates are supported along with the in-house civil service scientific staff, totalling some ten scientists. Because of the nature of this Work Unit, involving a high level of in-house computation and data handling, computer programming, and statistical techniques, will be used to provide optimum analysis and machine processing of the data. Needed will be a comprehensive analysis of the data, estimates available field data and completed analyses of the data, estimates will contribute to the plan. The plan will be designed to facilitate statistical analysis and machine processing of the data. Work will be accomplished in November and December, 1965.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish. Massachusetts State Government

4.0010, WEIR, TRAP AND SEINE FISHERY
A.E. PETERSON, State Div. of Marine Fisheries, Boston, Massachusetts

Objective: To obtain landing statistics, including location and gear, from weirs, fish traps, and seines.

Procedure: Weir and trap fishermen are required to submit monthly catch reports to the Director of the Division of Marine Fisheries. Catch reports would be required from seine operators landing their catch in Massachusetts. Interview sampling will be used to validate these reports.

Part 3 of 6.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish. Massachusetts State Government

4.0011, ANADROMOUS FISHERY
A.E. PETERSON, State Div. of Marine Fisheries, Boston, Massachusetts

Objective: To obtain accurate commercial landing statistics from the alewife fishways of the Commonwealth.

Procedure: All companies or individuals involved in commercial fishing for alewives in fishways of the Commonwealth will be required to submit weekly landing reports. It will be necessary to obtain a list of those individuals or companies involved in this fishery from the towns of the Commonwealth, since the leasing rights are vested in them. Interview sampling will be used to validate the catch reports.

Part 4 of 6.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish. Massachusetts State Government

4.0012, SHELLFISHERIES
A.E. PETERSON, State Div. of Marine Fisheries, Boston, Massachusetts

Objective: To obtain accurate commercial landing statistics, including location, catch, effort, and gear of the shellfisheries of the Commonwealth.

Procedure: Commercial shellfishermen are required to have a 'bed certificate' issued by the Director of Marine Fisheries in order to sell shellfish. As a requirement for obtaining a 'bed certificate', the fisherman will be required to submit a monthly catch report, stating species, amounts, location, and gear. Town shellfish officers will also be asked to submit monthly reports on landings for their towns. Stimulations for such reports from the officers can be made under the Division of Marine Fisheries' shellfish assistance program. A random sample, utilizing interviews, will be used to verify fisherman catch reports.

Part 5 of 6.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish. Massachusetts State Government

4.0013, OCEANOGRAPHIC DATA SYSTEMS
R.F. HILL, Univ. of Rhode Island, School of Engineering, Kingston, Rhode Island 02881

The development of techniques for the optimum design of total synoptic data systems on the basis of specific missions and under the constraint of cost.

SUPPORTED BY Raytheon Company

4.0014, DESIGN OF SAMPLING PLAN AND PROCURE-MENT OF CHARTER VESSEL
E.B. JOSEPH, Virginia Inst. of Marine Sci., Gloucester Point, Virginia 23062

The objective is to design a plan for exploratory bottom trawling on the continental shelf between Cape May, N. J. and Cape Hatteras, N. C. and to charter a vessel capable of executing the plan. Trawl stations will be spaced so as to sample representative bottom types and depths and to indicate the kinds, numbers, and distributional patterns of the fishes available to bottom trawls, with emphasis on those of potential industrial importance. Information obtained by interviewing trawlermen familiar with the area and by observing catching of trawlers fishing in the area will contribute to the plan. The plan will be designed to facilitate statistical analysis and machine processing of the data. Work will be accomplished in November and December, 1965.


4.0015, USES OF STATISTICAL INFERENCE AND EXPERIMENTAL DESIGN FOR EFFICIENT COLLECTION OF OCEAN DATA
J.C. KELLEY, Univ. of Washington, Graduate School, Seattle, Washington 98122 (NONR)

Objective: In order to monitor and predict the environment, operational and research activities supported by the Navy must place measurement devices within and collect samples from the ocean. This research will provide the plan or design for a sampling program which meets, for minimal cost, the scientific and technological requirements stated as objectives by investigators directing Navy-sponsored ocean research.

Approach: This task makes extensive use of shore-based and shipboard digital computing equipment at the University of Washington. Under investigation are techniques to make available in easily understood graphical representations the state of available information at each state of a cruise. More efficient methods of data storage and retrieval are being developed. Using available field data and completed analyses of the data, estimates will be made of sampling error associated with a single data point. The results of the studies, together with state-of-the-art programming and statistical techniques, will be used to provide optimum sampling plans and costs for specific field experiments. The type of data to which this approach can be applied ranges from the mineral analyses of bottom samples to surface water temperatures.

SUPPORTED BY U.S. Dept. of Defense - Navy
4B. DATA PROCESSING AND ANALYSIS

4.0016. SYSTEM DESIGN STUDY FOR THE U.S. NAVAL OCEANOGRAPHIC OFFICE INTELLIGENCE DATA HANDLING SYSTEM

J.D. LITTLE, Planning Research Corporation, Los Angeles, California

PRC conducted a system analysis and design study for an automated data handling system for the U.S. Naval Oceanographic Office (NAVOCEANO) Mapping, Charting, and Geodetic Divisions. Current operations and future NAVOCEANO requirements were investigated in the areas of nautical and aeronautical charts and publications, and the handling and utilization of geodetic, gravimetric, magnetic, and hydrographic data.

The purpose of the study was to design a system which optimized the automation in handling both the source and reference information and materials used in graphic preparation. Data collection and reduction were performed, followed by the formulation of an operational concept and a time-phase system development plan. Interface requirements with all NAVOCEANO data interchange organizations were studied in order to maximize compatibility in information transfer and file formatting.

SUPPORTED BY U.S. Dept. of Defense - Air Force

4.0017. DATA COLLECTION

H. KLEIN, Univ. of California, Scripps Inst. of Oceanography, San Diego - La Jolla, California 92038 (NONR)

This effort provides techniques trained to take observations independently, maintaining equipment, making measurements ashore of samples taken at sea, processing data, and producing data reports and charts. Procurement, calibration, and maintenance of much used instruments are carried on. Data processing is carried to the point of distribution as tables, charts, and diagrams adapted to the needs of different users.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0018. EVALUATION AND STATISTICAL ANALYSIS OF ALL DATA

T.P. RITCHIE, State Comm. on Shell Fisheries, Dover, Delaware 19901

The data obtained from the first three phases of this project will be evaluated by a qualified statistician. The new data that is obtained will be compared with the data available from Moore's survey in 1910. The net loss or gain in natural seed bed area will be documented and mapped. The uncharted hard bottom areas will be mapped in order to permanently establish the areas where future rehabilitation projects should be conducted.

Part 4 of 4

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish. Delaware State Government

4.0019. BIOMETRY

E. LUKACS, Catholic University of America, Graduate School, Washington, District of Columbia 20017 (NONR)

This task is concerned with the application of statistical methods to biological problems. The investigator and his staff consult with biologists in areas of mutual interest and provide advice and assistance on the design of experiments and the interpretation of mathematical results. Current emphasis is on new methods of statistical analysis of direction of movements and time periods involved in biological orientation. An attempt to develop new methods of multiple comparisons is being made where a sample range is used instead of ordered observations. This is especially useful in taxonomy and population variation.

This task is part of the program of oceanic biology and serves as a valuable analytic tool. It also serves in the translation of biological observations to mechanical and electronic equipment which the Navy requires for knowledge of such biological capabilities as homing, navigation, and avoidance and accurate integration of environmental clues.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0020. AUTOMATIC DATA PROCESSING - SEABIRD DISTRIBUTION

G.E. WATSON, Smithsonian Institution, Washington, District of Columbia 20560

Numerical codes for computer analysis have been developed for at-sea bird observations made during the Pacific Ocean Biological Survey Program so that they may be computer analyzed. The International Seabird Committee has requested the Smithsonian Institution World Data Center and the Woods Hole Oceanographic Center to coordinate the storage and analysis of similar records on a world-wide basis. The first phase of this study will deal with adapting the POBSP codes for international use, devising a suitable nomenclature and code for seabirds of the world and establishing a uniform format for recording data. Later phases will deal with analyzing records.

SUPPORTED BY Smithsonian Institution

4.0021. FOSDIC APPLICATION TO CURRENT-METER RECORDS


The output films of certain commercially-made underwater recorders should be reducible by Government-owned scanners such as FOSDIC. It is the goal of this project to program the MOBIDIC - FOSDIC VI combination to scan these films, and to make the necessary modifications to its film-handling mechanism. It is expected that the use of this equipment will greatly reduce the cost of handling these records. As a programmable film reader, FOSDIC VI should be able to sense the multi-track lines so as to determine the direction of water flow. Velocity indication should be derived from counting the number of dots in groups on the films.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

4.0022. ANALYSIS AND DISPLAY OF HYDROGRAPHIC DATA


Objective: Develop automatic cartographic compilation and reproduction techniques and equipment to reduce, by a factor of 2, the time required for base plant compilation and reproduction of charts in support of amphibious, port, and search/retrieve operation, as well as for general navigation purposes. Production of a chart presently requires six to nine months. This development will reduce the required lead time to three or four months for production of a chart. Coordinated development of components is scheduled through FY 73 to provide a logical sequential upgrading of functions. This effort is directed toward solving problems within the scope of mapping, charting, and geodetic functions as defined in the report, Effective Use of the Sea, June 1966, published by the panel on oceanography of the President's Science Advisory Committee.

Approach: In-house and contractual evaluation and studies of cartographic digital library functions, and of selected automated digital compression and manipulation techniques and concepts for image and graphic data processing will be made. Hardware development will be directed toward automatic digitization of cartographic data and color separation functions and chart correction techniques. This will be followed by development of prototype automated correlation and mensuration techniques and equipment and a rapid graphic imaging and dissemination system. Evaluation of prototype components will provide the basis for development of an operational system.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

4.0023. OCEANOGRAPHIC INFORMATION PROCESSING TECHNOLOGY


OBJECTIVE: Develop a 'Live Atlas' consisting of highly compacted oceanographic data which are retrievable in real-time from a master file through use of computers and which allow man interaction through use of CRT displays.

SUPPORTED BY U.S. Dept. of Defense - Navy
4. SURVEY AND PREDICTION

APPROACH: Compress voluminous National Oceanographic Data Center data files and unifying them into a master file using common geographical and chronological sorting parameters. Data are to be stored in binary format. The file will have an open end capability to allow addition of new data.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0024. ANALYZE AND PUBLISH BASIC DATA FROM PILOT STUDY

G.R. SECKEL, U.S. Dept. of Interior, Bureau of Fisheries, Honolulu, Hawaii 96812

Heat, salt, and momentum 'budgets' are to be calculated and the study to determine the mechanisms which change the distribution of properties and waters masses in the trade wind zone. Using pilot study data analytical studies are undertaken to develop the necessary water 'budget' techniques. The feasibility of the investigation will be demonstrated in publications of the analytical studies.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

4.0025. DIGITAL RECORDING AND PROCESSING OF IN SITU DEPTH-TEMPERATURE-SALINITY DATA

V. GRAEFE, Univ. of Hawaii, Hawaii Inst. of Geophysics, Honolulu, Hawaii 96822

A commercially manufactured depth-temperature-salinity recorder (DTS) is being used by the Department of Oceanography. It presents the measured data in the form of a graph of temperature and salinity versus depth. Digitizing equipment has been developed which transforms the telemetry signals produced by the DTS system into digital values of the three variables and records these on a teleprinter. Simultaneously the values are punched on paper tape for later computer processing and the rate are also transmitted via a radio-teleprinter link to the HIG for immediate processing. The data are then checked on an IBM 1401 computer for errors which might have been introduced by slipping noise or malfunction of the teleprinters. To some extent these errors are corrected automatically, while other errors have to be corrected by hand. The data are then smoothed, freed from systematic errors, and punched on cards in a standardized format on an IBM 360/50 computer. These cards contain one value each for temperature and salinity for every two meters of depth; the values are believed to be correct to plus or minus 0.002 degrees C (temperature) and 0.003% (salinity). Other programs have been written which use these cards to compute--among others--density, dynamic height, and sound velocity--and which present derived as well as observed quantities in graphic and numerical form.

The two-meter data cards are made available to the NODC.

SUPPORTED BY University of Hawaii

4.0026. PHYSICAL AND CHEMICAL ATLAS

K. WYRTKI, Univ. of Hawaii, Graduate School, Honolulu, Hawaii 96822

This grant is for continued preparation of the physical and chemical oceanographic atlas resulting from the International Indian Ocean Expedition. The atlas will be in two parts: Part I will contain the distribution of physical and chemical properties at selected levels and along specific sections of the ocean. Part II will consist of an analysis of all data submitted to World Data Center A, including property distribution, core layer analysis, oxygen, dynamic height, and sound velocity--and which present derived as well as observed quantities in graphic and numerical form.

The two-meter data cards are made available to the NODC.

SUPPORTED BY U.S. National Science Foundation

4.0027. RESEARCH IN MARINE GEOLOGY

A.F. RICHARDS, Univ. of Illinois, Graduate School, Urbana, Illinois

The primary objective of this research is to complete the data reduction, interpretation, and publication of results obtained on the 1966 cruise of the OCEANOGRAPHER (OPR-470). To analyze and prepare for publication the seismic profiles, magnetics and gravity data.

The bathymetry, magnetics, gravity, and reflection seismic profiles have been compiled in the form of charts and profiles.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

4.0028. ANALYTICAL OCEANOGRAPHY

R.B. MONTGOMERY, Johns Hopkins University, Graduate School, Baltimore, Maryland 21218 (NONR) - Supported by U.S. Dept. of Interior

The purpose of this work is to develop improved procedures for the analysis and presentation of serial oceanographic data and also to utilize these procedures in the analysis of existing data to attain better descriptions of oceanic structure. Sets of oceanographic statistics are to be utilized to describe various aspects of the ocean such as the distribution of temperature, salinity, and oxygen from 1500 to 4000 meters as observed at Weather Station PAPA are being analyzed; and studies the Gulf Stream and Mindanao Current are being made.

The proper analysis of oceanographic data and synthesis of a clear picture of oceanic structure is essential for a clear understanding of the environment. The results from this task contribute both to better description and understanding of the ocean environment and the development of techniques that are useful to survey programs.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0029. DISSEMINATION OF COMMERCIAL FISHERIES STATISTICS

A.E. PETERSON, State Div. of Marine Fisheries, Boston, Massachusetts

Objectives: To disseminate statistics in monthly bulletins in cooperation with the Bureau of Commercial Fisheries.

Procedures: The catch statistics will be compiled under the phases listed above. After evaluation and application of various descriptive statistics, the data will be submitted to the Bureau of Commercial Fisheries, to be published in cooperation with the monthly 'Massachusetts Landings' bulletin.

Location: Boston, Massachusetts, and throughout the Commonwealth as required.

Part 6 of 6.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

4.0030. GRAVITY AND MAGNETIC DATA COLLECTED DURING THE INTERNATIONAL INDIAN OCEAN EXPEDITION AND IN THE CARIBBEAN SEA

C.O. BOWIN, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543

A vast amount of geophysical data has been collected during the several cruises of the R/V CHAIN and R/V ATLANTIS II into the Indian Ocean. The purpose of this study is to analyze and interpret the gravity and magnetic data obtained on the geophysical cruises to the Indian Ocean, Red Sea, Mediterranean Sea, Atlantic Ocean and the regions around Hispaniola. The research will be conducted primarily by means of using new programming methods on digital computer equipment. Important steps in the analysis of the information are reduction of the raw data, reprocessing, testing, and plotting maps and profiles. The comparison of calculated gravity anomalies from model crustal structure profiles with observed values will also be undertaken as it has great promise as a means of exploring the oceanic crust.

SUPPORTED BY U.S. National Science Foundation

4.0031. WOODS HOLE SHIPBOARD DATA PROCESSING

E.E. HAYS, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543 (NONR)

Objective: To carry out real time oceanographic data processing, computation, and plotting required for research on oceanic phenomena.

Approach: Continue the development of a computer system aboard CHAIN centered about the Hewlett-Packard 2116A digital computer to produce a real time system for acquisition, reduction, recording, and display for navigation, gravity, and magnetic information.
4. SURVEY AND PREDICTION

The principal investigators have been engaged in the design, development, and installation of an ocean bottom geophysical station since 1963. The present observatory was placed on the ocean floor approximately 200 km west of San Francisco at a depth of 3.9 km in May 1966 and has operated with a high degree of reliability since that time.

The primary elements of the ocean bottom instrument are:
1. a three-component set of pendulums with 15-sec natural periods;
2. a three-component set of pendulums with natural periods of 1 sec;
3. two hydrophones;
4. a vibrotron pressure transducer;
5. a water temperature sensor;
6. a current magnitude sensor;
7. a current direction sensor.

Data are transmitted by cable to the recording station at Point Arena, California. The demodulated signal is recorded on magnetic tape, strip chart recorders, and photographic drum recorders at the Point Arena station. A three-channel set of short-period seismometers and a wave recorder are presently in operation at the Point Arena recording station.

The experiment has thus far returned 18 months of data from the ocean bottom at a total cost of $1.2 million dollars. While this expense may seem large, it must be weighed against the large number of important contributions which have been made in a variety of fields.

This proposal is for:
1. the operation and maintenance of the recording station at Point Arena, California, and
2. support of a data analysis program.

SUPPORTED BY U.S. National Science Foundation

4.0036, A SHIPBOARD DIGITAL DATA ACQUISITION SYSTEM

R.A. BRODING, Seismograph Service Corp., Tulsa, Oklahoma

Summary: A digital system was developed for shipboard acquisition of exploration data that makes use of a small, high-speed computer for formatting, compositing and system control. A 4.096-16 bit core and a 6 million bit disc are used for storage. Dual tape decks provide for continuous operation as well as auxiliary operations, such as tape-to-tape transfer, editing and offline computing. Typically, 24 channels of seismic data are quantized at 1, 2, 4 or 8 milliseconds sample rates. Computer input is via multiplexer, magnetic tape, paper tape or teletype keyboard. Output is on standard 1/2" magnetic tape 800 bpi 9 channel, dual tape decks provide for continuous operation as well as aux-

4.0037, SURVEY, EVALUATION & SUMMARIZATION OF LITERATURE ON ENVIRONMENTAL REQUIREMENTS OF MARINE ORGANISMS LEVELS OF POTENTIAL TOXICITY OF CHEMICALS


It is proposed that each of the sections and the units within the section will deal with those parts of the literature which are pertinent to their work. All papers will be abstracted, a summary given as to the significance of the paper, and key words developed so that the paper and the abstract can be fitted into a data retrieval system. It is planned to do this for a few years, and then to contract work on past literature in order to build up a library for use at the National Marine Water Quality Laboratory and elsewhere in the research program for the development of water quality criteria.
4. SURVEY AND PREDICTION

4.0038, MARINE DIGITAL GRAVITY PROFILING SYSTEM
J.K. PAWLEY, Teledyne Incorporated, Houston, Texas 77036
Specify and implement a coordinated digital hardware-soft-
ware system for gravity profiling at sea. The critical requirement of
resolution of ship velocity to 0.1 knot is to be met by continu-
ous recording of radiolocation data plus statistical processing.
SUPPORTED BY Teledyne Exploration Company

4.0039, DIGITIZING SYSTEM FOR OCEANOGRAPHIC DATA
J.S. CREAGER, Univ. of Washington, Graduate School, Seattle,
Washington 98122
Acquisition of a on-board graphical-to-digital data conver-
sion system is needed to convert graphically recorded data includ-
ing continuous seismic reflection profiles, in situ acoustic absorp-
tion records, precision depth recordings, and records for frequen-
cy spectral analysis of scattering layers. Also, even though a
graphical-to-digital data conversion facility will soon be available
on the University campus, the Department of Oceanography feels
that previously recorded analogue records are comparable to cur-
cently recorded records only if they are digitized on the same
device. Quality control is possible only with the specified equip-
ment.
SUPPORTED BY U.S. National Science Foundation

4C. ENVIRONMENTAL PREDICTION

(see Also Chapter 3, Meteorology)

4.0040, FJORD OCEANOGRAPHY
J.B. MATTHEWS, Univ. of Alaska, Inst. of Marine Sciences, Col-
lege, Alaska 99735 (NONR)
The objective of this task is the prediction of oceanographic
parameters of fjord type estuaries. This will be accomplished by
evaluating field data in conjunction with the hydrodynamic equa-
tions and from this information form a numerical model which
will predict the parameters. During the coming year a concen-
trated effort to sample these parameters necessary to establish a
simple numerical model will be undertaken in Endicott Arm
estuary. Measurement techniques will include moored current
meters, tide gauges, and shipboard u. apling.
This work is of interest to the Navy because very little is
known about the oceanography of this region of the United
States. In addition, the fjords of Southeast Alaska are typical of
those throughout the world and our increased knowledge of the
oceanographic processes taking place there will have universal
application.
SUPPORTED BY U.S. Dept. of Defense - Navy

4.0041, NUMERICAL PREDICTION
P.M. WOLFF, U.S. Navy, Fleet Numerical Weather Facil., Mon-
terey, California 93940
Objectives: The success of a military operation may well de-
pend on intelligent understanding of the natural environment
within which the operation takes place. The requirement exists
for the determination and display of the expected values of criti-
cal environmental variable both in time and space. This must be
accomplished for various projected (future) time periods. This
task supports exploratory development of techniques to provide
the navy with timely and accurate forecasts of weather, both
oceanographic and meteorological.
Approach: To cope with the enormity of the problem and
provide forecasts in a time frame to insure their maximum useful-
ness this task area is automating the complete forecasting cycle
which consists of data processing, data analysis, preparation of
forecasts, rapid dissemination and dissemination and display of
the final product. Automation is achieved through the use of com-
puters and high speed communications networks.
SUPPORTED BY U.S. Dept. of Defense - Navy

4.0042, OBJECTIVE WEATHER ANALYSIS
H.A. BEDIENT, U.S. Dept. of Commerce, Natl. Meteorological Ctr.,
Washington, District of Columbia 20233
Objective - The objectives are to develop improvements to
the analysis of data required for numerical weather prediction.
Approach - Work is being done to improve analysis on a
tropical strip from 48 degree N to 48 degree S around the earth.
Additional work will be done to incorporate heights in the tropi-
cal analysis as described by Bedient in NMC Office Note No. 21.
The technique of Office Note No. 21 is being developed and
tested for the NMC octagon grid. Tests are being made to incor-
porate the Offutt gradient wind system as an alternative to the
preceding method. Work is being done on improvement of the
250 mb analysis.
Progress - Some tests were being made with the solution of
the balance equation across the equator. The tests of Office Note
No. 21 in the tropics have been combined with the high latitude
analysis and will be done together. Complete coding was done
on a procedure for the octagon to carry out the proposal of Office
Note No. 21. One run was successfully made through the whole
procedure. Results were encouraging but accumulation of in-
tegration errors cause a new look to be taken at the procedure.
This is being reprogrammed and work will continue through the
rest of the year. The 250 mb analysis was put into operation dur-
ing the period; results seemed to be good. Further study is being
made to determine improvements. The gradient wind analysis
modification has been programmed and tests will be made on the
procedure during the next period.
SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

4.0043, LARGE-SCALE ATMOSPHERIC EVOLUTION
J. NAMIAS, U.S. Dept. of Commerce, Natl. Meteorological Ctr.,
Washington, District of Columbia 20233
Objective - The objective is to apply physical principles
governing the evolution of the atmosphere and oceans to the pre-
diction of sea temperature, storminess, and weather changes for
periods of a month or longer.
Approach - The objectives are approached through study of
the energy balance of the atmosphere, land and ocean, and the
exchange of energy between them, in relation to such things as
anomalies in ocean temperature, snow, and ice cover. Acquired
knowledge is included in physical models for numerically predict-
ing the evolution of monthly-mean states of the atmosphere and
ocean. Access to electronic computers and close coordination
with other research in numerical weather prediction is essential
for progress.
Progress - In the year ending June 30, 1967, the study of the
northeastern United States drought was concluded. It led to a
more general study of seasonal precipitation in this region related
to that in other states. New emphasis is on ocean-atmosphere in-
teractions over the Pacific Ocean. Tests and evaluations continue
on numerical models for predicting mean rainfall, and tempera-
ture in the atmosphere and ocean for a month in advance. Work
now centers on developing an improved model which can incor-
porate already-formulated better estimates of the mean water
budget of the atmosphere, horizontal heat transfer in atmosphere
and ocean, and reflectivity of the earth's surface.
SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

4.0044, MAGNETIC AND GRAVITY PREDICTION
J.A. BRENNAN, U.S. Navy, Oceanographic Office, Washington,
District of Columbia
OBJECTIVES: Determine the affect of magnetic storms and
micropulsation activity on present and future magnetic sensors.
This effort is directed toward reducing or eliminating this source of
noise.
APPROACH: A magnetic recording station will be es-
ablished in order that very sensitive magnetic data can be
acquired. Noise will be catalogued as to frequency of occur-
cences, amplitude, and coincidence with effects on fleet equipment.
The observed station data and fleet effects will be further corre-
lated with standard geomagnetic 'K' and 'A' indexes. An attempt
will be made to define magnetic activity in terms of a magnetic ac-
tivity index.

66
4.0045. WEATHER ANALYSIS AND FORECASTING


Objective: To develop new or more efficient techniques for analyzing and forecasting environmental factors; to establish the influence of these environmental factors on naval operations and to develop efficient systems for display and presentation of environmental data that will ensure optimum comprehension by the users.

Approach: Development of new and improved prediction techniques is largely based on new knowledge resulting from research in the atmospheric and oceanographic sciences. To bridge the process from research to exploratory development specially qualified personnel at the naval weather research facility and a few select contractors are employed. Developed techniques are tested and evaluated and if successful are either placed into operational use or, if required, go into advanced development.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0046. GLOBAL OCEAN FLOOR ANALYSIS


OBJECTIVES: To improve Navy capability to describe, understand, predict and ultimately utilize geological and geophysical parameters of the ocean floor in support of NAVOCEANO's mission of providing pertinent and vital environmental information for the operating forces.

APPROACH: Collect geophysical and sub-bottom acoustic profiles; analyze them in reference to physical, particulate, and chemical properties. Integrate these data into a physiographic and structural charting program permitting predictive determination of limits and areal extent of specific acoustic absorption and attenuation characteristics. Correlate bottom current effects, magnetic and stratigraphic patterns, sediment properties, and physiographic features with respect to more rapidly collectable bathymetric data.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0047. INVENTORY OF THE GULF ESTUARY SYSTEM

N.G. VICK, U.S. Dept. of Interior, Bureau of Sport Fish. & Wife., Panama City, Florida 32401

The objectives of this study unit are to procure and document environmental and ecological data on the St. Andrew Bay System, Panama City, Florida. These data will include (1) area descriptions (2) hydrology of the bay system (3) sedimentology, and (4) samples of the biological materials available seasonally with emphasis on the sporting species of marine fishes.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0048. PREDICTION OF EXTREME ENVIRONMENTAL FACTORS

N. BUSKE, Ocean Science & Engin. Inc., Bethesda, Maryland 20014

Dimensional analyses of factors associated with extreme winds and extreme waves. Development of universal prediction method for extreme wind or wave occurrences.

SUPPORTED BY Ocean Science & Engineering Incorporated

4.0049. ARCTIC RESEARCH

K.L. HUNKINS, Columbia University, Graduate School, Palisades, New York 10964

The objective of this research program is to understand (1) the topography, crustal structure, and sediment regime within the Arctic Ocean basin, (2) the motions of Arctic ice and water, and (3) the acoustic properties of the Arctic Ocean. Measurements are made on a year-round basis from Fletcher's Ice Island, T-3, to provide information on geographic position, depth, sub-bottom reflections, bottom sediments, gravity and magnetic field strengths, currents, and sound-scattering layers.

SUPPORTED BY Ocean Science & Engineering Incorporated

4.0050. OCEANOGRAPHIC PROCESSES IN ESTUARINE AND COASTAL WATERS

C.A. BARNES, Univ. of Washington, Graduate School, Seattle, Washington 98122 (NONR)

Objective: To improve Navy capability to describe, understand, predict and ultimately utilize all environmental factors which influence the environment in estuarine and coastal areas of the world. This research effort is to produce a better understanding of the small-scale velocity distributions in the physical characteristics and circulation of the waters in a variety of coastal environments.

Approach: A field program is being conducted in the Puget Sound region and its approaches and in the waters of the Pacific Ocean bordering the State of Washington. A series of temperature, salinity, density, speed, current measurements are being made to assess the role of thin lens water parcels injected into Dabob Bay upon the properties and structure of the waters in that estuary. Analysis also will be made on the vertical oscillations of the depth of the region of maximum density gradient to determine the dependence upon tide height, mean water level, barometric pressure and wind stress.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0051. DISTRIBUTIONS OF CURRENTS AND PHYSICAL PROPERTIES WITHIN THE ARCTIC OCEAN

L.K. COACHMAN, Univ. of Washington, Graduate School, Seattle, Washington 98122 (NONR)

Objective: A thorough knowledge of the Arctic Ocean and its adjacent seas is of fundamental importance to naval operations in the area. This research supports that objective. Among the aspects of this work which are of particular significance to the Navy are: (1) discovery and measurement of swift, time-dependent currents in the operational region of submarines; (2) distribution of super cooled water which may affect navigation and icing under surface ice; (3) the distribution of water which may affect navigation and icing under surface ice; (4) monitoring oceanographic literature (particularly Soviet) of the Arctic; (5) measurement of surface currents in Bering-Chukchi Sea, Greenland-Norwegian Sea and Baffin Bay, which are important to navigation and ice distribution in these peripheral areas; and (6) studies of heat exchange across the air-sea surface which are important to arctic meteorology and ice prediction.

Approach: The work is conducted by: literature monitoring; laboratory work continuing the analyses of water masses; the development of theoretical models; and field observations conducted from the ice island T-3 and available vessels. In the central Arctic basin a program to study motions and water properties will continue from T-3. Utilizing ships of opportunity, in cooperation with the U.S. Coast Guard, and current meters suspended from buoys the flow through the Bering Strait will be measured as a function of time. Programs are underway to investigate numerically (1) the wind-induced circulation in the Greenland and Bering Seas, and (2) the effects of bottom topography on currents in the Arctic.

SUPPORTED BY U.S. Dept. of Defense - Navy

4D. MAPPING, CHARTING, AND GEODESY

4.0052. LOCATING AND MAPPING HARD BOTTOM AREAS NEAR EXISTING NATURAL SEED OYSTER BEDS

T.P. RITCHIE, State Comm. on Shell Fisheries, Dover, Delaware 19901

The objective of this phase is to determine the location and acre extent of hard bottom areas which could be used to create...
4. SURVEY AND PREDICTION

new oyster seed beds. Preliminary surveys indicate that high salinities now prevail over many of our formerly productive seed oyster beds. Spat bags indicate that oysters will set and survive in areas where oyster shells are totally lacking on the bottom. Our objective is to determine the size and shape of hard bottom areas that we may have to use in the future.

Some indication of bottom hardness can be obtained by use of a fine-line depth recorder. Several oyster shell dredging companies routinely use these instruments to determine the extent of sub-surface oyster shell deposits. The actual bottom consistency will be determined by grab samples and by use of a sounding pole.

Part 3 of 4.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish. Delaware State Government

4.0053, PHOTOGRAPHIC IMAGE EVALUATION


To study human evaluation and machine measurement of the qualities of photographic images.

Objectives: The overall objective is to establish control standards, working in each particular area until the job is completed as permitted by weather and tidal conditions. Each area will be selected on the basis of the greatest need; however, proximity of such areas will be carefully coordinated insofar as possible.

Procedure and Work Schedule - 1. Monuments are to be set in place around the bays at approximately 1/2 mile spacings. 2. A Traverse Line will then be run, beginning from a known location of a U.S. C.G. Triangulation Station and joining all monuments together, and then tied into another U.S.C.G.S. Triangle Station. 3. All oyster leases will then be tied into the designated base line monument.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish. Louisiana State Government

4.0054, TEKTITE I


This project is investigating the efficacy of pursuing geologic mapping of the sea floor and the study of geologic processes operating there, utilizing an undersea habitat and saturation diving techniques. A geologist, in company with several marine biologists, will spend 60 days continually submerged, working from a habitat at 60' depth off the coast of the Virgin Islands. This project is being carried out in cooperation with Bureau of Commercial Fisheries, Navy Department, NASA, Bureau of Mines and General Electric Corporation.

SUPPORTED BY U.S. Dept. of Interior - N.B.S.

4.0055, BOTTOM TOPOGRAPHY AND SEDIMENTS-MIDDLE ATLANTIC SHELF


Mapping of bottom topography and sediments of the Middle Atlantic Continental Shelf region of eastern North America. The principal sources of data are gravity and magnetic survey, echosounding, and acoustic survey.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

4.0056, WORLD WIDE MARINE MINERAL RESOURCES


To prepare maps at various scales of the world's continental margins and deep oceans and ultimately to accumulate and computerize data on location and quality of marine mineral and related resources for evaluation of the world's real and potential mineral resources.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

4.0057, OYSTER LEASE CONTROL MONUMENTS - BAY ADAM, BASTIAN BAY AND SANDY POINT BAY AREAS

J.W. LAY, State Wildlife & Fish Comm., New Orleans, Louisiana

Objectives: The overall objective is to establish control monuments throughout the oyster growing areas of coastal Louisiana at 1/2 mile spacings on the land from which surveys of waterbottoms for oyster leases could be coordinated as a specific reference point. This work will be performed on a compartmental basis, working in each particular area until the job is completed as permitted by weather and tidal conditions. Each area will be selected on the basis of the greatest need; however, proximity of such areas will be carefully coordinated insofar as possible.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish. Delaware State Government

4.0058, MARINE PHYSICAL GEODESY

W. FONARV, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts

The objectives of this program are to (a) continue development of marine geodetic instrumentation, (b) define the geoid at sea, (c) measure departures of the physical sea surface from the geoid, and (d) interpret these departures in terms of the meteorological, tidal and ocean current forces which cause them. During this contract year VLF range rate information will be integrated into a satellite navigational receiver system. This is expected to improve geographic positioning accuracy to the astronomical positioning accuracy of about 6 seconds of arc presently available with GEON. Development of an improved theodolite for use on GEON will continue. Astrogravimetric areas will be run in significant areas such as the Florida Straits as opportunities arise.

The accuracy of inertial navigation systems is limited by insufficient knowledge about the earth's gravity field and deflections of the vertical. In support of the Navy's effort to remove this limitation, this program is developing and evaluating new techniques and instruments in the fields of navigation and marine gravimetry; providing direct measurements of deflections of the vertical at sea; and obtaining marine gravity data.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0059, OCEANOGRAPHY ATLAS OF THE NORTH CAROLINA CONTINENTAL MARGIN

O.H. PILKEY, Duke University, Graduate School, Beaufort, North Carolina 28516

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

4.0060, DEVELOPMENT OF A PHOTOGRAPHIC SUIT FOR STEREOPHOTOGRAMMETRIC MAPPING BY SUMMERIBLE

G.F. BASS, Univ. of Pennsylvania, Graduate School, Philadelphia, Pennsylvania 19104 (N00014-67-A-0216-0002)

The objective of this task is to develop, construct and evaluate stereophotogrammetric equipment for underwater mapping and to evaluate scanning sonar techniques and transponder navigation systems for underwater search. The evaluations will be
made during an underwater archeological expedition off the coast of Turkey.

The present efforts of the Navy to use deep diving submarines for search and rescue are hampered by our lack of ability to navigate and map underwater. The results of this study should improve our capability in this field.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0061. FEASIBILITY STUDY FOR SYNTHETIC APERTURE ACOUSTIC BOTTOM MAPPING SYSTEM
G.M. WALSH, Unknown, Rhode Island

The application of the synthetic aperture array principle to a high resolution, ocean bottom mapping system is shown to be feasible for system applications. The model's predictions of water quality, spatial and temporal characteristics of the imaging system will be demonstrated by a combination of computer output as to ease of analysis format, and alternative computer output as to ease of analysis format, and alternative

SUPPORTED BY Raytheon Company

4.0062. GALVESTON BAY STUDY
W.H. ESPEY, Tracor Incorporated, Austin, Texas 78721

The Galveston Bay Study. Computer models are being developed which describe the hydrologic, chemical, and biological responses of the estuarine system. The models will predict the water quality characteristics at various points in the bay as defined by various boundary and input conditions. The two-dimensional hydraulic model will predict the spatial and temporal distribution of tides, velocities (magnitude and direction) and phasing between tides and velocities in response to tidal action, wind stress, fresh water flows, physiographic features, etc., by the numerical solution of the Navier-Stokes and continuity equations. The transport characteristics of the bay system are being incorporated into the water quality models to allow the temporal and spatial variations of mixing and exchange of Gulf waters throughout the bay system. The models will be sufficiently flexible to permit the study of water quality and assimilative capacity under a variety of levels of waste treatment and methods of waste treatment.

Results of the evaluation of various alternative waste treatment systems will define the input to the optimization model. This model will provide a quantitative framework from which to determine the most cost-effective system in terms of design, operation, and various legal and institutional constraints to achieve optimum use of the resources.

SUPPORTED BY Texas State Government

4E. MODEL STUDIES

(General Construction and Application, Models of Specific Systems Found Under that Subject.)

4.0063. SIMULATION MODEL FOR THE ANALYSIS OF ADVANCED MARINE SHIPPING SYSTEMS
UNKOWN, Univ. of California, Graduate School, Berkeley, California 94720

PURPOSE: To explore the applicability of modular transportation computer simulation, TRANSIM, for analyzing advanced marine shipping systems.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

4.0064. COMPETITIVE MERCHANDISE SHIP (BULK) TECHNICAL INNOVATIONS
UNKNOWN, Litton Industries Incorporated, Culver City, California

Purpose: To forecast the technical innovation climate for bulk carriers in support of preparation of a plan for producing advanced dry bulk shipping systems.

Description: Technical and economic analyses of innovations which could be included in new bulk carriers to maximize returns to the owners and to the Government will be carried out. The research will provide a means of evaluating: different ship sizes and types, advanced equipment, methods of construction, innovations in the design process, and the value of ship standardization.

An analytical model will be developed to evaluate technical concepts. The results will serve as input to the development of a Strategic Development Plan for producing competitive bulk carriers.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

4.0065. MULTISPECIES FISHERIES MODELS
W. LENARZ, U.S. Dept. of Interior, Fishery Oceanography Ctr., La Jolla, California

The pelagic fisheries of California are based on a multispecies ecosystem. Because of the nature of the oceanographic climate, the ecosystem is unlikely to remain in a stable equilibrium, even in the absence of a fishery. To assist our understanding of the likely consequences of fishing effort and climatic change on such an ecosystem, we must be able to interpret our findings in terms of the theoretical multispecies fisheries models currently being developed elsewhere and to construct a model (perhaps by computer simulation studies) relevant to California fisheries.

This project was initiated in FY 1969 with the recruitment of the senior investigator. A general computer simulation model of a fishery on interacting species is presently being developed, in two major parts: a biological section and an economic section. The biological section will include interactions among the species at several stages of their life histories. The economic section will include capital and operating expenditures of the industry and management agency. Potential profit under various fishery and management policies will be based on current knowledge of the population dynamics and fisheries of Pacific sardine, northern anchovy, and Pacific mackerel.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

4.0066. SIMULATION MODELS OF SHALLOW-WATER AND COASTAL ENVIRONMENTS
J.W. HARBAUGH, Stanford University, Graduate School, Palo Alto - Stanford, California 94305

DESCRIPTION: The TRANSIM transportation system simulator was developed by the University of California to fill the need for a general purpose computer simulation method which is simple and economical to use in a wide variety of transportation problems. The objective was to develop a method by which problem formulation, model structuring, and setting up the simulation could be accomplished by individuals who are not necessarily familiar with programming and computers.

This research study will analyze a high speed shuttle ship system and a detachable power plant system. Results will determine: (1) the complexity of TRANSIM's use with problem formulation, model structuring, organization of data input, and in general, setting up the computer simulation; (2) the flexibility and type of computer output as to ease of analysis format, and altering; (3) the costs and manhours associated with the use of TRANSIM; (4) the applicability for future, more complex simulations.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.
4. SURVEY AND PREDICTION

Versatile, general simulation computer programs are being developed to realistically imitate major natural processes operative in coastal and shallow-water environments. These models are being modified and adapted to simulate selected specific localities such as Florida Bay, Mississippi Delta, and the barrier beaches of southern Texas, to assure their validity.

Environmental information is often inadequate on coastal and nearshore areas in which operations must be performed. One means of filling gaps in the data and of inferring the hydrologic and sedimentary processes responsible for the observable environmental features is through the use of mathematical simulations. A realistically performing model should reveal the magnitude and interrelations of local environmental variables and predict environmental conditions.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0067, MODEL FOR PRELIMINARY EVALUATION OF TOTAL CARGO TRANSPORTATION TIME AND TRANSPORTATION COST FOR ADVANCED CARGO TRANSPORTATION SYSTEMS

J.G. GROSS, U.S. Dept. of Commerce, Maritime Administration, Washington, District of Columbia 20235

This computerized transportation analysis model is an approach to the determination of 'total system' costs involved in cargo movement, and 'Total' transportation time involved with this movement. The goal was to explore a method for determining transport cost and time on a comparable system basis, irrespective of the vehicles used in the system: and to have minimum input other than that required for the physical structure of the system.

The program was developed for a preliminary analysis of a broad range of vehicle types - aircraft to displacement ships, and the analysis of comparable transportation costs for each - shipper to consignee. It considers the vehicle is engaged in a hypothetical transportation system consisting of inland rail and truck logistics, marine cargo consolidation and packaging, inland and port cargo handling, and prime vehicle line haul movements. The range cost considerations are prime vehicle line haul movements. The range of cost considerations are prime vehicle investment, cargo handling (inland and prime vehicle terminal), cargo characteristics (packaging, specific volume, value), type of handling equipment, packaging, insurance (vehicle and cargo), documentation, cargo claims (inland and port), vehicle operation, wharfage or terminal, vehicle handling, and inland line haul cost. Transportation time factors include the same areas, particularly vehicle port interfacing, vehicle speed variations, inland and terminal delays of cargo, and port cargo storage times.

The model output included one detail system time and cost breakdown, and a less detailed output of speed, transport time, specific volume, transport costs for variations in cargo specific volume. The model is of the deterministic steady state type. It is written in FORTRAN IV for H200. As yet no model operating documentation exists.

Operation to date has been good when analyzing broad category of vehicles on a consistent basis. Such vehicles as hydrofoil, surface effect ships, various displacement ships types, and aircraft have been explored by the model. Estimating relationships and logic are still considered preliminary.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

4.0068, ADVANCED MARINE TRANSPORTATION SYSTEM/ANALYSIS MODEL

J.G. GROSS, U.S. Dept. of Commerce, Maritime Administration, Washington, District of Columbia 20235

This overview study and project outline was made to determine the composition of models that could be used effectively to determine long range commodity demands for international transportation, and to analyze advanced marine transportation systems.

A Transportation Requirements Model is needed to provide the ability to identify and analyze major flows of commodity by sources, sinks and time frame. The input to this model will be records and statistics of government agencies charged with compiling information on industry production, raw material requirements, population level, area technology and social development status. The algorithm output will include quantity and type of commodity, transport demand at each source and sink during each time increment, and the transportation quality required.

An Advanced Ship Analysis Model is needed to consider the output of the Transportation Requirements Model, and reject or analyze advanced vehicle concepts as a part of the total system for future time frames. It has the function of providing a means of loading the demand into the optimum transportation network, and listing by ranked order the best choice of mode, next best, etc.

The study considers such factors as transportation market requirements, modal performance, selection of the best mode, transport system characteristics, route structures, level of operation and system constraints. The program was written in FORTRAN IV for IBM 7090. As yet, no model operating documentation exists and further analysis is needed to accurately determine model correction and performance.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

4.0069, MODEL FOR THE PRELIMINARY EVALUATION OF TOTAL VALUE AND QUANTITY OF IMPORT AND EXPORT FOR WORLD TRADE AREAS

J. GROSSE, U.S. Dept. of Commerce, Maritime Administration, Washington, District of Columbia 20235

This study is an attempt to idealize world trade flow into a mathematical model. The goal is to determine if, for two selected countries, such parameters as GNP, distance between countries, variables for neighboring countries, trade policy preferences, levels of industrialization, and population can be related so that the value, tonnage, and transportation characteristics between the two countries can be determined. The rate of change of each variable with time is built into the model, thus giving some capability to forecast cargo flow for future years.

The model has been operated to the extent that measurement of trade value and tonnage between two trade nodes were determined in ten increments to the year 2010. A summation of the cargo flow to and from all trade areas to a selected trade area yields the import and export of that trade area.

The model is written in Fortran IV for IBM 7090. As yet, no model operating documentation exists and further analysis is needed to accurately determine model correction and performance.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

4.0070, NUCLEAR FUEL COST ANALYSIS MODEL

P.B. MENTZ, U.S. Dept. of Commerce, Maritime Administration, Washington, District of Columbia 20235

A Nuclear Fuel Cost Analysis Model has been developed to analyze fuel costs for potential nuclear merchant ships. The model has been programmed in Fortran IV and is currently being run on a Honeywell 200 computer.

The model will calculate overall fuel cost, for nuclear ship propulsion systems on a life cycle basis. Included within the cost structure are components dealing with uranium inventory, enrichment, conversion, fabrication, refueling, and reprocessing. For convenience, the estimating relationships for each of these key economic parameters may be readily modified in order to assess the effect of a potential change in either technology or pricing.

The operational characteristics of a thermal, pressurized water reactor (PWR) are approximated by the use of a simplified nuclear fuel model, utilizing average values of conversion ratios, cross sections, and leakage probabilities. Output parameters, in addition to specific fuel cost, include initial and final enrichments, uranium inventory and burnup, and fission plutonium discharge.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.
4.0071, ARGONNE MICROMETEOROLOGICAL MODELING FACILITY PROPOSAL
H. MOSES, Argonne National Laboratory, Argonne - Lemont, Illinois

Argonne National Laboratory is proposing to the Atomic Energy Commission a program for modeling micrometeorological phenomena, with special emphasis on atmospheric diffusion problems. This program will include basic research into the structure of turbulence and diffusion and applied research into such areas as flow patterns and dilution rates in the vicinity of buildings, reactor complexes, etc. Theoretical analyses and field experiments will be conducted in addition to and supplementing the modeling work. Turbulence and diffusion rates in areas of complex terrain are poorly understood. Safety analysis reports for reactors based on current knowledge are not very reliable and may lead to improper or overdesign of safety features. Modeling air flow in a large wind tunnel, with proper controls of turbulence intensity of vertical temperature and wind speed profiles, will result in more accurate hazard reports.

Results to Date: A feasibility study for the modeling facility has been completed by the Cornell Aeronautics Laboratory, Buffalo, New York. This study included: (1) a conference attended by fluid dynamicists and meteorologists to advise on design criteria for the wind studies including experimental tests on techniques for proper simulation of atmospheric motions, (2) literature and engineering studies including experimental tests on techniques for producing turbulence necessary for modeling atmospheric diffusion, (3) a literature and engineering study on techniques for controlling the temperature field with emphasis on maintaining a preset vertical temperature gradient over a range of turbulence intensities, and (4) development and analysis of tunnel design parameters.

SUPPORTED BY U.S. Atomic Energy Commission

4.0072, COMPETITIVE MERCHANT SHIP (BULK) DEVELOPMENTAL PLAN

PURPOSE: To develop a plan for producing advanced high capacity dry bulk cargo ships that best fulfill national requirements, and have multi-application and lowest life cycle costs.

DESCRIPTION: An investigation of the commercial and national requirements for American Flag dry bulk cargo ships and an evaluation of feasible shipping concepts will be made. This will include forecasts of the inbound-outbound movement of dry bulk commodities and other cargoes which might feasibly be carried. The bulk form available is the largest of bulk cargo ships and the shipping capacity will be studied to determine possible effects on strategic, economic and political national goals. An economic and technical analysis of all feasible shipping concepts will be conducted along with investigations to determine the most effective financing method to employ, the technical innovations which would ensure lowest life time cost, and the trades in which these ships could compete most effectively. The results will be used as a basis for preparing a Strategic Development Plan that will most effectively produce competitive dry bulk carriers.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

4.0073, THE APPLICATION OF MATHEMATICAL METHODS IN CERTAIN OCEANOGRAPHIC PROBLEMS
J. CARRIER, Harvard University, Graduate School, Cambridge, Massachusetts 02138

0000 SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY John S. Guggenheim Memorial Foundation

4.0074, EFFECTS OF SCALE AND OPERATING TECHNIQUE ON HARBOR MODELS
R.Y. HUDDSON, U.S. Army, Waterways Experiment Sta., Vicksburg, Mississippi

4. SURVEY AND PREDICTION

The objective of this project is to determine the effects of model scale and the techniques of model operation on the accuracy of model results. Tests will be conducted to establish the bases of model design, operation, and analysis of test results. Studies to be made are wave filters for harbor models and wave flumes, wave attenuation due to bottom friction, and design of ripple tank and appurtenances.

SUPPORTED BY U.S. Dept. of Defense - Army

4.0075, DYNAMIC MODEL STUDY OF LAKE ERIE
R.R. RUMER, State University of New York, School of Engineering, Buffalo, New York 14214

A rotating laboratory (11' x 18') is being used for a hydraulic model study of Lake Erie. The principal objective of this study is to determine the degree of usefulness of a rotating vertically distorted Froude model in the prediction of the response of Lake Erie to various physical inputs such as inflows, wind stress, etc. Analytical studies of others as well as of the investigators will be used in attempts to predict the dynamic behavior of the model lake. Field data taken during the GLRB study and reports of other field studies will be used in the model verification process.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

4.0076, HYDROLOGIC SYSTEMS ANALYSIS OF THE GREAT LAKES
W. BRUTSAERT, Cornell University, School of Engineering, Ithaca, New York

The objective of this project is a preliminary study of the Great Lakes as a hydrologic system. In other words an attempt will be made to characterize the basin as a 'black box' from physical as well as from purely mathematical considerations.

The inflow-outflow and storage relationships will be investigated by means of different linear and non-linear models which are presently known in the literature. New runoff-routing models appropriate for the specific conditions of large water bodies - with or without regulated water levels - will be developed and tested.

The usefulness of the available hydrographic and meteorologic data will be assessed; this will in part dictate the direction of future studies.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rch
Cornell University

4.0077, NUMERICAL OCEANOGRAPHIC MODEL DEVELOPMENT FOR ENVIRONMENTAL PREDICTION
W.J. PIERSON, New York University, School of Engineering, New York, New York 10013 (NONR)

Objective: Navy oceanographic forecasting services require improved numerical models of the ocean to support tactical and logistical operations of the fleet. The aim of this research is to develop a numerical model of the ocean and overlying planetary boundary layer of the atmosphere to contribute to the improvement of meteorological forecasts over oceanic areas as well as oceanographic forecasts.

Approach: A finite difference mathematical model of the Atlantic is being developed according to the 'Box Method' used previously by other investigators. A quasi-climatological model for typical monthly conditions will be generated first to develop water mass distributions and currents more realistically than is done presently by available models. Methods for altering the grid system within the model are being devised to account for moving shear zones, meandering currents, and varying depth of the thermocline. A computer program also is being developed to obtain the amount of solar radiation that hits the surface waters of the ocean.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0078, AIR-SEA INTERACTION AND PLANKTON ECOLOGY
E.R. BAYLOR, State University of New York, Graduate School, Stony Brook, New York 11790
4. SURVEY AND PREDICTION

The project is to test the predictions of two models that relate the in situ abundance of plankton to the air and the water circulation patterns at the sea surface.

The first of the two models relates small-scale patchiness of plankton abundance to the water circulation patterns described by Langmuir (1938). The second of the two models related larger-scale (one kilometer) patches of plankton abundance to air circulation patterns such as those described by Woodcock and Wyman (1947).

The model that relates Langmuir circulation to small-scale patchiness of plankton predicts that localized increases of plankton abundance are correlated with the temperature perturbations produced by the Langmuir circulation pattern.

The kilometer scale model relates patchiness of plankton to the Wynn-Woodcock horizontal vortex air-circulation pattern and predicts large patches of plankton abundance beneath the parallel lines of clouds that mark the up-welling air from circulation convergences at the sea surface.

The sampling program was designed to ask whether plankton abundance (in situ high frequency sonar counts) was correlated with water temperature perturbations at Langmuir down-welling and whether air temperature and humidity (kite borne telemetry at cloud base level) were correlated with cloud lines and large scale patches of plankton.

SUPPORTED BY U.S. National Science Foundation

4.0079, ESTUARINE SEDIMENTARY MODELS
G.S. VISHER, Univ. of Tulsa, Graduate School, Tulsa, Oklahoma 74104

The primary aims are to provide information for a general process-response model for the tidal-estuary-distributary environmental association, and to test the hypothesis that texture may be used directly in the identification of specific sedimentary processes. Work on fluid flow in natural stream channels has demonstrated the association of textures with specific flow regimes. In addition, recent textural studies of clastic sediments suggest the possibility that texture may be used directly in determining ancient sedimentary processes in a more specific manner than previously possible. An observation program to test these hypotheses will be carried out in the estuary of the Altamaha River.

The data will be used to develop a statistical model of the area for comparison to ancient rocks, and to evaluate the effects of differing sedimentary processes on grain size distributions.

SUPPORTED BY U.S. National Science Foundation

4.0080, DELAY LINE COMPUTER
D.D. AUFENKAMP, Oregon State University, Graduate School, Corvallis, Oregon 97331

The purpose of this task is to apply modern computer techniques to oceanography on a real time basis. It is anticipated that this will be accomplished by first developing a mathematical model to describe the exchange processes taking place within a given volume of the ocean and then, using moored buoys and other platforms to measure the oceanographic and meteorological parameters, compare the model in a hybrid analog digital computer with the actual measurements correcting the model as necessary to fit the real environment.

The ability to predict acoustic conditions as they affect Navy systems and water motions as they affect vehicle operations and underseas construction depends on a thorough knowledge of the energy exchange processes taking place within the ocean and between the ocean and the atmosphere. This task holds great promise for improving our understanding of these processes.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0082, COMPUTER SIMULATION OF THE PROPAGATION OF SURFACE WAVES
W.H. ESPEY, Tracor Incorporated, Austin, Texas 78721

The propagation of surface waves from deep to shallow water over composite or irregular slopes is an extremely difficult and complex fluid problem. In many cases, semi-empirical approaches have been used to solve practical problems because of the complexity of the basic Navier-Stokes equations which describe the flow field. In deep water there assumptions of irrational flow and small particle motion, which lead to linearized equations, are justified. However as the wave advances toward the shore, the wave form changes and becomes highly nonsteady and non-linear. Because of these effects, a true description of the propagation of surface waves from deep to shallow water over complex bottom geometry must be based on the complete Navier-Stokes equations. The problem approach used in this study is based on a combination of numerical computer simulation techniques to solve the complete Navier-Stokes equations.

The TRACOR Hydrodynamic Model, which solves the two-dimensional Navier-Stokes equation, has been expanded to simulate the propagation of surface waves in the Coastal Engineering Research Center large wave tank. The tank employs a flap-type wave generator. However, due to the rectangular grid representation of the fluid in the model, it is convenient to replace the flap-type wave generator for this study by an equivalent piston type wave generator. Model results are presented in the form of water surface fluctuations at various stations in the large wave tank for later comparison with actual field data collected in the CERC wave tank. Model results in the form of slamming amplitudes and velocity profiles are also compared with small amplitude wave theory.

SUPPORTED BY U.S. Dept. of Defense - Army

4.0083, NUMERICAL SIMULATION OF HYDRODYNAMIC PHENOMENA BY DIGITAL COMPUTER
C. LAI, U.S. Dept. of Interior, Water Resources Division, Arlington, Virginia

Purpose: To develop numerical methods for solving selected surface and ground water fluid dynamics problems; to develop new computer simulation techniques with which to model natural field phenomena.

Methods: Movements of wave-crest in open channels will be simulated, pictorial representations of surface profiles of wave-crest movements will be developed and results will be compared with field observations.

The near-surface, unsteady, gravity flow through porous media induced by transient open-channel flows will be simulated by digital models.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

4.0084, UTILIZATION OF PHYSICAL AND MATHEMATICAL MODELS IN MARINE WATER RESOURCES RESEARCH AND MANAGEMENT
W.J. HARGIS, Virginia Inst. of Marine Sci., Gloucester, Virginia

Increased use of hydraulic and mathematical models in research, planning engineering and conserving estuarine and coastal environments is important. The proposed project will utilize VIMS hydraulic model of the tidal James system and
analogue, digital and hybrid mathematical modeling capabilities in a program of research designed to evaluate and improve the capabilities of each technique. Thus, the accuracy, precision and capabilities of all likely will be improved, or at least, clarified.

It is expected that improved ability to predict the changes which will result in such biologically, economically, socially and politically important environmental factors as salinity distribution, currents sedimentation, bottom scour and shore erosion will result.

This project is relevant to the projected Chesapeake Bay Hydraulic Model.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rch
Virginia Institute of Marine Science

4F. NAVIGATION

4.0085, EARTH CURRENT STUDIES
V.P. HESSLER, Univ. of Alaska, Geophysical Institute, College, Alaska 99735

At Barrow and College, Alaska, and on drifting ice stations records are made of macro-telluric activity in a study of the relationships between the orientation and motions of auroral forms, as photographed by an All-Sky camera, and variations in the telluric vector in the sea. Geomagnetic micropulsation studies are made with perpendicular induction loops oriented in the H, D and Z coordinates with the primary objective of studying the polarization of both the electric (telluric currents) and the magnetic perturbation vectors. Data are analyzed for characteristic polarization with respect to diurnal variation, storm time and spectrum of the disturbance.

A close relationship exists between ionospheric auroral activity, geomagnetic micropulsations and earth current phenomena. Such relationships are relevant to the evolution and applications of communication, navigation and detection systems and are of interest, therefore, to all NAA Bureaus and Laboratories having responsibilities in those areas.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0086, VISUAL LANDING AIDS FIELD

To study under service conditions the performance of visibility meters, the characteristics of fog, the threshold constants of the human eye, and the performance of airfield lighting systems and components. Related to NBS Mission Component 1.6 Research and Development for another agency.


Four fog detectors/visibility meters developed by commercial firms have been installed at the NBS Arcata Field Laboratory for study. The instruments are 1) a near-infrared back-scatter meter developed by Hoffman Electronics, 2) a forward-scatter meter developed by Thomas A. Edison Industries, 3) a fog detector developed by the AGA Corporation of Sweden, and 4) a modified Frungel side scatter meter. Recordings of the outputs of these instruments are being obtained in a variety of weather conditions. Simultaneous recordings are being made of the outputs of the several transmissometers installed in the test area. Preparation of an airfield lighting maintenance manual has continued. Field tests have been made of various lighting fixtures.

SUPPORTED BY U.S. Dept. of Commerce - NBS

4.0087, EVALUATION OF CONTEMPORARY PRECISION NAVIGATION SYSTEMS

The design, installation, test and evaluation of a RADIST plotter aboard the R/V VIRGINIA CITY, which will be used in conjunction with the RADIST navigating instruments that were procured during FY 1968.

To conduct feasibility studies for adapting the R/V VIRGINIA CITY to utilize the Satellite Navigation System presently scheduled to be operational by January 1970.

4. SURVEY AND PREDICTION

The design, installation, test and evaluation of a recording fathometer aboard the R/V VIRGINIA CITY, which will be used in conjunction with the presently installed fathometer.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

4.0088, A STUDY OF PROBLEMS RELATED TO WIND-GENERATED WAVES
R.L. STREET, Stanford University, School of Engineering, Palo Alto - Stanford, California 94305

This research will complement theoretical analyses and extend a previous investigation of wind-generated waves. Specific programs to be covered during the course of this research are: 1) Investigations of the characteristics of a turbulent boundary layer over a progressive wave surface. 2) Investigations of the interactions between the perturbation velocity and natural free-stream (or background) turbulence. 3) Measurements of normal pressures over wind-generated waves.

SUPPORTED BY U.S. National Science Foundation

4.0089, WWV BROADCASTS

To provide state-of-the-art accuracy High Frequency Time Signals.

Standard frequency and time broadcasts are being provided at six high frequencies, 2.5, 5, 10, 15, 20, and 25 MHz from the station located at Fort Collins, Colorado. These signals are maintained, as broadcast, within 10 microseconds of the NBS-Boulder master clocks.

These broadcasts are received nearly worldwide and are used extensively as a timing reference in many navigation systems. A navigator can easily determine his position on the earth by utilizing WWV timing signal along with other observations.

SUPPORTED BY U.S. Dept. of Commerce - NBS.

4.0090, WWVB-WWVL BROADCASTS

To provide state-of-the-art accuracy Low Frequency Time Signals and to provide experimental Very Low Frequency Broadcasts. Continental U.S. is served by 60 kHz for precise signals suitable for automatic recording. Experimental 20 kHz signals are being used in quest of a world-wide timing system.

Standard frequency and time broadcasts are being provided at 60 kHz. Experimental low frequency transmitted oscillators are being provided at 19.9 and 20.0 kHz. These transmissions presently maintain a frequency accuracy better than 1 part in 10 to the 11th and time information within plus or minus 10 microseconds of NBS-Boulder master clocks.

SUPPORTED BY U.S. Dept. of Commerce - NBS.

4.0091, SATELLITE TIME DISSEMINATION

The technical objective is to study, both theoretically and experimentally, the feasibility of disseminating time and frequency from an artificial earth satellite.

A literature survey has been conducted to determine what success various experimental satellite timing systems have had to date. Theoretical studies have been made to evaluate various atmospheric effects as a function of radio frequency and a small experimental program has been undertaken to evaluate the possibility of satellite range determination based upon Doppler frequency measurements.

The literature survey is being kept up to date and the theoretical studies are essentially complete and await further experimental data before significant additional progress may be made. Several satellites are being observed at the present time for Doppler data. Simple procedures have been developed for range determinations. Although these methods will not produce results which are attainable by more elaborate, sophisticated methods.

73
4. SURVEY AND PREDICTION

(which are not suitable for the average user of a timing signal), preliminary results indicate that, under good conditions, range determinations may be made to 100 km which correspond to a timing error of about 300 microseconds compared with 1 ms which is available, under good conditions, from WWV.

Navigation systems used in the oceans and over the oceans (air navigation) are particularly dependent on the accuracy of received time and frequency information.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

4.0092. VLF TIMING STUDIES


The project studies propagation characteristics of VLF signals as they apply to the dissemination of standard time and frequency signals. The main concern is the area of spectrum occupied by NBS station WWVL. The project deals mainly with phase velocity, group velocity, signal attenuation and total path delay.

The approach to the solution of the problem is to measure the phase path delay as a function of direction from the transmitter, frequency and distance. This is accomplished with precision clocks and stable receivers. The group velocity is computed by measuring several frequencies that are closely spaced.

To date, the project has been able to measure the phase velocity at 18.6, 19.9, 20.0, and 20.5 kHz. Directions used have been all except North. The measurements range from 100 to 5000 km from the respective transmitters. In addition to the field measurements, a theoretical model is being generated that will permit time and group delay predictions over continental paths. Also the measurement technique has been developed to a point where it is felt that useful group delay measurements can now be made.

Sea navigation systems are dependent on VLF transmissions which are unaffected by atmospheric disturbances. The received signal has little degradation compared to transmissions at higher frequencies.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

4.0093. IMPROVED STANDARDS FOR RADIO AND ELECTRONIC EQUIPMENT


PURPOSE: To investigate and recommend improvements in ship communications and electronic navigation.

DESCRIPTION: Cooperative efforts of government agencies and industry are undertaken to investigate ship communications, navigation and safety by special committees that are assigned on a problem and need basis. The technicians and scientists on these committees secure contributory research and investigation inputs on technical, economic, social and political matters within the best competence of their agencies and companies. Forecasts are made of most probable directions, importance, and timing of technical needs for future innovations. Special committees prepare reports on satellite communications, radar criteria, and navigation aids.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

4.0094. MICRONESIAN NAVIGATION AND SAILING

S.H. RIESENBERG, Smithsonian Institution, Washington, District of Columbia 20560

This is an ethnographic study of Puluwat, in the central Caroline Islands, focused on Micronesian navigation and sailing. It includes studies of the technological, linguistic, and cognitive aspects of the sailing complex, and an examination of its ramifications with and functional interrelationships with the entire culture of Puluwat.

SUPPORTED BY Smithsonian Institution

4.0095. AUDITORY DETECTION


To determine the optimum spectrum of fog signals for detectability against background of shipboard noise. To develop a description of the spectral and temporal characteristics of fog signals that would optimize their detection above the background of shipboard noise, for the use of the Coast Guard in setting up fog signals.

January 1 to December 31, 1967. Samples of shipboard noise provided by the U.S. Coast Guard have been analyzed by several filtering techniques. Durations of spectral features are such that analysis over tenth-octave bands does not impair observations of the temporal structure, whereas a wave analyzer having less than 3% bandwidth evidently integrates over features in the original signal. Equipment for gating brief signals of controlled character has been set up, for use in simulating fog signals.

Study time-varying spectral distributions of specimen fog signals and shipboard noise and reduce with regard to loudness-weighting behavior of ear. Evaluate, using signal-detection theory as applied to ear, in terms of engineering predictions of audibility. Devise improved spectral distributions and check against jury.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

4.0096. DUPLICATE LIMIT STANDARDS FOR SIGNAL COLORS


Traffic control for land, sea, and air transportation depends upon signal-light colors largely produced by plastic or glass filters combined with an incandescent lamp. The permitted range of chromaticities for each of the fifteen colors is specified in terms of the CIE (X,Y)-chromaticity diagram, but the practical control of these chromaticities is by means of eighteen limit standards in the form of two-inch glass squares. The problem is to obtain a supply of duplicate limit standards for issuance to manufacturers of glass and plastic ware, manufacturers of signal lights, and purchasers of such lights.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

4.0097. APPLICATION OF ISCC-NBS CENTROID COLORS AND METHOD OF DESIGNATING COLORS


The problem is the application of the ISCC-NBS centroid colors and ISCC-NBS Method of Designating Colors to the solution of problems in the fields of color charts, color codes, color standards, color communication and color designation. This project is closely related to NBS Mission Component 2, Physical Measurement Systems.


The extent to which the application of ISCC-NBS centroid colors has grown and the diversity of the applications can be indicated best by listing a number of them for 1967. These are: colors of plastic-coated fencing; revision of Federal Standard 595 (Paint); IBM color standards and color programs; Science Fair projects; Army Map Service map color; B. F. Goodrich color book on plastics; colors of HEW flag; colors of envelopes for auto sorting of P.O.; color in thermoplastics; color comparison methods; color and illuminants; representations of color blindness; Things of Science by Science Service; FAA color standards and tolerances; color in the building industry; centroid colors in fashion colors in communications in Simplicity Fashions Magazine; teaching color (Vienna, Austria); matching centroids in printing inks (Pantone Press); World Book of Knowledge; traffic signal color code; Central America Research Institute for Industry (Guatemala); Manz1 of American Society of Photogrammetry, Dr. I. M. Yemmen (Turkey). To disseminate information about this method of designating colors, an NBS Staff lecture and five talks before technical organizations, ISCC Subcommittee on Color in the Building Industry; Color Marketing Bureau of Public Roads; were given on invitation during the year.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

4.0098. DIVER-ASSISTED OCEANOGRAPHY


40
OBJECTIVE: The investigators will develop a diver-assisted oceanographic surveying capability for determining the nature of the underwater environment with ultra-high resolution to a depth of 100 fathoms. They will integrate diver-aided survey techniques with conventional oceanographic methods to produce an optimum blend of techniques for any oceanographic survey mission. Research efforts will involve conducting diver-assisted oceanographic experiments which will include: (A) Determining the temporal and spatial variability of seafloor and water column features. (B) Directly observing and measuring the effects of the biocenosis, and correlating their variability with the ocean environment characteristics.

APPROACH: Divers can provide the closest control obtainable on underwater investigation by performing direct observations, and by selectivity operating measurement devices, sampling devices, and photographic equipment. Scientifically trained personnel can make quick evaluations of underwater conditions to design and/or modify experiments on site, tailoring efforts to obtain desired results. Divers will make sea floor traverses to supplement, and test the resolution of conventional survey methods in continental shelf areas. Diving scientific personnel will experiment with and evaluate diver operated vehicles and instruments, in order to develop capabilities for advanced underwater studies. They will develop and test underwater surveying techniques for: (1) Bottom truth surveys (A) Exact mapping of seafloor topography, sediment types, and bedrock. (B) Characteristics of seafloor slope, stability, and scour resistance. (2) Water column seafloor interaction--make firsthand observations and design instrument arrays and methods of measurement of water column-seafloor interactions including corrected-topography relationships, sedimentation rates, and near-bottom current velocity profiles. (3) Detailed study of temperature-density structure and mass movements in the mixed surface layer. The investigators will develop techniques for specifying details of internal wave motion, thermal structure, and layer movements in the highly structural mixed layer.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0109, PRECISE RADIO NAVIGATION FOR SHIPS
Objective: Develop improved surface references (including buoy, mooring, radar, target, light, and flags) required for navigation by radio frequency sensors, and time-controlled radio frequency positioning equipment.
Approach: The performance of buoyant components will be compared when size and shape are varied and tested. Mooring techniques will be investigated and compared. The value of secondary references on the bottom will be investigated. Improved buoys such as lights, flags, and radar reflectors will be developed. Techniques of anchoring will be investigated and small lightweight anchors with improved holding capability will be developed. Components will then be integrated.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0106, SONIC UNDERWATER NAVIGATION FOR SHIPS
Objective: To develop a means for accurate navigation of ships utilizing acoustic techniques. The equipment should provide for guidance in the channels of Barbers Point, Oahu. The equipment should be portable and capable of rapid installation, and references should have a life of at least two months. Presently, traffic control must utilize equipment normally carried on board for ocean navigation, and narrow channels cannot be navigated without pilots and visual references.
Portable shipboard equipment which can be installed on any ship must minimize the total equipment cost by allowing the same equipment to be used by more than one ship. Previous studies concluded that, when performance and development time and cost are considered, the acoustic approach ranks significantly higher than radio ranging, radar, visual piloting, leader cable, and visual beam guidance.

SUPPORTED BY U.S. Dept. of Defense - Navy

4. SURVEY AND PREDICTION

4.0101, NAVIGATION SYSTEMS FOR SURVEY APPLICATIONS
W.M. SWARTWOOD, U.S. Navy, Oceanographic Office, Washington, District of Columbia
Objective: Provide 24-hour positioning and/or precise navigation capabilities for survey vehicles under technical control of NAVOCEANO, on a worldwide basis to meet the requirements of hydrographic, oceanographic, bathymetric, and geophysical surveys. Provide precision navigation capabilities for positioning survey craft engaged in coastal operations without the use of land based equipment. Present capabilities for mid-ocean surveys are limited to areas serviced by relatively short ranged electronic positioning systems.

Approach: Testing and evaluation has begun on the VLF/OMEGA/NAVSAT system which should increase navigational control accuracies in the broad ocean areas covered by OMEGA, or VLF ranging.

Development will then be initiated to find an appropriate inertial, or other type sensor, which can be interfaced with the VLF/OMEGA/NAVSAT system to provide continuous control with accuracies on the order of the plus or minus 0.5 miles now possible in good Loran-C areas.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0102, ORIENTATION CUES AND PATTERNS OF LONG-DISTANCE TRAVEL OF MARINE TURTLES
A.F. CARR, Univ. of Florida, Graduate School, Gainesville, Florida 32601 (NONR)

The investigator is conducting research with regard to tracking marine turtles in their extensive migrations in the open ocean in an effort to determine their routes and the environmental cues that guide them to breeding and feeding sites. He is also examining the 'fine scale' homing abilities displayed by hatchlings in reaching the sea from inland nests.

The identification and analysis of biological mechanisms and systems are of considerable importance to the Navy. The implications to Naval operations made clear by increasing information about biological orientation are expanding, not only to include machine concepts, but also systems concepts and will ultimately relate directly to improved systems.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0103, RADAR SCATTERING
K. HASSELLMANN, Univ. Hamburg, Hamburg, Germany

Approach - Conduct theoretical research in radar scatter by ocean waves at radar wavelengths comparable to ocean wavelengths, and at radar wavelengths small compared to ocean wavelengths. Calculations will be made by back-scattered energy as a function of wave spectrum, radiation pattern, and position of the source.

Objective - The goal of this work is to guide development work in radar scattermeters for open ocean wave work, either from ships, aircraft, or satellites.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0104, BARBERS POINT HARBOR MODEL STUDY
H.P. HARRENSTEIN, Univ. of Hawaii, School of Engineering, Honolulu, Hawaii 96822

This was a hydraulic model testing project. The purpose was to aid in the selection of the most suitable plan for design of a deep draft harbor at Barbers Point, Oahu. This project is being continued beyond June 30, 1968, but is expected to be completed by the end of the calendar year. A number of plans have been developed and a great number of tests performed. The selection of the final plan and additional tests were made after June 30, 1968.

SUPPORTED BY U.S. Dept. of Defense - Army

4.0105, VHF SATELLITE COMMUNICATIONS
UNKNOWN, Westinghouse Electric Corp., Baltimore - Elkridge, Maryland

Purpose: To evaluate the future potential of satellite relays for marine communications, ranging and ship control, using experimental data obtained from ship to shore tests.
4. SURVEY AND PREDICTION

Description: Experiments are being conducted with the NASA ATS-1 and ATS-3 Synchronous Satellites. A shipboard satellite terminal has been installed aboard the Grace Line ship SS SANTA LUCIA and two test voyages have been completed. During these voyages, tests were conducted at a number of points along the ship's route from Newark, N.J., to Valparaiso, Chile, and return. Communications and tests are made between the ship and the three NASA ATS ground stations located at Rosman, North Carolina; Mojave, California; and Cooby Creek, Australia. Particular emphasis is being given to certain areas pertinent to shipboard application: (1) propagation characteristics and signal yield; (2) transmission and reception of voice communications; (3) feasibility of obtaining accurate position fixes using the satellite ranging technique; (4) accurate time synchronization using time code signals; and (5) transmission and reception of teletype messages.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

4.0106. VLF/OMEGA NAVIGATION
J.J. STANBROUGH, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543 (N00014-66-C0241)
The purpose of this study is to (1) provide high precision relative navigation for on station drift measurements, ship speed and course made, doppler corrections for the satellite navigator, and (2) assess Omega/VLF navigation for oceanographic vessels. This study will contribute to the solution of problems in precise determination of position at sea and to precise navigation.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0107. MARINE GRAVITY
J.L. WORZEL, Columbia University, Graduate School, Palisades, New York 10964
The objective of this research is to investigate deflections of the vertical in areas of interest to the Navy. Use will be made of satellite gravity data and shipboard gravity and topographic data. Deflections of the vertical computed from these data will be thoroughly evaluated in terms of the data accuracy and distribution which are required to adequately map deflections of the vertical at sea.

The accuracy of inertial guidance systems which are used extensively by the Navy in ships and airplanes is presently limited by insufficient knowledge about the earth's gravity field and deflections of the vertical. In support of this effort, with the present limitation, this program is (1) providing gravity data of increased accuracy over the world's ocean; and (2) developing and evaluating both the computational techniques and the data requirements for determining deflections of the vertical at sea.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0108. SENSORY BASIS OF NAVIGATION IN HOMING PIGEONS
C. WALCOTT, State University of New York, Graduate School, Stony Brook, New York 11790
The purpose of this project is to find out what sensory modalities are employed by some birds in responding to environmental cues. The Principal Investigator will continue his research on the orientational-navigational abilities of homing pigeons utilizing radio-telemetric devices. Flight pattern analyses are being made and air-borne tracking methods employed to find the basis for the homing phenomenon.

1. ability of animals to navigate accurately over long distance, without clues obvious to man is a phenomenon of particular interest to the Navy. Either the mechanism by which the bird navigates can provide information applicable to improved navigation and guidance equipment, or a discovery of environmental directional clues can suggest new concepts of navigation. Such studies may also bring to light human sensory abilities which are not being used.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0109. DISTANT GOAL ORIENTATION
L.C. GRAUE, Bowling Green State University, Graduate School, Bowling Green, Ohio 43402 (NONR)

The investigator studies distant goal orientation in homing birds in an attempt to discover the internal and/or environmental conditions which influence their movements. Magnetic conditions, especially irregularities, are analyzed in relation to both long and short distance homing phenomena. Electronic tracking devices have been used to determine the route of the homeward path under experimental conditions. In the final segment of this project, the navigation ability of the animals, when displaced across an ocean, will be studied.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0110. INTEGRATION OF DOPPLER SATELLITE AND LORAC NAVIGATIONAL SERVICES
E.H. MAHONEY, Seismograph Service Corp., Tulsa, Oklahoma

This study will contribute to the solution of problems in precise navigation in a local area. The normal technique is to deploy three transponders on the ocean bottom, survey them in, and then, using the slant range of each of these transponders the position of the ship can be determined relative to the transponder array. We presently have in our oceanographic equipment line of products the shipboard interrogation gear and the transponders. In order to have a complete range determining system, we have designed the three channel shipboard navigation receiver. This receiver works in conjunction with our present shipboard interrogation gear and provides the slant range from each of the three

SUPPORTED BY Seismograph Service Corporation
transponders directly in the form of a digital display. This range information can then be fed into a computer for computation or the computations can be made manually.

A prototype has been built and manufacturing drawings are complete. The first production model will be built before the end of the year.

SUPPORTED BY Amer. Machine & Foundry Company

4G. SURVEYS-CRUISES

4.0113, 146 D EASTROPAC
C.M. LOVE, U.S. Dept. of Interior, Fishery Oceanography Ctr., La Jolla, California

This project has been designed to obtain oceanographic and fish distribution data from the eastern tropical Pacific and represents the Bureau of Commercial Fisheries contribution to a multiagency, international oceanographic survey and monitoring operation. The Bureau objectives are (1) to evaluate the potential of the oceanic tuna stocks; (2) to locate potentially rich areas of aggregation of these fish; and (3) to add to the basic knowledge of the oceanographic climate of the eastern tropical Pacific, particularly to assist in the understanding of seasonal changes. It is the latter phase of work whose results will be immediately applicable in forecasting the movements of tropical tuna on the present fishing grounds which lie generally to the east and inshore of the EASTROPAC area.

Collection of data at sea (the first phase of EASTROPAC) has been completed; the reporting phase, in which the material will be processed and analyzed, is just now beginning. Data will be summarized in three ways: (1) as published charts of vertical sections and horizontal plots of parameters to be used directly in the production of an atlas-type presentation; (2) as tabulated digital data which will form the basis of special studies of biological phenomena and of papers published by individual researchers; and (3) as digital data recorded in computer-compatible form, mostly from physico-chemical measurements, to be used for computer calculation of dynamic equations and for individually published studies.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

4.0114, CALIFORNIA CURRENT SURVEYS
P.E. SMITH, U.S. Dept. of Interior, Fishery Oceanography Ctr., La Jolla, California

Sea surveys have been conducted off the California coast from 1939-41 on a limited scale, extensively on a monthly basis, off California and Baja California, from 1949-60, and on a quarterly basis from 1961-65. The CalCOFI surveys were resumed in 1968 with two cruises and in 1969 it is planned to carry out a full-scale monthly survey, in cooperation with the University of California, Scripps Institution of Oceanography and the California Department of Fish and Game, of the entire area between San Francisco Bay and lower Baja California.

Data collections include oblique plankton tows, deepened to 200 meters, and hydrographic casts to 600 meters. Physical and chemical oceanographic observations are made at all stations. The processed data will include (1) determinations of depth fished, volume of water strained, etc. for each haul, (2) measurements and standardization of plankton volumes, (3) separation of all fish eggs and larvae from plankton samples, (4) identification and enumeration of fish eggs and larvae and standardization of data.

Information is provided for (1) distribution and numbers of the eggs and larvae of commercial valuable fishes and their ecological associates, (2) physical and chemical environment, (3) plankton volumes related to area, season, and year, (4) plankton communities which serve as food for most pelagic fish at all stages of development, (5) plankton predators and competitors on eggs and larvae.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

4.0115, SUPPORT OF RESEARCH VESSEL VELERO 4
J. SAVAGE, Univ. of Southern California, Graduate School, Los Angeles, California 90007

4. SURVEY AND PREDICTION

The research vessel VELERO IV, 110-foot ship of tuna clipper design, owned and operated by the Allen Hancock Foundation of the University of Southern California, has served as the major marine facility in a productive research and training program in marine biology and geology since 1948. This ship contains extensive oceanographic and sampling gear, and has an endurance capability of from 30 to 40 days.

SUPPORTED BY U.S. National Science Foundation

4.0116, DESCRIPTIVE OCEANOGRAPHY
W.S. WOOSTER, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

The objective is to undertake a detailed investigation and interpretation of the boundary current areas in the eastern Pacific Ocean. During the coming year, the effort will continue to be an integral part of the systematic EASTROPAC investigation aimed at obtaining an understanding of the temporal variations in the circulation of the Eastern Tropical Pacific and of the large-scale air-sea interactions associated with the El Nino phenomenon.

During this period, emphasis will be upon the processing and analysis of data collected during the 13-month, multiple cruise EASTROPAC investigation. This work is of a reconnaissance nature. A considerable amount of such work is needed in relatively little known waters, in waters where there are steep gradients or in waters which change rapidly with time (as off Peru). Such work must be undertaken before other studies can be planned to investigate specific phenomena. Only when there is an adequate description of the overall distribution of properties of an area as well as the annual trend of conditions can meaningful observations be obtained.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0117, SEA SURVEY INVESTIGATIONS
J.L. BAXTER, State Dept. of Fish & Game, Terminal Island, California

Objectives: To conduct research vessel surveys designed to assess the distribution, abundance and other vital statistics of the fish populations comprising the fishery resources of the California Current System.

Procedure: Conduct 10, 20-day sea survey cruises; eight echosounder and two combination intensive sampling - gear research cruises aboard the Research Vessel ALASKA. Data resulting from these cruises will be compiled and published in the form of data reports.

Location: Cruises will be conducted in coastal waters of California and Baja California, Mexico. Terminal Island for laboratory work and analysis.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish. California State Government

4.0118, SCIENCE AND ENGINEERING GOALS FOR THE INTERNATIONAL DECADE OF OCEAN EXPLORATION
S.R. KEIM, Natl. Academy of Sciences, Washington, District of Columbia

The National Academy of Sciences and the National Academy of Engineering will jointly undertake to provide advice to the National Council on Marine Resources and Engineering Development on the scientific and engineering aspects of the U.S. participation in an International Decade of Ocean Exploration during the 1970’s.

As an initial step, the Academies will conduct this contract study which will identify scientific and engineering goals, objectives, milestones, priorities, and timing. Included will be the identification of capabilities required to achieve the goals in terms of manpower, marine data, instrumentation, sea and shore facilities, and funds. The study will also identify end products which should result from the Decade such as charts, maps, research projects, and atlases. Benefits in terms of advances in science and engineering and in the Nation's increased capabilities to use the seas more effectively will be considered.

4. SURVEY AND PREDICTION

4.0119, EAST COAST CONTINENTAL MARGIN WOODS HOLE OCEANOGRAPHIC INSTITUTE CONTRACT

Reconnaissance study of the Atlantic Shelf is essentially complete; a more detailed study of the geology of the Gulf of Maine at intermediate scale is now underway, as well as study of geochemistry of interstitial waters in marine sediments, and of hydrologic processes operating in marine and estuarine areas.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

4.0120, EASTERN TROPICAL ATLANTIC COOPERATIVE SURVEY 12 SEPTEMBER TO 20 DECEMBER 1968
R.B. ELDER, U.S. Dept. of Transportation, Oceanographic Unit, Washington, District of Columbia

The U.S. Coast Guard and the Bureau of Commercial Fisheries are cooperating in a study of the Eastern Tropical Atlantic. Following are the objectives of the program: a. To investigate the distribution of surface schooling tunas in relation to oceanic physical, chemical, and biological parameters, and to sample such schools whenever possible to provide specimens for biological studies. b. To locate and investigate an oceanic front which is found about 1 degree - 3 degrees S. during June-August and appears to move eastward about 15 degrees each month during the rest of the year. c. To study the region of the Angola Dome; a region having anomalously low temperatures in the near surface layers.

The Coast Guard Cutter ROCKAWAY and the Bureau of Commercial Fisheries research ship UNDAUNTED will conduct multi-disciplinary oceanographic investigation in the area. The physical oceanographic data will be published in the CG 373 series publications. Other data will be published by the Bureau of Commercial Fisheries.

SUPPORTED BY U.S. Dept. of Transportation - Coast Guard

4.0121, INTERNATIONAL WEDDEL SEA OCEANOGRAPHIC EXPEDITION
R.B. ELDER, U.S. Dept. of Transportation, Oceanographic Unit, Washington, District of Columbia

On January 3 1969 the USCGC GLACIER (WAGB 4), CAPT Eugene E. McCORKY, Commanding, will depart Punta Arenas, Chile to commence a two phase multi-disciplinary oceanographic survey of the Weddell Sea. Although primarily an iceberg breaker, the USCGC GLACIER has been extensively modified for oceanographic research.

This will be CGG GLACIER's second oceanographic investigation of the Weddell Sea. This research, to be conducted in the austral summer of 1968-1969, will be a logical extension of that already completed during the previous austral summer. The duration of the survey will be approximately four months. The research will be conducted in cooperation with the Argentine Icebreaker, San Martin.

The overall program is being coordinated by the Office of Antarctic Programs, National Science Foundation. The program will include the recovery of current buoys installed during IWSOE-1968, hydrograph, nutrient determination, primary productivity, chlorophyll analyses, bottom photographs, benthic biology, sea ice, and dynamic population studies and pestor coring.

SUPPORTED BY U.S. Dept. of Transportation - Coast Guard

4.0122, EASTERN TROPICAL PACIFIC COOPERATIVE SURVEY
R.B. ELDER, U.S. Dept. of Transportation, Oceanographic Unit, Washington, District of Columbia

EASTROPAC is a cooperative project by several groups to study the Eastern Tropical Pacific Ocean. The goals of this effort are to increase the harvest of fisheries in this region, to improve weather forecasting, and to improve shipping and navigation in the study area which ranges 20 degrees north and south of the equator. As far as the collection of data is concerned EASTROPAC is complete for the Coast Guard. Processing of the tremendous amount of information that has been gathered is not complete however. The primary interest of the past one and one-half years of EASTROPAC has been physical, chemical and biological oceanography. In these efforts the Oceanographic Unit and CGC ROCKAWAY have been working in cooperation with various U.S. Institutions and those of other countries.

CGC ROCKAWAY participated in three surveys of the project area. In the course of her work CGC ROCKAWAY took a total of 1458 stations in which Nansen, STD, and expendable BT (XBT) casts were made. There were 383, 534, 571 stations respectively for the three cruises.

When all the data has been compiled by EASTROPAC Headquarters a complete oceanographic atlas will be published. Also, the Oceanographic Unit will publish their findings in their Oceanographic Report, CG-373 Series.

SUPPORTED BY U.S. Dept. of Transportation - Coast Guard

4.0123, OCEANOGRAPHIC STUDY OF NORTHEASTERN U.S. COASTAL WATERS FOR INTERNATIONAL COMMISSION FOR NORTHWEST ATLANTIC FISHERIES
M. LIGHT, U.S. Dept. of Transportation, Oceanographic Unit, Washington, District of Columbia

This study consists of a series of oceanographic surveys conducted by CGC EVERGREEN (WAGO 295) in support of a research program planned by the International Commission for Northwest Atlantic Fisheries. The Bureau of Commercial Fisheries, Biological Laboratory, Woods Hole, coordinates U.S. participation. This cooperative undertaking involves a study of the offshore fishery resources which are fished by the U.S. and other member nations. The aim of the international program is to seek an understanding of natural fluctuations in abundance of commercial fishes in the area and to assess the effect of fishing. The surveys are conducted 2 or 3 times a year in the coastal slope waters between Cape Cod and Nova Scotia, and the hydrographic data collected supplement data previously collected in the same area during a series of quarterly environmental survey cruises by BCF R/V ALBATROSS III.

The purpose of these surveys is to determine the vertical and horizontal distribution of temperature, salinity, dissolved oxygen in these waters which support an intensive commercial fishery. These environmental factors are considered to have important effects on the distribution of pelagic and demerial species of fish and invertebrates.

Data from these cruises are available at the National Oceano graphic Data Center approximately two months following the cruise. Complete reports on cruise data will be published by CG Oceanographic Unit in collaboration with the BCF in the Oceanographic Report series (CG 373).

SUPPORTED BY U.S. Dept. of Transportation - Coast Guard

4.0124, OCEANOGRAPHY OF THE GRAND BANKS AND LABRADOR SEA
M.J. MOYNihan, U.S. Dept. of Transportation, Oceanographic Unit, Washington, District of Columbia

The oceanographic program of the Grand Banks and Labrador Sea area is in direct support of the International Ice Patrol mission of the U. S. Coast Guard. The U.SCGC EVERGREEN (WAGO 295) makes several cruises annually during the ice season (normally February to July) to conduct a comprehensive current survey of the region. The data is processed by computer at sea and transmitted to the Commander, International Ice Patrol in New York for the forecasting of iceberg drift. Deep-narrow oceanographic buoys for the collection of hydrographic and weather data have been used and are under further development.

Post Season cruises are made into the Labrador Sea region to study the characteristic circulation of the entire iceberg producing environment, particularly with regard to the sources and variations of the Labrador Current.

Data from these cruises are available at the National Oceanographic Data Center approximately two months following the cruise. These data with analyses are published by the U. S. Coas Guard in the Oceanographic Report Series (CG-373).

SUPPORTED BY U.S. Dept. of Transportation - Coast Guard
4.0125, ARCTIC EAST OCEANOGRAPHIC PROJECT (OCEANOGRAPHY OF THE BAFFIN BAY REGION)  
M.J. MOYNIHAN, U.S. Dept. of Transportation, Oceanographic Unit, Washington, District of Columbia  
The U. S. Coast Guard, by virtue of its operation of all the icebreakers under the U. S. flag has a definite responsibility for the support and coordination of polar research. The oceanographic program in the Baffin Bay region has its emphasis on the description of the physical, chemical and biological features of Baffin Bay and water exchange through Narres Straits, Jones Sound, Lancaster Sound, and the Davis Strait. This work is designed to support and augment the research of the National Science Foundation, U. S. Navy and other groups working through the Arctic Institute of North America.  
Observations from U. S. Coast Guard icebreakers are limited to special selected and scheduled projects and to other available times when these vessels are not engaged in their primary mission of the support of shorebased defense and scientific installation.  
Data from these cruises are available at the National Oceanographic Data Center. The scientific results, with contributions from invited scientists, are published by the U. S. Coast Guard in the Oceanographic Report Series (CG-373).  
SUPPORTED BY U.S. Dept. of Transportation - Coast Guard  

4.0126, ATLANTIC OCEANIC BIOLOGY  
C.R. STEPHAN, Florida Atlantic University, School of Engineering, Boca Raton, Florida (NONR)  
The investigator is now integrating the results from the successful Research Ships of Opportunity cruise across the Atlantic Ocean with an evaluation of associated data received from Numerical Weather Facility, Monterey, California, and General Motors Research Laboratory that can lead to a system for rapid transmission of data from RSO’s to oceanographic data centers. During the extension period, improved design studies for RSO Instrumentation Modules will be concluded.  
The Research Ships of Opportunity concept serves as an implement to hydrobiological research by providing platforms for a broad coverage of the open ocean area, an area hitherto sampled only sporadically. The Navy’s need to know about the characteristics of the surface waters might be served more expeditiously by this means. Such properties as water viscosity, color, and plankton density are especially important.  
SUPPORTED BY U.S. Dept. of Defense - Navy  

4.0127, DESCRIPTIVE PHYSICAL OCEANOGRAPHY OF THE EASTERN TROPICAL ATLANTIC  
Objectives: 1. To describe the oceanic circulation and the distribution of environmental variables in space and time in regions of interest in the eastern tropical Atlantic Ocean. 2. To locate and describe oceanic features in the physical and chemical environment which are significant to primary and secondary production and to the distribution of commercially significant pelagic fishes.  
SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.  

4.0128, THE EVALUATION AND USE OF SUBMERGED RESEARCH VESSELS IN STUDYING CONTINENTAL SHELF ENVIRONMENTS  
H.G. GOODELL, Florida State University, Graduate School, Tallahassee, Florida 32306  
Two submarines have been constructed by Lutjens; one of which is completed and is under evaluation as a one-man reconnaissance vehicle, the other a five-to-six-man diver lockout vessel which will hopefully be completed by June 1969, and it too will undergo evaluation as a research and reconnaissance vehicle.  
SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.  

4.0129, PILOT STUDY OF LIMITED PORTION OF TRADE WIND ZONE OCEANOGRAPHY (DATA AND DESCRIPTIVE REPORTS)  
The Trade Wind Zone Oceanography investigation deals with the mechanisms which change the distribution of properties and water masses in the area bounded by latitudes 10 degrees N., 30 degrees N., and longitudes 130 degrees W. and 180 degrees.  
A pilot study to test the feasibility of the investigation is in progress and sampling and processing techniques using a single ship are to be developed. Results of this development are presented in data and descriptive reports.  
SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.  

4.0130, INTERNATIONAL INDIAN OCEAN EXPEDITION PHYSICAL AND CHEMICAL ATLAS  
K. WYRTKI, Univ. of Hawaii, Graduate School, Honolulu, Hawaii 96822  
When the International Indian Ocean Expedition was originally planned, it was proposed that atlases containing the distribution of all data accumulated during the Expedition would be prepared. This grant will support the production of the oceanographic atlas which will be in two parts and amenable to research use. Part I will contain the distribution of physical and chemical properties at selected levels and along specific sections of the ocean. Part II will consist of an analysis of all data submitted to World Data Center A, including property distribution, core layer analysis, oxygen, minima and maxima, phosphates, bottom temperature, depth of the mixed layer and intensity of thermocline.  
SUPPORTED BY U.S. National Science Foundation  

4.0131, DEEP OCEAN RESEARCH AND DEEP OCEAN ENGINEERING  
S.C. DAUBIN, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543 (NONR)  
Objective: This research is part of the long range program to utilize the deep ocean. It is based on the use of a system centered about the Deep Research vehicle Alvin. This submersible will take scientists into the ocean to depths of 7500 ft. for observation and sample collection. The studies are divided among geology, biology, geophysics, and engineering. The results will contribute to the ability to use the deep ocean and the sea floor in support of the National Purpose.  
Approach: The Deep Research Vehicle Group at Woods Hole will operate the system composed of ALVIN and LULU to make scientific observations to depths of 6500 ft. The biologic studies will encompass life forms and benthic animals that will affect sea floor structures. Additional work on a coherent long range investigation of the geological structure of the continental margin and geophysical studies of slope stability and sediment composition and stability will be undertaken. The moorings of a deep buoy will be examined. Revisits to sites will provide long term observations and tests in the various disciplines of ocean science and ocean engineering.  
SUPPORTED BY U.S. Dept. of Defense - Navy  

4.0132, MEDITERRANEAN OCEANOGRAPHY  
A.R. MILLER, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543 (N00014-66-CU241)  
The purpose of this task is to permit Woods Hole research scientists to participate in a survey in the Eastern Mediterranean aboard the Federal Republic of Germany research vessel PLANET. The primary task will be to determine advective oceanographic processes taking place in the area. Secondly, observations from cloud camera, pyroheliometer, net radiometer, infra-red and surface microstructure measurements will be taken. Reduction, analysis and interpretation of the data will be accomplished as part of the task.  
SUPPORTED BY U.S. Dept. of Defense - Navy  

79
4. SURVEY AND PREDICTION

4.0133, ANTARCTIC PHYSICAL OCEANOGRAPHY

A.L. GORDON, Columbia University, Graduate School, Palisades, New York 10964

Lamont Geological Observatory of Columbia University proposes to collect data on physical and geological oceanography of the southern Pacific and southern Indian Oceans during the period from approximately December 30, 1967, to August 31, 1968. These data would be taken at hydrographic stations from on board the Antarctic Research Vessel USNS Eltanin. They would include the salinity and temperature of the water at known depths, and the bottom, using both bathythermographs and a salinity-temperature-depth, continuous recorder. An expendable bathythermographic system would also be used to yield continuous temperature measurements 700 meters while the ship is under way. A structural framework would lower to the bottom at selected stations. It would incorporate equipment to produce oriented bottom photographs, make measurements of bottom currents, and take readings on the light-scattering characteristics of the near-bottom water. Lamont Geological Observatory would process and analyze these data for distribution to other interested scientists and institutions and for deposit in the National Oceanography Data Center. This research is a continuation of LGO work on the Eltanin Cruises 4 to 27.

Five technicians would be on the Eltanin for each cruise during the period of the grant.

SUPPORTED BY U.S. National Science Foundation

4.0134, WATER MASSES, CURRENTS AND ORIGIN OF THE ATLANTIC BOTTOM WATER IN THE WEDDEL SEA, ANTARCTICA

L.R. CAPURRO, Texas A & M University System, Graduate School, College Station, Texas 77843

Research will be continued by Texas A & M on the physical oceanography of the Weddell Sea, Antarctica, in the summer of 1968-69, as part of the International Weddell Sea Oceanographic Expedition-19. The research will be carried out on the Argentine icebreaker, General San Martin, and at Argentine Antarctic research stations. Hydrographic casts will be made at each ship station for water samples and temperature. In addition, continuous salinity, temperature, and depth measurements, in the upper part of the water column, will be made with a standard instrument. The water samples will be analyzed for salinity, pH, and nutrients. Current measurements will be repeated at the Argentine stations General Belgrano, for about seven days in 1000 meters of water.

Capurro will join the General San Martin, in Argentina, with two research scientists from the United States and two marine technicians from Louisiana. They will stay with the ship throughout the expedition, until it returns to Argentina. Capurro and the other two research scientists will then return to the United States.

SUPPORTED BY U.S. National Science Foundation

4.0135, OCEANOGRAPHIC SURVEY OF CONTINENTAL SHELF WATERS OFF CHESAPEAKE BAY

J.J. NORCROSS, Virginia Inst. of Marine Sci., Gloucester Point, Virginia 23062

Purpose: To acquire a body of data sufficient to describe in general the physical processes which occur in Continental Shelf waters since December, 1959. The first surveys were directed toward determination of the distribution of eggs and larvae of fish. Oceanographic data were collected during the three years of the biological survey and the present program is an outgrowth of the initial surveys.

We occupy a total of 36 stations located on four transects. The east west transects are positioned on parallels 37 degrees 10'N, 37 degrees 00'N, 36 degrees 50'N and 36 degrees 40'N. Nansen bottles and bathythermographs are used to obtain measurements of temperature and salinity distributions.

We are working toward development of computer programs which will plot isopleths from the data collected during the cruises.

This is a continuing program.

SUPPORTED BY Virginia State Government

4.0136, ENVIRONMENTAL APPLICATIONS OF PASSIVE MICROWAVE SENSORS

A.T. EDGERTON, Aerojet General Corporation, El Monte, California 91734 (NONR-4767(00))

Research is being conducted into the applications of passive microwave radiometers to the remote sensing of earth surface and near-surface environments. Laboratory and field studies are relating the microwave brightness temperature within specific environments, including snow and ice, sea ice, soils and sediments, and beach and near-shore localities to a variety of frequencies and observation conditions.

By evaluating the effectiveness of this type of terrain sensor, progress is being made toward exploitation of the high potential of passive microwave radiometers to operate in day/night, all weather conditions, to detect anomalous materials below the earth's surface, and to discriminate between materials of differing dielectric constants such as ice, water, or soil.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0137, APPLICATION OF METEOROLOGICAL SATELLITE SENSING TO GENERAL CIRCULATION MODELS

Y. MINTZ, Univ. of California, Graduate School, Los Angeles - U.C.L.A., California 90024

Objective: To determine which of the sensing devices presently used on Nimbus and ATS and proposed for future spacecraft will give the best numerical weather prediction when used to determine the initial conditions, and the utility of non-synoptic data in the numerical prediction procedures.

Approach: A program of testing various types of input data from hypothetical satellite instrumentation in large computer runs of numerical atmospheric models will be carried out. This will include the preparation of a numerical weather prediction procedure and program for experiments with wind and temperature data from such sources as the horizontal sounding balloon systems of the FR-2 (Eole) and Nimbus IRLS Experiments and the Nimbus Infrared Interferometer Spectrometer (IRIS) inferences of vertical temperature profiles in the atmosphere. Simulation runs will be made on a computer prior to the actual satellite launches, and real data from FR-2 and other meteorological systems will be used in the future.

During this period, the Mintz-Arkawa numerical model for simulating atmospheric experiments was revised to include more complicated processes and, thus, more closely reflect the behavior of the true atmosphere. Of the many revisions, two are especially notable: (1) the evaporation of water from the oceans and the condensation of water vapor in the atmosphere have for the first time been treated explicitly, thereby improving the simulation of these important thermodynamical effects and (2) the horizontal grid spacing of the two level model has been reduced from 1 degree latitude to 9 degrees longitude to 4 degrees latitude x 5 degrees longitude, thus improving the model’s ability to represent smaller scale atmospheric disturbances.

The new model was used to investigate the dispersion of constant level balloons in a simulated satellite-ballooning horizontal sounding system. The results show that the unrealistically strong Hadley cells which swept the balloons out of the tropics in the former model no longer predominate, resulting in a more nearly random distribution of balloons everywhere for a period of the order of one month. These investigations are encouraging in the development of such systems as the Nimbus IRLS and International FR-2 satellite-ballooning experiments.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

4.0138, CLOUD PATTERNS RELATED TO SELECTED CIRCULATION SYSTEMS IN EASTERN PACIFIC

S.M. SEREBRENY, Stanford Research Institute, Menlo Park, California

Technical Objective: Certain characteristic cloud patterns seen in satellite photographs tend to accompany circulation pat-
mechanisms at the fish oil ocean interface and make experimental measurements with IR thermal sensors over the ocean.

It is believed there is a good possibility for developing an infrared scanner incorporating spatial filtering which will be able to discriminate fish oil slicks on the surface of the ocean from orbital altitudes.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

4.0141. RESEARCH NEEDS FOR REMOTE SENSING OF THE ENVIRONMENT

E.M. RISELT, Natl. Academy of Sciences, Washington, District of Columbia

A general study of the field of remote sensing of environment is being conducted by the NAS-NRS Committee, to determine the status of sensor technology and its application to research on the earth's environment, to provide guidance for the development of a stronger national program of research in this field, and to concentrate effort on specific problem areas.

Needs for large quantities of information on a wide range of earth environments are greater than ever. While techniques of multispectral sensing, e.g. visible, infrared, radar, and passive microwave sensing systems, are advancing very rapidly, there is a serious lag in the applications of these techniques that provides coordination of efforts at the highest scientific and governmental levels, and points the way to the fastest and most effective achievement of the required research objectives.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0142. REFLECTIVITY AND EMISSIVITY STANDARDS


The technical objectives of this project are (1) to develop accurate and precise procedures for measuring thermal radiation properties of materials, particularly over the wavelength range of 0.2 to 40 milliradians, and (2) to select and calibrate standards of reflectance and emittance over the same wavelength range, and at temperatures from room temperature to 2000 K or above. The most important thermal radiation properties to be worked on are reflectance and emittance ( emissivity). Such methods and standards are needed for radiant heat transfer computations, particularly in the space program, and in connection with infrared reconnaissance, particularly by D.O.D., and for remote infrared sensing as used by the Weather Bureau and Geological Survey. Major effort will be concentrated on (1) adapting existing equipment to use an available interferometer spectrometer as the monochromator-detector in thermal radiation property measurement, and (2) studying materials in an effort to find suitable standards of diffuse reflectance in the desired wavelength ranges.

The interferometer spectrometer has the potential of greatly increasing the precision of measurement and extending the wavelength range of thermal radiation property measurements. The spectrometer will be evaluated with existing auxiliary equipment, modified if necessary to overcome its limitations, or new equipment will be designed and built to exploit its advantages and overcome its limitations.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

4.0143. RELATION OF SATELLITE DATA TO LARGE SCALE ATMOSPHERIC CIRCULATION AND ENERGETICS


Technical Objectives. (a) Study of the temporal and spatial variations in long and short-wave radiation. (b) Examination of the relationship of the radiation patterns to the state of the large-scale circulation in the Northern Hemisphere; e.g., it is important to determine quantitavely how radiation patterns vary with the latitude and strength of the zonal Westerlies, within the planetary waves and also within the smaller scale waves. (c) Where extensive temperature data are available (i.e., the Northern Hemisphere) computation of the generation of available potential energy on various scales and for various regions using observed distributions of infrared and reflected solar radiation. (d) In-
4. SURVEY AND PREDICTION

Investigation of the strength, location, and time variations in the intertropical convergence zone the subtropical anticyclones, and other large-scale circulation features of tropical and extratropical regions in both hemispheres, through utilization of satellite data as indicators of broad-scale dynamic processes in the circulation. From such studies more can be learned about the interactions of the circulation between the hemispheres.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

4.0144, REMOTE SENSING OF ESTUARINE WATER AND VEGETATION, MARYLAND


Purpose: To determine which film or film-filter combinations will provide the most information in aerial reconnaissance of estuaries ecosystems.

Methods: Correlate physical and chemical aspects of the estuarine environment with photographic and imaging characteristics on various types of films. The ultimate goal of the project is to be able to identify major plant communities associated with estuaries and evaluate water quality conditions both directly and indirectly using indicator plant species as a guideline.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

4.0145, OIL LEAKS AND SLICKS


Objective: Purpose of the study will be to determine the feasibility of detecting oil escaping from sunken wrecks and being discharged from other vessels in inland and near-shore areas by the use of remote sensors in aircraft and in spacecraft, and to apply knowledge gained toward the modification and design of equipment to perform the required tasks.

Approach: Studies will be performed based on data to be acquired in the ERA Program from Gesmii and from other past and future missions for data by earth pointing space observational systems. Primary instruments will be photographic cameras with varied film and filter combinations, ultraviolet and infrared scanning spectrometric and imaging systems, and absorption spectroscopy instruments.

Success in these studies would be of vital importance toward the protection and preservation of human life against explosion and fire hazards, the protection of recreation areas, fisheries, shore and marine birds, and sources of water supply against contamination and ruin.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

4.0146, APOLLO TEST SITE EXPERIMENT


Objective: Determine the use of sensors in Apollo applications experiments for hydrologic uses such as estuarine hydraulics, lake development, ground-water exploration, snow-field hydrology, and water pollution.

Approach: Based upon the results of aircraft testing of sensors and use of aircraft data in the above fields of hydrology, selected test site investigators will extrapolate their results to larger areas of the United States and other countries and will design data-use experiments for support of selected sensors in the Apollo Applications Program. The data-use experiments will also include requirements for spatial and spectral resolution, frequency of target coverage, and other instrument and mission parameters constraining the use of the data.

Status: Previous data-use experiments submitted to NASA (i.e., photographic, radar, and infrared) will be updated in their requirements, new test sites will be chosen, and new investigators will be selected. Success of this effort will depend upon both the success of aircraft data-use experiments and future plans of NASA in the Apollo Applications Program.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

4.0147, WATER PHYSICS AND CHEMISTRY


Approach: Conduct theoretical, laboratory, and empirical (test site) investigations of the responses of water bodies to active and passive remote sensing. For example, (1) determine the use of infrared radiometry and imagery for measurement of evapotranspiration, (2) determine the extent to which quantitative measurements of thermal pollution can be made by use of infrared imagery, (3) evaluate the use of photography and imagery for mapping the hydrodynamics of estuaries and lakes, (4) assess the use of lasers in water-quality data collection and 5) investigate the use of simulated luminescence detectors in hydrodynamic mapping.

Status: Several projects are in operation in '68 FY; one report is being transmitted to NASA, several others are in preparation. Basic infrared imagery investigations have been successful and are leading to more detailed investigations of the use of infrared imagery. Combinations of photography and imagery are proving to be highly useful in mapping current patterns and hydrodynamic features in water bodies.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

4.0148, AERIAL SEA SURFACE TEMPERATURE SURVEYS OF U.S. COASTAL WATERS

M. LIGHT, U.S. Dept. of Transportation, Oceanographic Unit, Washington, District of Columbia

Since 1963, the U.S. Coast Guard has furnished aircraft services to the Bureau of Sports Fisheries and Wildlife in support of monthly sea surface temperature surveys of U.S. coastal waters. Temperature data collected during these surveys are utilized in ecological studies; specifically to help explain the influence of temperature on the distribution of migratory fishes and upon seasonal cycles of ocean productivity. Charts are issued at the end of each series of flights, depicting the flight paths and contours of surface isotherms.

The standard U.S. Coast Guard search and rescue aircraft, the Grumman HU16E, is being used for these operations. Surface water temperatures are detected with a Barnes infrared thermometer sensor aimed through a small hatch in a rear window. A moving strip chart recorder is used to record temperature readouts.

Monthly survey flights are made over coastal waters along the East Coast between Cape Cod and Miami, and along the West Coast between the Vancouver Islands, British Columbia and Northern Baja California, Mexico.

During FY-1970, plans are for the U.S. Coast Guard to assume primary responsibility for the program. Eventually, it is planned to expand the present monthly flight coverage to include Sable Island to Key West along the East Coast, Alaska, Aleutian Islands to Baja California, Mexico along the West Coast, the Bering Sea, the Gulf of Mexico, and the Great Lakes.

SUPPORTED BY U.S. Dept. of Transportation - Coast Guard

4.0149, FISHERIES RESOURCES IDENTIFICATION AND ASSESSMENT


OBJECTIVES: (1) To develop the applications of remote sensors to locate (directly or indirectly) and quantify commercial fisheries stocks and (2) determine the methods for integrating these results into a fisheries research, development, and forecast program.

APPROACH: (1) Obtain and analyze color photography by color separation techniques for locating fish schools and/or fish environments, (2) Study the applications of multi-spectral photography aerial fishery surveying, (3) Study the feasibility of spectroscopy and spectrophotometry for locating fish and fish oil slicks, and (4) Determine the effectiveness of three color microdensitometry to assess aerial photographs of fish schools. Sensors - a. Color Photography; b. Multi-band Photography; c. Spectrometers; d. Spectrophotometers; e. Infrared Scanner; f. Multi-spectral Scanner. Proposed Contractor - Bureau of Commercial Fisheries - Sub-Contracts: Philco-Ford (Ross) - Barringer
PROBLEM ADDRESSED: There is evidence that fish schools can be detected from aerial and space photography. The use of spectrometers and spectrophotometers to detect fish, fish oils, chlorophyll, and water color correlation need to be tested and evaluated. The techniques of optimum analysis by color enhancement, color slicing, demisometry, and spectral correlation needs to be studied. Spectrally, spectral bands need to be determined for: a. maximum contrast of fish schools and background; b. optimum depth penetration; c. spectral reflectance difference for various species and surrounding media, and d. target to background contrast for different water masses.

BENEFITS: The demand for fish and fish products is dramatically increasing each year. Per capita consumption based on population and income projections indicate the demand will increase 134% by the year 2000. The constraints of shipboard and airborne searching can be reduced using space as a search tool to supplement present methods.

OTHER SUPPORT: 1. NASA aircraft - photography and infrared data; 2. Shipboard Ground Truth (BCF ships);

OTHER EFFORTS: 1. TRW Systems Spectrophotometer; Psilco-Ford color photography enhancements; 3. MIT color photo work; 4. WHOI studies; 5. NAVOCEANO Research Aircraft studies.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

4.0150. FISHERIES OCEANOGRAPHY AND ENVIRONMENTAL ASSESSMENT AND PREDICTION


OBJECTIVES: (1) To determine the effectiveness of presently available remote sensing instruments to supply pertinent data on marine fisheries; (2) to evaluate those remote sensing techniques which have the ability to indirectly locate, identify, and quantify fisheries stocks.

APPROACH: (1) To define ocean environmental features pertinent to fisheries using ground truth measurements concurrent with aircraft and/or spacecraft overflights of the following oceanic phenomena: (a) wind slicks, (b) bioluminescence, (c) oceanic fronts and productivity, (d) thermal-biological aspects, (e) upwelling, and (f) divergence/convergence zones. (2) Compilation of comprehensive bibliographies related to remote sensing of fisheries environments and automated handling of space and aerial acquired data. (3) Analyze ATS and APOLLO imagery for oceanic phenomena related to fisheries. (4) Study telemetry of environmental data related to fisheries.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

4.0151. SPECTRAL SIGNATURES OF FISH SCHOOL IDENTIFICATION


Approach: Lab tests over known fish samples will continue to be tested. In addition an airborne version of the spectrometer will be flown in the NASA aircraft concurrent with surface vessels taking surface fish and oil slick samples. Spectrometer signatures of fish oils and vapors will be cataloged. Feasibility for spaceborne application of spectrometer will be studied. a. Sensors - Airborne adaptation of absorption spectrometer. b. Proposed Contract - Barringer Research Ltd., Toronto, Canada. c. Allocation of Resources - Professional Manpower, 35%; Equipment, 35%; Overhead, 30%.

Problem Addressed: A previously funded NASA (SPOC) study has indicated a unique application of Barringer's correlation techniques for identification of various fish and mineral oil on water surfaces. The work was confined to the UV portion of the spectrum but should be expanded to include the near IR. The remote detection and identification of fish oil slicks needs to be tested. The work of McAlister and others who have contributed to the development of this (infrared radiometry) technique has profound implications in both oceanography and meteorology. Timofeev says 'The use of infrared techniques in the determination of the temperature gradient in a surface water layer was first suggested and realized by McAlister.'

4.0152. FLIGHT TESTING OF HIGH PERFORMANCE WIDE-RANGE IMAGE SPECTROPHOTOMETER (WISP) SYSTEM


OBJECTIVE: (1) To develop an optical system expressly to perform objective remote water color measurements, (2) to gather data via airborne flight tests to help with the development of the WISP (Wide-Range Image Spectrophotometer) into a space qualified system, (3) To gain experience in the operation of the WISP system and associated data collection and processing methods, (4) To perform an experimental investigation of ocean color measurement requirements.

PROBLEM ADDRESSED: Accurate charting of ocean color can be correlated to depth plankton content, chlorophyll, sediment, pollution, etc. The TRW study is addressed to developing the instrument, operation, and data processing requirements needed to give the oceanographer an analytical tool to observe and assess the ocean by color mapping.

BENEFITS: The color of ocean water in the past has not been measured objectively. Secchi disks and a 10-point Forel color scale have been used to describe ocean color. These methods are highly subjective and dependent on various human eye estimates to delineate a broad color band in the visible spectrum. An objective method of accurately noting ocean color numerically in narrow bands opens up a whole new field for correlating ocean color to ocean properties. Furthermore, TRW proposes to plot and correlate ocean color via computer techniques with 'surface truth' available; the study of chemical, biological and sediment content; depth slicks, water mass delineation; fresh/saline water ratios and other ocean properties to ocean color could be a major ocean measurement tool. The color of water is known to be applicable to fisheries locations (water mass boundaries, upwelling, etc.) Rapid global assessment of water color in oceanography should advance knowledge thru color correlations—the applications to oceanography seem particularly appropriate because its dynamic and changing character require the rapid, broad, and repetitive coverage afforded by space vehicles.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

4.0153. INFRARED RADIOMETRY FOR SURFACE HEAT FLOW


Objective: (1) To determine a technique of measuring the total heat flux from the sea using two-wavelength infrared radiometry. (2) To establish the feasibility of using this technique on an airborne platform.

Approach: a. Sensors - A two-wavelength infrared radiometer system owned by Scripps Institution of Oceanography 3.5-4.05 microns; 4.45-5.1 microns. b. Contractor - Scripps Institution of Oceanography. c. Allocation of Resources - This effort is supported by the Office of Naval Research (1/3), the National Science Foundation (1/3), and the NASA ERS Spacecraft Oceanography Project.

Problem Addressed: Prominent oceanographers such as Pierson and Neumann (NYU) and M. Timofeev (USSR) recognize the importance of establishing a direct method of measuring heat flow from the ocean surface. Pierson and Neumann note that work of McAlister and others who have contributed to the development of this (infrared radiometry) technique has profound implications in both oceanography and meteorology. Timofeev says 'The use of infrared techniques in the determination of the temperature gradient in a surface water layer was first suggested and realized by McAlister.'
4. SURVEY AND PREDICTION

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

4.0154, REMOTE SENSOR SYSTEMS INTERGRATION AND PRESENT OPERATIONS DESCRIPTION

OBJECTIVE: (1) To describe and analyze the present commercial methods in the mission of searching for and capturing fish; (2) To examine the role of air and space remote sensors and define their optimum applications for this mission.

APPROACH: A thorough study of operational procedures and techniques of commercial and other fishermen in locating and capturing fish will be made. The role of the environment and its prediction will be carefully analyzed. The optimum applications of remote sensing systems to the fishing environment and fishing operation will be evaluated and defined. a. Sensors - a. Infrared Radiometry; b. Photography; c. Spectrophotometry; d. Spectroscopy.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

4.0155, AIRBORNE REMOTE SENSING OCEANOGRAPHY PROJECT

Objective: Develop and implement Navy-wide plan to produce improved remote sensors for all-weather airborne and spacecraft-borne ocean surveys. Convert NAVOCEANO aircraft to multi-purpose oceanographic/hydrographic and geophysical aircraft. Conduct airborne remote sensing experiments.

Approach: Evaluate DOD, NASA, ESSA oceanographic satellite programs; conduct laboratory and field experiments in conjunction with the above programs to acquire and interpret ocean data from spacecraft and aircraft. Identify potential methods for integrating ocean data from spacecraft and aircraft into Navy systems. Conduct experiments from aircraft on an opportunity basis to evaluate oceanographic applications of remote sensing techniques for use in Navy ocean projects. Collect, analyze, and disseminate acquired data and publish scientific and technological conclusions.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0156, EXPERIMENTAL SEA ICE OBSERVATIONAL TECHNIQUES

Objective: To develop and apply airborne/satellite remote sensor systems, observation procedures and imagery interpretation techniques, surface telemetering sensors, and data acquisition methodology for observation of sea ice features, motion, deformation, and related environmental parameters.

Approach: Develop new methods, test, and evaluation of: (1) remote sensing systems, observation procedures, data collection methodology, and imagery interpretation techniques; (2) Interrogation, Recording and Location System (IRLS) by agreement with ONR, in conjunction with NASA Nimbus satellite.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0157, SPACECRAFT OCEANOGRAPHY

Objective: To provide manpower for managing and conducting research studies in the use of remote sensing techniques applicable to oceanography and marine technology. To define suitable instrumentation and air and/or spaceborne platforms for oceanographic observations and measurements through research and experimentation.

Approach: The Spacecraft Oceanography Project provides a small highly trained scientific management staff to plan and direct in-house and contractual studies to carry out the objectives of this work unit. In addition to research studies by nationally known specialists, a program to conduct and coordinate laboratory and field experiments at NASA, DOD, university, and industrial remote sensing aircraft and laboratory facilities is carried out.

The Project documents the results of studies and experiments funded by NASA/Navy SPOC Project as well as related work not funded through the SPOC Project.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0158, RESEARCH FLIGHT FACILITY
H.J. MASON, U.S. Dept. of Commerce, Research Flight Facility, Miami, Florida

Specially instrumented aircraft consisting of two DC-6's, one C-54, and one Martin B-57 are maintained and operated to obtain in-flight measurements of meteorological parameters in support of the research of the Research Laboratories, other government agencies, and non-government organizations whose research is government supported. Much of the flight activities is in support of the research of the National Hurricane Research Laboratory, the National Severe Storms Laboratory, and the Experimental Branch of the Atmospheric Physics and Chemistry Laboratory. The Facility also develops meteorological instruments for measurements from aircraft in response to research requirements of the above groups, and has the responsibility for installation of special equipment used by the various research groups.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

4.0159, REPRODUCTION AND FECUNDITY OF TUNAS

This study will attempt to gain knowledge of the spawning behavior of the Atlantic tunas through analysis of the growth of ova after the methods developed by Thompson, Clark, Shaefer, and June. Randomized samples of the ova are weighed, the mature ova present are then enumerated, and the fecundity computed.

This study was begun in FY 1966 with the study of gonad samples from yellowfin and skipjack tunas captured on Geronimo and UNDAUNTED tuna-oceanography surveys and from shore-based sampling at Puerto Rico and West Africa.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

4.0160, REMOTE SENSING, GULF COASTAL AREA, CENTRAL FLORIDA
R.N. CHERRY, U.S. Dept. of Interior, Water Resources Division, Tallahassee, Florida

Purpose - To develop criteria utilizing remote sensing techniques to identify areas where fresh water is likely to occur in an aquifer in near-shore areas.

Methods - An aerial survey will be conducted to sense the thermal contrasts of aquifer and sea water under at least four conditions during high and low tides in a period when fresh water stages are high and during high and low tides when fresh water stages are low.

Water temperatures, water velocity, and specific conductance of water from submarine springs previously located will be determined. The water stages of fresh water and sea water will be recorded. These determinations will be compared with remote sensing data which indicate submarine discharge and the relative position of the zero piezometric contour.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

4.0161, REMOTE SENSING, EVERGLADES AREA, FLORIDA
M.C. KOLPINSKI, U.S. Dept. of Interior, Water Resources Division, Tallahassee, Florida

Purpose: To determine the relations between water conditions and biological populations in the Everglades by interpretation of airborne data and to develop new applications in natural resource research for data from remote sensors.

Methods: Spectral reflectance measurements of floral communities and water will be obtained using an airborne 18-channel optical-mechanical scanner. The data will be accumulated in a form that will allow use of a computer to identify and map the dis-
tribution and amount of selected communities. Remote sensing data will be examined for potential in: detecting plankton blooms, locating alligator holes, and estimating populations of large animals.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

4.0162. EXCITED STATES MECHANISMS IN PHOTOBIOLOGY
W.D. MCERLOY, Johns Hopkins University, Graduate School, Baltimore, Maryland 21218

Technical Objective: To expand level of support of photobiology into mechanism of bioluminescence, chemiluminescence involving molecular oxygen; fluorescence polarization in analysis of protein and polypeptide structure, quenching, investigation infra-red emission of highly conjugated molecules; biological reactions initiated by light.

Approach: Design and construct specialized high sensitivity photon detection equipment for visible and infrared regions of the spectrum; investigation evolutionary aspects of bioluminescence. Studies of energy transfer and oxygen photochemistry; construction equipment to measure excited state short lifetimes (1-10 nanoseconds).

Progress: a. b. d. e. of the formation of excited states of molecules as the result of chemical transformation of energy, with particular attention to mechanisms of bioluminescence, chemiluminescence, quantitative measurement of quantum yields and emission spectra of fluorescence and bioluminescence.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

4.0163. AIR OCEANOGRAPHY
G. EWING, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543 (N00014-66-C0241)

This task is concerned with the development and utilization of aircraft and satellites in studies of oceanic phenomena. This year emphasis is upon the development of a free floating buoy system for the Nimbus IRLS experiment to be flown in spring 1968. The feasibility of tagging and monitoring daily the location of an eddy shed from the Gulf Stream by satellite will be determined. This also will complement work concerned with the dynamics of such eddies.

The capability to obtain environmental data from airborne sensors has potential for providing such information to Naval operations rapidly and in areas where it might not otherwise be available.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0164. SENSING OF ENVIRONMENT
G. ZISSIS, Univ. of Michigan, Institute of Sci. & Technology, Ann Arbor, Michigan

This task consists of research on remote sensing environment determination of state-of-the-art, and dissemination of knowledge and techniques through interdisciplinary symposia where progress in the field of remote sensing is facilitated by exchange of information among environmental scientists, physical scientists, engineers, and instrument specialists.

The increased understanding of emission and reflection of electromagnetic energy from the earth's surface, when coupled with the vast quantities of environmental data which can be obtained with remote sensing systems, will greatly improve our ability to rapidly assess actual ground conditions in land, water, and air environments.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0165. EFFECT OF TEMPERATURES AND CIRCULATION OF CONTINENTAL SHELF WATERS ON THE DISTRIBUTION OF FISHES
R.B. STONE, U.S. Dept. of Interior, Sandy Hook Marine Lab., Highlands, New Jersey

Description of Work: Conduct monthly aerial sea surface temperature surveys over Atlantic Shelf from Cape Cod, Mass., to Cape Fear, N.C. in Coast Guard aircraft. Additional flights will be made when necessary to complement game fish research in other areas of the Atlantic shelf. Flights will be coordinated where possible with cruises of research vessels to obtain reference surface and subsurface temperature data. Monthly isotherm charts will be produced and will include observations of fishing vessels, surface schooling fishes, large pelagic fish, marine mammals and other marine animals. An attempt will be made to correlate the catches of migratory game fish by sport and commercial fishing vessels with observed sea surface temperature patterns. Surface and bottom current drifters will be released at 10-mile intervals along transects normal to the coastline.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0166. MULTISPECTRAL SENSING OF COASTAL ENVIRONMENTS
E.P. YOST, Long Island University, Graduate School, Brookville, New York (N00014-67-C-0281)

A four-band airborne multispectral photographic system is being tested for its ability remotely to determine shallow water depths, bottom characteristics, and other aspects of coastal and near-shore environments. Films and filters have been selected so that blue, green, red and infrared portions of the spectrum are being sampled for the remote sensing tests. Camera, instruments and test targets have been calibrated, prior to ground and airborne field testing of the system over controlled coastal test sites. The improvement of multispectral sensing techniques resulting from this research has direct application to a wide range of remote environmental investigations. Faster, more accurate methods of determining beach characteristics, presence of underwater obstacles, and depth of shallow water will assist operations in coastal environments.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0167. PROJECT AQUA-MAP - DEVELOPMENT OF AERIAL PHOTOGRAPHY AS AN AID TO WATER QUALITY MANAGEMENT
G.J. NEUHAUSER, Cornell Aeronautical Lab. Inc., Buffalo, New York 14221

In this program, laboratory experiments were performed to determine the feasibility of using aerial photographic techniques for water resources research; in particular, for detecting, classifying and measuring concentrations of effluents. The spectral reflectance characteristics of several effluents were measured and suggestions were made for optimizing the detection and identification of these discharges. In addition, factors influencing the selection of sites for aerial photographic experiments were analyzed. The Finger Lakes and Lake Chautauqua were considered as well as the Niagara Frontier. The study indicated that it is feasible to enhance the photographic contrast of discharges with respect to their backgrounds, and with appropriate controls, to use spectral signatures for classifying types of discharges and for measuring concentration over certain ranges.

Phase II: In this phase of the AQUA-MAP program, aerial photographic flights are being conducted in the Buffalo area over the Niagara River and Tonawanda Creek. The types of discharges imaged are being studied in the laboratory under controlled conditions. Additional laboratory measurements have been made of the spectral reflectance characteristics of water samples taken from the Niagara River and Tonawanda Creek to supplement the data obtained during Phase I on discharges.

Theoretical investigations into the mechanics of scattering by polluted aqueous solutions are being examined. Laboratory and aerial validation of the theory are being performed, the intent being to allow a realistic model of the polluted bodies of water to be created. Such a model will serve to aid the identification of pollutants via aerial photography and also indicate the limitations of remote sensing analysis.

SUPPORTED BY New York State Government

4.0168. REMOTE SENSING OF DELAWARE ESTUARY

85
4. SURVEY AND PREDICTION

Purpose: To determine effectiveness and feasibility of remote sensing devices in estuarine hydrologic investigations.

Methods: A series of remote sensing data collection missions will be flown over the Delaware estuary by NASA and USGS aircraft. Sensitivities of sensors to water quality variations will be treated initially. Subsequent missions will be based on initial findings.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

4.0169, COORDINATION OF ESTUARINE REMOTE SENSING IN ATLANTIC COAST REGION

Purpose: To provide an overview of Atlantic Coast estuaries, now that it is practical to photograph or sense at frequent and regular intervals large areas of the earth's surface from space. To develop a program and modify research for studying estuaries and groups of estuaries from space.

Methods: Photographs, remote sensing data and other information from individual remote sensing projects will be compiled, collated, and coordinated to formulate an optimal synoptic approach to the study of the hydrology of estuaries from space.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

4.0170, REMOTE SENSOR OCEANOGRAPHY
L.R. CAPURRO, Texas A & M University System, Graduate School, College Station, Texas 77843 (NONR)

The basic areas of research of this task are: (a) to develop techniques whereby oceanographic features peculiar to the Mississippi Delta area may be investigated by using remote sensors; (b) to develop techniques for making conclusions about the character of the sea surface utilizing aerial and space photographs of clouds as well as other imagery of them including NIMBUS, IR and TV; (c) to develop methods of determining sea surface temperature patterns from IR imagery and radiometry in the presence of random, transitory cloud systems partially interfering with the field of view.

The sensing and interpreting of oceanographic and other environmental data from satellites is of significant potential value for acquiring such data on a global basis or in remote areas for environmental prediction purposes. The results of this task are expected to contribute to this developing capability.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0171, REMOTE SENSING
G.L. HUEBNER, Texas A & M University System, Graduate School, College Station, Texas 77843 (NONR)

The objective of this task is to determine the microwave characteristics of sea water and ultimately the optimum frequencies for oceanographic radiometry. Laboratory measurements are being made too over the frequency range of 1,000 to 30,000 megahertz. Aside from examining sea water over various salinity and temperature values, contaminants such as surface oil films, dissolved clay particles and dissolved gases are being studied to determine their effects on the microwave properties of sea water.

The possibility of using infrared remote sensing devices has been examined extensively but never fully resolved. I.e. fundamental mechanisms are not understood. These studies should contribute to that understanding and, in addition, are necessary to the successful use of remote sensor determinations of ocean currents upwelling, and other oceanic processes reflected in surface temperature measurements.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0172, SPACE APPLICATIONS TO FISHERIES OCEANOGRAPHY (GULF OCEANOGRAPHY PROGRAM)
J.S. BAILEY, U.S. Dept. of Interior, Biological Laboratory, Fort Crockett - Galveston, Texas

It is necessary to know what combinations of remote sensors suitably delineate known oceanic features and to establish the uniqueness of these instruments in the various combinations. A catalog of the spectral 'signatures' in terms of the recorded energy distributions must be acquired so that conditions measured can be related directly and quantitatively to the structure of the surface layers (top 400 meters) of the ocean.

Project goals are to (1) delineate those ocean features, in space and time, that are significant to the support of given fisheries; (2) accumulate and synthesize historical data to provide the basis of a computer program to relate catch to oceanic condition; (3) develop programming techniques to implement oceanic (fishery) survey systems aboard satellites (unmanned orbiting vehicles); and (4) accurately forecast, in an appropriately workable time frame, fishery dynamics for the proper exploitation of these fisheries.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

4.0173, UTILIZATION OF SYNCHRONOUS SATELLITE DATA
J.E. SUOMI, Univ. of Wisconsin, Graduate School, Madison, Wisconsin

Objectives: Develop methods of utilizing meteorological data from synchronous satellites and the conception of new techniques for observing and interpreting the state of the atmosphere to meet the requirements for global atmospheric research and prediction.

Approach: The geostationary satellites provide an opportunity to exploit the quantitative imaging of weather patterns on the Earth. ATS-I and ATS-III images of the Earth and cloud cover offer opportunities to determine wind velocity by cloud displacement analyses, cloud height estimates, and develop methods of utilizing the observation of sun glint upon the ocean surfaces. The analyses of these phenomena will lead to the extension and interpretation of the presently available observations and the development of new techniques for determining the status and structure of the atmosphere.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

4.1, ECONOMIC ANALYSIS

(Genral Studies. Specific Economic Analyses Found Under Subjects Being Studied.)

4.0174, ANALYSIS OF THE EFFECT ON OPERATING COSTS AND RETURN ON INVESTMENT OF VARIATIONS IN OPERATING PARAMETERS

To evaluate the importance of individual components in a mining system, their effects on the system must be known. Operating costs and return on investment are both important measures by which the efficiency of a mining system is evaluated. By analysis of the cash flow for an operation, the effects of variations in environmental or technical components may be determined. Computer will be used for these determinations.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

4.0175, 149A FISHERIES SYSTEMS ANALYSIS
R.E. GREEN, U.S. Dept. of Interior, Fishery Oceanography Ctr., La Jolla, California

The objective of this project is to determine what management practices may be most efficient in increasing the cost effectiveness of the wetfish fishery, consisting of a fleet of small fishing vessels working the coastal region of California and the distant water tuna purse seine fleet, both presently economically unsound. Analysis of the cost/earnings structure of the tuna purse seine fleet recently completed, has been useful in understanding the economics of that fishery; it is proposed to apply similar techniques to the wetfish fishery. Computer simulation studies will also be made on these fisheries to determine effects of various predictable factors on the efficiency and profit of the fisheries.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
4.0176, STUDY OF OCEANOGRAPHIC MARKETS
J. GOLDEN, Planning Research Corporation, Los Angeles, California

In this project, PRC conducted a developmental study of oceanographic markets for a large industrial manufacturer of specialized equipment and chemicals.

PRC reviewed all oceanographic markets - military and commercial - to provide rough-cut forecasts of future potential for the client's advanced equipment, services, and consumables; and to identify project areas of potential interest to the client.

Client capabilities, interests, and limitations were assessed in order to determine projects that would be especially suitable, and to select action for implementing specific projects. Detailed recommendations for project implementation were included.

SUPPORTED BY Industrial Manufacturer

4.0177, MARKET STRUCTURE OF THE COMMERCIAL FISHING INDUSTRY
R.C. SMITH, Univ. of Delaware, Agricultural Experiment Sta., Newark, Delaware 19711

Objectives: 1) To determine the product flow and existing characteristics of the commercial fishing industry and its relative importance in the Northeast; 2) To analyze the dynamic aspects of the supply and demand situation for the major species of finned fish and shellfish of the Northeast, and 3) To assess implication of potential changes in the market structure and its performance on the fishing industry, poultry and livestock producers and consumers.

Description of Work Proposed: The Delaware station will concentrate primarily on studying menhaden and other fish used in animal feeds. The first procedural step will require the compilation of data related to the distribution of menhaden fish including the primary markets, marketing channels and product use by poultry and livestock.

Estimates of supply and demand parameters for menhaden fish will be obtained. Statistical procedures including linear programming and single equation regression models will be used to evaluate the relationship of fish meal to poultry and livestock production.

SUPPORTED BY U.S. Dept. of Agriculture Delaware State Government

4.0178, ECONOMICS OF NUCLEAR FUEL
UNKNOWN, N U S Corporation, Washington, District of Columbia 20036

Purpose: To establish a frame of reference for assessment and projection of the costs of nuclear fuel for merchant ships.

Description: A detailed investigation has been made of the economics of nuclear fuel as a source of energy for merchant ships. The initial studies made under this contract have been reevaluated and updated to incorporate latest cost estimates. The research consists of evaluation of currently proposed pressurized water maritime reactor core design, identification of significant costs; projection of costs based on past and present levels; and comparison of cost trends with selected central station reactors that employ similar fuel technology. The results will be put in a form that can be used in making an economic assessment of commercial nuclear ships.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

4.0179, MARINE TRANSPORTATION ECONOMIC ANALYSIS
P.B. MENTZ, U.S. Dept. of Commerce, Maritime Administration, Washington, District of Columbia 20235

With the objective of outlining a formalized approach to selection of appropriate economic criteria and use of realistic costs of capital in the conduct of marine transportation analysis, this study reviews the available economic criteria for financial decision making. Among those considered are the internal rate of return, life cycle cost, required freight rate, net present value, and net cash flow indices. Use is made of the concepts of 'opportuni-

4.0180, DETERMINATION OF THE STRUCTURE & ECONOMIC IMPORTANCE OF THE VARIOUS SEGMENTS OF THE SEAFOOD INDUSTRY
D.H. CARLEY, Univ. of Georgia, Agricultural Experiment Sta., Athens, Georgia 30602

Objectives: To determine the structure and economic importance of the various segments of the seafood industry of Georgia including: a. Volume, trend and seasonality and value of landings of fish and shellfish; b. Number employed, and wages and earnings in various segments of the industry; c. Capital investment in facilities and equipment. d. Expenditures for supplies and services.

Procedures: Secondary and primary data, including personal interviews of fishermen, processors and industry representatives, will be used to fulfill the objectives. Budgetary and other quantitative techniques will be used in this phase of the study.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish. Georgia State Government

4.0181, FISHING VESSEL CONSTRUCTION COSTS AND THE U.S. FISHING VESSEL CONSTRUCTION DIFFERENTIAL SUBSIDY
C. HAMLIN, Ocean Research Corporation, Kennebunk, Maine 04043

The purpose of this study was to establish valid, directly comparable, fishing vessel construction costs, to review the present system of setting fishing vessel co-ordination subsidies paid by the Federal government, and to make recommendations for improvements to this system. Direct shipyards costs of building fishing vessel were obtained, by personal visit, from yards in the U.S., Japan, W. Germany, Norway, Netherlands, and U.K. Cost comparisons on the basis of cubic number (LWL x Beam x Depth), vessel type, construction material, and country of build, were established, and a formula devised for suggested use in establishing subsidy percentages at the preliminary design stage.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

4.0182, ECONOMIC ANALYSIS OF THE MARKET STRUCTURE OF THE COMMERCIAL FISHING INDUSTRY IN THE NORTHEAST
UNKNOWN, Univ. of Maryland, Agricultural Experiment Sta., College Park, Maryland

1. To determine the product flow and existing characteristics of the commercial fishing industry and its relative importance in the Northeast.

2. To analyze the dynamic aspects of the supply and demand situation for the major species of finned fish and shellfish of the Northeast.

3. To assess implications of potential changes in the market structure and its performance in the fishing industry, poultry and livestock producers, and consumers.

DESCRIPTION OF WORK PROPOSED: The Maryland contribution will relate to all three objectives. Secondary data will be compiled related to the product flows and structure of the fishing and seafood processing industries in the Chesapeake Bay Area. Factors effecting the supply of both fresh and processed fishery products from the Chesapeake Bay Area and the factors effecting the demand for these products will be considered.

SUPPORTED BY U.S. Dept. of Agriculture Maryland State Government
4. SURVEY AND PREDICTION

4.0183, ECONOMIC ANALYSIS OF THE MARKET STRUCTURE OF THE COMMERCIAL FISHING INDUSTRY IN THE NORTHEAST

UNKNOWN, Univ. of Massachusetts, Agricultural Experiment Sta., Amherst, Massachusetts 01003

Objectives: 1. To determine the product flow and existing characteristics of the commercial fishing industry and its relative importance in the Northeast. 2. To analyze the dynamic aspects of the supply and demand situation for the major species of finned fish and shellfish of the Northeast. 3. To assess implication of potential changes in the market structure and its performance on the fishing industry, poultry and livestock producers, and consumers.

Massachusetts will determine consumer demand for hadlock, cod, redfish, whiting, and flounder using cross-section data obtained from a sample of consumers.

SUPPORTED BY U.S. Dept. of Agriculture Massachusetts State Government

4.0184, SECOND HAND PRICES FOR TANKERS

P.A. EMBIRICOSCOUMO, Mass. Inst. of Technology, School of Engineering, Cambridge, Massachusetts 02139

The purpose of this thesis is to describe the mechanics of the second hand market in oil tankers. Since the value of an oil tanker depends upon the value of its flow of services, the market for tanker transportation services is examined in detail. This examination reveals that although the oil companies have enough market power to maintain stable rates under normal conditions, they hedge against unexpected market changes by engaging in a substantial portion of the available tonnage under long term contract. This results in a very thin market for the tonnage that is free of long term commitments. This latter market, called the spot market, is thus subject to fluctuations which, in turn, are responsible for large fluctuations in the value of tonnage free of long term contract.

In order to clarify the movements of the market for used oil tank ships a theoretical model was developed through which first, the conditions for equilibrium of the market were derived and second, the adjustment behavior of the market was traced. Expectations were explicitly introduced into the model. A time series of prices and transactions was compared to the theoretical conclusions, and found to compare favorably.

The importance of short run expectations having been confirmed, the influence of long term expectations was investigated. It was determined that the increasing change in technology has resulted in the greater importance of long term expectations of transportation rates on the level of oil tank ship prices.

SUPPORTED BY Massachusetts Institute of Technology

4.0185, FINANCING OF FISHING VESSELS

A. HOLMSEN, Univ. of Rhode Island, Agricultural Experiment Sta., Kingston, Rhode Island 02881

Availability of funds at reasonable terms for financing of fishing vessels seem to be one of the most important factors responsible for the slow growth of the R. I. fishing fleet. At the present time the commercial banks charge a 6 1/2% compounded interest while in other fishing ports in New England commercial banks lend at 5 1/2% of the outstanding balance. Most banks in Rhode Island refuse to finance fishing vessels. The primary reason seems to be lack of knowledge of the risk involved and of the returns to capital in the industry.

This project will, by use of the interview questionnaire method, determine the return to capital for the various kinds and sizes of commercial fishing vessels in Rhode Island, determine how vessels are financed and the difficulties involved. A sample of vessels in Stonington, Connecticut and New Bedford, Massachusetts will be studied to determine whether significant differences occur. The policies of the various financing institutions will be studied with respect to fishing vessel financing.

SUPPORTED BY Rhode Island State Government

4.0186, MARKET STRUCTURE OF COMMERCIAL FISHING INDUSTRY IN THE NORTHEAST

H.C. LAMPE, Univ. of Rhode Island, Agricultural Experiment Sta., Kingston, Rhode Island 02881

Objectives: 1) To analyze the economic aspects of the supply and demand situation for the major species of finned fish and shellfish of the Northeast. 2) To assess implication of potential changes in the market structure and its performance on the fishing industry, poultry and livestock producers, and consumers.

One emerging simultaneous equation model of the haddock market will be revised. Major revision will be affected in the wholesale and import equations. Particular efforts will be made to obtain measures of the transactions associated with cold storage holdings and the prices at which transactions are made. In addition the revision will seek to avoid the problems associated with movements of cold storage holdings from one location to another within a firm. A model of fish population will be coupled with the market model above to provide the basic simulator of the market population system. The dynamic properties of the system will be evaluated in successive simulator runs on computer. The influence of changes in parameters of the markets and populations on the equilibrating properties of the system will be presented and evaluated. A preliminary simulator has been developed and will be improved.

SUPPORTED BY U.S. Dept. of Agriculture Rhode Island State Government

4.0187, ECONOMIC IMPACT OF MARINE-ORIENTED ACTIVITIES IN THE SOUTHERN NEW ENGLAND MARINE REGIONS

N. BORHOLM, Univ. of Rhode Island, Agricultural Experiment Sta., Kingston, Rhode Island 02881

Objectives: 1) To determine the present and estimate the future amounts of human economic resources employed in marine-oriented activities of commercial, educational, research, defense and recreational nature. 2. To analyze the relationship between the marine-oriented activities and the general economy of the area including estimates of economic and employment impact.

Procedures: The initial work (Phase I) will concentrate on a detailed study of the marine-oriented activities. On the general economy only secondary data will be collected. Later phases will deal with the remaining parts of the regional economy and the region’s population. Data on human economic resources employed, investment, costs, sales and future plans will be gathered through personal interviews. Secondary data from Sales Tax Divisions, Census of Manufacturers, Census of Business and Department of Labor will also be utilized.

SUPPORTED BY Rhode Island State Government

4.0188, CONFERENCE ON THE FUTURE OF THE U.S. FISHING INDUSTRY

R. VANCLEVE, Univ. of Washington, Graduate School, Seattle, Washington 98122

A conference on the U.S. fishing industry was held in Seattle in March, 1968, under the sponsorship of the University of Washington. Its purpose was to identify the problems that beset the U.S. fisherman; the causes for the economic decline of some portions of the fish catching industry in the face of growing worlds markets; and the rising percentage of unmarketed fish. It represented a cross-section of U.S. fishing interests, university faculties, and government agencies. The contract provided for a summary report which analyzed the conference, developed conclusions of the General Committee, and presented a consensus of recommended corrective actions. This report was completed in August, 1968.


5. LIVING SYSTEMS (NON-HUMAN)

(see Also Chapter 7 For Engineering Aspects)
5. FISH POPULATIONS

5.0001. STOCKING AND SURVIVAL OF STRIPED BASS FINGERLINGS

E.W. SHEE, Auburn University, Graduate School, Auburn, Alabama 36830

Objectives: To determine if the periodic stocking of striped bass (4 to 6 inch group) into river systems connecting estuarine areas of Alabama will establish this species at a sufficient level to allow the development of a commercial fishery.

Procedure: Large striped bass fingerlings (4 to 6 inches) produced under Job II of the study will be stocked in selected areas determined under Job I. Fingerlings will be bar marked so that they can be identified on subsequent recovery. Fishermen will be interviewed, and sampling will be done by seineing, trawling, and by rotenone or other chemical methods to determine the survival of stocked bass.


5.0002. KVICHAK RIVER TOTAL SMOLT

S. PENNOYER, State Dept. of Fish & Game, Anchorage, Alaska

A long term declining trend in the important Kvichak River fishery at Bristol Bay coupled with extreme annual fluctuations in run size demand that research be undertaken to accurately predict returning run size and estimate the annual escapement levels needed to sustain maximum yield. The present index sampling of smolt abundance has not fulfilled this need. This project will seek to estimate total annual smolt outmiguration eliminating many of the sources of error in the index method and allowing quantitative evaluation of production from escapement and mortalities at various life history stages.

This phase of the study will consist of the following steps: 1) location of suitable sampling site, 2) recording of physical properties of the site, e.g., depth, width, flow, water clarity, that might affect smolt migration patterns and behavior, 3) establishment of a fixed area at the site, 4) a single fyke net or similar capture device covering the same water areas as the present index net will be fished on a twenty-four hour basis at the site for comparison with present index catches. Some modifications in counting gear and fishing apparatus will be tested, 5) smolt distribution across the channel(s) will be sampled by fishing at intervals across the river with some form of mobile sampling gear and comparing counts with those of the stationary gear, 6) experimentiation with various forms of capture and counting gear will be initiated to develop counting units that can be placed at intervals across the river (photo-electric grids are contemplated). The use of lourves and light for smolt guidance will also be investigated, 7) smolt behavior and reaction to various forms of gear will be studied by use of SCUBA and underwater photographic equipment.

(Part 1 of 2)


5.0003. KVICHAK RIVER SMOLT STUDY LITERATURE SURVEY

S. PENNOYER, State Dept. of Fish & Game, Anchorage, Alaska

A long term declining trend in the important Kvichak River fishery of Bristol Bay coupled with extreme annual fluctuations in run size demand that research be undertaken to accurately predict returning run size and estimate the annual escapement levels needed to sustain maximum yield. The present index sampling of smolt abundance has not fulfilled this need. This project will seek to estimate total annual smolt outmiguration eliminating many of the sources of error in the index method and allowing quantitative evaluation of production from escapement and mortalities at various life history stages.

During the first year of the project the available literature on smolt sampling and enumeration will be surveyed and correspondence with individuals involved in this type of research in other areas will be contacted. A great deal of work has been done on sampling, guiding and counting downstream migrants and some of the work done and devices tested are applicable to the Kvichak River program. This phase will continue throughout the life of the project with the main emphasis during the period January through April of 1966. The project leader and assistant will be responsible for this work.


5.0004. BRISTOL BAY ESTUARINE ECOLOGY

C.J. DICOSTANZO, U.S. Dept. of Interior, Biological Laboratory, Auke Bay, Alaska

During the past few years intensive work has been done on the freshwater and the high seas phases of the life history of the sockeye salmon. Recent work has indicated that the ocean survival rates may not be nearly as constant as formerly thought and that estuarine conditions strongly influence these rates. Thus it seems necessary to supplement the freshwater and oceanic studies with investigations into the ecology of the sockeye salmon in estuarine areas.

The early phase of this study will be largely exploratory in nature. The objectives are: 1. To delineate the water masses within the Bristol Bay area and determine the physical and chemical features of the estuarine and adjacent coastal waters. 2. To determine the pattern of movement and distribution of smolts from the parent river into the estuary and ocean waters. 3. To determine the growth and survival of smolts as they pass through this transitional phase of their life cycle. The first full season of study will utilize aircraft and radiometer to delineate water masses in Bristol Bay.

More specific oceanographic studies will be conducted from a surface vessel. It is expected that much time will be spent in assembling gear and developing standard stations and techniques. Sampling of juvenile salmon will be accomplished with various kinds of gear, including tow net, trawls, seines, and gill nets.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0005. NAKNEK SYSTEM RED SALMON STUDIES

C.J. DICOSTANZO, U.S. Dept. of Interior, Biological Laboratory, Auke Bay, Alaska

The Naknek River System is composed of several large nursery lakes, connected by short streams. Each lake receives stocks of adult red salmon which utilize various types of adjacent spawning grounds. Juvenile salmon migrate ocean-ward from lake to lake at various times of the year.

The objectives of this program are to obtain an understanding of the various factors influencing the abundance, distribution, survival, growth, and movement of adult and juvenile sockeye salmon in the system. The expanded program includes all studies of the former Brooks Lake research program. Several related studies are currently in progress concerning the following: 1. Determine vital statistics of red salmon adult and young fish populations through systematic collection of data pertaining to length, weights, sex fecundity, and abundance at successive life history stages. 2. Determine the direct causes of mortality and the nature of their effects. 3. Determine required population densities for optimum utilization of available spawning gravels and nursery areas. 4. Determine morphological and physiological characteristics and behavior patterns that distinguish spawning colonies. 5. Determine the effects of intra and interspecific competition. 6. Identify what measures involving manipulation of the spawning or lake nursery environments or the salmon populations themselves may result in maximizing freshwater production.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0006. KARLUK LAKE RESEARCH STATION

C.J. DICOSTANZO, U.S. Dept. of Interior, Biological Laboratory, Auke Bay, Alaska

The broad objective of the Karuk research program is to determine the cause(s) of the long-term decline in the spawning run of red salmon and to try to reverse this downward trend. To this end, investigations are directed toward identifying, enumerat-
5. LIVING SYSTEMS (NON-HUMAN)

ing, and determining productivity of subpopulations and calculating mortality rates at various stages of the red salmon life cycle.

Size, age, and fecundity of subpopulations are being studied as well as their timing, distribution, and abundance on various spawning grounds.

Adult escapement and smelt outmigrations sizes are being determined and sampled to obtain vital descriptive data. We are using these data to calculate mortality rates during the ocean phase of the red salmon life cycle.

Potential egg deposits and fry productions are being determined for diverse spawning grounds so that mortality rates during that stage of the freshwater life cycle may be calculated.

Methods of indexing abundance of juven-ile red salmon have been developed.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0007, CHUM SALMON INVESTIGATIONS
C.R. MATTSON, U.S. Dept. of Interior, Biological Laboratory, Auke Bay, Alaska

Salmon research by the Chum Salmon Investigation is centered at the Traitors Cove field station, which is located on Revillagigedo Island approximately 25 airline miles north of Ketchikan, Alaska. Original research emphasis, the station was established in 1960, was upon the freshwater and early marine life phases of the chum salmon, Oncorhynchus keta, life cycle. In 1964 research emphasis was shifted to the early marine life history stage of the young chum and pink, Oncorhynchus gorbuscha, salmon. This change was made because intensive freshwater and intertidal salmon research was being conducted at other field stations in Alaska. Additional factors justification the change was the availability of two connected, enclosed marine basins ideal for estuarine salmon research, and pink salmon were included as they were available in even greater abundance than chum salmon.

General research objectives include the following: Determine relative abundance and timing of juvenile pink and chum salmon migrants from Traitors River and within the two marine basins forming Traitors Cove; study food habits of the salmon and determine availability of food organisms; determine salmon growth rates within an estuarine environment; and study estuarine environmental factors such as water temperatures, salinities, currents, and turbidites and relate these to juvenile salmon abundance and behavior.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0008, MARINE BIOLOGICAL INVESTIGATIONS - TAXONOMIC COLLECTION OF THE FRESH AND SALTWATER FISHES OF ALASKA
J.C. QUAST, U.S. Dept. of Interior, Biological Laboratory, Auke Bay, Alaska

The fish collection comprises approximately 250 species of Alaskan marine and freshwater fishes. Eventually nearly all fish species inhabiting Alaskan waters will be represented. Scientific uses include collection of growth series so that juveniles, larvae, and eggs may be identified, the accurate identification of specimens taken in research activities, and recognition and definition of new species, the accumulation of series for racial work and variation analyses, and the construction of faunal lists and keys. Museum facilities are available to investigators, and specimens are available on loan to research institutions.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0009, GULF OF ALASKA DEMERSAL FISH INVESTIGATIONS
J.C. QUAST, U.S. Dept. of Interior, Biological Laboratory, Auke Bay, Alaska

Goals of the long-term projects are: (1) to assemble all available data, published and unpublished, on the physical ecology, faunal assemblages, and population parameters of the demersal fishes of the Gulf of Alaska; (2) to classify this information on the basis of the statistical grid for the North Pacific Ocean in current use by the International North Pacific Fisheries Commission and store the information in suitable form on IBM cards to allow: (3) the retrieval of information in the form of geographic and bathymetric distribution charts and density charts of species, the detection of faunal assemblages, the delineation of areas of high and low fish production, the assessment of future stock deterioration with fishing, and general correlation analysis to bring out salient relationships between biological, physical, and fishery factors and demersal fish production.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0010, MARINE BIOLOGICAL INVESTIGATIONS - ANALYSIS OF HERRING FISHERY DATA
J.C. QUAST, U.S. Dept. of Interior, Biological Laboratory, Auke Bay, Alaska

Analysis of data on catch per unit effort and age frequencies of Alaskan herring in the fishery. Data extending from the present to 1929. Analyses of data on herring movements in Southeastern Alaska as revealed by radioactive tagging experiments in 1960 and 1961. Preparation of manuscripts.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0011, MARINE BIOLOGICAL INVESTIGATIONS STUDIES PROJECT (FISHES)
J.C. QUAST, U.S. Dept. of Interior, Biological Laboratory, Auke Bay, Alaska

Quantitative studies of the complete fish fauna of selected bays of Southeastern Alaska. Goals: to identify the fishes and determine the ecology, density, growth, and mortality of their populations in the present nearly natural state. Such data to serve as benchmark information for comparison with future surveys of the same or similar bays of the region when these bays have been changed by man-made or natural causes. Ancillary objectives include the determination of possible faunal gradients that occur from the coast eastward in the inside waters and from north to south.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0012, MARINE BIOLOGICAL INVESTIGATIONS - JAPANESE FISHERY OBSERVERS PROJECT
J.C. QUAST, U.S. Dept. of Interior, Biological Laboratory, Auke Bay, Alaska

Goals are to monitor the take of Pacific halibut by Japanese fishery vessels in the Gulf of Alaska and to obtain information of possible use by the U.S. fishing industry. Project started in 1964. Approximately 300 hours of trawling observed each year.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0013, INVESTIGATION OF ANADROMOUS DOLLY VARDEN POPULATIONS IN HOOD BAY DRAINAGES, SOUTHEASTERN ALASKA
R. ARMSTRONG, State Dept. of Fish & Game, Juneau, Alaska

Objectives: (1) Determine the number and timing of Dolly Varden leaving Hood Bay Creek on their first migration to sea. (2) Determine the number and timing of Dolly Varden entering and leaving Hood Bay Creek. (3) Determine the size, sex ratio and age of Dolly Varden migrating to sea for the first time from Hood Bay Creek. (4) Determine the size, sex ratio and age of Dolly Varden entering and leaving Hood Bay Creek. (5) Determine the homing tendencies, within the year, of Dolly Varden leaving Hood Bay Creek on their first migration to sea. (7) Determine the homing tendencies, within the year, of Dolly Varden displacing from Hood Bay Creek. (8) Determine the homing tendencies of Dolly Varden entering Hood Bay Creek. (9) Determine the number of mature (potential spawners for the year) and non-spawning Dolly Varden entering Hood Bay Creek. (10) Determine the frequency of spawning, by sex, of Dolly Varden spawning in Hood Bay Creek. (11) Determine if mortality of char occurs after spawning and obtain an estimate of mortality rate of spawned-out char by sex. (12) To locate spawning areas of Dolly Varden in Hood Bay Creek. (13) Estimate Dolly Varden egg deposition and over-winter survival of
the eggs in a selected area of Hood Bay Creek. (14) Evaluation of hydraulic sampling techniques in providing a deposition index. (15) Determine the distribution of Dolly Varden and salmon in Hood Bay Creek on a weekly basis. (16) To obtain information on the physical and chemical conditions of Hood Bay Creek. (17) Determine the food of Dolly Varden migrating to sea for the first time from Hood Bay Creek. (18) Determine a tag suitable for use on Dolly Varden less than 150 mm in fork length. (19) To evaluate the effectiveness of the Hood Bay Creek weir to stop and trap Dolly Varden on their first migration to sea.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish. Alaska State Government

5.0014. COOK INLET CATCH AND ESCAPEMENT AGE AND SEX COMPOSITION STUDIES
A.S. DAVIS, State Dept. of Fish & Game, Juneau, Alaska

The purpose of this phase of a long range sockeye study is to separate the returning adult runs by age and sex groups. The obtained information is necessary for evaluating optimum escapement indices and marine survival evaluations. Attempts to separate catch samples by river systems by scale characteristics will also be investigated.

Sampling of characteristics of the salmon caught in each of the several gill net fishing areas of the Inlet, along with spawning ground sampling for the same characteristics will be conducted at selected points.

A two-man crew will begin sampling July 1 in the set net fishery in the Ninilchik to Kasilof River area. Sampling will be conducted at the Columbia Ward's Cannery at the mouth of the Kenai River when fish are available in sufficient numbers. The crew will sample set net catches at Kilgin Island, Kalkofonk Beach, Salamato Beach, and Harrriet Point on the west side of Cook Inlet. The drift fishery will be sampled on two separate fishing days, July 21 and July 24. Spawning ground sampling will begin August 5.

Part 2 of 3


5.0015. COOK INLET SMOLT ENUMERATION STUDY
A.S. DAVIS, State Dept. of Fish & Game, Juneau, Alaska

The purpose of this phase of a long range sockeye salmon study is to enumerate the smolt production from the Kenai River. This will allow the establishment of index values which can be related to total smolt run size and will enable estimates of fresh water production under different escapement levels. It will also provide a better means for predicting future spawning run size other than current escapement indices.

Starting May 10 or as soon after as ice conditions permit, downstream migrant trapping will commence on the Kenai River. The trap site will be located at the sonar unit installation. Downstream migrant fyke nets, with detachable cod ends will be utilized for the sampling. Lengths, weights, and scale samples will be taken to establish freshwater life characteristics of these sockeye salmon runs. The Kenai River adult-counting sonar installation will be tested for its possible application to smolt enumeration. The annual outmigration of smolts will be sampled on the Kenai River until early June when the smolt migration will be over. A preliminary investigation of smolting sites and some test fishing will also be attempted on the Kasilof River.

Part 3 of 3


5.0016. SOCKEYE SALMON MIGRATORY BEHAVIOR AND BIOLOGICAL STATISTICS COLLECTION, SOUTHEASTERN ALASKA
C. ENGELKING, State Dept. of Fish & Game, Juneau, Alaska

Objectives: A. Delineation of migration routes. Determination of the migration routes utilized by sockeye salmon approaching their home streams has been indeterminate in Southeast Alaska for a number of years. One portion of the run will be identified by tagging in the Sumner Strait and North Clarence Strait approaches and subsequent recovery of the marked fish in (1) the commercial fishery, (2) at canneries, weirs on the spawning streams and (3) by teams of men conducting foot surveys on the spawning grounds of sockeye stream without weirs.

B. Biological Statistics Collection. The collection of biological statistics in the fishery, at canneries, weirs and in the estuarial areas at the mouths of the streams without weirs will greatly enhance the knowledge required to properly manage the sockeye salmon resource of Southeast Alaska. This will be accomplished through collection of scale and length data to assess the age classes in the fishery and in the total run; the rate of exploitation by the fishery and the timing of the various races comprising the run.


5.0017. PRE-EMERGENT FRY PINK SALMON FORECAST (KODIAK, ALASKA)
D.P. HENNICK, State Dept. of Fish & Game, Juneau, Alaska

This phase provides for the expansion and refinement of pink salmon forecast research in the Kodiak Island area. Objectives are (1) egg and pre-emergent larva sampling of sufficient size to assure reliable forecast of the island runs and to assure a gradual accumulation of optimum escapement data in the major streams. Essentially we are excavating random plots in important and accessible spawning streams in a manner which should give reliable year-to-year comparisons of larva survival and relative abundance. Approximately 22-25 streams are sampled annually using a standard hydraulic sampling tool. This is accomplished very near the end of freshwater life when many causes of population fluctuations have passed. With proper selection of streams about 80 percent of the escapement can be monitored.

During the early fall sampling is conducted in several selected streams for egg deposition, October through November. During the winter months analysis of data and reports are completed. In March a crew of five temporary aides are hired and arrangements are made to charter a vessel and helicopter. Pre-emergent sampling of 22-25 streams is conducted from March through April, usually a 6 week period. Throughout the summer and spawning period the streams to be sampled are traversed on foot and via light plane to access escapement and distribution of spawning populations and permanent markers are installed to pinpoint the location of the sampling areas.

Part 2 of 2


5.0018. EXPANSION OF CURRENT AND DEVELOPMENT OF ADDITIONAL COMMERCIAL FISHERIES CATCH, PRODUCTION AND GEAR STATISTICS
B. HILL, State Dept. of Fish & Game, Juneau, Alaska

Objectives of the study are to (1) increase the accuracy and reliability of current state fishery statistics through the coordination of proper sampling methods, and (2) to compile and publish statistics on an area and individual fishery basis rather than on a regional or statewide basis. Procedures will consist of the following: (1) Establish uniform sampling techniques in the various areas throughout the State. (2) To test adequate and reliable weight, number and value data can be collected. (2) Compile the catch in number and weight on a weekly or suitable time period basis for each fishery in each area of Alaska. (3) Compile the value to the fishermen of the various fisheries in each area of the State. (4) Compile survey statistics for each fishery in each area of the State. (5) Compile the volume and value of manufactured fishery products on an area basis. (6) Publish detailed annual production, catch, production, and effort statistics for each fishery on an area basis.


91
5. Living Systems (Non-Human)

5.0019, Pre-emergent Fry Pink Salmon Forecast - Southeastern Alaska
T.C. Hoffman, State Dept. of Fish & Game, Juneau, Alaska

The objectives of this phase of a long range pink salmon study is to compliment and extend the presently established pre-emergent fry pink salmon forecast program in Southeastern Alaska with the long range goals: (1) develop useful predictions to provide for more efficient means of harvesting existing runs, (2) to see if the same sampling methods can be utilized with chum salmon.

Previous sampling activities, because of access problems, have been primarily located in intertidal and adjacent spawning areas. Distribution of sampling effort is made randomly within the total area included in a base stratum. This yields fry abundance from sixty plus streams in Southeastern Alaska which is projected statistically to the total area of the base stratum.

Fry production information for areas considerably removed from tidal influence especially in very large streams is an unknown factor and the primary emphasis of this phase is to fill that knowledge gap.

Fry production estimates will be made in upstream areas of twenty formerly inaccessible streams in Southeastern Alaska. These estimates will be integrated with the existing program in attempting to return pink salmon runs. Sampling will be conducted with a hydraulic pump and the procedures are essentially as described in McNeil, William J. 1962. Mortality of pink, and chum salmon eggs and larvae in Southeast Alaska streams.

Supported by U.S. Dept. of Interior - Bu. Comm. Fish. Alaska State Government

5.0020, Population Studies of Anadromous Fish - Upper Cook Inlet Drainsages
W. J. Lechner, State Dept. of Fish & Game, Juneau, Alaska

Objectives: (1) To determine the sport fish catch of king salmon and evaluate angling pressure in the selected freshwater areas of Upper Cook Inlet. (2) To determine the distribution, abundance, size classes, sex ratios and angular scales in spawning areas of adult king salmon and silver salmon in the various streams of Upper Cook Inlet. (3) To investigate Ship Creek and associated areas on Upper Cook Inlet as a source for the procurement of king salmon eggs for experimental hatching and rearing. (4) To evaluate the contribution of artificial ponds to the stocks of anadromous fishes to Ship Creek. (5) To conduct silver salmon harvest studies in selected tributaries of the Susitna River Drainage.

Procedures: (1) Crecel census efforts will be directed towards obtaining information on numbers of king salmon caught, angling effort, lengths, weights, and sex of an adequate sample of fish caught. Scale samples will be collected for age analysis as appropriate. Data obtained from the return of the special king salmon punch cards will be evaluated in terms of total harvest, individual stream harvest, and angler success and participation.

Supported by U.S. Dept. of Interior - Bu. Sport Fish. Alaska State Government

5.0021, Identification of Red Salmon Stocks Taken in the Cape Kumluk-Aniakchak Bay Fishery (Chignik Area)
J. Lechner, State Dept. of Fish & Game, Juneau, Alaska

A red salmon Cape fishery has developed at Cape Kumluk on the south side of the Alaska Peninsula, since 1960. This study will determine the origin of these red salmon stocks, so that an established management basis may be determined for this Cape fishery. Indications from a limited tagging study in 1963, suggests that these stocks are bound for the Chignik River red salmon system, which is presently closely managed for obtaining of desired escapement goals. A building return of red salmon has escaped into the Aniakchak system, which must be evaluated for the degree of contribution to the building Cape fishery. The location of the work will require tagging of red salmon at the Cape Kumluk fishery with Pedersen type disc tags, which will be in number sequence and the recovery of these tags by method of tag reward from the commercial fishery and spawning ground tag recovery from the two major red systems within the area. Red salmon scales will be taken for morphological differentiation, from the Cape fishery and the major red salmon's systems within the area. A temporary field camp will be established for the Aniakchak spawning ground survey. One Fisheries Biologist IV, one Fisheries Biologist I, and six temporary Fish and Game Aides will conduct the study.

Supported by U.S. Dept. of Interior - Bu. Comm. Fish. Alaska State Government

5.0022, Bristol Bay Intermediate High Seas-Insshore Test Fishing
K. R. Middleton, State Dept. of Fish & Game, Juneau, Alaska

A) Objectives - 1) To provide annual forecasts of the magnitude and age composition of the Bristol Bay sockeye runs after the runs have been exposed to the high sea fishery and just prior to the time they reach the insshore fishery. These forecasts will be used in conjunction with the existing high seas and insshore forecasts. 2) To obtain information regarding the annual timing and pattern of entry of the Bristol Bay sockeye into Bristol Bay.

B) Procedures - 1) A large fishing vessel equipped with sonar fish-finding equipment will be used to fish standard 5-3/8' stretch measure gillnet north of Port Moller during the period 6/10-7/10 to obtain an index of abundance of red salmon migrating to Bristol Bay. The basic procedures will be designed after existing high sea procedures. 2) Fish captured will be sampled for age-weight-length data to provide an estimate of the age composition of the returning run. This will provide a second check on previous forecasts which provide estimates of total catch. Differentiation of the stocks according to river system may also be possible on the basis of scale characteristics. 3) Information will be radioed daily to the King Salmon management office to aid in the management of the returns.

Supported by U.S. Dept. of Interior - Bu. Comm. Fish. Alaska State Government

5.0023, Bristol Bay Offshore Test Fishing Program
K. R. Middleton, State Dept. of Fish & Game, Juneau, Alaska

The objectives of this program is to annually monitor the Bristol Bay adult sockeye run as it passes north of Port Moller enroute to Bristol Bay in an attempt to estimate the magnitude, age composition and pattern of entry.

Test fishing will be conducted nightly with 5-3/8' gill net as utilized by the Bristol Bay Inschore commercial fishery. Approximately five test drifts will be made nightly at different stations along a 50-mile northerly transect originating at Port Moller. The data from the five drifts will be combined to obtain a nightly index of fishing success. Fish captured will be sampled for age composition.

Test fishing on the 1967 sockeye run will be completed during the period July 1-10, 1967. During the period July 10 to June 30, 1968, reports will be completed on the 1967 season. Sampling plans will be revised if necessary for the 1968 season. Test fishing on the 1968 run will be conducted during the period June 30-30, 1968.

In addition to the five-man crew for the charter fishing vessel, two biological aides will be aboard the fishing vessel during the test fishing period.

Supported by U.S. Dept. of Interior - Bu. Comm. Fish. Alaska State Government

5.0024, Arctic-Yukon-Kuskokwim Area Anadromous Fish Investigations
R. I. Regnart, State Dept. of Fish & Game, Juneau, Alaska

Salmon research studies in this area prior to 1961 are almost non-existent. Recent studies by the Alaska Department of Fish and Game have been encouraging but accurate estimations of the sizes of runs and escapements have yet to be determined. Also much basic life history information is still lacking for some species of salmon.
The long range objectives of this project are to determine the population sizes and escapements, destination and timing of different segments or races and life histories of Arctic-Yukon-Kuskokwim drainages. Aerial surveys and boat or ground surveys will be made of ‘key’ rivers in Southeastern Alaska, e.g. Kuskokwim, Yukon and Kotzebue Sound drainages. Recently there have been numerous requests on the part of area residents and interested processors relative to the feasibility of establishing commercial fisheries for sheefish. The habits, life histories and productivity of sheefish are virtually unknown. The objectives of this phase of the project are to acquire the necessary population dynamics, life history and other pertinent information needed to determine the feasibility of developing a sheefish commercial fishery. Procedures are to include the following: (1) research of existing literature and interview of fishermen, buyers, pilots, etc., (2) operate various types of fishing gear on a year-round basis, (3) tag and release sheefish in selected areas and offer rewards for tag recoveries. (4) conduct surveys of subsistence fisheries by distribution of catch calendars and actual counts and, (5) sample test net and subsistence-commercial catches for age, size, sex and fecundity information.

Subsistence fishery - Subsistence utilization of salmon and sheefish will be documented by personal interviews, direct counts, and catch questionnaires from August through September.


5.0025, COPPER RIVER SOCKEYE SALMON INVESTIGATIONS

R.S. ROYS, State Dept. of Fish & Game, Juneau, Alaska

A. OBJECTIVES: 1) To determine the qualitative and quantitative Copper River sockeye salmon escapement immediately following exploitation by the commercial gill net fishery and on the upstream migration.


C. PROCEDURES: 1) Delta Investigations a. Test fishing will be employed as an immediate index of escapement. Four chartered gill net boats utilizing standard gear will fish during closed fishing periods. Relative abundance per time of set, timing of runs, and migration patterns will be obtained. b. Scales for age determination and other biological statistics will be obtained by sampling the canneries and from the test fishing operations. 2) UPPER RIVER INVESTIGATIONS - a. Tagging will be employed to separate the different stocks of fish. Fishwheels at Woods Canyon will be used in a cooperative effort with the River Basins Branch, BCT. Tagged and untagged fish will be identified by tagging in the Sumner Strait and North Clarence Strait approaches and subsequent recovery of the marked fish in (1) the commercial fishery, (2) at weirs on the spawning streams and (3) by teams of men conducting foot surveys on the spawning grounds of sockeye streams without weir. b. Biological Statistics Collection: The collection of biological statistics in the fishery, at the weirs and in the estuarial areas at the mouths of streams without weirs will greatly enhance the knowledge required to properly manage the sockeye salmon resource of Southeast Alaska. This will be accomplished through collection of scale and length data to assess the age classes in the fishery and in the total run; the rate of exploitation by the fishery and the timing of the various races comprising the run.


5.0027, SOCKEYE SALMON MIGRATORY BEHAVIOR AND BIOLOGICAL STATISTICS COLLECTION, SOUTHEASTERN ALASKA

UNKNOW, State Dept. of Fish & Game, Juneau, Alaska

Objectives: A. Delineation of Migration Routes: Determination of the migration routes utilized by sockeye salmon approaching their home streams has been indeterminate in Southeast Alaska for a number of years. One portion of the run will be identified by tagging in the Sumner Strait and North Clarence Strait approaches and subsequent recovery of the marked fish in (1) the commercial fishery, (2) at weirs on the spawning streams and (3) by teams of men conducting foot surveys on the spawning grounds of sockeye streams without weir. B. Biological Statistics Collection: The collection of biological statistics in the fishery, at the weirs and in the estuarial areas at the mouths of streams without weirs will greatly enhance the knowledge required to properly manage the sockeye salmon resource of Southeast Alaska. This will be accomplished through the collection of scale and length data to assess the age classes in the fishery and in the total run; the rate of exploitation by the fishery and the timing of the various races comprising the run.


5.0028, OFFSHORE SALMON ABUNDANCE INDEX

UNKNOW, State Dept. of Fish & Game, Juneau, Alaska

Objectives: A. To establish an index of abundance of salmon (primarily pink salmon) in the immediate offshore waters of Southeastern Alaska prior to the appearance of the runs in the commercial fisheries. B. Stock identification and timing as the runs approach the coast, the fishery and their home streams.

Procedures: Gill nets and long line gear will be fished on a predetermined schedule. All viable salmon will be tagged and released after a scale and length measurement are taken.

Tag recovery will be effected in the commercial fishery, at weirs on streams and by foot survey crews on the salmon streams. The area to be fished is a 50 mile band off the coast of Southeastern Alaska from Yakutat to Dixon Entrance from approximately June 1 to July 31.

The program is designed to operate a minimum of five years. All data collected will be processed by electronic data processor methods and will be available for correlation with previous and current programs of the United States and Canada in this area of work.

Personnel will involve two temporary biological aides on each vessel and a permanent biologist in charge of the program.


5.0029, FISH POPULATIONS IN THE CHENA RIVER

F. VANHULLE, State Dept. of Fish & Game, Juneau, Alaska

93
5. LIVING SYSTEMS (NON-HUMAN)

Objectives: (1) Become familiar with the Chena River watershed and test various methods of sampling the fish populations. (2) Establish techniques for determining the following populations and dynamics of the fish in the Chena River: a) Species composition. b) Age and sex composition of grayling, pike and whitefish. c) Trends and extent of natural movements. d) Spawning locations. (3) Determine the present utilization of the recreational fishery on the Chena River.

Procedures: (1) Initial investigations will be directed toward becoming familiarized with the Chena River watershed. The river will be visited, all the techniques described above, and a number of basic reference points for the different aspects of the study program will be selected to obtain a number of basic reference points for the different aspects of the study program. Fish will be collected from the Chena River and by those means which are deemed most efficient at the time. (2) In conjunction with Objective (2), the following procedures will be followed: a) Location and time of capture will be noted for all fish taken. Fish released will be marked; in addition, all grayling and pike over 6 inches will be tagged. b) Scale samples, length and weights will be taken of all tagged fish. In addition, random samples of grayling, pike and whitefish will be sacrificed for sex identification. c) Periodic surveys and sampling will be conducted throughout the year to determine, as far as possible, the movements of the fish within the river system. Investigations will be conducted to determine the areas that their utilization by the various fish populations. d) An extensive stream survey will be initiated. Basic chemical and physical data will be collected and special emphasis placed on the location of active and potential spawning areas. e) Periodic fishermen interviews will be conducted on the Chena River. Aerial and ground counts of the number and location of fishermen will be made to determine present utilization of the sport fishery.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish. Alaska State Government

5.0030. BOTTOMFISH EXPLORATIONS
B.F. JONES, U.S. Dept. of Interior, Exptl. Fish & Gear Res. Base, Juneau, Alaska 99801

Bottomfish exploration is primarily concerned with benthic vertebrate populations. The objectives are to define, on a seasonal basis, the quantitative and qualitative distributions of aquatic benthic vertebrate resources having a potential for commercial utilization, and to provide an appraisal of those resources. In its full extent, bottomfish exploration is a cataloging of benthic vertebrate fauna in time and space. Area stressed is the Northeastern Pacific primarily the Gulf of Alaska and Bering Sea. The explorations are carried out by the Juneau-based vessel John R. Manning and chartered vessels.

Sampling has been conducted along the Continental Shelf with a standard commercial otter trawl. New trawling grounds and new commercial concentrations of bottomfish have been discovered. Sampling will be continued on the continental slope and a reevaluation of the shelf with different types of fishing gear including pelagic trawls will be done. Biological observations will be made.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0031. TECHNICAL ASSISTANCE TO INDUSTRY
B.F. JONES, U.S. Dept. of Interior, Exptl. Fish & Gear Res. Base, Juneau, Alaska 99801

This program is structured to provide the services and skills of a specialist (or specialists) in the field of commercial fishing to serve as a consultant, advisor, and instructor to fishermen and processors. The staff also provides similar services to other disciplines of the Bureau of Commercial Fisheries in this region - including biological, oceanographic and technological research. The project leader acts as liaison between the Bureau and segments of the commercial fishing industry as the need arises. In specific situations, and under proper control, assistance may be provided in the form of loaned fishing gear and equipment to permit individuals or processors to pursue new methods or developments in new fisheries or established fisheries.

Objectives: To furnish the fishing community with current information relative to new developments in their industry and provide assistance in the development and/or introduction of new fisheries to specific areas of Alaska.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0032. FISH POPULATION OFF THE ISLAND OF TUTUILLA, AMERICAN SAMOA
J.R. HOLLOWAY, Amer. Somoa Dept. of Agric., Pago Pago - Tu-

The project leader acts as liaison between the Bureau and segments of the commercial fishing industry as the need arises. In specific situations, and under proper control, assistance may be provided in the form of loaned fishing gear and equipment to permit individuals or processors to pursue new methods or developments in new fisheries or established fisheries.

Objectives: Locate banks and fish concentrations as well as determine availability and abundance of bait species. Collect specimens for taxonomic study and identification of potentially commercially valuable species.

Procedures: Scouting for fish concentrations and banks areas using small skiff and Furuno gear. Collect specimens by handlines and trolling. Survey accessible in-shore areas for bait species.

Location of Work: Around Island of Tutuilla, American Samoa.

Part 2 of 4.


5.0033. FISH POPULATIONS OF AMERICAN SAMOA
J.R. HOLLOWAY, Amer. Somoa Dept. of Agric., Pago Pago - Tu-

Objective 1, 1967 to June 30, 1967. Phase to be extended for at least 1 year for accurate records of seasonal and areal variation.

Work Schedule: Initial period - from approximately Febru-
ary 1, 1967 to June 30, 1967. Phase to be extended for at least 1 year for accurate records of seasonal and areal variation in abundance.

Part 3 of 4.


5.0034. TAXONOMIC STUDIES
E.S. HOBSON, U.S. Dept. of Interior, Tiburon Marine Lab., Belvedere - Tiburon, California 94920

Taxonomic studies (a continuous program considering material incidently becoming available in the course of the other projects). a. Revision of the family Scaridae in the eastern Pacific. b. Revision of the family Labridae in the eastern Pacific.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0035. LIFE HISTORY OF CLUPEA HARENGUS PAL-

G.B. TALBOT, U.S. Dept. of Interior, Tiburon Marine Lab., Belvedere - Tiburon, California 94920

Experiments will be undertaken to artificially fertilize the eggs of Pacific herring (Clupea harengus pallasi) and to raise them in captivity. When competence is developed in this procedure, experiments with these fish will be carried out to determine the effects of varying temperatures and salinities on their meristic characters.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0036. TAGGING PROGRAM WITH WOODS HOLE AND INTERNATIONAL GAME FISH ASSOCIATION FOR MAR-
LIN, SAILFISH AND OTHER GAME SPECIES MIGRATION STUDIES
G.B. TALBOT, U.S. Dept. of Interior, Tiburon Marine Lab., Belvedere - Tiburon, California 94920

Part 2 of 4.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.
Objective - To determine the population distribution and amount of inter-migration between oceanic areas for many of the marine game species.

Procedure - Develop a cooperative sportsman tagging program by encouraging participation by active sportsmen.Tagging and record deepening equipment shall be furnished, and records of all Pacific area game fish tagging shall be maintained by the Tiburon Marine Laboratory. Analyses will be made of tagging recoveries for species currently under study (marlin and sailfish). Program expected to be expanded to include sharks and other pelagic and demersal marine game species common to the eastern Pacific.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0037, SPECIES LIFE HISTORY AND DISTRIBUTION E.H. AHLSTROM, U.S. Dept. of Interior, Fishery Oceanography Ctr., La Jolla, California

This program deals with the identification, geographic distribution, and estimates of abundance of the younger stages of fishes—eggs, larvae, metamorphosing specimens, and juveniles—which are collected in quantitative plankton hauls. The area of principal concern is the California Current region off California and Baja California, but pelagic fish larvae are being studied from all parts of the eastern Pacific, including the eastern tropical Pacific (EASTROPAC cruises). We are concerned with descriptions of the younger stages of pelagic fishes and their zoogeographic distributions as related to water masses. We have developed the use of systematic surveys of ichthyoplankton as a fundamental means of assessing our pelagic fish resources. The ultimate objective is the description of the developmental stages of all common pelagic fishes in the eastern North Pacific.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0038, SCHOOLING BEHAVIOR J.R. HUNTER, U.S. Dept. of Interior, Fishery Oceanography Ctr., La Jolla, California

The purpose of this project is to obtain information on the internal structure of adult fish schools (anchovy, sardine, mackerel, etc.) important to the commercial fisheries of California. Research undertaken concerns study, under varying environmental and physiological conditions, of the manner in which fish react to one another, thereby altering the structure of the school. This work is based on experiments performed in large holding tanks and various experimental containers in the laboratory ashore.

In order to test whether these experimental models of fish schooling and behavior are applicable to fish under natural conditions, it is planned to observe the behavior of wild schools of the same species of fish at sea by aerial and underwater photographic techniques. The project will include investigations of the manner in which the adult schooling behavior patterns are developed during the larval stages of the same species and motor system development in larvae.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0039, FISH POPULATION PARAMETERS J.S. MACGREGOR, U.S. Dept. of Interior, Fishery Oceanography Ctr., La Jolla, California

A knowledge of the life histories of the various fish populations is necessary in order to understand the population dynamics of marine fish stocks. It is especially important to discover which factors are critical in determining year-class size. The purpose of this project is to describe the spawning cycle of the northern anchovy, of various rockfish, and of saury and to compare and contrast fish spawning patterns in time and space. These data in conjunction with estimates of stock abundance from egg and larval surveys will be used to inventory species biomass in the California Current.

Related work in this project includes a continuing analysis of the age and length composition of the anchovy population in cooperation with the California Department of Fish and Game, and the monitoring of the Ensenada wetfish landings to supplement information gathered by the State from the commercial landings of this species.

5.0040, FEEDING BEHAVIOR C.P. O'CONNELL, U.S. Dept. of Interior, Fishery Oceanography Ctr., La Jolla, California

The ingestion of food by an individual fish is the climax of a complicated and plastic behavior pattern. This project is planned to describe this behavior pattern, particularly for the northern anchovy and Pacific sardine, and to determine the effects of environmental and physiological variables on the nature of the feeding pattern.

Work in progress includes observation and experimentation upon captive schools of adults in the laboratory which will later be extended to larval and juvenile forms, and a study of the sensory mechanisms upon which the feeding behavior pattern is based in these species.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0041, REARING MARINE FISH G.O. SCHUMANN, U.S. Dept. of Interior, Fishery Oceanography Ctr., La Jolla, California

This project has as its primary goal the development of techniques to hold larval fish throughout their development in a healthy, normal condition under controlled conditions of temperature, light, food, etc. in experimental containers. Because of the excellent experimental aquarium facilities now available in the Fishery-Oceanography Center, more than 30 species of marine fish, including the sardine, anchovy, and Pacific mackerel, have been successfully reared by empirical methods, from the egg through the juvenile stage. When these techniques are standardized and quantified, it is planned to measure the effect of environmental variables on feeding, growth, survival and morphological development of larvae in the laboratory.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0042, SUBPOPULATIONS A.M. VROOMAN, U.S. Dept. of Interior, Fishery Oceanography Ctr., La Jolla, California

The purpose of this project is to study the subpopulation structure of commercially important fish species, i.e., to determine if a species is made up of a single homogeneous population or of several, genetically distinct subpopulations, each of which may have different characteristics of growth, mortality, longevity, fecundity, migration, and availability. Initial attention was centered on the Pacific sardine and three subpopulations have been recognized in this species by the frequency of occurrence of the C-positive antigen in the red blood cell.

Similar methods of analyzing genotypes are now being applied to the northern anchovy, Pacific hake, and Pacific mackerel. The study of each species may be divided into three parts: 1) the development of methods to identify subpopulations such as immunological techniques, 2) delimiting the geographical range of each subpopulation, and 3) supply data to determine the contribution of each subpopulation to the commercial catch.

When techniques have been worked out which will permit satisfactory shipment to laboratories in Japan and Oceania, a study will also be undertaken on the albacore which has been tracked across the Pacific.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0043, DISTRIBUTION OF THE MID-WATER FISHES OF THE GULF OF CALIFORNIA B.H. ROBISON, Stanford University, Graduate School, Palo Alto

The study is being conducted on collections made in the Gulf of California by the research vessel TE VEGA during its cruise number 16, September 15, 1967 to December 1, 1967.

Sampling gear consisted of a Tuckey net with an opening-closing device, a depth recorder and an attached meter net. Collections were made from Latitude 29 degrees 59' N. to Latitude 22 degrees 42' N. in the Gulf. Seventy collection stations resulting in the capture of over 10,000 fish were made.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
5. LIVING SYSTEMS (NON-HUMAN)

Hydrographic stations were made adjacent to the trawling sites where environmental parameters such as temperature, salinity, oxygen concentration, and water mass structure were measured.

At the Hopkins Marine Station, the fishes are to be identified and the collection data coordinated with environmental factors to provide an outline of distribution. Vertical distribution relative to light and the deep scattering layer is also being studied.

SUPPORTED BY U.S. National Science Foundation

5.0044, FOOD HABITS STUDY OF ORGANISMS OF THE CALIFORNIA CURRENT SYSTEM

P.M. ROEDEL, State Dept. of Fish & Game, Terminal Island, California

Objectives: To determine the food habits and requirements of as many of the significant fishes and cephalopods inhabiting the California Current System adjacent to California as can be accomplished.

Procedures: Stomachs of such economically important and potentially important organisms as hake, bonito, rockfish, albacre, jack mackerel, salmon, yellowtail, barracuda, squid, etc., will be systematically collected throughout their range and the contained food items will be identified to species, their number determined per stomach, and their original sizes determined from such component parts as can be found (fish otoliths, cephalopod beaks, crustacean legs, etc.). Sampling will take advantage of departmental investigation, both routine and exploratory, programs of other agencies and institutions, and commercial and sport fishing at ports and places of landing.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish. California State Government

5.0045, SPORT FISH BEHAVIORAL STUDIES

C.H. TURNER, State Dept. of Fish & Game, Terminal Island, California

Objective: To further our knowledge of sport fish behavior in rocky subtidal areas with particular emphasis being placed on sculpin (Scorpaena guttata), kelp, sand, and spotted sand bass (Paralabrax clathratus, P. nebulifer, and P. maculato-fasciatus, and sheephead (Pimelometopon pulchrum).

Procedures: At every opportunity, diving observations will be made, photographs taken and analyzed, and fish movements studied. In addition, an average of 2 days per month is scheduled for behavioral studies in promising areas where feeding, breeding, defensive schooling, and other aspects of social life can be observed and documented. Study emphasis is being placed on the five species listed because they are known to be important "reef-dependent" fishes (Turner, Ebert, and Given, Artificial Reef Ecology, unpublished ms; Carlisle, Turner, and Ebert, Calif. Fish and Game Fish Bull. 124; and Turner, Ebert, and Given, Calif. Fish and Game Fish Bull. 140, in press) which are actively sought by sportsmen, and because additional life history and behavior information - needed to permit the more effective management.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish. California State Government

5.0046, A STUDY OF THE RATE AND PATTERN OF SHAD MIGRATION IN THE CONNECTICUT RIVER UTILIZING SONIC TRACKING APPARATUS

W.C. LEGGETT, Essex Marine Laboratory Inc. - Essex, Connecticut

Objectives: To investigate rate of movement of American shad from the mouth of the Connecticut River upstream to include movement through the area of heated effluent outfall of an atomic power plant before operation and through non-channeled and major draining area of the river.

Procedures: Shad, taken with monofilament Gill nets and/or beach seine will be tagged with sonic tags and tracked as individuals and/or loose schools through the above areas of the river. Tagged shad will be held in live cars to check tag operation and delayed handling mortality. Hand held and boat mounted hydrophone receivers will be utilized to track shad as long as possible. Daily trips will be made to locate tagged fish. Data will be processed automatically and compared with other available tagging data.


5.0047, SHARK RESEARCH


Under this work unit, the Shark Research Panel, the International Shark Tagging Program, and other coordinating activities in relation to shark studies are supported. These activities include a determination of the seasonal and geographic distribution of all species of sharks on a world-wide basis and guidance for a scientific campaign of research and education regarding shark and shark repellents and a cooperative effort toward these goals with similar efforts in other countries.

This is part of the Noxious Marine Animals Program and is concerned specifically with the biology of sharks. These primitive fishes have adapted with great success to life in the sea and have evolved a wide variety of physiological and behavioral responses to marine environmental factors. These facts make the sharks a particularly difficult animal to control. They represent a physical, as well as a psychological, hazard to personnel operating in the water and to survivors of plane or ship disasters. The search for an effective control or repellent must be based on accurate information regarding their diverse habits and their distribution.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0048, STUDIES ON ANACANTHINE FISHES

D.M. COHEN, Smithsonian Institution, Washington, District of Columbia 20560

Much work remains to be done on the taxonomy of anacanthine (cod-like) fishes. Some projects under way are: (1) A monograph on Anacanthini (exclusive of Macrouridae) of the western North Atlantic. (2) A taxonomic revision of the family Morididae (mostly fishes of the continental shelves and slopes).

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0049, SYSTEMATICS AND BIOLOGY OF EPIPELAGIC AND BATHYPELAGIC FISHES

R.H. GIBBS, Smithsonian Institution, Washington, District of Columbia 20560

Studies on the systematics and biology of epipelagic and bathypelagic fishes will comprise the following units: systematics of Scombroidei, copepod parasites as indicators of scombroid phylogeny, zoogeography of the midwater fishes of the western Indian Ocean, ecological analysis of epipelagic fishes in the western North Atlantic, ecological analysis of the midwater fishes of a single water column in the western North Atlantic, systematics and biology of Atlantic flyingfishes, systematics of the Lancetfishes, and anatomy and histology of gonads as indicators of relationships in deep sea fishes.

SUPPORTED BY Smithsonian Institution

5.0050, SYSTEMATIC REVISION PLATYCEPHALIDAE (PICES)

L.W. KNAPP, Smithsonian Institution, Washington, District of Columbia 20560

The systematics of the Indo-Pacific fishes of the family Platyrhinae are poorly understood. This benthic group includes approximately 150 species, many of which represent some importance as food. Several species have been reported to be protandrous hermaphrodites but others appear to be gonochoristic.

Results of several recent regional studies indicate the need for a comprehensive family revision to untangle existing problems in nomenclature and phylogeny. A moderate amount of material for such a revision is available. These activities are supported.

SUPPORTED BY U.S. Dept. of the Interior - Bu. Fish.

96
As the majority of the types and a considerable amount of additional material must be studied in several European museums, a two-month trip for this purpose is planned for fiscal year 1971. Other important holdings of types and additional material are located in several Australian museums and a trip to these institutions is planned during fiscal year 1972.

SUPPORTED BY Smithsonian Institution

5.0051. SYSTEMATICS AND ZOOGEOGRAPHY OF THE BLOOMFIELD FISHES
V.G. SPRINGER, Smithsonian Institution, Washington, District of Columbia 20560

The ultimate purposes of this project are: the completion of systematic revisions of all the members of the superfamilly Blenniidae with emphasis on variation, distribution, and relationships; the determination of the nature of the extra-superfamilial relationships; and the application of the derived results towards an understanding of the percoid fishes in general. Present studies center on the osteology of the Blenniidae and a revision of the genus Atrosalarias.

SUPPORTED BY Smithsonian Institution

5.0052. STUDIES OF FISH FAMILIES ARIDAE AND ASPRENIDAE
W.R. TAYLOR, Smithsonian Institution, Washington, District of Columbia 20560

To study the systematics, relationships, and zoogeography of the tropical marine catfish family Ariidae and the South American marine species of Aspredinidae.

SUPPORTED BY Smithsonian Institution

5.0053. OSTEOLgy AND EVOLUTION OF ISOSPONDYLOUS AND OSTARIOPHYsAN FISHES
S.H. WEITZMAN, Smithsonian Institution, Washington, District of Columbia 20560

This project consists of several smaller research efforts all contributing to the understanding of the morphology and evolution of recent, relatively primitive teleost fishes.

SUPPORTED BY Smithsonian Institution

5.0054. STUDIES ON OPHIDIOID FISHES
D.M. COHEN, U.S. Dept. of Interior, Systematics Laboratory, Washington, District of Columbia 20560

There are perhaps 800 species of this group. Problems are: (1) Definition and relationships of Ophidiacea. (2) Families of Ophidiidae. (3) Anatomical studies which will allow definition of genera. (4) Description of species. (5) Studies on depth and areal distribution.

This group is an important part of the abyssal benthic fauna, and studies on general biology of abyssal fishes will be made as appropriate.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0055. TAXONOMIC REVIsION OF BATHYLAGIDAE
D.M. COHEN, U.S. Dept. of Interior, Systematics Laboratory, Washington, District of Columbia 20560

Taxonomic revision of the oceanic fish family Bathylagidae. These are small midwater fishes found in all major temperate and tropical oceans. About 20 species have been described. Keys, illustrations, description and distribution charts will be prepared.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0056. SYSTEMATIC STUDIES ON THE FAMILY SCOMB-BRIDAE
B.B. COLLETTE, U.S. Dept. of Interior, Systematics Laboratory, Washington, District of Columbia 20560

The family Scombridae is comprised of some 40-45 species of medium to large-sized fishes found in all the oceans. Many are of great commercial importance. The classification, both at the generic level and the species level, is confused in spite of the large amount of time and money that has been spent trying to solve the problems in the group. The search for characters useful in defining taxa within the family has led to the use of internal characters such as the osteology, circulatory system, and position of the viscera. This project is a long-term study that will redefine all the genera and species and provide keys for identification, figures, distribution maps, and summaries of the biology. A preliminary review of the family, an illustrated key to the species of the Indian Ocean, and anatomical and systematic revision of the great tunas, genus Thunnus have been published. Studies of Euthynnus, Kat-suwonus, and Alothunnus are under way. Skeletal material of all forms is being accumulated.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0057. DESCRIPTIONS OF NEW SHARKS
S. SPRINGER, U.S. Dept. of Interior, Systematics Laboratory, Washington, District of Columbia 20560

Collections of sharks made by research vessels over the past few years are being studied. These appear to contain at least 10 new species which will be described for publication. Continuing.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0058. A REVISION OF THE CAT SHARKS, SCYLIORHINIDAE
S. SPRINGER, U.S. Dept. of Interior, Systematics Laboratory, Washington, District of Columbia 20560

The work to redefine the family Scyliorhinidae, its genera, and the 50 to 60 included species. The last general revision (1908) and a partial revision (1948) were brief and were based on examinations of small numbers of specimens with attention to only a few morphological details.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0059. SYSTEMATIC STUDIES OF FISHES

Objectives: To improve upon our knowledge of the taxonomy of the orders, families, genera, and species of marine fishes, principally those of the Atlantic Ocean. To facilitate the ready identification of these fishes, especially those of commercial or potentially commercial importance. To determine data on the morphology and ontogeny of these fishes that will assist in early development and in life history studies. In the study of selected fish groups, to develop principles of morphology and ontogeny that will relate to the resolution of knowledge of other similar but unstudied groups.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0060. TAXONOMY AND BIOLOGY OF CLupeOID FISHES

To discriminate between the various species of Clupeidae and Engraulidae, especially those of tropical and subtropical marine waters, with emphasis on the Atlantic Ocean. To do this by study of their comparative morphology, and to a lesser degree with biochemical, behavioral, and certain life history studies. To prepare a field guide of these species that will facilitate their identification by ichthyologists, fishery biologists, and fishermen.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0061. SYSTEMATICs OF CARANGID FISHES

To obtain additional specimens of carangid fishes and appropriate field data to allow resolution of the taxonomic problems concerned. To prepare scientific accounts in the field guides that will define the various species and growth stages.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
5. LIVING SYSTEMS (NON-HUMAN)

5.0062, BEHAVIOR OF LARVAL FISHES

Objectives: 1. To rear fish larvae for confirmation of identification. 2. To study the growth, feeding habits, and tolerance of the larvae to temperature, salinity, oxygen, light and other environmental variables. 3. To study the general ethology of larvae and, in particular, their behavior in relation to thermal stratification and other simulated environmental barriers. 4. To study the feasibility of rearing fishes from the eggs on a commercial basis.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0063, DISTRIBUTION AND ECOLOGY OF ATLANTIC TUNAS

Objectives: To determine the effect of environmental parameters on the geographical and temporal distribution of Atlantic tunas in sufficient detail to be able to predict such distributions from knowledge of the environment so as to increase the efficiency of fishing effort.

Fishery-oceanography surveys of the tropical Atlantic have been and will continue to be carried out by the research vessels of this laboratory. Such surveys will yield data that will allow comparison in space and in time of the ecology and life history, as well as the population dynamics of the tunas in the areas surveyed.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0064, MIGRATION OF ATLANTIC TUNAS

We have made explorations into the possibilities of initiating a tagging program in cooperation with ORSTOM, and other West African activities. Operations probably will start in the West African tuna fishery. A staff member has investigated the possibilities of such an arrangement during a trip to African tuna ports. Present thinking lies along the lines that the BCF (TABL) coordinate and finance most of such a cooperative program, and that the other participating agencies provide the majority of the field personnel.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0065, POPULATION DYNAMICS OF ATLANTIC TUNAS

The most essential need is for a reliable estimate of the magnitude of the fishery, i.e., the total catch and landings. Second in importance is to obtain reliable figures on the catch-per-unit effort involved for at least representative portions of the fishing fleets, in order to estimate relative abundance and changes in abundance of the fishable stocks. Third is the biological sampling of the fishery—collection of data on length, weight, state of gonad development, stomach contents, etc., from the landed fish. Some of this information also is essential for other projects within this program.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0066, ICHTHYOFAUNA OF THE FLORIDA CURRENT
C.R. ROBINS, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124

The studies are on the fish faunas of the Florida current and emphasize seasonal and depth distribution and ecological parameters otherwise influencing numbers and abundance. Sampling of the sea bottom has enabled many distribution abundance questions to be answered. The overall aim is to identify the populations of fishes at all depths and latitudes in the Florida Current area, and to determine what ecological factors are responsible for differences in numbers and distribution.

SUPPORTED BY U.S. National Science Foundation

5.0067, SHORE FISHES OF ANNONOB AND FERNANDO POO
C.R. ROBINS, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124

Objective: To study comprehensively the collections of shore fishes collected at 18 stations at Fernando Poo and Annobon and to report on them in a series of short papers plus a comprehensive terminal report. The study will emphasize description and characterization and will not attempt (as part of this effort) to fill the more long-term need for detailed comparisons of transatlantic populations, etc.

Drawings will be made for the new species or for those previously unfigured or poorly illustrated. In some instances photographs will suffice, but in most, particularly the smaller forms, drawings are desirable.

The collections are now in alcohol but they must be sorted and processed. Most material ultimately will be deposited in either the National Museum, the Academy of Natural Science, or in both.

SUPPORTED BY U.S. National Science Foundation

5.0068, OCEANIC FISHES OF THE TROPICAL ATLANTIC
C.R. ROBINS, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124

This investigation is for the continuation of the research initiated under GB-1350 and GB-4389 for long-range exploration of the oceanic fish fauna of the tropical Atlantic.

The ichthyological program of the Institute of Marine Science has aimed since its inception at the delineation of the fish fauna of the Tropical Atlantic and at understanding the various community structures. Two aspects have been considered at the same time. One, to determine what species occur in various regions, has led to and continues to involve systematic studies of the fishes. The second aspect is to pick certain areas and to work them thoroughly and repeatedly so that information can be gained on the biology and ecology of oceanic fishes and their varied environmental roles.

The primary objectives of the present project are: 1) to complete the initial survey from 10 to 2000 fathoms along the Central American Coast and around Yucatan and into the western Straits of Florida; 2) to survey the hump of Brazil and the Fernando Noroña Archipelago, 3) to work along the coast of Colombia eastward from Cartagena and as time permits along the Antillean Arc, and 4) to continue the detailed studies of the fishes of the Straits of Florida with attention to seasonal, geographic, and bathymetric aspects and to the stages of the life history of the fishes involved.

SUPPORTED BY U.S. National Science Foundation

5.0069, STUDIES ON THE SPORT FISHERY FOR BILLFISHES AND TUNAS IN THE WESTERN ATLANTIC AND SOUTHEASTERN PACIFIC OCEAN
D.P. DESYLVIA, U.S. Dept. of Interior, Bureau of Sport Fish. & Wildlife, Panama City, Florida 32401 (14-16-0008-775)

Objective: To carry out a survey of the sport fishery for billfishes and tunas in the western hemisphere.

Information will be obtained on: (a) what species of sailfish, marlin, swordfish, and tunas are caught by anglers in the western hemisphere; (b) their seasonal distribution; (c) size composition of catch; (d) an estimate of the number of anglers engaged in the sport fishery; (e) the economic value of the fishery; and (f) the effect, if any, on the sportfish catch by commercial fishermen as reflected in either decrease in size of fish landed by sportmen or decrease in catch per unit of effort.

Questionnaires will be mailed to anglers, charterboat captains, angling clubs, marinas, and bait and tackle dealers who might be able to supply the above information. Personal logs and records will be borrowed or copied, and the data reduced for IBM processing.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.
5.0070. ENVIRONMENTAL EFFECTS ON ISTIOPHORID FISH DISTRIBUTION

N.G. VICK, U.S. Dept. of Interior, Bureau of Sport Fish. & Wife, Panama City, Florida 32401

The objective of this study is to establish and test relationships between the seasonal distribution and appearance of istiophorid game fishes in the northeastern Gulf of Mexico and seasonally hydrographic features producing quasi-stationary eddies. Twenty-four cruises are planned to test previously determined relationships. The project will determine the dispersal and abundance of these species. We must be able to identify the fish larvae of the area if the life history has been determined on only a few species. The project will contribute heavily to the broad estuarine studies planned for future years.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0071. INVENTORY OF LARVAL FISH

L.G. MCBAY, State Game & Fish Commission, Atlanta, Georgia

Objectives: To identify the types of marine or brackishwater larval fish available for flooding into the public fishing area and shrimp. Technical data secured to aid in management recommendations for these particular species will also be tested. Certain biological materials, i.e., eggs, larvae, serum samples, and juveniles of these pelagic species will be collected for distribution to other laboratories.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0072. FISHES TAKEN INCIDENTAL TO SHRIMP TRAWLING

W.W. ANDERSON, U.S. Dept. of Interior, Biological Laboratory, Brunswick, Georgia

During the course of studies conducted on the white shrimp, Peneaus setiferus, along the south Atlantic coast of the U.S. during the period of 1931 to 1935, records were made on the numbers of the various species of fish taken incidental to trawling for shrimp. Objectives are to make available in processed form, both tabular and graphic, the information on relative abundance of families and species of fishes, seasonal abundance of the species by regions, and related information, as revealed from shrimp trawling operations.

These records contain valuable information on relative abundance of the various families and species of fish, seasonal abundance of species by regions, and related information, as revealed from shrimp trawling operations. Information from this study will contribute much to the broader estuarine studies planned for future years.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0073. YOUNG FISHES OF A TIDAL ZONE

J.W. GERRINGER, U.S. Dept. of Interior, Biological Laboratory, Brunswick, Georgia

During a 7-year period (1953-1960) a systematic collection of larval and juvenile fishes was obtained from three types of habitat in coastal Georgia: an outer beach on St. Simons Island—a favorite habitat for the young of many species; the marshes which lie between the barrier islands and the mainland—a rich habitat serving as nursery grounds for the young of many species of fish and shrimp; and about tidewater limits in the fresh water Altamaha River—the young of some marine species are frequently taken under such conditions.

Objectives are to determine the species and size groups of fish occurring in the several habitats, their seasonal distribution, apparent hydrographic preferences and related facts. Many of the series will be incorporated into life history studies on individual species—some of which are spawned in the open ocean but utilize coastal and estuarine waters during part of their early development. This study will contribute heavily to the broad estuarine studies planned for future years.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0074. IDENTIFICATION AND DESCRIPTION OF FISH LARVAE

J.W. GERRINGER, U.S. Dept. of Interior, Biological Laboratory, Brunswick, Georgia

Project objectives are to identify to the most finite taxon possible (be it species, genus, or family) the fish larvae from collections of the M/V Theodore N. Gill made between February 1953 and December 1954 over the area from Cape Hatteras to the Bahamas and southern Florida, and from the beaches to beyond the Gulf Stream; seine collections; and other sources. Whenever possible, ontogenetic series which may be positively identified with larger fish to species are assembled and may be incorporated into early life history and other studies.

Knowledge of the fish occurring off the south Atlantic coast of the U.S. is limited; abundance of the various species is poorly known; and the life history has been determined on only a few species. We must be able to identify the fish larvae of the area if the early life histories are to be determined. With this accomplished, we can then determine the dispersal and abundance of many of the species.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0075. INTRODUCTION OF MARINE GAME FISHES FROM AREAS IN THE PACIFIC


Objectives: 1. To conduct follow-up observations and to document information relating to the probable establishment of exotic marine fish species introduced during previous segments and to ascertain if these species are established well enough to permit sport fishing for them.

Procedures: 1. For purposes of gathering data on the status of the exotic marine fish introductions released to date: (1) SCUBA divers will be conducted at sites known to harbor the exotic species or in areas where they have been reported as having been sighted, and (2) commercial and sports fishermen will be interviewed in order to gather information on possible inadvertent capture of the exotic. 2. Sampling of the exotic may be attempted by use of fish toxicants, traps, seines, spears, angling or other suitable methods. 3. The feasibility of importing additional stocks of groupers, especially matapuu (Epinephelus fuscatus) and pukokoo (E. spiniger), and the snappers, tufara (Lutjanus gibbus) and aaravi (Lethrinus sp.) should be investigated. The apparent failure of these species to establish themselves in Hawaii, thus far, is believed to be due mainly to insufficient numbers that were released originally.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0076. INVESTIGATE TUNA SUBPOPULATIONS THROUGH THE USE OF BLOOD GROUPS AND INHERITED PROTEINS


The objective of this project is to determine whether certain tuna resources are represented by a single ocean-wide population unit or are made up of smaller units, or subpopulations, of which the distribution of each is confined to smaller geographical area. Such knowledge is important in understanding the effects of the fisheries on the resources and the development of proper management techniques for these resources.

Objectives are to determine the characteristics of red blood cells, serum proteins and enzymes have been found in skipjack, yellowfin, bigeye, bluefin, and albacre tunas.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish. Hawaii State Government
5. LIVING SYSTEMS (NON-HUMAN)

A series of extensive Pacific-wide population studies of skipjack tuna has indicated (1) that skipjack tuna taken from the western Pacific (Palau, Mariana, Okinawa, and Japan coast) belong to a subpopulation (or subpopulations) which does not appear in the central Pacific (Hawaii, Line, and Society Islands) and eastern Pacific (Baja California) and (2) that skipjack tuna appearing in the central and eastern Pacific do not constitute a homogeneous population unit. Relations of skipjack that appear in the central, north and south Pacific and eastern Pacific are now being studied.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0077, INCREASE EFFICIENCY OF HAWAIIAN SKIPJACK FISHERY

Skipjack tuna fishermen in Hawaii spend a substantial amount of their time fishing for the live bait necessary for skipjack fishing. It is generally agreed among members of the fishing industry and scientists that elimination of the baitfishing operation would result in a significant increase in the yield of skipjack from Hawaiian waters.

The present project is designed to establish a pilot scale bait-catch-capturing and baitolding facility to determine if the separation of the baitfishing activity from the actual skipjack fishing operation will result in an economical gain to the fishermen. The expected increase in catch would have to be large enough to compensate for the cost of operating the baitholding facility. The establishment of a baitholding facility, then, will eliminate the need for a fishing boat to devote time and effort to a nonfishing activity. If successful, a full scale baiting facility could result in an additional 5-7 million pounds of skipjack landed per year. The present average annual catch is 10 million pounds.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0078, DEVELOP TECHNIQUES FOR CAPTURING JUVENILE TUNAS

Despite the many and intensive investigations during the past half century on the biology of the commercially valuable tunas of the Pacific Ocean, basic information of the younger stages is meager. Significant progress has been made in recent years on the identification, distribution, and abundance of tunas caught in plankton nets. Problems in identification of tuna larvae continue to exist, however, partly because large specimens needed to complete the size series necessary for identification are seldom caught by conventional sampling methods.

Juvenile tunas must be collected in large numbers in order to facilitate (1) the identification of immature specimens of each species and (2) the comparison of the immunogenetic affinities of skipjack and other tunas from different parts of the Pacific Ocean. Such information is required to delineate spawning areas and for an understanding of the relative contributions of the various subpopulations of skipjack and other tunas to the fisheries of the Pacific Ocean.

The objectives of the proposed investigation are (1) to develop techniques for capturing large numbers of juvenile skipjack and other tunas with a midwater trawl, (2) to investigate the feasibility of obtaining blood samples from juvenile skipjack and other tunas, and (3) to provide information on the bathymetric and areal distribution and abundance, ecology, morphology, and subpopulations of juvenile skipjack and other tunas. A 3-month trawling survey was completed in summer 1967 in Hawaiian waters. A total of about 1000 juvenile and prejuvenile tunas was collected in 83 six-hour hauls. Blood typing at sea was found to be feasible for 10-15 cm. tunas. Future plans are to extend trawling effort to the central Pacific, the area which, by hypothesis, supplies the 70,000 metric ton per year eastern Pacific skipjack tuna fishery.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0079, INVESTIGATE SYSTEMATICS AND ECOLOGY OF TUNA LARVAE AND JUVENILES
W.M. MATSUMOTO, U.S. Dept. of Interior, Bureau of Comm. Fisheries, Honolulu, Hawaii 96812

Close resemblance among the young of various species of tunas renders their identification difficult. Differing results obtained by various workers have yet to be resolved. Resolution of the identification problem will enable a better definition of spawning areas and seasons for the various species of tunas.

All available characters--morphometric measurements, meristic counts, sequence of pigment changes, etc.--are utilized to arrive at definitive identifications. Greater emphasis is being placed in artificial fertilization methods to obtain larvae of known identity. Of those species whose identity is more definite, particularly skipjack, delimitation and definition of spawning areas in the equatorial central Pacific are being investigated.

Other methods of identifying young tunas are being investigated. Preliminary work has been initiated on the study of adult eye lens protein of various tunas using the starch gel electrophoresis methods to determine if species separation is possible. This study is being pursued further under contract and, if successful, the method will be used to identify the young.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0080, DETERMINE ALTERNATE LIVEBAIT SPECIES
E.L. NAKAMURA, U.S. Dept. of Interior, Behavior & Physiol. Prog., Honolulu, Hawaii 96812

The Hawaiian fishery for skipjack tuna is believed to be capable of yielding more than double its present yearly landings. Since the fishery is dependent upon the use of live bait, live bait can be and often is a limiting factor in the landings. Of the combined time fishermen spend fishing for skipjack and catching bait, as much as 50 percent may be spent catching bait. If an alternate bait, one that is acceptable to fishermen and which is as effective as that presently used by the fishermen, can be found and cultured, the amount of time spent catching natural bait could be greatly reduced. This in turn would greatly increase the amount of time spent fishing for skipjack. The live bait used by the fishermen is the nehu, Stolephorus purpureus, a small Hawaiian anchovy. It is a species which is not too hardy and often suffers high mortalities after capture. Thus, a substitute bait, one which is as good as the nehu in attracting skipjack to the stern of a vessel and which will withstand handling and which will be acceptable to the fishermen would be a great boon to the industry.

The objectives of this project are to identify and quantify the qualities of a good live bait, find one or more species possessing these traits, test them at sea in the fishery, and determine the best means of culturing those that are efficacious.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0081, INVESTIGATE POPULATION DYNAMICS OF ALBACORE
T. OTSU, U.S. Dept. of Interior, Tuna Ecology Program, Honolulu, Hawaii 96812

Information on the vital statistics of the albacore populations is necessary in order to estimate the maximum sustainable yield of this resource. Furthermore, studies on the population dynamics of the albacore are required in anticipation of possible international discussions on management of this fishery.

The tuna longline fishery based in American Samoa has grown rapidly since its start in 1954. There is now a sizeable concentration of Korean, Chinese, and Japanese fishermen based in American Samoa. There are nearly 200 vessels in the fleet. The landings of albacore, the principal species landed by the fleet, have increased from 338 metric tons in 1954 to about 26,000 metric tons in 1966. The South Pacific albacore, which seems to be the only longline-caught tuna that is not now being fished at the maximum rate, may not enjoy this distinction for very long, however. With the continually increasing fishing effort, it is vitally important that this development be followed closely.

Excellent data from the fishery, obtained through the voluntary cooperation of the Japanese, Korean, and Chinese vessel operators, as well as biological data collected by our staff members stationed in Samoa, are being placed on IBM cards for
analyses. Some analyses have been made and the results have been prepared for publication. These data will play an invaluable part in our study of the population dynamics of the species; to learn the responses of the albacore to environmental and to fishing pressure, and to determine the effect of each on the population size.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0082. ASSESSMENT OF CENTRAL PACIFIC TUNA RESOURCES
B.J. ROTHSCHILD, U.S. Dept. of Interior, Bureau of Comm. Fisheries, Honolulu, Hawaii 96812

The central Pacific is a vast area that contains many fish stocks that undergo varying degrees of exploitation. Some of these stocks, such as the tunas, are quite valuable commercially.

The objective of this project is to determine the location and abundance and population dynamics of the tuna fishery resources in the central Pacific and to develop techniques for optimum exploitation of these resources. In order to demonstrate these we need to know the expected apparent abundance and size distribution of each commercially important tuna species in the central Pacific.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0083. INVESTIGATE POPULATION DYNAMICS OF SKIPPACK TUNA IN HAWAIIAN WATERS
B.J. ROTHSCHILD, U.S. Dept. of Interior, Bureau of Comm. Fisheries, Honolulu, Hawaii 96812

This basic problem in this project is to evaluate the methods by which skipjack tuna (Katsuwonus pelamis) fishers in Hawaii can obtain the maximum production of skipjack in terms of the amount of effort expended. This knowledge is closely tied in with the dynamics of the skipjack population, the environment, and the response of skipjack to variations in the environment and to exploitation by man. To evaluate these continuing population changes, we have used quantitative measures such as catch and effort data.

An approach to the problem is the OPERATIONS ANALYSIS project whereby observers are placed aboard the local skipjack fishing vessels during the peak fishing season to obtain detailed data of all aspects of the fishing operations, including baiting, scouting, and fishing. This project was implemented during the summer of 1967 and plans are to continue it over several seasons. The data will be analyzed and used as a basis for developing an optimum fishing strategy for the Hawaiian skipjack fleet.

In addition to fishery data, environmental data are also collected by the observers, in order that studies can be made of the relationship of skipjack tuna to the environment. The purpose is to improve fishing strategy by eliminating much of the unproductive scouting effort necessary under present operations.

There are other broad problems that bear on the specific problem. Since the Hawaiian skipjack fishery depends on live bait, the variation in availability and abundance of the bait is but one of these highly important problems. Size of vessel, fishing areas, the effectiveness of the fishing effort, and gear competition are other factors that need to be evaluated. Finally, there is a need to examine these problems using different types of data in order to refine our estimates.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0084. DEVELOP HIGH-SEAS TUNA FISHERY
R.S. SHOMURA, U.S. Dept. of Interior, Fishery Development Program, Honolulu, Hawaii 96812

There is a growing body of scientific evidence which suggests that there is a large under utilized skipjack tuna resource in the central tropical Pacific Ocean. The potential annual yield has been estimated conservatively to exceed 150,000 metric tons. Present indications are that these skipjack cannot be caught with existing conventional fishing gear. The objective of this project is to develop a method of catching skipjack tuna in commercial quantities in the high seas of the central tropical Pacific Ocean. From present indication this will involve the design and development of a new fishing gear and technique or a modification of existing fishing gears and techniques.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0085. INVESTIGATE TUNA RESOURCES OF THE TRUST TERRITORIES

In the Pacific the annual landings of skipjack tuna have consistently ranked first among the commercially important tuna species. Despite the important of skipjack, the total knowledge of its biology is limited and relatively little is known of its movements, growth, population size, etc. The objectives of this program are: (1) collect biological and environmental data which will aid the U.S. fishing industry in the Trust Territory for management of the resource and developing the industry to its maximum potential and (2) collect biological and environmental data which will add to our knowledge of the skipjack tuna and eventually lead to understanding the dynamics of the skipjack subpopulations. A skipjack sampling station in the Palau Islands has been initiated to (1) obtain data on the size composition of the tuna catch, (2) obtain catch and effort data of tuna fishing, (3) obtain samples of bycatch species for taxonomic studies, (4) obtain catch and effort data on bycatch catches, and (5) obtain through tagging, data on growth and movements of skipjack and yellowfin tuna in the Trust Territory region.

The Palau fishery is expected to be one of a number of fishing centers in the Trust Territory. Ecological studies of skipjack tuna will extend out on a broad scale to include at least the areas of Palau, Truk, and Saipan.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0086. DEVELOP FISHERIES FOR NON-TUNA RESOURCES
H.O. YOSHIT'ARA, U.S. Dept. of Interior, Bureau of Comm. Fisheries, Honolulu, Hawaii 96812

With the exception of the tuna fisheries, the commercial fishing effort in the Hawaiian Islands is restricted to the shallow waters near shore. The only fishing done in waters exceeding 50 fathoms in depth is bottom longlining fishing done in the backcountry. The objective of this project is to evaluate the fishery resources of the deeper waters of the Hawaiian Islands chain by using various types of conventional fishing gears. If latent or underutilized resources are located, effort will be directed to encouraging the development of a commercial fishery.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0087. MECHANISMS AFFECTING THE VERTICAL AND HORIZONTAL DISTRIBUTION OF TUNAS AND RELATED SPECIES
H.S. YUEN, U.S. Dept. of Interior, Bureau of Comm. Fisheries, Honolulu, Hawaii 96812

Information on the vertical distribution of tunas and related species has been obtained in the past mostly from sampling by longlines and deep trolling. Because of the time-consuming nature of these techniques information has been collected at a very slow rate resulting in an incomplete picture of vertical distribution and limited to the depth range of the gear used. To increase ability to study horizontal and vertical distribution of tuna, behavior of subsurface schools, and movement of tuna schools, an especially designed high-resolution sonar was built and installed on the TOWNSEND CROMWELL. This instrument will provide the means of not only increasing the rate of collecting data but collecting data unobtainable by other methods, for example, the depth limits of occurrence, size of school, the rate at which depth changes are made, swimming speeds at various depths, shapes of schools, the pattern of depth changes which may be investigated in relation to other variable such as fish size, time of day, salinity, temperature, light, features of the ocean bottom, presence of other organisms, etc. The need for data on vertical distribution and the factors which control the vertical distribution is particularly acute for the Hawaiian fishery for skipjack.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

101
5. LIVING SYSTEMS (NON-HUMAN)

5.0088, TAXONOMY AND DISTRIBUTION OF CLUPEIDS AND REVISION OF THE GENUS ILISHA OF THE FAMILY CLUPEIDAE

R.V. SESHAIY, Annamalai University, Porto Novo, India

The objective of this project is to collect and to preserve for study large series of the various kinds of clupeoid fishes from the estuaries and marine waters of India - with emphasis on the coastal area south of 13 degrees North latitude, as time and facilities allow. To study, compile and analyze data from, and to assess the taxonomy of the fishes of the clupeid genus Ilisha from the Indian Ocean and to prepare this revision for inclusion in the 'Field Guide to the Clupeoid Fishes of the Indian Ocean.'

Specimens of clupeoid fishes will be collected from Indian waters by seine and other gear, and specimens not available elsewhere will be purchased from commercial fishermen. Descriptive field data will be recorded, especially on coloration of live and fresh specimens, and on schooling habits and behaviour. Coincident to this, small synoptic series of other families of fishes will be collected for other taxonomic studies. The specimens collected will be preserved in 10 percent Formalin. Specimens of the genus Ilisha will be sorted from the collections and retained for study; specimens of the remaining families will be made available to research workers studying those families in collaboration with the Field Guide. Counts, measurements and morphological data will be recorded from the specimens of Ilisha following procedures established for the Field Guide. The taxonomy of the clupeid genus Ilisha in the Indian Ocean will be revised. Illustrations of each species and a manuscript guide to their identification will be prepared; these will be incorporated into the manuscript on the 'Field Guide to the Clupeoid Fishes of the Indian Ocean.'

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish. Louisiana State Government

5.0089, ECOLOGICAL INVESTIGATIONS OF SOME COMMON MARINE FISHES OFF THE MEDITERRANEAN COAST OF ISRAEL

L.B. ZISMANN, Israel Sea Fisheries Res. Sta., Haifa, Israel

The objectives of this project are: 1. To find what forms enter the food web of fish on the continental shelf of Israel's Mediterranean coast and their relationships. 2. To find the distribution and range limits according to depths, bottom structure, and distance from shore of the more common species of fishes. 3. To assess the relative abundance of the fish species. 4. To collect general biological data such as: spawning period, seasonal fluctuations, size-range, etc., on those fishes important in the food web for which such data is not yet available. 5. To consider which factors may influence population fluctuations.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0090, MOVEMENTS OF FRESHWATER CATFISH IN THE ESTUARIES OF SOUTHWEST LOUISIANA

W.G. PERRY, Rockefeller Wildlife Refuge, Grand Chenier, Louisiana 70643

Freshwater catfish will be collected, their total length and weights recorded, and the chemistries of the water from which they are obtained analyzed.

Recaptured fish will again be measured, weighed and water chemistry analyzed.

Objectives: 1. Determine if the freshwater catfish migrate in accordance with the salinity fluctuation. 2. Determine which of the catfish species present to be more tolerant to salinity.

SUPPORTED BY Louisiana State Government

5.0091, LAKE BORGNE-CHANDELEUR SOUND SYSTEM

J.G. BROOK, State Wildlife & Fish Comm., New Orleans, Louisiana

Objectives: 1. Determine the distribution and density of the fauna of the phase area. 2. Determine the hydrography of the phase area. 3. Process the data.

Procedures and Work Schedule: 1. Weekly plankton sampling in the major passes and throughout the system with a 6-foot beam plankton net. 2. Weekly sampling throughout the major nursery areas with a 6-foot 1/4' mesh trawl. 3. Bi-weekly sampling throughout the major nursery and near offshore areas with trawls. 4. Bi-weekly seine sampling at selected sites. 5. Monthly benthic sampling at selected sites. 6. Collection of selected hydrographic information at each sample station and continuous recordings of salinity temperature and tidal movements at selected stations. 7. The processing, tabulating and summarizing of collections and raw data which are to be transmitted to the project leader at the marine laboratory for compilation, analysis and interpretation.

Location of Work: This area extends from Bayou Lafourche on the east to Bayou Grand Caillou on the west, and includes Timbalier and Terrebonne Bays, Lake Pelto, and the intricate marshes north of these lodies.

Part 3 of 6.

5.0092, TIMBALIER - TERREBONNE BAYS SYSTEM

J.G. BROOK, State Wildlife & Fish Comm., New Orleans, Louisiana

Objectives: 1. Determine the distribution and density of the fauna of the phase area. 2. Determine the hydrography of the phase area. 3. Process the data.

Procedures and Work Schedule: 1. Weekly plankton sampling in the major passes and throughout the system with a 6-foot beam plankton net. 2. Weekly sampling throughout the major nursery areas with a 6-foot 1/4' mesh trawl. 3. Bi-weekly sampling throughout the major nursery and near offshore areas with trawls. 4. Bi-weekly seine sampling at selected sites. 5. Monthly benthic sampling at selected sites. 6. Collection of selected hydrographic information at each sample station and continuous recordings of salinity temperature and tidal movements at selected stations. 7. The processing, tabulating and summarizing of collections and raw data which are to be transmitted to the project leader at the marine laboratory for compilation, analysis and interpretation.

Location of Work: This area extends from Bayou Lafourche on the east to Bayou Grand Caillou on the west, and includes Timbalier and Terrebonne Bays, Lake Pelto, and the intricate marshes north of these lodies.

Part 3 of 6.

5.0093, BRETON SOUND - MOUTH OF MISSISSIPPI RIVER SYSTEM

J.G. BROOK, State Wildlife & Fish Comm., New Orleans, Louisiana

Objectives: 1. Determine the distribution and density of the fauna of the phase area. 2. Determine the hydrography of the phase area. 3. Process the data.

Procedures and Work Schedule: 1. Weekly plankton sampling in the major passes and throughout the system with a 6-foot beam plankton net. 2. Weekly sampling throughout the major nursery areas with a 6-foot 1/2' mesh trawl. 3. Bi-weekly sampling throughout the major nursery and near offshore areas with trawls. 4. Bi-weekly seine sampling at selected sites. 5. Monthly benthic sampling at selected sites. 6. Collection of selected hydrographic information at each sample station and continuous recordings of salinity temperature and tidal movements at selected stations. 7. The processing, tabulating and summarizing of collections and raw data which are to be transmitted to the project leader at the marine laboratory for compilation, analysis and interpretation.

Part 4 of 6.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish. Louisiana State Government

5.0094, VERMILION - CALCASIEU - SABINE SYSTEM

J.G. BROOK, State Wildlife & Fish Comm., New Orleans, Louisiana

Objectives: 1. Determine the distribution and density of the fauna of the phase area. 2. Determine the hydrography of the phase area. 3. Process the data.

Procedures and Work Schedule: 1. Weekly plankton sampling in the major passes and throughout the system with a 6-foot beam plankton net. 2. Weekly sampling throughout the major nursery areas with a 6-foot 1/4' mesh trawl. 3. Bi-weekly sampling throughout the major nursery and near offshore areas with trawls. 4. Bi-weekly seine sampling at selected sites. 5. Monthly benthic sampling at selected sites. 6. Collection of selected hydrographic information at each sample station and continuous recordings of salinity temperature and tidal movements at selected stations. 7. The processing, tabulating and summarizing of collections and raw data which are to be transmitted to the project leader at the marine laboratory for compilation, analysis and interpretation.

Part 4 of 6.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish. Louisiana State Government
5.5.097, REPOPULATION OF DECIMATED SECTIONS OF WARM-WATER STREAMS BY LONGEAR SUNFISH, LEPIOMIS MEGALOTIS (RAFINESQUE)  
T.M. BERRA, Tulane University of Louisiana, Graduate School, New Orleans, Louisiana 70118  
00NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE  
SUPPORTED BY Society of The Sigma Xi

5.5.098, DETERMINATION OF THOSE MARINE SPECIES HAVING THE GREATEST KNOWN POTENTIAL FOR THE COMMERCIAL FISHERY  
F.T. BAIRD, State Dept. of Sea Shore Fish., Augusta, Maine  
Objective: To determine those species having the greatest known potential.  
Procedures: Only a limited portion of the overall objective will be accomplished during the initial period covered by this proposal. Depending upon the expressions of industrial interest and cooperation, concentration will be given to a limited group of species that indicate the greatest promise for successful commercial development. As this program develops, this limited list will be changed to fit existing demands or potentials.  
During the first year, marine plants, primarily Fucus vesiculosus and Ascophyllum nodosum, will be collected seasonally, from areas along the coast, and furnished the Research Laboratory of Marine Colloids of Rockland, Maine, and other industrial users, for their industrial evaluation of alginic content and other products.  
We will act during the first year on recent industry requests that we investigate the potentials for an expanded industrial fishery. The first year will be spent in assembling data on inshore fishing craft having a potential for this type of fishery, their capabilities, what industrial fish are being caught, where they are being caught, and what equipment is being used, with a view to the further exploitation of underutilized species for fish meal or marine protein concentrate. Also considered will be how an industrial fisheries operation can fit into the vessels present operations.  

5.5.099, BIOSTATISTICS OF HERRING  
V. ANTHONY, U.S. Dept. of Interior, Biological Laboratory, Boothbay Harbor, Maine 04538  
Immature herring (Clupea harengus harengus) of the Maine commercial fishery are being studied. Otoliths have been validated for aging the fish and are a basis for three studies: Growth, stock separation, and age structure of the fishery. Basic parameters of populations are being estimated from a combination of catch, sample and tagging data. Catch data of sardines collected since 1947 are being analyzed for changes in abundance by year class according to effort, growth, and time. These data are being compared with environmental conditions for long-term trends in connection with a parent-progeny relationship. Sardine sample data collected since 1963 provide information on meristic counts, morphometric data, age and growth. These data show a relationship of stock abundance and growth at age 1. Meristic counts and growth parameters of herring indicate stock differences and growth rates have been estimated for Maine, Nova Scotia, and Georges Bank.  
SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.5.100, IDENTIFICATION OF WINTER FLOUNDER SUBPOPULATIONS  
A. PETERSON, State Div. of Marine Fisheries, Boston, Massachusetts  
To define the limits of the winter flounder populations or subpopulations and analyze the effect of present regulations on the fishery. Past tagging studies will be evaluated, experimental otter trawling will be analyzed, and the effect of regulations on exploitation based on the above data will be studied. Work will be conducted on this phase from July 1, 1966 through June 30.

5.5.095, ATCHAFALAYA RIVER - GAILOU LAKE SYSTEM  
J.G. BROOM, State Wildlife & Fish Comm., New Orleans, Louisiana  
Objectives: 1. Determine the distribution and density of the fauna of the phase area. 2. Determine the hydrography of the phase area. 3. Process the data.  
Procedures and Work Schedule: 1. Weekly plankton sampling in the major passes and throughout the system with a 6-foot beam plankton net. 2. Weekly sampling throughout the major nursery areas with a 6-foot 1/4" mesh trawl. 3. Bi-weekly sampling throughout the major nursery and near off-shore areas with trawls. 4. Bi-weekly seine sampling at selected sites. 5. Monthly benthic sampling at selected sites. 6. Collection of selected hydrographic information at each sample station and continuous recordings of salinity temperature and tidal movements at selected stations. 7. The processing, tabulating and summarizing of collections and raw data which are to be transmitted to the project leader at the marine laboratory for collection, analysis and interpretation.  
Location of Work: This area extends from Point Chevreuil on the east to Point Chevreuil on the west, including Lakes Maurepas, Pontchartrain and Borgne near the mouths of tributary streams.  
Part 5 of 6  
SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish. Louisiana State Government

5.5.096, TRAMMEL NET SAMPLING IN ESTUARINE AREAS  
J.T. DAVIS, State Wildlife & Fish Comn., New Orleans, Louisiana  
Objectives: 1. Determine fish population present in the areas of Lakes Maurepas, Pontchartrain and Borgne near the mouths of tributary streams. 2. Determine possible competitor species with estuarine species in these areas. 3. Establish data on relative densities of anadromous species at different seasons of the year.  
Procedures: 1. Monthly trammel samples will be taken at 30 designated stations. These include but are not limited to stream mouths, shoreline areas and passes. 2. Circle haul sets will be made with trammel nets of 1 inch mesh, six feet deep and 100 yards long. 3. All fish captured will be identified, weighed and measured. All data will be recorded for ADP.  
SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish. Louisiana State Government
5. LIVING SYSTEMS (NON-HUMAN)

1967. Meat of the work will be done at the Sandwich office of the Division of Marine Fisheries.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Massachusetts State Government

5.0106, ATLAS OF MARINE FAUNA
E.D. MCAE, U.S. Dept. of Interior, Exptl. Fish & Gear Res.
Base, Gloucester, Massachusetts 01930

Preparation of a series of atlases is being undertaken to graphically illustrate the seasonal commercial fishing grounds for various marine species in the area north of Cape Hatteras, N.C. A limited summary of supplemental or associated information concerning each species of fish (or shellfish) is included on text pages. Initial atlases will be concerned with the New England fisheries. Atlases on the fisheries of other sections of the general area will follow the New England series.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0107, LAKE SUPERIOR EXPLORATIONS
N.J. REIGLE, U.S. Dept. of Interior, Exptl. Fish & Gear Res.
Base, Ann Arbor, Michigan

The decline of high-value, food fish species and increases in populations of low-value fish stocks have left the Lake Superior fishermen with little chance to earn satisfactory incomes. Systematic exploratory fishing operations are being conducted for locating and assessing the potential commercial yield of additional or alternate fish stocks; introducing existing gear from other areas or improved or new methods and equipment to allow efficient and economical harvest of these populations; surveying the physical characteristics of Lake Superior to ascertain suitability for various types of fishing gear; and determining the seasonal availability of various species in order to stabilize production and counteract the effects of seasonal gluts.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0108, GREAT LAKES EXPLORATIONS
N.J. REIGLE, U.S. Dept. of Interior, Exptl. Fish & Gear Res.
Base, Ann Arbor, Michigan

Recent change in species composition and lack of technological progress in harvesting and handling populations of underutilized, low-value species have placed the Great Lakes commercial fishing industry in a poor economic position. Systematic exploratory fishing operations are being conducted for locating and assessing the potential commercial yield of additional of alternate fish stocks; introducing existing gear from other areas or improved or new methods and equipment to allow efficient and economical harvest of these crops, surveying the physical characteristics of the Great Lakes to ascertain suitability for various fishing methods; and determining the seasonal availability of various species in order to stabilize production and counteract the effects of seasonal gluts.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0109, ESTABLISHMENT AND PERPETUATION OF STOCKS OF EXPERIMENTAL FISH
G. WASHBURN, U.S. Dept. of Interior, Biological Laboratory, Ann Arbor, Michigan

This project is concerned with the development and application of techniques for the establishment and perpetuation of oceanic stocks of experimental fish.

SUPPORTED BY U.S. National Science Foundation
stocks of experimental fish primarily for studies of fish physiology and behavior at the Ann Arbor Biological Laboratory. Most fish are species present in the Great Lakes but which are not ordinarily maintained under artificial conditions. Studies are in progress to determine the most desirable type of closed water systems and to provide suitable environmental conditions to successfully complete all life-history stages. The project also requires studies of the development of special foods, treatment and prevention of diseases, the conditions that induce maturation and spawning, and the requirements for the production of viable eggs and young for a variety of species with a wide range of characteristics and requirements.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0110, EARLY LIFE HISTORY OF COREGONIDS
L. WELLS, U.S. Dept. of Interior, Biological Laboratory, Ann Arbor, Michigan

Little or nothing is known about the early life history of coregonids, and of related ecological events and requirements. This study is exploring means of locating and collecting juvenile coregonids from hatching through their second year. Only recently has it been possible to collect larvae and fry in limited numbers, but methods to locate and catch young from the middle of their first year until the start of their third year have not been found. Once satisfactory means of collection have been developed, studies will be directed to their distribution, growth, and mortality in relation to the physical, chemical, and biological characteristics of the environment. The results of this study will be used in making estimates of recruitment and early mortality in population studies.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0111, INTERRELATIONS OF ALEWIVES AND ASSOCIATED SPECIES
L. WELLS, U.S. Dept. of Interior, Biological Laboratory, Ann Arbor, Michigan

The recent invasion and subsequent population explosion of alewives has prompted a comprehensive investigation into the interrelations of this species and others in Lake Michigan. The project represents the field phase of a broad study involving species interactions, behavior, and physiology. Current studies include food competition between alewives and associated species, effects on species composition and distribution of major food items (zooplankton), host-prey relationships, seasonal and depth distribution of alewife larvae and associated species, and other factors which may provide information on the mechanisms which permitted the alewife to dominate fish stocks of Lake Michigan with an apparent detrimental influence on endemic species.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0112, ECOLOGY OF COMMERCIAL FISH SPECIES IN NORTHERN LAKE MICHIGAN
E.W. ROELOFS, Michigan State University, Agricultural Experiment Sta., East Lansing, Michigan 48824

Objectives: 1. To study the distribution of commercially important fish species in northern Lake Michigan. 2. To determine the factors influencing the abundance of successive year-classes of fish. 3. To identify the number and distribution of subpopulations of certain species.

Methods: 1. Study catch records provided by commercial fishermen to the Conservation Department. 2. Determine age distribution, growth rates and morphometric characteristics of fish taken from various localities.

SUPPORTED BY Michigan State Government

5.0113, INVESTIGATION OF COMMERCIAL FISH POPULATIONS IN WESTERN LAKE SUPERIOR
UNKNOWN, Univ. of Minnesota, Agricultural Experiment Sta., Saint Paul, Minnesota

This project is designed to (1) investigate the causes of declining herring stocks and (2) the relation of this and other commercial species to changing ecological conditions and types of exploitation. It is proposed to sample larval stocks, concurrently caught predatory fish, and food sources in the Duluth and Apostle Island areas to determine the inter-relationship of the different species. These samples will be taken during spawning seasons and throughout the season during various life history stages. Samples will be taken with ground trawls, mid-water trawls, larval nets and naturalists' trawls from research vessel Siscowet. Simultaneous physical and chemical observations will be made. Program is designed to extend over a four-year period.

SUPPORTED BY Minnesota State Government

5.0114, A STUDY OF THE SEASONAL ABUNDANCE, DISTRIBUTION AND SPECIES COMPOSITION, WITH PARTICULAR EMPHASIS ON FISHES
C.E. DAWSON, State Marine Conserv. Comm., Biloxi, Mississippi

Objectives: To provide information on growth rates, morphological development and life histories of various species in the north-central Gulf and possibly leading to the development of methods for predicting year-class success of certain economically important species.

Procedures: 1) Monthly and, when possible, semi-monthly quantitative sampling with meter nekton nets and neuston nets at 30 fathom depth intervals to 300 fathoms will be made off the Mississippi coast. Course tracks and station locations would be plotted from radar and Loran fixes. 2) Day and night collections would be included to make most effective use of ship time and to allow for analysis of diurnal variations in collections. 3) Standardized drags would be made with 40 ft. trawls for qualitative and quantitative analysis of the bottom fish and invertebrate fauna. 4) Concurrent salinity and temperature determinations would be made at each collection site. 5) Laboratory studies would include identification of fishes and larger invertebrates. Meristic and morphometric observations on dominant organisms for developmental and growth rate studies. Species would be analyzed for variations in seasonal abundance with depth, salinity, temperature, etc.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish. Mississippi State Government

5.0115, SYSTEMATICS AND DISTRIBUTION OF WORMFISHES (MICRODESMIADAE)
C.E. DAWSON, Gulf Coast Research Laboratory, Ocean Springs, Mississippi

Wormfishes (Microdesmidae) are a little known group of burrowing or inhabiting, elongate, marine and estuarine fishes which are apparently restricted to lower temperate, sub-tropical and tropical environments. They are presently recorded to a maximum depth of about 50'. Although poorly represented in museum collections, wormfishes may be locally abundant, with as many as fifty or more being taken in a single sample. Aside from a brief description of swimming behavior in one species, there is little or no information on their behavior, life history or biology.

The Investigator's current studies on the morphology and osteology of the wormfishes have resulted in the discovery of a number of heretofore unknown or unrecognized characters of systematic value which permit definitive approach to the phylogenetic systems within the group as well as some insight into its higher relationships within the Gobioidea. He has, with minor exceptions, examined all known specimens, but a number of problems of distribution, species divergence and variation cannot be solved until more study material is available. Thus, the proposed research will be for the continuation of these studies and intensive collecting in all known areas of distribution of the family of these studies and intensive collecting in all known areas of distribution of the family Microdesmidae. This work will result in a revision of the family supplemented with detailed accounts of distribution and ecology together with life history notes for each of the twenty-seven fishes now recognized as comprising the Microdesmidae.

SUPPORTED BY U.S. National Science Foundation

105
5. LIVING SYSTEMS (NON-HUMAN)

5.0116, EXPLORATORY COLLECTION AND CARE OF FISH FOR TESTING AT TIBURON
T. LANE, U.S. Dept. of Interior, Fish Pesticide Res. Lab., Columbia, Missouri 65201

The objectives of the work are to survey the sources of experimental fish for use in pesticide bioassay work and to develop an efficient means of harvesting and holding the fish at Tiburon, California. Examination of areas in San Francisco Bay and in the Sacramento-San Joaquin Delta, commercial sources, and culture of fish at Tiburon will be explored. Fishes will be collected, brought to the laboratory, and held under various conditions of water flow, time, feeding, and space conditions to measure the best procedure for each species and size group.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0117, DISTRIBUTION AND MIGRATION OF CENTRAL AMERICAN FRESHWATER ELASMOBRANCHS
UNKNOWN, Univ. of Nebraska, Graduate School, Lincoln, Nebraska 68508 (N00014-66-C-0161)

This is a continuation of an existing study for the clarification and documentation of the problematical movement of the freshwater or bull shark (Carcharhinus leucas) and the sawfish (Pristis perotteti) from the marine environment of the Caribbean Sea into the freshwater system of Lake Nicaragua, Nicaragua, as well as of the pattern and duration of these movements. The adaptation in osmoregulation for this shark from roughly saline sea water to the low salinity lake waters represents a phenomenon of wide biological interest. The program sets up tagging stations along the river outlet of Lake Nicaragua to determine whether or not this migration actually occurs. Trials will be made of a promising new sonic emission tag by which fish movements can be followed from a boat or passively recorded from shore monitoring stations.

The study of sharks and other potentially dangerous fishes, such as the sawfish, is of prime interest to the Navy in light of the growing numbers of lightly protected Naval personnel in swimming, diving, and emergency operations. The freshwater shark is regarded as a dangerous member of this group, and there are authenticated records of its attack on humans in the ONR-supported publication, 'Sharks and Survival.'

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0118, TEMPERATURE TOLERANCE OF MARINE ANIMALS THROUGH BEHAVIORAL RESPONSES
D.W. BRIDGES, U.S. Dept. of Interior, Sandy Hook Marine Lab., Highlands, New Jersey

Introduce acclimated and non-acclimated marine organisms into waters of various temperature regimes; observe and measure behavioral patterns such as rate of feeding of fishes, cirral activity, of barnacles and pumping rate of bivalves. Diagnose range of temperature in which experimental animals are able to maintain normal behavior as well as determine the thermal death point(s) for these organisms.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0119, DISTRIBUTION OF YOUNG STAGES OF COASTAL FISHES
J. CLARK, U.S. Dept. of Interior, Sandy Hook Marine Lab., Highlands, New Jersey

A survey is to be made of the continental shelf from Cape Cod, Mass. to Cape Lookout, N.C., utilizing the research vessel Dolphin. The goal is to determine relative abundance of young of the major game species in the open estuaries, along the coast, and seaward onto the continental shelf. A series of 14 transects will be established; each extending from the shore to at least the 50-foot contour. Eight cruises will be made at approximately 1-month intervals throughout one year. Collecting stations will be spaced along the lines at approximately 10 mile intervals; somewhat closer near shore. At each station along the survey transects a 20-minute oblique tow will be made with 1) a modified Gulf Ill sampler (for larvae and 2) a special 20-foot mid-water trawl for juvenile fish. All fishes taken will be identified to species and isometric charts of abundance of eggs, larvae, and juveniles will be drawn.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0120, TRACKING MIGRATIONS OF BLUEFISH POPULATIONS ALONG ATLANTIC COAST TO LEARN BIOLOGY OF THE SPECIES (MIGRATORY HABITS OF BLUEFISH)
J.R. CLARK, U.S. Dept. of Interior, Sandy Hook Marine Lab., Highlands, New Jersey

It is the purpose of this project to determine population structure of the bluefish species, abundance of the populations, times and routes of migrations of the different populations and rates of mortality of the different populations.

The plan of work is to carry out strategic tagging of 5000 bluefish from southern Florida to Cape Cod. Phase One will be to develop methods, determine suitability of various tag types and tagging methods, and to conduct limited tagging trials. Phase Two will be to conduct field tagging to test hypotheses regarding major populations of bluefish, which will be carried out at seasonal centers of abundance of bluefish in Florida, North Carolina, New Jersey and Cape Cod.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0121, LIFE HISTORY AND BEHAVIOR OF FISHES ON ARTIFICIAL REEFS
L. OGRENS, U.S. Dept. of Interior, Sandy Hook Marine Lab., Highlands, New Jersey

Determine the species composition, relative abundance, and temporal distribution of fish on artificial reefs and compare results with fish populations occupying natural reefs and areas devoid of reef habitat. Observe and describe the specific attraction to artificial reefs by fish in terms of nutrition, protection, reproduction, growth, and other life needs. Make direct observations of the fish fauna with SCUBA and correlate these observations with similarly conducted dives on natural reefs and barren bottom areas. Make underwater transects with a towed sea sled in each study area to aid in establishing the general faunal features of the locality. Quantitatively sample the reef sites and adjacent study areas with standardization fishing gear, i.e., fish traps. Record results and release fish at place of capture. Periodically sacrifice a sub-sample to study food habits and gonad development. Relate biological observations to the physical characteristics of the environment and to the artificial habitat.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0122, INFLUENCE OF UNLIMITED FOOD SUPPLY ON RHYTHMIC ACTIVITY OF BLUEFISH
B.L. OLLA, U.S. Dept. of Interior, Sandy Hook Marine Lab., Highlands, New Jersey

To learn what effect an unlimited food supply has on rhythmic activity of bluefish: introduce several thousand live prey fish into the experimental tank. Measure rhythmic activity as well as time and intensity of feeding throughout the day and night for a seven to ten day period. Tabulate, plot and analyze resulting data to bring out statistically significant tendencies.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0123, HYPOTHETICAL DISTRIBUTION OF 14 SPECIES OF ATLANTIC COASTAL GAME FISHES
L.A. WALFORD, U.S. Dept. of Interior, Sandy Hook Marine Lab., Highlands, New Jersey

Description of Work: 1, Assemble, tabulate and plot all available records of occurrence and catch data regarding the following species: Bluefish, bonito, cod, red drum, croaker, red hake, mackerel, pomfret, black sea bass, Spanish mackerel, spotted sea trout, po, tautog, bluefin tuna. 2. Collate plotted records with monthly maps of average sea temperatures resulting from work unit 5212-03. 3. Using all existing information and logical assumptions regarding responses of these fishes to temperatures, construct monthly hypothetical total distributions. Report the results in the graphic and written presentation.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.
5.0124, CREEL CENSUS OF SUMMER FLOUNDER SPORT FISHERY IN GREAT BAY, NEW JERSEY
W.S. MURAWSKI, State Div. of Fish & Game, Trenton, New Jersey

A. Project Objectives: To study these aspects of the life history of the summer flounder, Paralichthys dentatus, which are pertinent to the management of its fisheries, such as migration, spawning, distribution of the young and growth. Job Objective: The job objective is to conduct a creel census of a segment of the small boat fishery in Great Bay, N.J. during the summer months in order to provide an index to the quality and quantity of the summer flounder sport fishery catch for New Jersey.

B. Procedures: A complete creel census will be made at one small boat lively and ramp on Great Bay every Wednesday, Thursday, and Saturday during the months of June, July, and August. Direct interviews will be made at dockside by a creel census technician to determine the catch per effort and the size composition of the catch.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

New Jersey State Government

5.0125, SCHOOLING BEHAVIOR IN FISHES

Schooling in fishes represents a biosocial behavior which exhibits several distinctive features: movement of individuals in the same direction, parallel orientation to one another with more or less equal spacing, and synchronized turning in a manner that still has not been fully analyzed.

The principal investigator has been studying schooling under previous grants, her current grant being C-1083... Further studies on schooling are planned along the above lines of investigation. School structure will be analyzed three-dimensionally. The role of the visual and lateral line sensory systems in parallel orientation will be evaluated. The development of schooling and the influence of experiential factors will be observed and experimental procedures will be extended. A synthesis of these lines of investigation should provide a more comprehensive understanding of bio-social phenomena at this phylogenetic level, and should also provide a greater understanding of the factors that give rise to the formation of schools and to their maintenance in characteristic geometric patterns.

SUPPORTED BY U.S. National Science Foundation

5.0126, COLLECTION, COMPILATION, AND ANALYSIS OF GULF CATCH STATISTICS AND LOGBOOK DATA
R.B. CHAPATON, U.S. Dept. of Interior, Biological Laboratory, Beaufort, North Carolina 28516

To furnish basic information for interpreting the results of the biological investigations of the Gulf menhaden fishery, the historical and current landing records by vessel, date, and locality and the logbook records of fishing activities are required. Current records and historical records are being obtained from the reduction plants. Automatic data processing will be used for tabulations and analyses. Logbooks and fishing charts will be introduced in the fishery beginning in April 1964.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0127, TAGGING
R.L. DRYFOOS, U.S. Dept. of Interior, Biological Laboratory, Beaufort, North Carolina 28516

Results from size and age comparison, morphology and population studies, and estimating year class strength need confirmation from tagging and subsequent recovery. In addition, reliable information on movements, migrations, and mortalities can be obtained only from the direct results of marking and recovery data.

The mass catching, handling, and processing of menhaden require marking of large numbers of fish and the automatic recovery of those marked. Initial inquiries into marking with stains or pigments and subsequent recovery with an electronic device proved unsuccessful for field use.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0128, INVESTIGATION OF THE BIOLOGY AND POPULATION STRUCTURE OF GULF MENHADEN
P.L. FORE, U.S. Dept. of Interior, Biological Laboratory, Beaufort, North Carolina 28516

Measure of the species composition of the landings and related information on the distribution and abundance of three species reported in the Gulf of Mexico are needed to understand the Gulf menhaden resource. Whether one or more populations of Gulf menhaden supports the fishery and the biological characteristics of each also must be known to fulfill the objectives of the program and furnish the industry the information they need.

Species identification by external characters, vertebral counts, and other internal structures is an early objective. Collections of Gulf', yellowfin, and finnase Gulf menhaden were obtained from 1959 to date. These were examined to provide a field guide for the identification of the species.

An analysis of vertebral numbers of Gulf menhaden collected from Florida to Texas in 1960 was made to determine the range in morphological variations and for indications of population differences. No conclusions of population heterogeneity were made, although there were significant differences in the mean numbers of vertebrae from the eastern and western Gulf.

Juveniles were collected in 10 selected estuaries during September 1963 for a study of morphological variations during successive years.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0129, SAMPLING OF THE ATLANTIC COMMERCIAL CATCH
M.A. JUDY, U.S. Dept. of Interior, Biological Laboratory, Beaufort, North Carolina 28516

Determination of length, weight, sex, sexual maturity, and age composition of the Atlantic menhaden catch by geographical locality is accomplished by daily sampling of the landings at the principal ports throughout the range and season of the purse seine fishery. Landings, by vessel, for each day's fishing are obtained from reduction plant records. Logbook records of date, time, locality, and estimated catch for each purse seine set is kept by fishermen aboard a representative number of vessels. These data are used to provide calculated numbers and weights for each year class contribution to the fishery.

Fish are measured, weighed and staged of sexual maturity, designated by gonad weight, are recorded. Age is determined by annular marks in the scales. Distances between annuli are recorded. At present the information is analyzed and stored on hand-sorted punch cards. Automatic data processing with machine-punched cards is proposed. Cards on land document the Atlantic menhaden fishery from 1952 to 1963. Summaries for 1952-58 are published, with 1959-60 in press, and 1961-63 under preparation.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0130, POPULATION STUDIES
J.H. KUYKUHN, U.S. Dept. of Interior, Biological Laboratory, Beaufort, North Carolina 28516

Knowledge of the identity and distribution of species subpopulations is needed to understand the extent of the Atlantic menhaden resource and the effects of environmental factors and fishing upon it. Species identity and indications of population structure can be obtained from studies of the morphology and biology of the fish over their range. Occurrences of larvae, juveniles, and adults help determine the distributions of populations.
5. LIVING SYSTEMS (NON-HUMAN)

Variation in vertebral numbers of juveniles from localities along the Atlantic Coast have shown consistent differences between populations north and south of Long Island. Spawning adults from nearby localities also show similar differences. In addition, the hypothesis of an additional southern subpopulation from Cape Hatteras southward is being investigated.

The first phase of a study of the distribution and abundance of two or more species of menhaden in Florida has been completed. Yellowfin menhaden, Brevoortia smithi, occurs in Florida but is being little utilized at present. Continuing studies are concerned with determining population structure and identity of this species complex. Methods will include a detailed structural and serological comparison of the species and experimental cross-fertilization for possible hybridization.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0131, ESTIMATION OF JUVENILE ABUNDANCE IN ESTUARINE NURSERIES

W.F. TURNER, U.S. Dept. of Interior, Biological Laboratory, Beaufort, North Carolina 28516

Yontan menhaden provide a substantial portion of the menhaden landings in the Gulf of Mexico. Estimation and prediction of the incoming year class abundance can be made from measures of the relative abundance of juveniles in the estuaries in the preceding year. Methods employed will be the same as for the Atlantic menhaden and will include catch per unit of effort, measures with standard haul seine and trawl gear, fin clipping and recovery, and ground and aerial school counts.

Aerial counts of schools from Florida to south Texas were made in October 1962 and 1963.

Catches by haul seines and trawls were made in selected estuaries during September 1963. These observations mark the beginning of the project for Gulf menhaden.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0132, SYSTEMATICS, ZOOGEOGRAPHY, AND ECOLOGY OF ELASMOMBANCHES OF THE WESTERN ATLANTIC OCEAN

F.J. SCHWARTZ, Univ. of North Carolina, Institute of Marine Science, Morehead City, North Carolina 28557

All aspects of the systematics, zoogeography, biology, and ecology of Western Atlantic elasmobranchs are being investigated. Studies are aided through local tagging efforts.

SUPPORTED BY University of North Carolina

5.0133, FISH COLLECTION OF NORTH CAROLINA AND WESTERN ATLANTIC FISHES

F.J. SCHWARTZ, Univ. of North Carolina, Institute of Marine Science, Morehead City, North Carolina 28557

A curated and catalogued collection of fishes is maintained for research, teaching and systematic work. Species consist of freshwater and Western Atlantic fishes with emphasis on those now occurring in North Carolina.

SUPPORTED BY University of North Carolina

5.0134, LAKE ERIE INVESTIGATIONS - LIFE HISTORY AND ABUNDANCE OF THE YELLOW PERC

H.D. VANMETER, U.S. Dept. of Interior, Biological Station, Sandusky, Ohio

The abundance of year classes, rate of growth, and the effects of exploitation are determined from data collected from fish captured in experimental and commercial nets. Information on food, spawning habits, distribution, competition with other species, and other life history aspects are obtained from collections of fish taken in experimental gear. Environmental factors--oxygen, water temperature, bottom organisms, plankton, water currents, seaches, and the interrelations with other species of fish are determined from limnological and fish-population data obtained with the fish collections.

Current studies nearing completion include the age and growth, abundance, and history of the commercial fishery for this species from 1949 through the calendar year 1966, spawning and fry development, age and size at maturity, fecundity, and food habits. Studies of the effects of environmental conditions upon this species are described elsewhere as separate projects.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0135, FLUCTUATIONS IN SPECIES COMPOSITION AND YEAR-CLASS STRENGTH OF COMMERCIAL LANDINGS

H.D. VANMETER, U.S. Dept. of Interior, Biological Station, Sandusky, Ohio

This investigation requires the collecting, in spring and fall, of scale samples and meridional data from the species available in the commercial landings at fish houses at representative ports in the western, central and eastern basins of the lake. Species composition of the catches becomes evident from what is available for sampling. Examination of the scales of walleyes and yellow perch is kept current and year-class contributions to the catches of these species are summarized annually.

Scale samples and data for the remaining commercial species are made available to other investigators or are filed for future studies.

Reports summarizing major segments of these data for the walleye, sheepshead, and yellow perch are currently in preparation.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0136, PRELIMINARY STUDY TO DETERMINE ABUNDANCE AND RECRUITMENT OF BOTTOMFISH OFF OREGON

R.L. DEMORY, State Fish Commission, Astoria, Oregon 97103

This study will undertake to determine the factors associated with and responsible for the variations in abundance and year-class strength of Dover sole and other groundfish species supporting the commercial trawl fishery of Oregon. Dover sole data from past years will be reviewed and combined with data from the current sampling program. Collections of juvenile groundfish will be examined and identified, fish stomachs examined for larvae and juvenile fish, and collection trips taken aboard commercial shrimp vessels and chartered trawl vessels to collect juveniles. These collection and sampling procedures will be part of an overall assessment program to determine year-class strength, survival rates of juveniles, and juvenile abundance.

The work will take place at the ports of landing along the coast of Oregon and on the trawl fishing grounds along an adjacent Oregon coastline. Laboratory work will be handled at the Research Laboratory, Astoria, Oregon.


5.0137, OREGON FISHES - THEIR CLASSIFICATIONS, DISTRIBUTIONS AND LIFE HISTORIES

C.E. BOND, Oregon State University, Agricultural Experiment Sta., Corvallis, Oregon 97331

Objective: In general, to provide basic information concerning Oregon's fish fauna. Immediate objectives involve compilation of faunal lists, keys to Oregon marine fishes and studies of the Zoogeography and speciation of freshwater fishes. A special investigation will assess populations of certain estuarine fishes.

Work Proposed: A. Freshwater studies: Collection, cataloging, and ecological analysis will be continued in order to provide faunal lists and Zoogeographical Information. Collections of lampreys from inland as well as coastal areas must precede studies of speciation in this group. B. Marine studies: For lists and keys, additional collection, cataloging and taxonomic studies will be necessary. Populations of bay fishes will be studied by mark-and-recapture methods.

SUPPORTED BY Oregon State Government
5.0138, OREGON FISHES - THEIR CLASSIFICATION, DISTRIBUTION AND BIOLOGY
C.E. BOND, Oregon State University, Agricultural Experiment Sta., Corvallis, Oregon 97331

The object of this project is to provide basic information relating to Oregon's fish fauna, including both marine and freshwater species. Considerable effort has gone into field work and the maintenance of a reference collection. Studies of the biology of several species have been carried out. Keys and lists are being prepared and distribution records kept.

SUPPORTED BY Oregon State Government

5.0139, EARLY LIFE OF BOREAL FOOD FISH AND SHELLFISH
W.J. MCNEILL, Oregon State University, Agricultural Experiment Sta., Corvallis, Oregon 97331

Objectives: 1. Determine the time and place of occurrence of eggs and larvae of food fish and shellfish offshore Oregon coast. Systematic collections will be made at sea and taxonomic descriptions prepared in the laboratory. 2. Determine time and place of high and variable mortality of selected species. 3. To associate mortality of selected species with biological and physical-chemical factors in the environment. 4. To elucidate the nature of mortality processes through experimentation.

SUPPORTED BY Oregon State Government

5.0140, EVALUATION, COORDINATION, AND PLANNING OF PACIFIC SALMON AND STEELHEAD RESEARCH AND MANAGEMENT ACTIVITIES

To promote more efficient use of research and management efforts through better determination of needs, coordination of activities, evaluation of projects, dissemination of information and planning of programs both short- and long-range.

Present objectives are to compile an annual bulletin of coast-wide commercial and sport fishery catch statistics, update inventories of current salmon and steelhead research work, formulate long-range plans to maintain and enhance the resource, update assessments and compilations on the status of Pacific Coast salmon and steelhead stocks, review and evaluate major fishery problems and recommend solutions or procedures for dealing with these problems, sponsor and stimulate workshops in connection with these problems, and update the Salmon Compendium by including literature from 1960 to the present.

There is no precise timetable for the accomplishment of objectives but certain broad limits can be established for some items. The Salmon Compendium should be updated for the period 1960-64 by December 1968. Research inventories will be updated in 1968 and again in 1970. Catch statistics will be compiled annually. Major fishery problems will be dealt with at the estimated rate of five problems per year. Longrange planning will continue through the term of this program. Compilation of statistics, updating of inventories and status reports will be accomplished from information received from various state and federal agencies. The updating of the Salmon Compendium will be done through library research contracted to the Fisheries Research Institute at the University of Washington. The resolution of major fishery problems will be undertaken by the Technical Committee of the Pacific Salmon Inter-agency Council with assistance of experts in various fields through workshops, subcommittees, and other forms of communication.


5.0141, INVESTIGATE THE FEASIBILITY OF INTRODUCING SOCKEYE SALMON INTO RESERVOIRS
L. KORN, State Fish Commission, Portland, Oregon 97201 (14-17-001-1429)

Determine the ability of juvenile sockeye to survive and rear in and emigrate from certain reservoirs. Catalog reservoirs in Oregon as to their physical, chemical, and biological properties; evaluate these with respect to the potential for rearing sockeye.

5. LIVING SYSTEMS (NON-HUMAN)

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0142, SURVEYS OF SPAWNING SALMON
R.E. LOEFFEL, State Fish Commission, Salem, Oregon

Purpose: To establish trends of abundance for spawning salmon in Oregon.

Methods: Designated index areas of many streams are surveyed during spawning periods to determine peak counts of salmon. The counts are refined into a composite fish per mile index for each species and all stream areas surveyed.

Results: The trend in spawning populations of the various species aids in determining management policies.

Reports: Annual unpublished reports are prepared and maintained on file.

SUPPORTED BY Oregon State Government

5.0143, ALBACORE TUNA
R.E. LOEFFEL, State Fish Commission, Salem, Oregon

Purpose: To monitor the landings of albacore in Oregon fishery and collect information on the life history, behavior and environment of the albacore.

Methods: To conduct fishermen interviews and examine logbook data. To conduct a pre-season exploratory and oceanographic cruise annually in early July. Do limited tagging to learn more about migrations, age and growth of the albacore.

Results: The success of the albacore fishery fluctuates widely from year to year and is closely related to the ocean environment. The annual cruise enables us to gather environmental data to compare with catch and effort data. The cruises have enabled us to catch fish for tagging and have resulted in the early start of the commercial fishery on several occasions when we located quantities of tuna. The limited tagging work done to date shows that fishermen in Oregon waters and Japanese fishermen in the central and western north Pacific fish on the same stocks of albacore.


SUPPORTED BY Oregon State Government

5.0144, POPULATION ESTIMATES OF JUVENILE COHO SALMON IN SIX COASTAL STREAMS
R.E. LOEFFEL, State Fish Commission, Salem, Oregon

Purpose: To determine if annual fluctuations in abundance occur in juvenile coho populations and if the abundance can be related to parent abundance, returning adults and environmental conditions.

Methods: Stream sections have been identified. Each year the population of juvenile salmon in these sections is estimated. Results are compared to changes in temperature, flow, adult spawning populations, etc.

Results: Data suggest that abundance of juveniles during summer low-flow period not related to numbers of parent spawners but indicative of success of brood year.

Reports: Annual unpublished reports of population estimates.

SUPPORTED BY Oregon State Government

5.0145, MANAGEMENT OF THE OREGON TRAWL FISHERY
J.M. MEHEELAN, State Fish Commission, Salem, Oregon

Purpose: Monitor and regulate the fishery to obtain optimum yield and prevent overexploitation.

Methods: Interview fishermen for catch and effort data. Collect and analyze market samples for length-frequency, sex, age, and age. Estimate wink food and rockfish composition. Make periodic flights to survey foreign trawl fleets.

Results: We maintain continuous records of landing by species or groups, where these fish are caught and effort expended. Results are used for coast-wide management purposes such as the recent removal of the restriction of winter petrale sole landings.

SUPPORTED BY Oregon State Government
5. LIVING SYSTEMS (NON-HUMAN)

5.0146, MONOGRAPH OF THE FISHES OF THE ORDER PLECOTGNATHI
J.C. TYLER, Acad. of Nat. Sci. of Phila., Philadelphia, Pennsylvania 19103

This investigation is a continuation of research initiated under GB-5102. The Plectognathi are widely, but not unanimously, recognized as one of the major orders or phylectic lines of teleostean fishes derived of a perciform ancestry. The primary reason that there is any doubt about the naturalness of the Plectognathi is that it is a highly diversified order which has not yet been adequately defined. There are only about 320 Recent species of plectognaths, but the order is much more diversified than the majority of fish groups of a comparable number of species.

The investigator will systematically describe and illustrate the osteology of representatives of each of the presently envisioned 12 families of plectognaths, and of additional species of especially distinctive subfamilies when necessary, in order to compare the diversity of structural types within the order and to arrive at a meaningful classification that is in accord with what re-examination of the fossil record indicates. The usually reductive trends in the evolutionary pattern leading to the diversity of the plectognaths should be based on the osteology and the osteology of acanthuroids surveyed in order to re-evaluate the probability of their close relationship to the plectognaths.

SUPPORTED BY U.S. National Science Foundation

5.0147, MIGRATORY HABITS OF LARGE SHARKS
J.G. CASEY, U.S. Dept. of Interior, Marine Game Fish Research Lab., Narragansett, Rhode Island 02882

To determine the migratory patterns of sharks occurring in North Atlantic coastal waters from Maine to North Carolina. The plan of work is to: (1) tag sharks in the course of longline fishing operations conducted by the Sandy Hook Marlin and other longline operations under an additional shark study project; (2) supply tagging materials and instructions to cooperating sportmen and sporting clubs who have volunteered assistance; (3) continue tagging through October, 1966, at which time tag return data will be collected and analyzed.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0148, FAMILIAR RELATIONSHIPS IN TELEOST FISHES
C. HUBBS, Univ. of Texas, Graduate School, Austin, Texas 78712

It has recently been proposed that classification of teleost fishes should be based on phylectic lines. This philosophy has resulted in extensive rearrangement of families. Use of phylectic trends emphasizes parallel evolution of morphology. The absence of fossil evidence makes it difficult to determine which feature is a parallelism and which represents convergence. The interaction of two sets of chromatin in a single cytoplasmic environment is not likely to be influenced by parallel or convergent evolution, so it can be used to determine which alternative is actually parallel and which is actually phylogeny.

SUPPORTED BY U.S. National Science Foundation

5.0149, LIFE-HISTORY AND BIOLOGICAL WORK IN THE RESTORATION AND MANAGEMENT OD SPECIES OF IMPORTANCE TO THE FISHERIES OF THE VIRGIN ISLANDS

Phase 03: An analysis of the observed and collected materials from each station should eventually yield data related to species composition, population size, reproduction, feeding, and other biological functions related to fish and shellfish populations. In addition to plankton collections, nets, traps, hook and line, poisons, snares, and other collecting techniques will be employed to obtain and observe specimens. It is believed that the catamaran research vessel with its glass-bottomed well, large live well, provisions for SCUBA, and all its communications gear, will play an important role in this phase of the project. We anticipate much direct observation that could not readily be achieved by any other equally economical means.

Arthur E. Dammann and personnel to be hired or used on a collaborative basis.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish. Virgin Islands Government

5.0150, BIOLOGY OF ANADROMOUS ALOSIDS
J. DAVIS, Virginia Inst. of Marine Sci., Gloucester, Virginia

OBJECTIVES: 1. To obtain a collection of data on which to base estimates of the composition of the spawning run of aloidids in 1967 and the mortality rates of the species. 2. The estimation of the catch of each species of Alosa in each river system. 3. Finding the spawning sites of aloidid fishes in the York River system and in some of the tributaries to the Potomac River.

PROCEDURES: 1. Age and spawning history will be determined by counting rings and spawning checks on scales. 2. Catch records will be obtained from a sample of each type of gear in each river and the total number of gears of each type will be counted monthly. Total catch will be estimated by multiplying the average catch of the sample gears by the total number of units of gear. 3. The mainstem and its tributaries will be sampled for eggs, ripe fish, and newly hatched larvae. Presence of any of these will indicate a spawning area. Areas in which young fish are caught will be considered to be nurseries.


5.0151, ESTIMATION OF PARAMETERS OF STRIPED BASS POPULATION AND DESCRIPTION OF THE FISHERY OF LOWER CHESAPEAKE BAY
E.B. JOSEPH, Virginia Inst. of Marine Sci., Gloucester Point, Virginia 23062

The objectives of this research are three-fold: 1. To obtain an estimate of the age composition of the stocks of striped bass in lower Chesapeake Bay, with special reference to seasonal variation. 2. To determine the age selectivity of the major types of fishing gear that are removing striped bass from the population, and 3. To measure the relative strength of the incoming year class by means of young fish surveys.

The segment of the research covered by this contract period extends from 1 May 1967 - 30 November 1967. Since there are seasonal aspects to the above mentioned objectives, this research will not be completed in this period, but will be carried into future contract time segments.

Age composition will be based on samples of catch obtained from pound-nets and fyke-nets in the James, the York and Pohannock Rivers. Age determination will be based on the scale method.

Age selectivity will be determined for all major types of fishing gear, including hook and line, in use in the lower Chesapeake Bay area and compared to non-selective gear operating in the same river.

Young fish surveys will utilize both trawl and seine collections in all Virginia rivers supporting spawning populations.

The scientific personnel on this project will include, in addition to the principal investigator, Mr. Clarence Richards, Mr. Victor Burrell, and one PhD level biologist to be added. This staff will be assisted by technical and clerical help.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish. Virginia State Government

5.0152, THE DETERMINATION OF THE AVAILABILITY OF SEA ROBINS
E.B. JOSEPH, Virginia Inst. of Marine Sci., Gloucester Point, Virginia 23062

The objective of this phase will be to determine whether or not sea robins are equally available to bottom trawls in day and night. We anticipate that two species of sea robins Primus carolinus and P. evelains will comprise a significant portion of the total benthic industrial resource in the area under investigation. The diet availability of those species will be determined from
an analysis of catches from a series of experimental trawl tows conducted at frequent intervals through 24 hour periods. For consistency, the tows will be made in the same depth range, and so far as is possible on the same concentration of fish. This experiment will be done from the R/V Pathfinder working as close to Chesapeake Bay as concentrations of fish will permit. This work will be performed in November, 1965.

The information obtained in this phase will be used in formulating a sampling program to be described in a separate phase.

**Part 1 of 6.**


5.0153, **WINTER DISTRIBUTION OF FISHES**

_E.B. JOSEPH, Virginia Inst. of Marine Sci., Gloucester Point, Virginia 23062_

The objective is to determine the pattern of distribution in winter of ground fishes of potential industrial importance on the Continental Shelf between Cape May, N.J. and Cape Hatteras, N.C. Trawl tows will be made at predetermined stations and temperature and salinity of the bottom waters will be determined. The quantity of each size category of each species caught will be recorded on IBM cards with the associated physical data. Correlations between physical features of the environment and distribution of fish will be sought. Data gathering will extend from 1 January to 15 March 1966. Analysis will follow. Part 4 of 6.


5.0154, **SPRING DISTRIBUTION OF FISHES**

_E.B. JOSEPH, Virginia Inst. of Marine Sci., Gloucester Point, Virginia 23062_

The objective is to determine the pattern of distribution in spring of ground fishes of potential industrial importance on the Continental shelf between Cape May, N.J. and Cape Hatteras, N.C. Trawl tows will be made at predetermined stations and temperature and salinity of the bottom waters will be determined. The quantity of each size category of each species caught will be recorded on IBM cards with the associated physical data. Correlations between physical features of the environment and distribution of fish will be sought. Data gathering will extend from 15 April to 30 June 1966. Analysis will follow. Part 5 of 6.


5.0155, **DISTRIBUTION, AGE GROWTH, AND MORTALITY STUDIES OF SALT WATER FISHES OF IMPORTANCE TO SPORT FISHERMEN**

_C.E. RICHARDS, Virginia Inst. of Marine Sci., Gloucester Point, Virginia 23062_

Data on Pogonias cromis (black drum), Sciaenops ocellata (red drum), Leiostomus xanthurus (spot), Rachycentron canadum (cobia), and other fishes is obtained by various sampling methods carried out in Chesapeake Bay and the waters off Eastern Shore Virginia. Further study of tagging results to questions of migration, rates of exploitation and mortality is being conducted in addition to the common tagging program. A more intensive tagging effort will be made in 1966.

**SUPPORTED BY Virginia State Government**

5.0156, **INTERVIEW AND OBSERVATION**

_E.B. JOSEPH, State Comm. of Fisheries, Newport News, Virginia 23608_

The objective of this phase is to obtain information concerning the distribution of species of ground fish of potential industrial importance in the shelf waters between Cape May, N.J. and Cape Hatteras, N.C. Information will be obtained by interviewing fishermen who have fished the area and also by placing observers aboard trawlers fishing in the area. Data obtained will be stored on IBM cards to facilitate retrieval and analysis. Hampton, Virginia will be the primary interview site.

5.0157, **TAG LOSS**

_P.K. BERGMAN, State Dept. of Fisheries, Olympia, Washington_

Tagging will commence as soon after October (1966) as possible, located off the N. W. Washington coast. Fish will be sexed and measured. Data will be placed in a computer program so that differential tag loss can be studied, particularly in relation to fish size. Additionally, fish will be tagged under improved techniques and equipment adjustments to determine means of achieving more positive tag retention. X-ray techniques will also be used to study tag placement. Phase 1 will include lake poisoning where 1964 brood coho were reared and residualism occurs. Work will commence in June 1966.


5.0158, **TAGGING ENGLISH SOLE, PETRALE SOLE, AND PACIFIC COD**

_E.K. HOLMBERG, State Dept. of Fisheries, Olympia, Washington_

The objectives under the tagging phase will be to provide information relative to the migrations and status of English sole, Petrale sole, and Pacific Cod stocks, on which the Washington bottom fishery operates. The stock used for tagging will come from catches made from chartered commercial fishing vessels, during the normal fishing seasons for the respective species. Charters will include in addition to the vessels, crews, gear, supplies, and meals. Technical staff conducting the tagging will be assisted by the charter crews. Charter tagging trips will vary in time from 10 to 15 days according to conditions.

English Sole - Approximately 5,000 fish will be tagged with serial numbered Peterson disc tags. Tagging will commence as soon after October (1966) as possible, located off the N. W. Washington coast. Fish will be sexed and measured.

Petrale Sole - Approximately 5,000 fish will be tagged with serial numbered Peterson disc tags. Tagging will occur during November (1966), in the Estevan Deep. This work will provide information on the efficacy of the present winter closure regulations. Condition of the fish will be observed and measurements taken as above.

Pacific Cod - Approximately 5,000 fish will be tagged with serial numbered Peterson disc tags. Tagging will be performed during November (1966), in the Strait of Juan de Fuca, offshore from Port Angeles. Unmarked fish will be randomly sampled for a determination of sex ratios. Measurements as above will be taken.

**Part 1 of 3**


5.0159, **TAG RECOVERY, ENGLISH SOLE, PETRALE SOLE, AND PACIFIC COD**

_E.K. HOLMBERG, State Dept. of Fisheries, Olympia, Washington_

The objective of the tag recovery phase will be to ascertain the fate of fish tagged earlier, and in turn, interpret and relate the tagging results to questions of migration, rates of exploitation and mortality which recovered tags may reveal alone, or in conjunction with other biological data collected both on the tagging grounds and through sampling. Tagging will be a means of determining the identity of stocks and their population.

111
5. LIVING SYSTEMS (NON-HUMAN)

Scheduled daily port visits at which tags will be recovered, will be at Seattle, Everett, Anacortes, Bellingham, and (or) Blaine. These visits will be in conjunction with the Department’s fisherman interview and biological sampling program now in its 15th year.

Rewards of up to one dollar ($1.00) will be paid for tags recovered, as follows: Fifty cents ($0.50) for each tag returned, twenty-five cents ($0.25) for each tag with accurate fishing information provided, twenty-five cents ($0.25) for each tagged fish in a frozen condition.

For purposes of data analysis, Walford’s method will be used for asymptotic length, Von Bertalanffy’s Growth method will be followed and Peterson’s Population Estimate will be attempted. The experiments are designed for data treatment by computer analysis methods.

Part 2 of 3.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Washington State Government

5.0160, SAMPLING OF GROUNDFISH STOCKS

E.K. HOLMBERG, State Dept. of Fisheries, Olympia, Washington

The objective of sampling will be to provide background information to complement the tagging studies. Samples of 400 fish of each species involved in Subproject 1 will be taken at approximately fourteen day intervals throughout the season, as fishing conditions dictate. Fish will be sexed, measured to the nearest mm., and weighed to the nearest gram. Sampling will occur at landing ports of Bellingham and Seattle.

English Sole - The opercular bones will be taken for age determination. Catch curves (weighted) of age composition will indicate recruitment and total mortality rates.

Petrale Sole - Otoliths will be collected for age determination. Other biological data will be treated as above.

Pacific Cod - Age determinations will utilize length measurements using Harding’s Method. Other data will be treated as above.

Detailed examinations of biological material and data treatment will be conducted at the Department’s University of Washington Laboratory. During those sampling trips, where time will not permit sampling a full 400 fish without delaying processing plant operations, fish will be purchased and returned to the laboratory for detailed examinations.

Part 3 of 3.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Washington State Government

5.0161, COHO MARKING

H. SENN, State Dept. of Fisheries, Olympia, Washington

Coho marked under this phase will ultimately contribute to a better knowledge of the contribution of hatchery propagated coho to the several fisheries of Washington, Oregon, and Canada.

Marking of 1965 brood Puget Sound hatchery coho will commence in June. These will include four double-fin marks established at a meeting of the Pacific Marine Fisheries Commission.

Marking procedures will be those previously established for marking fall chinook under the Columbia River Fishery Development Program.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Washington State Government

5.0162, SAMPLING OF MARKED COHO

H. SENN, State Dept. of Fisheries, Olympia, Washington

Coho of 1965 brood, previously marked at the Department’s Columbia River hatcheries, will be sampled during October and November to determine the numbers of marked and non-marked which will be released in the spring of 1967. This sampling procedure is one established and in use for fall chinook under the Columbia River Fishery Development Program.

Part 2 of 4.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Washington State Government

5.0163, RECOVERY OF MARKED COHO

H. SENN, State Dept. of Fisheries, Olympia, Washington

During the last half of spring and early fall of 1966, marked coho of the 1964 brood, liberated from Puget Sound hatcheries, will be returning to hatchery racks at jacks. Where possible, these will be recovered by hatchery crews. Others of the same brood year will appear in the fishery, where they will come within the scrutiny of existing catch sampling programs. Recovery data will be forwarded to the Oregon Fish Commission Data Processing Laboratory at Clackamas, Oregon, under procedures now followed in the recovery of marked fall chinook for the Columbia River hatchery evaluation program. Additional mark recovery data will be supplied by Canada, from similar sampling conducted in the British Columbia fisheries. Procedures for reporting will conform to those established between the state of Washington and British Columbia for the mutual exchange of marked and tagged fish data.

Part 3 of 4.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Washington State Government

5.0164, MARKED COHO LIBERATION

H. SENN, State Dept. of Fisheries, Olympia, Washington

Coho of the 1965 brood, at both Puget Sound and Columbia River hatcheries, will be liberated at the hatcheries’ sites in the customary manner for yearling coho, during early spring months of 1967. These will comprise both marked and unmarked fish. Marked to unmarked ratios will be established for each hatchery.

Part 4 of 4.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Washington State Government

5.0165, MANAGEMENT OF COLUMBIA RIVER COMMERCIAL FISHERY

A.L. OAKLEY, State Dept. of Fisheries, Seattle, Washington

Purpose: Regulation of commercial fishery to obtain maximum sustained yields from the resource.

Methods. Predict run size and timing for certain anadromous species, monitor commercial catch and escapement and compile detailed landing statistics for purposes of evaluating commercial fishery. Analyze escapement-production data to establish optimum escapement levels for important runs.

Results: Columbia River fish runs are being harvested commercially on a biological basis. Declines in certain stocks can be evaluated, based on data collected in this program, and corrective action suggested.

Results: Annual progress reports. Publications have been completed on fecundity of Columbia River chinook, timing of Willamette River spring-run chinook in the Columbia River, racial timing of chinook salmon in the lower Columbia River, trends in production rates for upper Columbia River runs of salmon and steelhead and a depensatory process based on predation concept of hunger. A manuscript relating to the effect of environmental changes on reproductive curves was submitted for publication. Several reports relating to fish passage and spill patterns at ice harvest Dam were submitted to the U. S. Army Corps of Engineers.

SUPPORTED BY Washington State Government
Oregon State Government

5.0166, ANALYSIS OF JAPANESE CATCH STATISTICS

R.A. FREDIN, U.S. Dept. of Interior, Biological Laboratory, Seattle, Washington 98102

The Japanese high seas salmon fishery annually operates about 370 catcher boats over several hundred square miles of ocean during a 60 day fishing season, exploiting major salmon runs of both Kamchatka and Alaska.

The work of this project consists of collating and analyzing fisheries statistics and biological data from the Japanese high seas salmon fishery and Japanese research vessels in the North Pacific Ocean to (1) determine annual fluctuations in abundance of the 5 species of salmon in the high seas fishing areas and causes of same, (2) ascertain seasonal and intra-seasonal changes in the temporal-spatial distributions of the 5 species of salmon and re-
late these to oceanographic conditions, maturity schedules, timing of inshore runs or other factors, (3) assess effects of high seas salmon fishing on the conservation and productivity of Bristol Bay sockeye salmon and northern Alaska chinook salmon runs, (4) provide stock and fishery information for predicting the size and high seas rate of exploitation of Bristol Bay sockeye salmon runs, and (5) determine potential effects of expanded high seas salmon fishing operations on U.S. salmon stocks.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0167, POPULATION DYNAMICS (BIOMETRICS) OF EXPLOITED FISH GROUPS OF THE NORTH PACIFIC OCEAN AND PACIFIC COAST
R.A. FREDIN, U.S. Dept. of Interior, Biological Laboratory, Seattle, Washington 98102

Research on the population dynamics of exploited fish stocks of the North Pacific Ocean and Pacific Coast of North America is conducted for the purpose of evaluating the current status of the stocks, measuring the degree of utilization, and determining the conditions necessary for achieving maximum average yields. Fishery statistics and biological data on Pacific salmon, Pacific halibut and other exploited fish stocks, such as king crab and bottom fish, are analyzed for fluctuations in abundance and changes in composition and characteristics of the stocks. Various statistical methods and mathematical population models are employed in studying causes of fluctuations in abundance of stocks, estimating the effects of fishing on sustainable yields for single and mixed stocks, determining yield per recruit and stock recruitment relationship, and estimating optimum stock sizes and maximum average yield.

Oceanographic and meteorologic observations and measurements might contribute significantly to the interpretation of biological information on population sizes and changes.

Most of the data compiled and analyzed in this research project are recorded on punched cards or magnetic tape and processed by electronic computers.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0168, BOTTOMFISH EXPLORATIONS

Bottomfish exploration is primarily concerned with benthic vertebrate populations. The objectives are to define, in time and space, the quantitative and qualitative distribution of aquatic benthic vertebrate resources having a potential for commercial utilization, and to provide an appraisal of these resources.

In FY 68 a cruise in scheduled to develop new techniques in the use of rollers on the footrope of a bottom trawl to permit trawling on rough bottom, and to explore rough-bottom areas off the Washington coast. Also proposed is a cruise to assess deep-water sablefish resources off Washington and Oregon.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0169, ADULT SALMON BEHAVIOR STUDIES IN RIVERS AND AT DAMS (SONIC TRACKING)
J.H. JOHNSON, U.S. Dept. of Interior, Biological Laboratory, Seattle, Washington 98102

This project seeks information which will contribute to a sound assessment of the effect of reservoirs and dams on anadromous fish runs, specifically on adult salmonid returning to Columbia River system spawning areas. Such an assessment requires an accurate knowledge of migration timing and spawning area locations before dams are constructed, and of the amount and nature of mortality resulting directly from fish passage over dams.

The project's primary research tool at present is the sonar fish tag, a miniature high frequency sound transmitter attached directly to the fish. Sonic tagged fish can be tracked individually from boats, their continuous movements noted in precise detail, or their progress and dispersant upstream can be measured by means of automatic recording monitors placed at intervals along the shore above a tagging site.

Studies in progress are attempting to pinpoint the causes for losses of adult salmon between Bonneville, Priest Rapids, and Ice Harbor dams using sonic tracking devices and automatic recording monitors placed at strategic intervals along the Columbia River and tributary streams.

Studies are planned on the behavior of adult salmonids in estuaries, using sonic tracking techniques to examine migration in relation to tides, freshwater inflow, salinity, and other environmental factors.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0170, OCEAN GROWTH AND MORTALITY OF SALMON J. LALANNE, U.S. Dept. of Interior, Biological Laboratory, Seattle, Washington 98102

Tagging studies have demonstrated that it is not presently feasible to obtain reliable estimates of short-term natural mortality for salmon. Consequently, these mortality studies are deferred with a report on Tagging Experiments on the Natural Mortality of Bristol Bay Sockeye Salmon (O. nerka) during their last few weeks at sea. Growth work will continue and includes a study of the marine growth of chum salmon (O. keta) based on periodic sampling at sea and a study of the relationship between the scale growth-body growth of chinook salmon (O. tshawytscha).

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0171, GROUNDFISH INVESTIGATIONS (POTENTIAL YIELD OF UNDERUTILIZED GROUNDFISH STOCKS) H. LARKINS, U.S. Dept. of Interior, Biological Laboratory, Seattle, Washington 98102

Program objectives: short-range, to determine maximum sustainable yield for fish stocks that are currently underutilized or are being endangered by foreign fishing; long-range, to predict year-class fluctuations and distribution patterns allowing maximum harvest of Pacific Northwest groundfish stocks, and to develop the scientific background necessary for sound international management of such stocks.

Recent increases in program funds and personnel will allow many of the planned research phases to be started earlier than anticipated or operated at an accelerated level. Along with the biological work already in progress with Pacific hake and Pacific ocean perch (size, age, maturity, growth, mortality, and recruitment) we are beginning; a groundfish tagging research and development project; a biological survey of latent fishery resources; an evaluation of economic conditions that affect the groundfisheries and resultant catch per unit of effort statistics; an egg and larval fish identification study; and a cooperative age reading unit with the Washington Department of Fisheries.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0172, PELAGIC FISH EXPLORATIONS M.O. NELSON, U.S. Dept. of Interior, Exptl. Fish & Gear Res. Base, Seattle, Washington 98102

Pelagic fish exploration is concerned with pelagic vertebrate populations. The objectives are to define, in time and space, the quantitative and qualitative distribution of aquatic pelagic vertebrate fish resources having a potential for commercial utilization, and to provide an appraisal of these resources.

Emphasis during FY 68 will continue on hake. Extensive use will be made of acoustical counting equipment to quantify hake populations.

A new project to assess the offshore saury resources was initiated in FY 68. One three-week cruise was conducted using various colored lights to attract the saury to the vessel, and lift and gill nets were employed to harvest them.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
5. LIVING SYSTEMS (NON-HUMAN)

5.0173, ADULT MIGRATION RATES
H.L. RAYMOND, U.S. Dept. of Interior, Fish Passage Res. Program, Seattle, Washington 98102

The environment in the Columbia River System has been changed from a free-flowing stream to a series of dams and impoundments. In a few years a similar change will take place on the lower Snake River. How will this progressive change in environment affect the populations and timing of the many races of salmon migrating upriver to spawn? Data obtained from this program would be useful in: (1) planning adequate fish facilities, by knowing numbers and times of arrival at planned dams; (2) managing the fishery by knowing times of arrival and expected numbers of the major races of chinook salmon in the commercial fishing areas; (3) identifying spawning grounds in areas soon to be inundated by new dams; and (4) planning rehabilitation of depleted runs by seeding these runs with other races having similar timing.

The technique involves sonic tagging a specific number of salmon at Ice Harbor Dam on the lower Snake River and monitoring their progress upstream to their spawning grounds by means of recorders at intervals up the main river and in the major tributaries. Gradual expansion of the program would follow until the entire Columbia River System is under study.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0174, FISH POPULATION STUDY
R.P. SILLIMAN, U.S. Dept. of Interior, Biological Laboratory, Seattle, Washington 98102

This is a study of the response of fish populations to fishing and to environmental changes. It will be conducted by two means: (a) Experimental laboratory fish populations (b) Mathematical models of populations.

Initial experiments are testing the interaction effects of holding populations under three different food levels and three levels of fishing intensity (3 x 3 table). An analog computer is being used for the simulation of fishing yields through the continuous solution of differential equations. Future experiments will study the effect of other variables, such as temperature and water chemistry.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0175, FISH POPULATION STUDY
R.P. SILLIMAN, U.S. Dept. of Interior, Biological Laboratory, Seattle, Washington 98102

The purpose of this work is to study the detailed responses of fish populations to varying fish stock levels and environmental conditions. Work is being performed with experimental laboratory populations in aquaria, and with mathematical models. Experimental animals include Lebistes reticulatus, Xiphophorus helleri, Tilapia macrolepida and T. mossambica. An analog computer is employed in constructing mathematical models.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0176, MARINE FISH BEHAVIOR
R.B. THOMPSON, U.S. Dept. of Interior, Biological Laboratory, Seattle, Washington 98102

Researchers will conduct basic and applied behavior studies on commercially exploited and potentially exploitable marine species. The objective of this project is to improve the efficiency of harvesting and managing marine fishery resources through the better understanding of the continuous behavior patterns of the target species. Fundamental principles of fish psychology will be developed; patterns of behavior will be investigated, analyzed, and described so that these can be used to best advantage by the fishers and resource managers. Studies will be made of the biological and exploitative significance of the different behavior patterns; especially the controlling stimuli and physiological mechanisms involved in feeding, individual and group movements, and migrations, reproduction, and the reactions of fishes within the zone of influence of fishing gear.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0177, DROPOUT OF SALMON FROM GILL NETS
R.B. THOMPSON, U.S. Dept. of Interior, Biological Laboratory, Seattle, Washington 98112

The objectives are to study the effects of gill nets on adult salmon in the commercial fishery in terms of dropouts and mortalities.

1. Within the artificial environment of a salt water pond observe the dropout ratio, mortality rates, behavior patterns, external injuries, and measure fatigue of salmon exposed to gill nets.

2. Determine the effects of gill nets on adult salmon in the inshore commercial fishery.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0178, ESTUARINE WATER QUALITY AND FISH DISTRIBUTION
D.E. BEVAN, Univ. of Washington, Graduate School, Seattle, Washington 98122

Increasing demands upon the water resources of the estuary of the Nooksack River threaten alteration in water quality. The project will develop measures of 'fishes well-being' in areas of dispersal of pulp and paper effluents. Patterns of feeding and the physiological condition of juvenile salmon moving through the estuary will be related to environmental conditions. Quantitative measures of the fish's distribution and behavior will be related to chemical and hydrographic monitoring of the estuary.


5.0179, FORECAST OF KODIAK ISLAND PINK SALMON RUNS FROM ABUNDANCE OF JUVENILES IN ESTUARIES
D.E. BEVAN, Univ. of Washington, Graduate School, Seattle, Washington 98122

The objective of this work is to develop a method of predicting the returning runs of pink salmon to Kodiak Island based on the relative numbers of juvenile salmon migrating seaward. Annual variations in abundance of juvenile salmon are estimated from the results of surface trawling in 4 bays which are representative of most streams on Kodiak Island. Since the sampling gear and methods developed for this work are new and have potential for widespread use, it is essential that the dynamics of the sampling be determined in order to achieve its most efficient use. Such a study will be accomplished by analysis of performance tests of the net to be conducted at Kodiak Island in conjunction with the trawling surveys. These tests will enable us to determine the variabiliy and efficiency of the tow net.

Commensurate with the need for improving this forecast technique, the recent development of a method for mass marking salmon fingerlings by means of sprayed fluorescent pigment promises to be a valuable aid in determining mortality, migration, and quantitative abundance of young salmon. A feasibility test will be conducted at Kodiak Island to determine whether a marking program successfully can be integrated with juvenile salmon indexing studies.


5.0180, TAGGING SALMON IN THE OFFSHORE WATERS OF THE NORTH PACIFIC
R.L. BURGER, Univ. of Washington, Graduate School, Seattle, Washington 98122

The main objective of the research is to study the distribution, abundance, migrations, and general ecology of the principal stocks of salmon, both Asian and North American throughout the North Pacific Ocean and Bering Sea. The tagging is part of a large scale research program being pursued by the International North Pacific Fisheries Commission (Canada, Japan, and the United States) in order to provide data to implement the terms of a tripartite treaty between the three countries. The research is coordinated and similar research is being pursued in Canada and the United States. The work is also coordinated with a number of other approaches to the problem including research on methods...
of identification by means of serology, meristic counts, morphological features and parasites. Methods used are to catch salmon of all species and age groups at sea with purse seine gear and longline gear, tag them and later recover them from the commercial fisheries around the Pacific rim. Scales are taken for age determination, and some specimens examined internally for parasites, maturity, and stomach contents. Oceanographic data on temperature, salinity and currents are collected at all fishing stations. Operations in 1967 will be directed at the migration and ecology of juvenile salmon during their early ocean residency.

The work is being performed in the Gulf of Alaska and in the Bering Sea from the United States and Canadian coast westward to 180 degrees. The project started in fiscal year 1955 and the termination date is indefinite.

SUPPORTED BY University of Washington

5.0182. A PROGRAM FOR THE TRAINING OF STAFF MEMBERS FROM THE SCHOOL OF FISHERIES OF THE CATHOLIC UNIVERSITY OF VALPARAISO CHILE
J. LISTON, Univ. of Washington, Graduate School, Seattle, Washington 98122

In many of the protein-deficit countries of the world, the food potential of the sea has remained largely unexploited because of lack of technical proficiency. Chile's 2,900-mile coastline represents a valuable fisheries resource, insufficiently exploited because of the shortage of trained manpower. To build the necessary scientific competence, the School of Fisheries, founded at the Catholic University of Valparaiso about ten years ago, has made constant efforts to develop its facilities and strengthen its curriculum. Scientific and technological studies at the School are combined with practical experience, in a four-year course leading to a bachelor's degree. In addition to academic work in fisheries technology, food processing, biochemistry, marine biology, and oceanography, its students spend at least three semesters on fishing boats and in fish canneries and a processing plant.

SUPPORTED BY Rockefeller Foundation

5.0183. CHARACTERISTICS OF LAKE SUPERIOR WHITEFISH
M.M. BAILEY, U.S. Dept. of Interior, Research Station, Ashland, Wisconsin

The drastic decline of the lake trout in Lake Superior has made the whitefish of prime importance to the economy of Lake Superior commercial fishermen. Critical examinations of the several populations in the lake are mandatory to provide data for sound management and rational utilization of the species.

5.0184. LIFE HISTORY OF THE BURBOT AND LONGNOSE SUCKER
M.M. BAILEY, U.S. Dept. of Interior, Research Station, Ashland, Wisconsin

An understanding of the biology of Lake Superior requires knowledge of the life histories of fish inhabiting the lake. The burbot and longnose sucker are abundant in Lake Superior but little is known of their role in the biological community.

Present research is directed toward life history aspects of the species—distribution, age, growth, maturity, fecundity, and food—and their interrelationships with other species. The data and materials are collected in western Lake Superior by the Bureau's research vessel Siscowet.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0185. PINK SALMON INVESTIGATIONS - FRESHWATER ECOLOGY
W.R. HEARD, U.S. Dept. of Interior, Biological Laboratory, Auke Bay, Alaska

Total freshwater mortality of pink salmon (Oncorhynchus gorbuscha) has been measured in Sashin Creek since 1940. For the average brood year, only 6 percent of the total eggs potentially available for deposition produce fry migrating to the estuary, but survival may vary between 0.2 and 23 percent. Since 1943, odd year runs have consistently produced a greater magnitude of spawners and higher freshwater survival than even year runs. Mortality occurs between the time of egg deposition and fry emergence.

One of the goals of this research is to identify the factors causing mortality in spawning beds, determining which are density dependent and which are non-density dependent. Environmental factors including water flow and temperature, dissolved oxygen supply, gravel composition, permeability of the stream-bed, rates of oxygen removal due to decomposing organic matter and the mechanics and kinetics of spawningbeds, are studied in relation to mortality rates. Biological factors, including density, temporal and spatial distribution, fecundity and size of spawning adults are also measured in Sashin Creek and related to mortality rates.

Four experimental spawning channels in nearby Lovers Cove Creek provide similar natural environments where spawner density is controlled. Factors studied here, as related to spawner density, include distribution and other behavior patterns on the spawning beds, efficiency of egg deposition, egg retention and total freshwater mortality.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0186. PINK SALMON INVESTIGATIONS - INTERTIDAL ECOLOGY
J.H. HELLE, U.S. Dept. of Interior, Biological Laboratory, Auke Bay, Alaska

Periodic examinations are made of commercial landings and data are collected on size, age, sex distribution, and maturity. Assessment studies of spawning populations in western Lake Superior are conducted annually by the Bureau's research vessel Siscowet. Tagging studies currently in progress are designed to yield information on exploitation rates and homing instincts of the spawning population. Information gained from these studies may lead to recommendations for adjustments in the legal size limit for optimum utilization.

Future plans call for a comprehensive study of the early life history of the whitefish. Data will be collected on factors affecting year-class strength, survival of eggs and fry, and the distribution and habits of O- and I-group whitefish. Special emphasis will be given to the interrelations between whitefish and other species, both native and exotic.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5. LIVING SYSTEMS (NON-HUMAN)

Periodic examinations are made of commercial landings and data are collected on size, age, sex distribution, and maturity. Assessment studies of spawning populations in western Lake Superior are conducted annually by the Bureau's research vessel Siscowet. Tagging studies currently in progress are designed to yield information on exploitation rates and homing instincts of the spawning population. Information gained from these studies may lead to recommendations for adjustments in the legal size limit for optimum utilization.

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SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5B. FISH HABITATS

Physiochemical and Biological Properties: Effects of Environment. Including Pollution, on Fish.)

SUPPORTED BY Rockefeller Foundation
5. LIVING SYSTEMS (NON-HUMAN)

The life history and ecology of pink and chum salmon spawning in stream intertidal zones has been under study at Olsen Creek, Alaska since 1960. Olsen Creek is located in Prince William Sound where intertidal spawning by these two species is of major importance.

Research during the first four years was aimed at describing the physical changes which occur within the streambed during active tide cycles; assessing the magnitude, timing, distribution and biological characteristics of spawners; and measuring rates of growth, development and survival of eggs deposited in the various ecosystems of the intertidal zone.

On March 27, 1964, the Great Alaska Earthquake caused drastic changes in stream elevations in Prince William Sound through uplift or subsidence of large areas of land. Stream channels within the intertidal zone were most vulnerable to the effects of land changes associated with the earthquake. Olsen Creek was uplifted about four feet, resulting in a removal of 1/4 of a mile of stream channel from tidal influence and creating a new intertidal zone in a previously unexposed area.

Present research includes a continuation of the observations initiated during the first four years of study and an evaluation of the ecological changes brought about by the earthquake. In addition, laboratory research on the effects of salinity on the growth and survival of pink and chum salmon eggs and larvae is in progress.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0187. PINK SALMON INVESTIGATIONS - EARLY SEA LIFE OF SALMON
J.W. MARTIN, U.S. Dept. of Interior, Biological Laboratory, Auke Bay, Alaska

Studies of the early sea life of pink and chum salmon were initiated in 1962 at Auke Bay; in lower Chatham Strait in 1963; and extended throughout southeast Alaska in 1964 and 1965 as part of the Bureau's long-range pink and chum salmon research program.

Operations are based from the 58-foot research vessel M/V Heron which makes 8 to 12 day cruises throughout southeast Alaska from May to September. The M/V Heron serves as a mother-ship for Blue Boat, a 20-foot high-speed reconnaissance-catcher and has a laboratory for processing biological specimens and instruments for monitoring the sea-surface environment. Blue Boat, is equipped with a bow steering station for observations and fishing with a 100-fathom small fish round haul net. It ranges through study areas at high speed, while Heron proceeds between stations.

Additional biological investigations include: investigation of the relation of sea temperatures to survival of salmon fry; studies of the effects of water temperature on growth of salmon fry; rearing pink salmon in controlled saltwater temperature tanks in the laboratory; and investigation of the life histories of parasites which infect juvenile pink salmon in the sea.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0188. PINK SALMON INVESTIGATIONS - FRESHWATER ECOLOGY
W.I. MCNEIL, U.S. Dept. of Interior, Biological Laboratory, Auke Bay, Alaska

Total freshwater mortality of pink salmon (Oncorhynchus gorbuscha) has been measured in Sashin Creek since 1940. For the past two seasons only 6 percent of the total eggs potentially available for deposition produce fry migrating to the estuary, but survival may vary between 0.2 and 23 percent. Other studies have revealed that mortality occurs mostly between the time of egg deposition and fry emergence.

One goal of research conducted at Little Port Walter is to identify the causes of mortality in spawning beds, determining which are density dependent and which are non-density dependent. (Environmental factors including water flow and temperature, dissolved oxygen supply, and gravel composition and permeability are measured and related to mortality rate.) Biological factors, including density, temporal and spatial distribution, and size of spawning adults are also measured and related to mortality rate.

Another research goal is to develop a better understanding of the factors responsible for ecological change in spawning beds. In this regard, we are investigating rates of oxygen removal due to decomposing organic matter and the mechanics and kinetics of spawningbed siltation.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0189. SILVER SALMON STUDIES IN THE RESURRECTION BAY AREA
S.M. LOGAN, State Dept. of Fish & Game, Juneau, Alaska

Objectives: (1) To collect and analyze biological data concerning the distribution, abundance and timing of adult and out-migrant silver salmon smolts in the Resurrection Bay area. (2) To determine the age composition of adult and juvenile silver salmon smolts. (3) To determine the sport harvest of silver salmon in Resurrection Bay and natural mortality in salt water. (4) To investigate the fresh water environmental limitations on juvenile silver salmon in this area. (5) To determine the methods and means of increasing or extending the fresh water spawning and rearing areas of the watershed and mitigating fresh water mortality. (6) To determine the reintroduction potential of silver salmon in rehabilitated Beer Lake. (7) To provide recommendations for the management of silver salmon in these waters and direct the course of future studies.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0190. INVESTIGATION OF SPAWNING GROUND POTENTIALS AND GROWTH AND SURVIVAL OF JUVENILE SOCKEYE SALMON IN FRAZER LAKE SYSTEM
W.R. MEEHAN, State Dept. of Fish & Game, Juneau, Alaska

The objectives of this phase of the project are:

1) To evaluate spawning ground potentials of Frazier Lake in terms of quality and quantity of available gravel.
2) To determine present utilization of spawning areas by tagging upstream-migrant sockeye adults at Dog Salmon weir, and observing their distribution on spawning tributaries of Frazier Lake.
3) To enumerate and sample downstream-migrant sockeye salmon to obtain data regarding age, size and timing of smolts in the system.
4) To obtain preliminary limnological information concerning productivity of the lake itself, in terms of physical characteristics and plankton abundance and distribution.
5) To obtain preliminary limnological information concerning productivity of the lake itself, in terms of physical characteristics and plankton abundance and distribution.
6) To determine the reinfestation rate of non-salmon species.
7) To determine the age composition of adult and juvenile silver salmon smolts.
8) To determine the sport harvest of silver salmon in Resurrection Bay and natural mortality in salt water.
9) To investigate the fresh water environmental limitations on juvenile silver salmon in this area.
10) To determine the methods and means of increasing or extending the fresh water spawning and rearing areas of the watershed and mitigating fresh water mortality.
11) To determine the reintroduction potential of silver salmon in rehabilitated Beer Lake.
12) To provide recommendations for the management of silver salmon in these waters and direct the course of future studies.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0191. RESTORATION AND REHABILITATION OF EARTHQUAKE DAMAGE TO PINK AND CHUM SALMON STUDIES IN PRINCE WILLIAM SOUND
P.S. ROYS, State Dept. of Fish & Game, Juneau, Alaska

Major Overall Objectives: (1) Restoration of earthquake destroyed pink and chum runs in Prince William Sound. (2) Rehabilitation of spawning areas where production has been seriously curtailed.

Initial Objectives: (1) Biological and Engineering studies on 12 major streams in the subsided zone and 43 major streams in the uplifted zone. (2) Monitor streams to which restorative measures were applied during June 1067.

Procedures: (1) Engineering studies of priority streams to determine drainage areas; maximum-minimum volumes of flow; flow velocities; bottom composition; bed load; contours; profiles; cross-sections; silt content; and rate of erosion followed by topographic mapping of study sections. (2) Biological studies of pri-
Early life history data will be obtained from plankton samples and night lighting from oceanic cruises. Data on catches and catch per unit of effort will be obtained from resorts and charter boat operators.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0196, PELAGIC SHARKS OFF SOUTHERN CALIFORNIA
G.W. Baine, Univ. of California, Graduate School, Irvine, California 92664

This equipment will be utilized as the primary research vessel for a study of the pelagic sharks off Southern California. The objectives of this project are: the identification of those species found in this offshore region of the Northeast Pacific Ocean; the seasonal and annual population variations; and the physical factors influencing the abundance and distribution of these pelagic species. Detailed life history studies will also be undertaken for the more prevalent sharks encountered.

As a personnel menace, sharks constitute a severe morale problem. By studying the fundamental factors that affect and/or govern the distribution of sharks and other animals, one can gain knowledge that can be used to develop more effective techniques and concepts of personnel protection.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0197, FISHERY FORECASTING - TEMPERATE FISHERIES
G.A. Flitner, U.S. Dept. of Interior, Fishery Oceanography Ctr., La Jolla, California

This continuing project seeks to gain an understanding of the relationship between fish stocks and their environment which will serve as a basis for predicting time and space fluctuations in the availability of fish resources.

Sea-surface temperature charts for the eastern Pacific have been issued monthly since January 1960 and 15-day charts for the region adjacent to the U.S. west coast have been issued from April through October every year since 1960. Source of the temperature data is the ESSA-Weather Bureau’s marine synoptic weather observations collected from cooperating ships at sea; about 12,000 individual observations are obtained monthly. These charts have been highly successful and useful to tuna fishermen and to oceanographers and other marine scientists studying circulation features in the Pacific.

By-products of the weather summary program derived by using the computer at the University of California at San Diego, include the following: average sea temperatures (degrees F) by 2-degree squares; average sea temperatures (degrees C) by 5-degree squares; barometer averages (mb) by 1-degree squares; average meridional and zonal wind vectors (kts) by 1-degree squares; average wind velocity (kts) by 1-degree squares; and oceanic heat budget data (cal/ sq cm/day) by 5-degree square.

The present system acquiring real-time oceanographic and meteorological data from other Federal agencies has worked well and we plan to improve this system further by use of automatic data processing equipment. Future plans are to extend the forecasting service to other fisheries in the temperate fisheries zone—the salmon trolling fishery off northern California and the wetfish fishery out of southern and central California ports.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0198, LOCAL FISHERY SYSTEMS DEVELOPMENT
F.H. Hester, U.S. Dept. of Interior, Fishery Oceanography Ctr., La Jolla, California

The purpose of this project is to identify and develop new or underutilized fishery resources in California. Presently underway is a new basking shark fishery for the extraction of squalene from their livers. Investigation is continuing of the pandalid shrimp resources of the continental slope and of the canyons across the continental shelf in southern California in cooperation with the California Department of Fish and Game. Also under investigation is the possibility of introducing the small floating longline for broadbill and other swordfish to the California fishery, presently worked by small harpoon boats.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0199, LIFE HISTORY OF BILLFISHES
G.B. Talbot, U.S. Dept. of Interior, Tiburon Marine Lab., Belvedere - Tiburon, California 94920

OBJECTIVE: To determine age, growth rate by sexes, food habits, spawning period and spawning location, and catch statistics of striped marlin and Pacific sailfish.

PROCEDURE: Biological data will be collected from sport catches at Mazatlan, Baja California, and southern California.

5.1095, ECOLOGY OF THE KELP FORESTS
E.S. Hobson, U.S. Dept. of Interior, Tiburon Marine Lab., Belvedere - Tiburon, California 94920

This program attempts to determine relationships between sportfishes and their environment in this extremely important, but rapidly diminishing California marine habitat. Emphasis is on understanding and behavior in relation to time of day and night.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.1092, THE ROLE OF THE SENORITA, OXYJULIS CALIFORNICA, AS A CLEANING ORGANISM
G. W. Bane, Univ. of California, Graduate School, Irvine, California 92664

in the investigation of this cleaner fish, an attempt is being made to assess its role in maintaining the health of inshore sport fishes, which has been widely contended that most of the better inshore fishing locations in southern California are, in fact, cleaning stations, where sport fishes, and other species, are concentrated to have exoparasites and diseased tissue removed by this cleaner. Our work is designed to better understand this phenomenon, and to evaluate its significance to the sport fishery.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.1093, LIFE HISTORY OF BILLFISHES
G.B. Talbot, U.S. Dept. of Interior, Tiburon Marine Lab., Belvedere - Tiburon, California 94920

OBJECTIVE: To determine age, growth rate by sexes, food habits, spawning period and spawning location, and catch statistics of striped marlin and Pacific sailfish.

PROCEDURE: Biological data will be collected from sport catches at Mazatlan, Baja California, and southern California.

5.1094, LIFE HISTORY OF BILLFISHES
G.B. Talbot, U.S. Dept. of Interior, Tiburon Marine Lab., Belvedere - Tiburon, California 94920

OBJECTIVE: To determine age, growth rate by sexes, food habits, spawning period and spawning location, and catch statistics of striped marlin and Pacific sailfish.

PROCEDURE: Biological data will be collected from sport catches at Mazatlan, Baja California, and southern California.
5. LIVING SYSTEMS (NON-HUMAN)
SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0199, SPORTFISH YIELD OF NATURAL REEFS
D.J. MILLER, State Dept. of Fish & Game, Menlo Park, California

Objectives: To determine the yield in numbers and by weight of all species of fish taken by sport fishermen from two heavily fished reefs in Monterey Bay. Additional data on the movement by species, time of year, and size of fish from these reefs to adjacent areas will be gathered. Effects of kelp canopy removal on fish density and distribution will be determined on the Monterey Reef area.

Procedure: Reef yield procedures will include an intensive sport catch sampling program at Monterey and Capitola as well as tagging and trapping procedures on the reefs under study. The catches at these ports will be separated as to reef area of origin. Rewards will be given for fish returned with the tag intact. All species will be captured by hook-and-line or with traps using the project's 18-foot skiff. Scale samples will be taken from all fish released, for supplemental age and growth information.

Objectives: Effects of kelp canopy removal of giant kelp (Macrocystis) and bull kelp (Nereocystis) on resident fish populations (both juvenile and adult) will be determined on the reef area under study near Monterey. Underwater observations by SCUBA divers, photography, and trapping procedures will be used to determine density, distribution by species, and size of fish.

Comparisons of fish density-distribution will be made before and after cutting operations. Continued periodic observations will be made over several seasons in this experimental area.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.
California State Government

5.0200, SCRIPPS TUNA OCEANOGRAPHY RESEARCH PROGRAM
M. BLACKBURN, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

The Scripps Tuna Oceanography Research program has received practically all of its support from the Bureau of Commercial Fisheries through a continuing contract beginning in 1957. The purpose of this investigation is to increase the knowledge and understanding of physical, chemical, and biological conditions in the eastern tropical Pacific Ocean; to use this information to understand changes in availability of tuna in areas where a fishery now exists; and to identify areas into which the fishery for skipjack tuna might expand.

Since tuna spend their entire life on the high seas, their behavior is greatly influenced by changes in the oceanic environment. Research in this program, therefore, has centered on such subjects as the relation between tuna and temperature, between tuna and the distribution of their food organisms, primary production, and wind-caused upwelling. The STOR group has described and charted oceanographic properties and features of the eastern tropical Pacific which have been shown to be tuna-connected, and has begun the charting of chemical nutrients and microzooplankton samples taken on the EASTROPAC expeditions (1967-68). Other accomplishments of the program in tuna ecology are as follows: Experimental studies on the effects of various physical and chemical conditions affecting growth of phytoplankton, generalized summaries of oceanographic information of regions of present potential or potential tuna catch, analysis of time series of property measurements, studies of the El Nino current system, evaluation of planktonic fishery resources, studies of the distribution of pelagic mysid shrimps, and food chain studies.

From the beginning of the program to the present time, STOR members have published 70 scientific papers; in addition 7 are in press or have been submitted for publication.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0201, LOCATION OF INSHORE SPAWNING AREAS
W.A. LUND, State Board of Fish, & Game, Hartford, Connecticut

Objective: To determine the location of inshore spawning areas.

Procedure: Ripe bluefish are found in Long Island Sound during the latter part of July, and the spawning area for these fish is not known. A concentrated plankton sampling program should determine whether bluefish spawn in the sounds off Connecticut.

The problem of determining bluefish they might not exist in future years. If it does, samples can still be obtained in Block Island Sound and perhaps in the western end of Long Island Sound. Last year no attempt was made to sample these areas or to attempt to determine the extent of bluefish abundance. A concentrated effort was made in the offshore area where positive results were being obtained.

It is proposed to begin sampling the inshore areas during the first week of July. Sampling will continue on a biweekly basis until bluefish larvae are obtained. Once positive evidence has been gathered, a concentrated effort will be made to determine the extent of inshore spawning. Samples will be taken, when possible, throughout Block Island and Long Island Sounds.

The nets to be used will be the type which have proved to be successful in catching larval bluefish in offshore waters.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.
Connecticut State Government

5.0202, POTENTIAL FISHERY FOR RIVER HERRINGS IN CONNECTICUT RIVER
W.A. LUND, State Board of Fish, & Game, Hartford, Connecticut

During 1966, basic information will be gathered on the time and duration of the run of each species of herring (with the exception of Alosa sapidissima) which enters the Connecticut River. Physical data will be gathered and temperature will be constantly monitored near the mouth of the river. The entering adults will be sampled with gill nets and lengths, weights and sex will be recorded. Scale samples will be taken for age determination. This sampling will continue periodically during the entire run. The techniques worked out and the basic data gathered at this time will be used to plan a more intensive study to be conducted in 1967 and 1968.

A survey will be made to ascertain the major spawning areas of each species. This area will be sampled with gill nets, seine and plankton nets to determine the species present and if spawning has occurred. Physical and chemical data will also be collected at this time.

This preliminary survey augmented by information gathered on the other sub-projects should enable us to design an intensive survey which will be carried out in 1967 and 1968.

The laboratory facilities of the University of Connecticut, Marine Research Laboratory will be utilized for this sub-project.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Connecticut State Government

5.0203, FARMINGTON RIVER SHAD STUDIES
W.R. WHITWORTH, Univ. of Connecticut, Agricultural Experiment Sta., Storrs, Connecticut 06268

Objective: To determine the ability of a section of the lower Farmington River (1) to provide a migration route for American shad and anadromous salmonids, and (2) to hatch and rear eggs and young of the above fishes.

Procedure: Various points will be periodically sampled for plankton, bottom fauna, fish (eggs, larvae, and adults), selected chemical and physical characteristics, and a water-sample taken back to the laboratory for routine bioassay. Data will be compared by analysis of variance and graphically.

SUPPORTED BY Connecticut State Government

5.0204, FEEDING HABITS OF ATLANTIC TUNAS AND NEKTON ECOTOLOGY

Objectives: 1. To investigate and describe the feeding habits of Atlantic tunas. 2. To describe the distribution of components of the nekton community of the tropical Atlantic upon which tunas prey. 3. To investigate and describe the dynamics of the tuna forage nekton community and the ecological relationships
between these organisms and measurable environmental variables. To investigate how environmental variables relate to, and have an effect upon the distribution of tuna forage nekton.

Once the important food species are identified, attempts will be made to sample them by an adequate sampler and synoptically observe environmental features. Through this synoptic approach the ecological relationships between the organisms and their environment will be studied and described.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0205, STRUCTURE OF THE FISH FAUNA OF A FLORIDA CORAL REEF

W. A. STARCK, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124

The project involves three phases. The first is preparing maps of the topographic features and bottom types of the study area. The dominant sessile organisms associated with each bottom type will also be described. The second phase is a phylogenetic presentation of the fish species found in the area. Information on general behaviour, habit, size, color pattern, feeding habits, nocturnal behaviour, and various other information when available will be given for each species. The third and final phase involves putting together information from the first and second phases. Various characters of the fish species involved will be related to the distribution of the species in the environment and will also be related to the presence or absence of other associated characters. This work is the culmination of eight years of past effort in the study area and varying portions of the three phases are already complete.

SUPPORTED BY U.S. National Science Foundation

5.0206, EFFECTS OF MARSH MANAGEMENT STRUCTURES UPON FISHES

W. G. PERRY, Rockefeller Wildlife Refuge, Grand Chenier, Louisiana 70643

More and more people are trying to get maximum yield from their lands. This has lead to gradual draining, channelization and drying of many acres of prime marsh land. It is a known fact that these estuaries bring in young stages of game fish populations and the salinity of the water. 2. To determine the abundance of fish present with relation to tides, turbidity and water temperatures.

Procedure: When fish populations are sampled, salinities will be taken with the aid of a field hydrometer kit. Other field chemistries will include determinations for carbon dioxide and carbonate and bicarbonate alkalinity. At the same time, secchi disc reading will be made at each station and a water sample collected to be read later using a Jackson Turbidimeter. The corresponding collecting gears are Gulf III sea bed drifters. To ascertain the movements and migration of pre-recruit herring, exploratory cruises will include estuarine situations and some gear development will be undertaken for specialized sampling.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0209, THERMAL PREFERENCES OF MARINE FISHES AND INVERTEBRATES

D. W. BRIDGES, U.S. Dept. of Interior, Sandy Hook Marine Lab., Highlands, New Jersey

Introduce marine fishes and invertebrates into experimental aquaria or tanks having temperatures similar to the natural environment of the organisms. By altering substrates, lighting, etc., attempt to determine normal patterns of behavior and response in a particular temperature regime; compare the activity in experimental aquaria with that observed in the field. Then manipulate temperature so that vertical and horizontal gradients or thermal regimes are established; observe behavior which occurs concomitant with alteration of established temperature in order to determine if thermal preferences or optimal temperatures exist.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0210, EFFECTS OF HOT WATER MASSES ON MARINE FISHES

D. W. BRIDGES, U.S. Dept. of Interior, Sandy Hook Marine Lab., Highlands, New Jersey

After conditioning a group of fish to approach a feeding station on cue, introduce different hot water strata between the fish and the food source to determine the effect of water temperature on modifying their behavioral responses.

We will measure the rate of fish passage through heated water to determine at what level temperature may act as a barrier. Experimental animals will include forms commonly found in the Cape Cod area. Techniques will be developed which can be adapted to similar studies for evaluating effects of thermal influences anticipated in other coastal areas.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0211, INFLUENCE OF THE PHYSICAL ENVIRONMENT ON DISTRIBUTION OF YOUNG STAGES OF COASTAL GAME FISH

R. STONE, U.S. Dept. of Interior, Sandy Hook Marine Lab., Highlands, New Jersey

The fate of critical young stages of coastal migratory fish is governed largely by conditions of the physical environment. Physical measurements of the continental shelf waters will be concurrent with the collection of ichthyoplankton (see 2541-01- in an attempt to relate the distribution of young stages of fish to physical conditions in the environment. Hydrographic stations will be made on each of eight cruises from Cape Cod, Mass., to Cape Lookout, N.C., along 14 transects. Observations will include temperature, salinity, oxygen content and turbidity. Drift bottles and bottom drifters will be released at each station.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

119
5. LIVING SYSTEMS (NON-HUMAN)

5.0212, HYDROGRAPHY, SEDIMENTATION AND CHEMICAL ASPECTS OF THE REEF ENVIRONMENT
R.B. STONE, U.S. Dept. of Interior, Sandy Hook Marine Lab., Highlands, New Jersey

Measure selected parameters of the physical environment surrounding the reef materials to determine how these factors relate to the distribution of fish on the reef site. Divers will determine and record the following: speed and direction of current flow, rate of scouring or sedimentation, alignment and height of ripple marks, bottom type and water transparency at surface and bottom. Standard shipboard methods for measurement of temperature and salinity will be used to determine vertical and horizontal gradients of temperature, salinity and density.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0213, ESTUARINE BIOLOGY--RESPONSE OF LARVAE TO TEMPERATURE AND SALINITY
R.M. LICHTENHEK, U.S. Dept. of Interior, Biological Laboratory, Beaufort, North Carolina 28516

Atlantic menhaden hatch in the ocean and migrate into shallowest nursery areas at larval stage. The effect of temperature and salinity on survival may be a determining factor in year class size. Field observations have shown that low temperatures delayed entry of larvae into the estuary from the ocean and after establishment in the nursery, caused massive mortalities. Laboratory experiments were conducted to determine the lethal temperatures. Preliminary findings confirmed that larvae with a 3 degrees Centigrade may be the lower limit at estuarine salinities.

Plans are underway to continue the laboratory work when larvae become available in January 1964. Methods consist of holding larvae at various temperatures and salinities, with and without acclimatization to lower temperatures, to determine the lethal limit of chilling.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0214, ROUTINE SAMPLING AT SEVEN INDEX STATIONS
V.C. APPLEGATE, U.S. Dept. of Interior, Biological Station, Sandusky, Ohio

Early work conducted by the R/V Cisco in Lake Erie in 1957 indicated the desirability of establishing regular sampling stations in the western basin of the lake for collecting both fishery and limnological data. Relatively rapid changes in both the environment and the fisheries that were known to be occurring could only be identified in a long-term basis by such a program.

In 1958 and 1959, seven stations in the western end of the lake were visited in the spring, summer, and fall. Since 1960, only the summer visit to each station has been made due to limitations of funds, personnel, and equipment.

At each visit to each station, physical and chemical limnological data and plankton and bottom samples are collected by conventional procedures. Larger fish are collected by trawling and fry are sought with tow nets. Limnological data and plankton and bottom samples are turned over to the Biological Laboratory's Environmental Research Unit for analysis. Fish and fry collections are retained at the Sandusky Biological Station for current and future studies. Ultimately, all fishery and limnological data will be integrated by the two groups to demonstrate relationships that may exist between them.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0215, EVALUATION OF ESKAPEMENT OF ADULT SALMON TO OREGON COASTAL STREAMS
D.G. SKEESICK, State Fish Commission, Charleston, Oregon 97420

Numbers of chinook, coho and chum salmon in spawning runs in Oregon coastal streams are counted at times of peak of activity in standard survey units to record trends of abundance of these salmon. Analysis of this information is expected to show relations of biological and environmental factors to numbers of spawning fish in these streams.

SUPPORTED BY Oregon State Government

5.0216, ECOLOGY OF RECREATIONALLY IMPORTANT ESTUARINE FISHES IN OREGON
H.F. HORTON, Oregon State University, Agricultural Experiment Sta., Corvallis, Oregon 97331

The first objective of this project is to provide fundamental understanding of the ecological factors which influence the abundance and well being of the recreationally important fish species in Oregon estuaries. The second objective is to develop the understanding of the ecology of the various species into recommendations for management practices for the conservation of populations of estuarine fishes. Immediate objectives are: (1) To study the movements and migrations of Oregon's estuarine fishes in relation to the factors of their environment. (2) To estimate the periodic abundance and angler yield of the various populations of estuarine fishes. (3) To study the growth and mortality factors which may influence the maintenance of populations of estuarine fishes.

Intra-estuarine and coastal movements of the recreationally important fishes will be determined by the analysis of recoveries of tagged specimens. Estimates of population size and angler yield will be determined by use of the capture-mark-release-and-recapture technique. Growth rates will be determined by scale analysis, length-frequency distributions and empirical data on length recorded at periodic intervals. Mortality factors will be determined by fecundity, longevity and angler yield data. Environmental factors as temperature, salinity, tidal cycle and associated fauna will be recorded and related to the factors listed above. Based on the relationships developed, recommendations for management will be made.

SUPPORTED BY Oregon State Government

5.0217, INVENTORY SURVEYS OF OREGON COASTAL STREAMS
R.E. LOEFFEL, State Fish Commission, Salem, Oregon

Purpose: To assess the value of streams for spawning and rearing of salmon and to locate fish passage obstructions.

Methods: Salmon and steelhead habitat are evaluated on coastal river systems. Records are kept of bottom composition, obstructions, observations of fish, condition of the watershed and accessibility.

Results: Approximately 2,600 miles of coastal streams have been surveyed. These surveys have provided information for stream clearance, laddering projects and planting fish.


SUPPORTED BY Oregon State Government

5.0218, SPRING CHINOOK SALMON ECOLOGY STUDY
A.L. OAKLEY, State Fish Commission, Salem, Oregon

Purpose: To study production and ecology of spring chinook salmon in an eastern Oregon stream.

Methods: Trap and enumerate upstream-migrating adult spawners and downstream-migrating juveniles to measure production. Monitor physical factors affecting production. Study behavioral activities of juvenile chinook at various stages of development in their natural environment.

Results: Trapping facilities have been constructed for capturing upstream and downstream migrants. A detailed inventory of the physical environment was accomplished for each 100-foot section in 15 miles of the study stream. Downstream-migrating juvenile salmonids have been marked for recapture at locations below the trapping facilities. The efficiency of the downstream-migrant trap is being evaluated at various stream flow markng the fish at the trap and recapturing them after, release upstream. Length and weight data were obtained from juveniles collected in the study stream by seining and electro-fishing. Spawning ground surveys are conducted annually to determine potential egg deposition and the relationship of physical factors to choice of spawning locations.

Reports: Annual Progress Reports.

SUPPORTED BY Oregon State Government
The text is fragmented and contains errors. It appears to be discussing various biological and environmental studies related to fish and the Columbia River. Here is a summary of the topics mentioned:

1. **Stream Improvement Planning**
   - **R. Kramer**
   - Objectives: Focus on cataloging rivers and stream obstruction, utilizing upstream by anomalous fish, and conducting biological evaluations and specific improvement projects.
   - Work planned: Assessing various streams in Western Washington, excluding the Columbia River watershed, listing provided in detail.

2. **Effect of Supersaturation of Dissolved Nitrogen on Migrating Salmonids**
   - **J. Ebel**
   - Study on the significance of nitrogen in the Columbia River and its impact on migrating salmonids.

3. **Relation of River-Run Impoundments to Salmon Production**
   - **A.J. Novotny**
   - Focus on developing a self-sustained, field laboratory system designed for maximum flexibility. Will provide a working base for environmental studies in navigable impoundments, eventually in marine bays and estuaries.

4. **Juvenile Migration Rates**
   - **H.L. Raymond**
   - Studies on juvenile salmon and the changes in their migration rates.

5. **Prediction of Environment**
   - **G.R. Snyder**
   - Research on predicting environmental changes and their impact on salmon populations.

These topics are part of larger studies supported by various government organizations, including the U.S. Department of the Interior and others.
months. Potential benefits from timed releases of stored waters also are being evaluated in the light of proposed thermal-nuclear power developments in the Columbia Basin.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

50226. EFFECTS OF INDUSTRIAL EXPANSION ON THE AQUATIC ENVIRONMENT OF ESTUARINE AREAS

G.R. SNYDER, U.S. Dept. of Interior, Biological Laboratory, Seattle, Washington 98102

The Lower Columbia River and its estuary plays a critical role in the life cycle of anadromous salmonids. Each year millions of young fish move downstream from native rearing areas and artificial propagation facilities. These fish all pass through the lower river and estuary where they undergo physiological transformations in preparation for their movement from fresh to salt water. The estuary also is an important nursery area and the transition zone for marine species of fish.

Industrial expansion in this area by the thermal electric power, aluminum, and pulp and paper industries can drastically modify the environment. Forecasts indicate that over 2000 MW. of electricity (possibly 4000MW.) could be produced in the Columbia estuary by 1985. The effects of waste heat discharged from these plants could be detrimental to the overall aquatic ecology and specifically to the production of commercial species of fish. Limnological studies are planned to determine the existing ecology at sites known to have potential for industrial expansion. The effects of increases in water temperature on aquatic organisms at specific sites will be studied. Predictions of physical and biological changes will be made. The effects of the environmental changes on fish and on secondary organisms necessary for their survival and growth will receive initial emphasis.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

50227. WATER QUALITY AS RELATED TO SURVIVAL OF SALMON EGGS AND LARVAE

D.E. BEVAN, Univ. of Washington, Graduate School, Seattle, Washington 98122

One of the major uses of water reservoirs in the Pacific Northwest is the reproduction of salmonid fishes. Previous work has shown that water quality is of major importance in the success of salmon reproduction. The project will investigate the suitability of spawning areas in the Snohomish River drainage and measure the mortalities of eggs and larvae. Observations will be made to relate other uses of the water resource to water quality and water quality changes will be directly related to salmon embryo mortality. Water quality will be measured both in the stream flow and the sub-surface flow within the gravel by observing flow rate, oxygen content, pH, alkalinity, and the presence or absence of some of the more common insecticides.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rch University of Washington

50228. STUDIES OF SOCKEYE SALMON, ONCORHYNCHUS NERKA, IN THE NUSHAGAK DISTRICT, ALASKA

R.L. BURGNER, Univ. of Washington, Graduate School, Seattle, Washington 98122

The project is a long-range comparative study of the sockeye producing lake systems in the Nushagak District of Bristol Bay in Northwestern Alaska. Studies are made of the spawning and nursery area capacities of the lakes, the growth, abundance and survival of young salmon in relation to parent population density, the ecological and inter-specific relationships, and the limnology and food chain dynamics of the lake systems. Effects of the selective commercial gill net fishery on the salmon population dynamics are also under study.

SUPPORTED BY University of Washington

50229. MEASUREMENT OF SPAWNING SUCCESS AND FRY QUALITY OF CHUM SALMON UTILIZING A SPAWNING CHANNEL AT BIG BEEF CREEK, WASHINGTON

E.O. SALO, Univ. of Washington, Graduate School, Seattle, Washington 98122

The proposed work will include the improvement of the existing spawning channel, dikes, ponds and laboratory. The improvements include (1) additions to the walls of the channel, (2) addition of selected gravel, (3) reinforcement of dikes, (4) improvement of instrumentations and techniques in the laboratory for the measurement of fry and fingerling quality.

The schedule calls for the channel and ponds to be completed by August 1, 1968 to accommodate the early spawners. The work will be contracted. The location is the same as described in the original proposal. Principal and co-investigator are (1) Professor Ernest O. Salo and (2) Predoctoral Associate, K. Victor Koski. Additional biologists include one Master of Science candidate.


5. FISH PHYSIOLOGY-BIOCHEMISTRY

50230. DIURNAL-NOCTURNAL ACTIVITY OF THE QUEENFISH, SERIPHUS POLITUS

E.S. HOBSON, U.S. Dept. of Interior, Tiburon Marine Lab., Belvedere - Tiburon, California 94920

The habits of this croaker provide insight into factors influencing schooling, vocalizing and other behavioral characteristics of inshore fishes. Work is limited to the months May-September, when this fish is present inshore. During this period underwater observations made at all hours of day and night, along with analysis of digestive-tract contents and recordings of vocalizations by the croaker and incident-light measurements provide the data upon which this study is based.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

50231. MOTIVATIONAL ANALYSIS OF COURTSHIP BEHAVIOR

G.W. BARLOW, Univ. of California, Graduate School, Berkeley, California 94720

This grant is for the continuation of studies conducted under GB-5314. For the past decade, the investigator has been interested in the behavior of the cichlid fish, with the general approach being ethological in nature. An important part of the present proposal is to analyze aggressive, and courtship behavior in this species. An interrelationship between the two behavior patterns is noted in that aggressive behavior of the male toward the female first takes place followed by courtship and mating. Animated models will be used, with early work devoted to an examination of the role of basic variables involved in the presentation of the model itself. Subsequent studies will examine those stimulus conditions which influence aggressive as well as courtship behavior. Physiological indices, i.e., tissue changes found in the gonads and pituitary, will be correlated with behavioral changes.

SUPPORTED BY U.S. National Science Foundation

50232. EXPERIMENTAL STUDIES OF BEHAVIOR IN A CICHLID FISH

G.W. BARLOW, Univ. of California, Graduate School, Berkeley, California 94720

Brief Description of Research Project: This grant is for the continuation of studies conducted under GB-2210 at the University of Illinois. Cichlid fishes are ideally suited for studies relating sexual and parental behavior. Pair bonds persist, facilitating joint parental care. The female may be active in courtship, permitting a precise comparison of male and female behavior. Furthermore, cichlid fishes have relatively indeterminate growth. Sexually mature animals are thus available over a wide size range (up to four fold
in weight in the orange chromide), affording a unique opportunity to separate the influences of sex and size (dominance).

Under the present grant some information will be sought to clarify earlier findings on the effect of size on courtship, using artificial fishes to determine the specific parameters involved. Particular attention will be directed toward the parental phase. Egg-fanning will be resolved into its components and related to host, digging, and retrieving activities. To facilitate the analysis of retrieving, bubbles will be substituted for the eggs and larvae. The bubble carrying response will also be investigated to clarify the role of experience in developing the response, and to analyze the build-up and decay of a partially inborn response to a stimulus to which the fish do not habituate.

SUPPORTED BY U.S. National Science Foundation

5.0233, FUNCTION OF THE INTERRENAL GLAND IN TELLOST FISHES
H.A. BERN, Univ. of California, Graduate School, Berkeley, California 94720

This study is a continuation of work on the pituitary-interrenal axis of Tilapia mossambica and its regulation to osmoregulation. The effects of various experimental manipulations on quantitative and qualitative aspects of in vitro corticosteroid production by the interrenal-containing head kidneys of Tilapia are being studied, this work being directed toward eventual utilization of in vivo secretion as an index of in vivo interrenal activity. Analyses of corticosteroids in Tilapia plasma and of possible steroid secretory products of the Stannius corpuscles are also being carried out.

Morphologic responses of interrenal, adenohypophysis and Stannius corpuscles to changes in environmental salinities and other conditions are being investigated, using mean nuclear diameter as an index of activity. Osmoregulatory responses of Tilapia to hormone administration or deprivation are also under study. The effects of prolactin and of hypophysectomy on osmoregulation of Tilapia plasma under conditions of osmotic stress are being examined, and parallel experiments using interrenal hormones or ACTH alone and in combination with prolactin are being undertaken.

Comparative studies in these areas are being conducted on other teleosts. In particular, analysis of steroids and measurements of interrenal and adenohypophysial activity in relation to environmental salinity are being carried out in Mugil specis at the Stazione Zoologica of Naples.

SUPPORTED BY U.S. Dept. of Hth. Ed. & Wel. - P.H.S.

5.0234, CELL TRANSFORMATIONS, DIVISION, AND MOTION
D. MAZZA, Univ. of California, Graduate School, Berkeley, California 94720

In summarizing this program by 3 faculty members and 29 predoctoral and postdoctoral associates, only the main lines of study can be indicated. These are (1) the investigation of the subunits of microtubules and their assembly; (2) the interaction of colchicine and other antimitotic agents with structure proteins; (3) the structure proteins of motile systems other than cilia and the mitotic apparatus, especially ameboid movement; (4) the active role of surface processes in cell association in very early development; (5) nucleoproteins as primers for nuclear DNA polymerase; (6) characterization of an RNA that turns over rapidly in the nuclei of sea urchin embryos during early development; (7) structure of chromatin in sea urchin embryos; (8) the role of cell interaction in the control of hemoglobin synthesis in the chick; (9) the regulation of d-amino levulinic acid synthetase in the activity of the chick embryo; (10) biochemical changes accompanying muscle cell fusion and differentiation, including studies of (a) synthesis of myosin, (b) synthesis of DNA, (c) levels of DNA polymerase, (d) levels of RNA synthesis.

SUPPORTED BY U.S. Dept. of Hth. Ed. & Wel. - P.H.S.
5. LIVING SYSTEMS (NON-HUMAN)

properties of single units in the reptilian optic tectum. Parallel studies have been initiated for comparing the superior colliculus of many different types of animals. In the rat, studies of the rat colliculus and protoc-
tectal region have been completed. Current emphasis is being placed on the binocular projection in the primate colliculus.

Microscopic studies of the visual pathway in the primate colliculus. One series of experiments deals with axonal degeneration with silver and electron microscopic methods. This study establishes conclusively the purely afferent nature of the reptilian optic nerve. Other studies involve autoradiographic techniques employing thymidine-3H in regenerating optic pathways of teleosts.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0239, BLOOD CHEMISTRY OF FISHES
M.R. URIST, Univ. of California, School of Medicine, Los An-
geles - U.C.L.A., California 90024

Investigations will continue into the skeleton and body fluids of the Elasmobranchii with special attention being given to spe-
cies taken in deep water from the Pacific coast. Analyses of the sera of cyclostomes and teleosts taken in the same locations in deep water will be made for controls. By use of X-ray and flou-
rescent examination techniques, research will be conducted on the secretion of enamel and the basic biology of vertebral forma-
tion in deep water sharks, as well as the morphology and identifi-
cation of various types of vertebra. Complementary studies will be continued on tissue transplants and bone repair in saures, as well as blood calcium studies in cyclostomes, sharks, and bone/ fish.

This is part of the program in Hydrobiology concerned with the adaptations of marine organisms to life in the sea. Navel problems caused directly or indirectly by biological organisms, such as fouling forms, sonic forms, and other pests, require for their solution a thorough knowledge of the natural conditions of life of the organisms necessarily acquired for life in the sea.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0240, BIOLOGICAL TRANSPORT OF GASES AND OTHER SUBSTANCES
T. ENS, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

Transport of dissolved CO2 and bicarbonate ions in cells and across cell membranes, particularly the facilitation of such trans-
port by carbonic anhydrase, is being measured. Studies are being extended from mammalian red cells to other animal and plant

S.fk. in vitro studies of the carbonic anhydrase facilitation of CO2 transport are also being conducted.

Relative renal excretion patterns of urea, creatinine, water and electrolytes in kidneys of elasmobranch fishes are being ob-
tained. These will yield new information regarding the renal han-
dling of urea. This will be correlated with the handling of CO2 and bicarbonate ions in an attempt to examine the possible role of carbonic anhydrase in kidney function.

Transport of labeled water, electrolytes, and other sub-
stances across the gills of elasmobranch and teleost fishes is being studied. The data will be compared with those obtained in mammal-

S_SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0241, PHYSIOLOGICAL STUDIES ON FISHES LACKING HEMOGLOBIN
E.A. HEMMINGSEN, Univ. of California, Graduate School, San De-
mo - La Jolla, California 92038

The University of California, San Diego, proposes to con-
tinue investigating the physical adaptation of animals inhabiting polar regions by extending studies begun under GA-272 at Me-
Muro Station, Ross Sea, to the region about Palmer Station, Ant-
artic Peninsula.

The work involves catching fish of the family Chaenichthyidae which are characterized by an absence of hemoglobin for live specimens which will be needed in laboratory experiments to be conducted in the biolaboratory at Palmer Sta-
tion. Experiments include metabolic and respiratory studies to determine the oxygen consumption in terms of environmental oxygen tension and termpe ‘ure. Attention will be given to the effi-
ciency of the gills and importance of cutaneous respiration. The oxygen-carrying capacity of the circulatory system will be as-
essed by measurements of arterial and venous oxygen tensions of

cells, volume, heart rate and capillarization of skin and tissue. Comparative measurements will be carried out on other fishes possessing hemoglobin.

The field work will be completed at Palmer Station during austral 1967-68 by the principal investigator and one assistant.

SUPPORTED BY U.S. Dept. of Defense - P.H.S.

5.0242, CYTOTAXONOMIC STUDIES OF TELEOST FISHES
A.W. EBELING, Univ. of California, Graduate School, Santa Bar-
bara, California 93018

This investigation is for continuation of the research initiated under NSF grant GB-4277 for studies on the cytotaxonomy of
deepea.fishes.

Recent comparative studies of shallow marine and fresh-

C.S. fishes have strengthened hypotheses to be further tested during the proposed investigation; that even closely related teleosts are karyotypically distinguishable both numerically and morphologically; that most diploid numbers approximate or equal 48 with lesser numbers being the more specialized; that cytologically expressed heterogamy is widespread among teleosts and is especially prominent in deep-sea species; and that deep-sea fishes have longer, more heterochromatinized chromosomes, possibly relating to decelerated mitosis and therefore an 'economy of life' in the cold, impoverished depths. Also, as time permits, special studies of cytotaxonomic sex heteromorphy in the genetically well known freshwater cyprinodontiform minnows will broaden the more general investigations of teleost heterogamy.

Generally, the acet-orcein method of squashing hyptoni-
cally pretreated colchicinized tissues will be continued in observing karotypes of additional deep and shallow species and of the female tissues neglected in the previous investigation. Tissues other than gonadal will be more intensively treated, staining techniques will be expanded, and live specimens will be variously colchicinized. Tissue -culture of blood cells will be included in the

S_SUPPORTED BY U.S. Dept. of Defense - P.H.S.

5.0243, PARASITISM IN DEEPSEA FISHES
E.R. NOBLE, Univ. of California, Graduate School, Santa Bar-
bara, California 93018

The aim is to characterize parasitism in a deepsea environ-

S_SUPPORTED BY U.S. National Science Foundation
5.0244. **REPRODUCTIVE ISOLATING MECHANISMS IN PANAMANIAN INSHORE MARINE FISHES**

I. RUBINOFF, Smithsonian Institution, Baltim Heights, Canal Zone

Pairs of closely related species of fishes occur in Panama separated by the isthmus. The ancestral populations have been separated only since emergence of the Isthmus probably in the Pliocene. This project is designed to investigate the reproductive isolating mechanisms that have evolved since this separation. The ecology and behavior of the fish is being observed in nature. Reproductive behavior is being observed in the laboratory and tests of interbreeding potentials of species pairs are being made. Artificial hybridization will be attempted in all pairs.

**SUPPORTED BY** Smithsonian Institution

5.0245. **STUDY OF THE RIVER PHASE OF THE LIFE HISTORIES OF ALOSA PSEUDOHARENGUS AND AESTIVALIS**

W.A. LUND, State Board of Fish. & Game, Hartford, Connecticut

To study the life histories of Alosa pseudoharengus and aestivalis under the most ideal field conditions available and then utilize the results in large river systems, like the Connecticut River, where an intensive study such as this would be extremely difficult to do.

In general, it is proposed to construct a weir at a narrow section of the river to obtain: a. The range in temperature when the fish enter the stream. b. The size composition, sex ratio and age structure of the entering groups. c. The effects of illumination on the movements of the fish to the spawning grounds. d. An estimate of the total numbers of fish entering the book. e. An estimate of the total numbers of fertilized eggs which might be produced. f. An estimate of the mortality rate of adults on the spawning grounds by estimating the total number of fish returning to the sea. g. Fish for marking. The objectives of the mark are: 1. To establish whether it is possible to estimate total numbers of fish on the spawning grounds by a mark and recapture study. 2. To determine length of time fish remain on the spawning grounds. 3. To determine the degree of homing, and 4. If a high degree of homing is found, estimate the mortality at sea.

**Part 2 of 2.**


5.0246. **STUDIES OF FISH ENDOCRINOLOGY**

G.E. PICKFORD, Yale University, Graduate School, New Haven, Connecticut 06520

The objectives of this research are to enlarge our knowledge of endocrinological functions in the euryhaline teleost, Fundulus heteroclitus. Specific attention will be paid to the role of hormones in fresh-water adaptation, with special reference to the regulation of the blood; the regulation of thyroid function and characterization of the teleostean thyrotrophin; the separation and characterization of the teleostean growth hormone (in collaboration with Dr. A. E. Wilhelmi, Emory University); hormonal stimulation of the regressed testes of hypophysectomized fish and to study the growth rate. The data is incomplete but there is evidence that this animal has a wide tolerance to temperature and salinity conditions.

Levels-frequency distributions have been determined for the striped killfish, Fundulus majalis, to determine the salinity death point at high and low temperatures; to observe egg hatching time under varying temperatures and salinity conditions; to study the food intake; and to study the growth rate. The data is incomplete but there is evidence that this animal has a wide tolerance to temperature and salinity conditions.

**SUPPORTED BY** U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0247. **EVOLUTION OF ALL-FAEMALE FISHES**

R.J. SCHULTZ, Univ. of Connecticut, Graduate School, Storrs, Connecticut 06268

The genus Poeciliopsis, a viviparous fish found along the Pacific slope of Mexico, is made up of approximately 16 species. In addition to these, there are 5 forms of Poeciliopsis that give birth to exclusively female progeny. These all-female 'species' do not reproduce without benefit of males but must rely on other species for fertilization. The mode of reproduction and the appearance of the offspring depends upon the species that provided the sperm. In some cases the young are identical to the mother suggesting that the sperm merely served as a stimulus to embryonic development; in others, the progeny share characteristics of both parents and are true hybrids. All five forms are believed to have arisen through hybridization. It is the purpose of this investigation to determine the evolutionary pathway of these all-female fishes and to verify it by laboratory synthesis.

**SUPPORTED BY** U.S. National Science Foundation

5.0248. **MARINE SPORTS FISHES RESEARCH**

F.C. DAIHER, Univ. of Delaware, Graduate School, Newark, Delaware 19711

This project has been divided into different parts which include studies on the effects of temperature and salinity on striped killfish, an analysis of the fish populations in Delaware Bay and an analysis of the hogchoker population in Delaware Bay.

The general objectives of the study on the striped killfish, Fundulus majalis, are to determine the salinity death point at high and low temperatures; to observe egg hatching time under varying temperatures and salinity conditions; to study the food intake; and to study the growth rate. The data is incomplete but there is evidence that this animal has a wide tolerance to temperature and salinity conditions.

**SUPPORTED BY** Delaware State Government

5.0249. **OSMOTIC COMPONENTS IN ELASMOBRANCH BLOOD**

K.S. PRICE, Univ. of Delaware, Graduate School, Newark, Delaware 19711

Levels of the major osmotic components (urea and sodium chloride) in elasmobranch blood are being determined from specimens collected from the lower Delaware Bay region. Samples will be collected in the field from fish taken from waters of naturally varying salinity over the entire range of salinity and temperature that the particular species normally experiences. Additional specimens are being subjected to controlled salinity and temperature conditions in the laboratory in order to determine the changes which occur in plasma levels of the major osmotic components due to 1) changes in external salinity and 2) changes in water temperature.

**SUPPORTED BY** U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0250. **BIOLOGY, MORPHOLOGY, AND EVOLUTION OF THE DISK-FISHES OR SHARKSUCKERS**

E.H. LACHNER, Smithsonian Institution, Washington, District of Columbia 20560

The objectives of this study are: 1. To determine characters contributing to an understanding and interpretation of the nominal families and genera in the Order. 2. To determine the diagnostic characters in the analysis of the living and fossil species. 3. To determine the extent of differentiation of the various oceanic populations. 4. To study the hosts and the degree of specificity and association of the sharksuckers with other marine animals. 5. To correlate morphology with behavioral evolution among the species.

**SUPPORTED BY** Smithsonian Institution

5.0251. **PARASITES OF PHILIPPINE FISHES**

C.C. VELASQUEZ, Smithsonian Institution, Washington, District of Columbia 20560

(1) Preparation of manuscript of completed studies on trematodes and nematodes of freshwater and marine fishes. (2) Collection of more specimens for intraspecific variation. (3) Life cycle studies will be done when materials are available. (4) Studies on distribution, ecology and host-parasite relationships will be done when feasible.

**SUPPORTED BY** U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.
5. LIVING SYSTEMS (NON-HUMAN)

5.0252, STOCK IDENTIFICATION OF ATLANTIC TUNAS

An investigation of tuna population genetics by biochemical or serological means is being undertaken in the Atlantic. This study is an extension of the genotypic composition of tuna populations in the Caribbean and the tropical Atlantic by means of electrophoretic analysis of selected enzymes in tuna tissues.

Supported by U.S. Dept. of Interior - Nat. Res. - F.H.S.

5.0253, BEHAVIOR AND SENSORY PHYSIOLOGY OF SHARKS
A. Myrberg, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124 (NONR)

Objective: Sharks pose a physical, as well as psychological, hazard to personnel in the sea for operational or recreational purposes. They may also cause the loss of moored and floating equipment. They are capable of biting through armored cables and of puncturing flotation gear. In order to develop effective shark repellents and survival techniques, it is necessary to determine the factors in the environment which the shark can perceive and which it may use in locating and identifying sources of food.

Approach: The investigator is studying and measuring the sensitivity and range of vision and audition of a variety of shark species. He utilizes behavioral, as well as physiological responses obtained by electrocardiogram, respiration rate measurements as indicators of stimulus reception. Additional mechanisms are being used to detect responses, especially to sound and light which may be more accurate and quantitative than gross behavior patterns. The Acoustic-Video Array is being used to conduct sound playback experiments with free-swimming sharks.

Supported by U.S. Dept. of Defense - Navy

5.0254, RENEWAL RESEARCH PROPOSAL FOR HEARING AND ALLIED SENSES IN FISHES
A.A. Myrberg, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124

This work will be a continuation of research begun under grant GB-6 on hearing and allied senses in fishes. The principal and immediate objective of the proposed investigation is to obtain basic information about the quantitative aspects of hearing in fishes and on the physiological mechanisms of their hearing. Such information is of importance in the development of electronic equipment capable of detecting biological sound sources. Behavioral studies should be helpful in understanding how these animals utilize acoustic energy for the detection and location of moving objects and for orientation and communications. It is expected that major emphasis will be placed on measuring the acuity and sensitivity of these senses in the initial phases of the investigation and that later phases will deal with the significance of various sounds of animal origin to fishes as well as their ability to orient to sounds of underwater origin.

Supported by U.S. National Science Foundation

5.0255, IMMUNE MECHANISMS AND RESISTANCE FACTORS IN MARINE FISHES
M.M. Sigel, Univ. of Miami, School of Medicine, Miami - Coral Gables, Florida 33124

Immunological and immunochemical studies are being conducted in fishes at several phylogenetic levels. All of these animals are capable of responding to primary stimulation with a variety of antigens. They differ, however, in immunologic memory. So far, all antibodies, regardless of the duration of immunization, have been predominantly or exclusively associated with IgM, but a search for IgG in certain species is continuing. In some of these fishes, but not all, antibody activity is associated with a 7S moiety of IgM which is believed to be the monomer of the 19S pentamer. Although these fishes lack certain of the components of the immune mechanism of higher vertebrates their immune mechanism is not readily depressed by factors and conditions known to suppress immunity in higher animals. Suppression of the primary, but not secondary, response has been obtained with 6-MP. The thymus and pronephros of two marine teleosts are directly involved in antibody synthesis. Studies on antigen metabolism and clearance are in progress.

Supported by U.S. Dept. of Hlth. Ed. & Wel. - F.H.S.

5.0256, ARTIFICIAL SELECTION - FISH
D.L. Coppage, U.S. Dept. of Interior, Biological Laboratory, Sabine Island - Gulf Breeze, Florida

The objectives of this project are: (1) to determine if fish that survive lethal concentrations of pesticides possess some genetic factor that can be intensified in succeeding generations, and (2) to determine whether immature but rapidly developing ova concentrate proportionately more pesticide than mature ova, and what extent pesticides affect embryonic development and hatching, or growth and vigor of the fry.

Fish surviving pesticide tests will be selectively bred to drastically alter the genetic make-up in favor of these individuals. We will continue this selection for as many generations as are necessary to achieve our objectives. We will also expose mature fish to radioactively-labeled pesticides to trace transport of these chemicals to specific tissues, especially reproductive. Fertilized eggs of several species of estuarine fishes will be exposed to various pesticides at different stages in embryonic development, and the responses of different age fish to toxicants will be studied.

Supported by U.S. Dept. of Interior - Bu. Comm. Fish.

5.0257, LIFE HISTORY STUDY OF THE MOI, POLYDACTYLYS SEXFILIS

Objectives: To study various aspects of the ecology and life history of the moi, Polydactylus sexfili, with the ultimate objective of obtaining sufficient scientific information necessary for the proper management of this highly important salt water game species.

Procedure: 1. Assistance from selected sport fishermen and fishing clubs will be enlisted for the gathering of moi gonad samples and length-weight data. 2. A short manuscript on the hermaphroditic condition of the moi gonad will be prepared. Completion of the study on most aspects of the reproductive habits of this species is anticipated. 3. To obtain information on growth and migration, an intensive tagging program will be undertaken which will entail the capturing of moiilii, tagging with an internal anchor tag, and the immediate release of the tagged fish. (Previously moiilii were captured and reared for several months before being tagged and released). 4. Supplemental growth data will be acquired by releasing tagged moiilii in several commercial fish ponds.

Supported by U.S. Dept. of Interior - Bu. Sport Fish.

5.0258, PROVIDE FOR ACTIVITIES OF TUNA BLOOD GROUP CENTER
K. Fujino, U.S. Dept. of Interior, Bureau of Comm. Fisheries, Honolulu, Hawaii 96812

Since tunas are distributed in wide geographic areas, cooperation between national and international institutions and agencies is essential to accomplish the objectives. Studies by immunological techniques. The Tuna Blood Group Center established at the Bureau of Commercial Fisheries Biological Laboratory, Honolulu, will serve as a focal point to foster this cooperative study. The Center will serve as a medium to standardize blood typing reagents and techniques thus making comparison of results produced by different institutions possible.

Recent exchange of serum specimens of skipjack and yellowfin tunas, already typed, between Tuna Blood Group Center and the Inter-American Tropical Tuna Commission, has made the identification of a genetic system in the serum transferrin component possible.

Supported by U.S. Dept. of Interior - Bu. Comm. Fish.

126
5.0259, INVESTIGATE PHYSIOLOGY OF TUNAS
Proc., Honolulu, Hawaii 96812

The physiology of tuna is poorly understood. Knowledge of the functions of body processes of these fishes is essential to understand better the relationship of the distribution of tunas to environmental factors, their responses to variations in these factors, and the sensory mechanisms involved in these responses. Studies on the inorganic constituents of muscles and blood, on the role of red and white muscles, and on oxygen consumption by red and white muscles have been made. Some work has also been done on olfaction and on schooling behavior. Other physiological studies such as those on digestion rates, visual acuity, and auditory acuity have been made under other project titles. These studies have been made by university personnel under contract with the laboratory, by visiting investigators who were provided space and materials, and by laboratory personnel. Physiological studies in the immediate future will be made on oxygen consumption and body temperatures of tuna.


5.0260, STUDY OF THIAMINASE IN HAWAII FISH
D.M. HILKER, Univ. of Hawaii, Agriculural Experiment Sta., Honolulu, Hawaii 96822

1. To test for thiaminase activity in various species of fish found in Hawaiian waters. 2. To study physical properties such as pH and temperature optima, enzyme inhibitors, and separability into apo and coenzymes. 3. To carry out biological studies of thiaminase activity in fish using rats and human subjects.

This study involves the determination of thiaminase activity in fish caught in Hawaiian waters and the physiological significance of the ingestion of fish containing this enzyme by rats and human subjects.

SUPPORTED BY Hawaii State Government

5.0261, ISOLATION OF ANTI-THIAMINE FACTORS IN HAWAII FISH
D.M. HILKER, Univ. of Hawaii, School of Agriculture, Honolulu, Hawaii 96822

The principal objectives of this project include: 1. The isolation of anti-thiamine factors in the muscle and viscera of Hawaii fish. 2. The study of the stability of anti-thiamine preparations to various treatments including ionizing radiation. 3. The study of the mechanism by which anti-thiamine agents inactivate thiamine.

SUPPORTED BY U.S. Dep. of Hith. Ed. & Wel. - P.H.S.

5.0262, FACTORS AFFECTING THE BEHAVIOR OF SHARKS
A.L. TESTER, Univ. of Hawaii, Graduate School, Honolulu, Hawaii 96822

The proposed research will include continued studies on the identification, distribution, morphology, histology, innervation, and function of superficial neuromasts and laterals, system of sharks. As more knowledge is gained with regard to innervation and function of the sensory organs, selected stimuli will be employed in order to conduct comparisons of resting potentials as opposed to action potentials resulting from the applied stimuli. As a personnel menace, sharks constitute a severe moral problem. By studying the fundamental factors that effect and/or govern the behavior of sharks and other animals one can gain knowledge that can be used to develop more effective techniques and concepts of personnel protection.

SUPPORTED BY U.S. Dep. of Defense - Navy

5.0263, RATE OF ABSORPTION OF ENDRIN BY BLUEGILL SUNFISH
A.L. BOWN, Louisiana State University, Graduate School, Baton Rouge, Louisiana 70803

The purpose of this research is to determine the effects of sublethal and lethal concentrations of endrin on bluegill sunfish, Lepomis macrochirus, and to study the rate of absorption by the entire fish and by selected organs.


5.0264, COMPARATIVE BEHAVIOR OF HATCHERY-READED AND WILD SALMONIDS
W.H. EVERHART, State Inland Fish & Game Dept., Augusta, Maine 04330

This grant is for the continuation of research initiated under GB-3859, dealing with the behavior of hatchery-reared and wild juvenile salmon (Salmo salar). The purpose of the study is to determine whether or not young salmon raised in an artificial environment have behavioral deficiencies which may affect their survival beyond that normally expected in a wild population. The hatchery fish used in the experiments are the progeny of wild parents, and any departure from the behavior of wild salmon is considered a result of behavior modifications imposed by the hatchery environment. Observations are made in a 50-foot artificial stream approximating the natural stream environment in which long-term observations could be made. Aquaria are used to supplement field observations when experimentally controlled conditions are necessary.

Under the new grant the investigators will complete several phases of the study of salmon. They also plan to initiate a comparative behavior study of hatchery and wild brook trout (Salvelinus fontinalis), an investigation of the behavior of salmon and trout in the hatchery environment, and an investigation of the physiological effects of stress on the endocrine system of salmon and trout reared under different environmental conditions.

SUPPORTED BY U.S. National Science Foundation

5.0265, RACIAL STUDIES OF HERRING
G.J. RIDGWAY, U.S. Dep. of Interior, Biological Laboratory, Boothbay Harbor, Maine 04538

The stocks of herring in the areas of coastal Gulf of Maine, Georges Bank, and Nova Scotia are being studied with a variety of serological and biochemical methods to find genetically variable characters that can be used to identify and discriminate between reproductively isolated populations. Proper management of these stocks requires that the reproductivity isolated segments be recognized, since they are being harvested by several domestic and foreign fisheries. The serological approaches to the problem include work on blood groups and serum differences. Biochemical methods include a variety of electrophoretic methods coupled with methods which stain specifically for various enzymes. The data are analyzed by population genetic methods.


5.0266, COMPARATIVE ETHOLOGY OF FISHES OF THE GENUS MACRPODUS
C.H. SOUTHWICK, Johns Hopkins University, School of Public Health, Baltimore, Maryland 21218

Brief Description of Research Project: The proposed research involves comparative ethological studies of wild-trapped...
5. LIVING SYSTEMS (NON-HUMAN)

strains of the ambelent fishes Macropodus opercularis, M. cupanus, M. chinensis, and M. davi. The locomotory, feeding, rest-
ing, sexual, agonistic, parental, and communicative behavior of these species will be studied in detail.

The greatest emphasis will be placed on qualitative and quant-

5.0267, RESPIRATORY EXCHANGE IN FISH GILLS

C.S. BROWN, Hydronautics Incorporated, Laurel, Maryland

The purpose of this project is to provide a quantitative un-
derstanding of the mechanisms involved in the respiratory

exchange of gases across fish gills. The study is designed to pro-

vides both detailed information on the counterflow system, and

computer analyses of the exchange process. Attention will be
given to the computation of gasous losses in the lamellae, the

ability of gill systems to recover oxygen and eliminate carbon
dioxide with special consideration of the dissociation charac-

teristics of these gases in respect to the sea water - Blood Media,

and a complete analysis of the gill structure and pumping

mechanism.

The increased incidence of Naval personnel in submerged

cellular conditions for example, free diving operations, excursions

from underwater habitats, and other facilities, and the increasing

utilization of submeribles of all types, emphasizes the need for
detailed understanding of systems for gas exchange already suc-

cessfully employed in the oceanic environment.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0268, PHYLOGENETIC SIGNIFICANCE OF SOUND-

PRODUCING MECHANISMS OF OPHIDIOID AND

RELATED FISHES

W.R. COURTEENAY, Boston University, Graduate School, Boston, Massachusetts 02215

This project is concerned with the phylogenetic significance

of sound-producing mechanisms in ophidiid and related fishes.

The work is anatomical, investigating the structure of the sonic

mechanisms in these fishes. It is hoped that by this time, the

morphology of these structures can be grouped into two

basic patterns; if these are indications of relationships, some of

test species in three formerly distinct families of fishes cross over

and a complete analysis of the gill structure and pumping

mechanism.

The increased incidence of Naval personnel in submerged

cellular conditions for example, free diving operations, excursions

from underwater habitats, and other facilities, and the increasing

utilization of submeribles of all types, emphasizes the need for
detailed understanding of systems for gas exchange already suc-

cessfully employed in the oceanic environment.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0269, REGULATION OF AMMONIA EXCRETION IN

FISH AND AQUATIC AMPHIBIA

L. GOLDSTEIN, Harvard University, School of Medicine, Boston, Massachusetts

Investigations will be conducted on the regulation of am-

monia production and excretion in fish and aquatic amphibia.

Pathways of ammonia assimilation will be examined in teleosts and

other fishes. Activities of amino acid deaminating enzymes will be

assayed in tissue homogenates and optimal assay conditions will be

defined. Substrate, cofactor and product levels will be mea-
sured in frozen sections of fish tissues and these values will be

used to assess the rate of amino acid deamination in vivo. The

adaptation of nitrogen metabolism (ammonotelism to ureotelism)

that occurs in the lungfish (Protopterus dolloi) during estivation

will be investigated. Levels of amino acid deaminating enzymes,

substrates, cofactors and products and the activity of the or-
nithine cycle will be determined in estivating and nonestivating

fish.

The adaptation of nitrogen metabolism (ammonotelism to

ureotelism) that occurs in Xenopus laevis during water depriva-
tion will be studied. The mode of ammonia excretion will be ex-
named in artificially perfused kidneys. Changes in renal function
during water deprivation will be assessed. The lev-

SUPPORTED BY U.S. National Science Foundation

5.0270, BEHAVIOR IN EMBRYOS AS IT RELATES TO

ENCEPHALIZATION

P.B. ARMSTRONG, Marine Biolog Laboratory, Woods Hole, Massa-

chusetts 02543

This investigation will be concerned with the correlation of

neuroanatomical mechanisms responsible for the negative

phototaxis in developing Ictalurus nebulosis. Positive phototaxis

appears when the rods and cones first show a development of the

receptor elements. Throughout the major part of embryonic
development this reaction persists. However, toward the end of

embryonic development the photomechanical mechanisms

characteristic of the adult eye appear and the embryos are able to

adapt to light and darkness. The projection of the optic

nerves to the lateral geniculate and the optic tracts is currently under

investigation and the behavioral responses are being followed with

partial and complete ablation of the optic tracts by electrocautery.

Further extension of this work involves a study of the lateral

line system and the Mauthner cells in the mechanisms.

A subsidiary problem concerns the comparative physiology of

the intrinidal muscles involving these in the eel, goosefish and

toad which show direct contractility to light.

SUPPORTED BY U.S. Dept. of Hth. Ed. & Wel. - F.H.S.

5.0271, FURTHER STUDIES ON A FLUORESCENT COM-

POUND IN THE DOGFISH LENS

J. TUTTLE, Marine Biolog Laboratory, Woods Hole, Massa-

chusetts 02543

NO SUMMARY HAS BEEN PROVIDED TO THE

SCIENCE INFORMATION EXCHANGE

SUPPORTED BY National Council to Combat Blindness Inc.

5.0272, THE PHYSIOLOGY OF TUNA AND OTHER

PELAGIC FISH

F.G. CAREY, Woods Hole Oceanographic Inst, Woods Hole, Mas-

sachusetts 02543

The main objective of this work will be the further study of

the heat conservation mechanisms used by certain sharks and
to maintain body temperatures above their environment. We

hope to get quantitative data to demonstrate how effectively the

heat exchange mechanisms in these animals function and infor-
mation on how they regulate their temperatures and make use of

their ability to stay warm. When opportunity permits we will also

carry out experiments with blood physiology and other aspects of

the physiology of these fish.

SUPPORTED BY U.S. Dept. of Hth. Ed. & Wel. - P.H.S.

5.0273, ENERGY REQUIREMENTS OF MARINE ORGAN-

ISMS

J. TEAL, Woods Hole Oceanographic Inst., Woods Hole, Mas-

sachusetts 02543

Part of the work was devoted to studying the body tempera-
ture of warm bodied fishes, tunas, and Lamnid sharks, all of which

have countercurrent heat exchangers but the tuna and mako fishes is currently under in-

vestigation and the behavioral responses are being followed with

partial and complete ablation of the optic tracts by electrocautery.

Further extension of this work involves a study of the lateral

line system and the Mauthner cells in the mechanisms.

A subsidiary problem concerns the comparative physiology of

the intrinidal muscles involving these in the eel, goosefish and

toad which show direct contractility to light.

SUPPORTED BY U.S. Dept. of Hth. Ed. & Wel. - F.H.S.

5.0274, THE PHYSIOLOGY OF TUNA AND OTHER

PELAGIC FISH

F.G. CAREY, Woods Hole Oceanographic Inst, Woods Hole, Mas-

sachusetts 02543

The main objective of this work will be the further study of

the heat conservation mechanisms used by certain sharks and
to maintain body temperatures above their environment. We

hope to get quantitative data to demonstrate how effectively the

heat exchange mechanisms in these animals function and infor-
mation on how they regulate their temperatures and make use of

their ability to stay warm. When opportunity permits we will also

carry out experiments with blood physiology and other aspects of

the physiology of these fish.

SUPPORTED BY U.S. Dept. of Hth. Ed. & Wel. - P.H.S.

5.0275, ENERGY REQUIREMENTS OF MARINE ORGAN-

ISMS

J. TEAL, Woods Hole Oceanographic Inst., Woods Hole, Mas-

sachusetts 02543

Part of the work was devoted to studying the body tempera-
ture of warm bodied fishes, tunas, and Lamnid sharks, all of which

have countercurrent heat exchangers but the tuna and mako fishes is currently under in-

vestigation and the behavioral responses are being followed with

partial and complete ablation of the optic tracts by electrocautery.

Further extension of this work involves a study of the lateral

line system and the Mauthner cells in the mechanisms.

A subsidiary problem concerns the comparative physiology of

the intrinidal muscles involving these in the eel, goosefish and

toad which show direct contractility to light.

SUPPORTED BY U.S. Dept. of Hth. Ed. & Wel. - F.H.S.

5.0276, THE PHYSIOLOGY OF TUNA AND OTHER

PELAGIC FISH

F.G. CAREY, Woods Hole Oceanographic Inst, Woods Hole, Mas-

sachusetts 02543

The main objective of this work will be the further study of

the heat conservation mechanisms used by certain sharks and
to maintain body temperatures above their environment. We

hope to get quantitative data to demonstrate how effectively the

heat exchange mechanisms in these animals function and infor-
mation on how they regulate their temperatures and make use of

their ability to stay warm. When opportunity permits we will also

carry out experiments with blood physiology and other aspects of

the physiology of these fish.

SUPPORTED BY U.S. Dept. of Hth. Ed. & Wel. - P.H.S.
5.0274, DEVELOPMENTAL MORPHOLOGY OF COREGNIDS
L.E. CABLE, U.S. Dept. of Interior, Biological Laboratory, Ann Arbor, Michigan

Study of the morphology of young coregonids of the Great Lakes was begun to determine what differences exist between the several indigenous species. To date, seven species, one hybrid, and one Panagrolaimus have been reared from the egg to adulthood in the laboratory. Some specimens of each species were preserved at intervals as development progressed. This phase of the work is completed.

Since completion of the first phase, from 20 to 60 mm. isometric characters have been measured or counted on many of the specimens at 10 mm. intervals of total length in search of one or more characters that can be used in the field to distinguish the young of one species from those of the other species. This morphometric data is being transferred to punch cards and programs written for electronic data processing to determine the potential independent variables and their reliability in multiple regression and/or discriminant analyses.

A paper in preparation will describe laboratory methods, food, growth, diseases, survival, and reproduction in the laboratory, also the morphology of the first and second generation whitefish reared in captivity. The morphometry of the other species being analyzed along with that of the whitefish will be reported in separate papers.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0275, SIMULATED WEIGHTLESSNESS IN FISH
R. VONBAUMGARTEN, Univ. of Michigan, School of Medicine, Ann Arbor, Michigan (NGR)

Objective: a. Problem: To surgically produce a condition simulating weightlessness in fish. b. Applications: Elucidate the function of gravity receptors using the fish as an experimental organism. c. To collect information about aspects of weightlessness in an organism which permits elimination of the effects of gravity force on the cardiovascular system, and proprioceptive antigravity reflexes.

Approach: Iron particles will be implanted into the utricular system of the larval fish. Strong magnetic fields will be applied at different directions, thus altering orientation, and behavioral observations made. Additional studies will be made using microelectrode recordings in marine organisms.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

5.0276, FISH HOLDING AND LIFE STAGE SENSITIVITY STUDIES
C.M. TARZWELL, U.S. Dept. of Interior, Natl. Water Quality Lab., Dubuque, Iowa

All fish of importance in the upper Great Lakes area will be collected and brought into the laboratory for sensitivity studies. As the work progresses, feeding and other procedures will be developed so that selected species can be kept through the winter for sensitivity studies. Species which comprise a significant portion of the total fish population will be used in the sensitivity studies to determine those species which are most sensitive to a particular material or waste. Not only will the adult, but the fingerlings and fry will be studied, as well as the eggs and sperm to determine the most sensitive development stage of these fishes. As with the other projects, the most sensitive form will be used in the Toxicological Unit for the determination of safe levels of a particular toxicant under conditions of long-term exposure.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0277, PESTICIDE RESISTANT FISH IN NATURAL ECOSYSTEMS
D.E. FERGUSON, Mississippi St. University, Graduate School, State College, Mississippi 36762

The applicant and his students first reported pesticide resistance in natural populations of fish in 1963. Since that time, our studies have concerned the extent of resistance in vertebrates, and little effort has been directed to an assessment of the significance and potential of resistance to natural ecosystems.

5. LIVING SYSTEMS (NON-HUMAN)

Recent findings indicate that the ecological impact of resistant populations of fish may be so great and macabre as to stagger the imagination. For example, large numbers of highly resistant mosquitofish are able to survive 10-day exposures to 2000 ppb endrin. If a medium-sized predaceous fish eats just one of these survivors, death ensues in about 6 hours. We suspect that the same would be true of an egret, snake, turtle or any other predator. What about man?

In a paper now in press, we show that a single resistant fish exposed to 1000 ppb endrin will release sufficient toxicon to 10 liters of tapwater to kill 5 susceptible fish in 38.5 hours.

How much pesticide are resistant fish able to tolerate? How much do they actually contain in heavily contaminated areas? What predators eat them? What is the consequence? Are humans eating them? These are some questions we hope to answer, and it is a matter of urgency that they be answered quickly! Our objectives are to attempt to assess the actual and potential significance of the presence of resistant fishes in natural ecosystems.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0278, TOXICANT TOLERANCE STUDIES-SCREENING OF PESTICIDES AND FISH AT TIBURON
T. LANE, U.S. Dept. of Interior, Fish Pesticide Res. Lab., Columbia, Missouri 65201

The objective is to obtain acute toxicity information on marine and estuarine fishes with insecticides, herbicides, and other pesticides at Tiburon, California. Fish and toxicants will be tested in continuous-flow systems in the laboratory, according to a standard method, and the later will be treated by probit analysis to obtain LC50 values under various time schedules.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0279, MECHANISMS OF HOMING AND ORIENTATION OF SALMO CLARKI IN YELLOWSTONE LAKE AND ITS TRIBUTARIES
C.J. BROWN, Montana State University, Graduate School, Bozeman, Montana 59715

Since 1964 the principal investigators have been studying the movement behavior of mature, migrating cutthroat trout displaced from their homestreams to the open water of Yellowstone Lake, Yellowstone National Park, Wyoming. Evidence of within-generation homing has been presented as a result of tagging experiments. It has also been demonstrated by float and ultrasonic tracking that cutthroat trout have oriented movement patterns, probably responsive to visual cues. Under the present grant the investigators will continue their research to determine: (1) some of the sensory mechanisms (particularly visual) of homing and orientation in open water particularly by the use of ultrasonic tracking; and (2) the extent, specificity, and sensory mechanisms of homing within a tributary system primarily by mark-and-recapture methods.

SUPPORTED BY U.S. National Science Foundation

5.0280, OSMOREGULATION
T.B. THORSON, Univ. of Nebraska, Graduate School, Lincoln, Nebraska 68508

Marine fish and fresh-water fish are usually able to cope with only one external medium, but certain species are able to make the change successfully from one medium to the other. These euryhaline fish are especially appropriate subjects for osmoregulatory studies. Such species are the bull shark, Carcharhinus leucas, and the sawfish, Pristis perotteti, both of which occur in substantial numbers in the Lake Nicaragua-Rio San Juan System of Nicaragua and Costa Rica. I am studying the chemical anatomy of the serum, cranial fluid, pericardial fluid, perirenal fluid, urine and rectal gland secretion of these elasmobranchs (1) taken from salt water, (2) taken from fresh water, (3) following transfer from fresh water to salt water and vice versa. These species appear to be marine animals that make their way into fresh water, but there are other elasmobranchs that are permanent residents of fresh water rivers and probably have been for thousands of generations. These are the river rays of the family Potamotrygonidae found in...
5. LIVING SYSTEMS (NON-HUMAN)

rivers of South America and Africa. The chemical anatomy of their body fluids will also be analyzed to determine whether they have retained the urea-retaining habitats of the marine elasmobranchs.

SUPPORTED BY U.S. Dept. of Hith. Ed. & Wel. - P.H.S.

5.0281, MORPHOGENETIC MOVEMENTS IN FISH EMBRYOS
W.W. BALLARD, Dartmouth College, School of Medicine, Hanover, New Hampshire 03755

To determine whether photomechanical changes occur in the retinas of young bluefish and to measure the extent to which they are affected by internal controls. A group of bluefish will be kept under constant light and dark for three days. Fish will periodically be enucleated, and the eyes sectioned and stained. Measurements of the pigment and sensory layers will reveal the degree of internal control.

SUPPORTED BY U.S. National Science Foundation

5.0282, RETINAL RHYTHMS UNDER CONTROLLED LIGHT
B.L. OLLA, U.S. Dept. of Interior, Sandy Hook Marine Lab., Highlands, New Jersey

To determine whether photomechanical changes occur in the retinas of young bluefish. Bluefish will be subjected to varying periods of light and darkness and their retinas will be removed, sectioned and stained. Measurements of the pigment and sensory cell layers will be taken to establish the degree of response and length of time required for complete light-and dark-adaptation.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0283, LIGHT AND DARK ADAPTATION IN THE RETINAE OF YOUNG BLUEFISH
B.L. OLLA, U.S. Dept. of Interior, Sandy Hook Marine Lab., Highlands, New Jersey

To determine the degree of photomechanical response in the retinas of young bluefish. Bluefish will be subjected to varying periods of light and darkness and their retinas will be removed, sectioned and stained. Measurements of the pigment and sensory cell layers will be taken to establish the degree of response and length of time required for complete light-and dark-adaptation.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0284, RELATION OF TEMPERATURE TO RHYTHMIC BEHAVIOR
B.L. OLLA, U.S. Dept. of Interior, Sandy Hook Marine Lab., Highlands, New Jersey

To observe the effect of low water temperature on adult bluefish. Gradually lower the water temperature in a large sea tank while measuring swimming speeds. Determine the level which disrupts normal behavior.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0285, RHYTHMIC ACTIVITY OF BLUEFISH IN RELATION TO NORMAL LIGHT REGIME
B.L. OLLA, U.S. Dept. of Interior, Sandy Hook Marine Lab., Highlands, New Jersey

To determine whether a rhythmic pattern of activity is present in a group of bluefish residing in a tank under a 24-hour artificial day-night cycle: (1) measure average speed of swimming each hour of day and night as an index of activity; (2) tabulate, analyze, and plot resulting data to bring out statistically significant tendencies.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0286, RHYTHMIC ACTIVITY OF BLUEFISH UNDER EXPERIMENTALLY VARIED LIGHT REGIMES
B.L. OLLA, U.S. Dept. of Interior, Sandy Hook Marine Lab., Highlands, New Jersey

To test whether the rhythmic activity of bluefish held in an experimental tank: (a) persists under constant illumination, and (b) adapts to a change of phase in the day-night cycle: Measure activity of the fish under (a) constant illumination over varying lengths of time, and (b) an artificial day-night cycle which is seven hours out of phase with the original cycle. Analyze and compare the data with measurements collected under a normal light regime.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0287, AGE AND GROWTH OF BLUEFISH
L.A. WALFORD, U.S. Dept. of Interior, Sandy Hook Marine Lab., Highlands, New Jersey

To measure growth rates and determine age composition of bluefish populations occurring from Cape Cod to Southern Florida. Sample, measure and take scales from bluefish caught by commercial and sport fishermen and by research biologists, to represent full range of size along entire Atlantic coast. Study lengths and scales, and interpret their significance using standard techniques.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0288, ENDOCRINE REGULATED PROCESSES IN TELEOST FISHES
M.P. SCHREIBMAN, City University of New York, Graduate School, Brooklyn - Brooklyn College, New York 11210

Diverse mechanisms for osmoregulation are operative in fishes. How these mechanisms are interrelated is not well understood - undoubtedly their relative importance varies in the major groups of fishes. Some species must be maintained in dilute sea water following hypophysectomy. They will die if placed into fresh water, even though this may be their natural environment, unless injected with mammalian prolactin. In other species freshwater survival is independent of hypophysial control. The distribution of these two mechanisms may have considerable evolutionary significance. The aim of the proposed research is to determine the distribution of the two mechanisms along phylogenetic lines and to study the nature of the control.

To clarify the taxonomic picture, eight to ten species, belonging to several families and orders, will be hypophysectomized each year and tested for freshwater survival. The mechanisms involved will be investigated by the use of hypophysectomized fish, hormone replacement, and transplantation of endocrine organs. All organs that may be concerned with osmoregulation will be examined histologically for sites of hormone action. Cytological studies of pituitary glands, including cytochemical, autoradiographic, and ultrastructural methods, will be employed to ascertain the site of production of the hormone(s) involved with freshwater tolerance.

SUPPORTED BY U.S. National Science Foundation

5.0289, ACOUSTICO-LATERALS FUNCTION IN FISH ORIENTATION AND COMMUNICATION
P.H. CAHN, Long Island University, Graduate School, Brooklyn, New York

The research constitutes a many-pronged attack on the problem of the fishes' perception of his environment. The overall aim of the proposed study is to assess the relative importance of hydrodynamic and acoustic stimuli in fish orientation. Data is obtained by the following principal approaches: a. The behavioral
5. LIVING SYSTEMS (NON-HUMAN)

SUPPORTED BY U.S. Dept. of Hith. Ed. & Wel. - P.H.S.

5.0293. ACCUMULATION OF RADIONUCLIDES BY VERTEBRATES (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION)

J.P. BAPTIST, U.S. Dept. of Interior, Radiobiological Lab., Beaufort, North Carolina 28516

Experiments are conducted with several marine fishes such as croakers, Micropogon undulatus; mummichog, Fundulus heteroclitus; pinfish, Lagodon rhomboides; bluefish, Pomatomus saltatrix; and flounder, Paralichthys sp. Accumulation of radionuclides both from sea water and from natural food containing radioactivity in known concentrations is determined.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0294. THE EFFECTS OF RADIATION ON THE PHYSIOLOGY OF MARINE ORGANISMS (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION)

D.W. ENGEL, U.S. Dept. of Interior, Radiobiological Lab., Beaufort, North Carolina 28516

Ionizing radiation has always been a part of the natural environment; however, the advent of the atomic age has increased the amount of radioactivity in the environment. The marine environment is subject to possible radioactive contamination from the growing numbers of reactors as well as from fallout and waste disposal. Though it is known that marine organisms tend to concentrate radionuclides, very little is known about the effects of ionizing radiation on these organisms. A more complete understanding is needed of species sensitivities to radiation and specific physiological effects of acute and chronic exposures. This information will aid in predicting effects from radioactivity in the environment and in applying controlled irradiation to eradicate undesirable species or to breed desirable species that are more resistant to environmental stresses. The purpose of this project is to describe the effects of acute and chronic doses of radiation from both internal and external sources on the physiology of marine organisms.

The effects of radiation may be death or alteration in some physiological or metabolic activity. In this investigation, LD-50's will be used to describe species sensitivity to radiation under varying conditions; while blood components, hematopoetic tissues, and respiration rates of whole organisms of tissues will be used as indices of radiation effects.

Sources of radiation will be by Cobalt-60 irradiators, an x-ray machine, labeled food, and administered radionuclides. Standard hematological and manometric techniques will be used to measure the various parameters. The marine teleost fishes used in this project will include Opsanus tau, Paralichthys sp., Pomatomus saltatrix, and Scymerberos maculatus. The project will also encompass representatives of other groups of marine organisms.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0295. THE EFFECTS OF RADIATION ON THE MORPHOLOGY OF MARINE ORGANISMS (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION)

J.C. WHITE, U.S. Dept. of Interior, Radiobiological Lab., Beaufort, North Carolina 28516

Estuaries and brackish water areas provide a nursery ground and habitat for many commercially important fish. They also provide receiving waters for waste products, including radioactive effluents from power reactors, hospitals, and laboratories. Marine vertebrates can accumulate radioactive elements which could be harmful to them and render them useless as seafood for man. Since the marine environment is complex and each estuary is different, in some way, from all the others, various factors influencing accumulation must be determined.

The objectives of this project are to measure under controlled laboratory conditions, the accumulation and retention of radionuclides by marine fish; to study the importance of various factors which may affect accumulation; and to observe the feeding processes of commercially important fish through the use of radioactive tracer techniques.

Experiments are conducted with several marine fishes such as croakers, Micropogon undulatus; mummichog, Fundulus heteroclitus; pinfish, Lagodon rhomboides; bluefish, Pomatomus saltatrix; and flounder, Paralichthys sp. Accumulation of radionuclides both from sea water and from natural food containing radioactivity in known concentrations is determined.
5. LIVING SYSTEMS (NON-HUMAN)

Little is known about the effects of ionizing radiation on marine organisms. There is no information available on which to predict possible effects from accidental or purposeful irradiation. Due to the possibility of radiation being used as a tool in the management of the marine environment, it is essential that more knowledge of its effects be gathered. This project has been undertaken to help evaluate the effects of radiation on marine organisms by investigating comparative radiation sensitivities and morphological changes due to radiation.

Marine organisms may be exposed to radiation from both external and internal sources. Such irradiation may be chronic or acute and may cause either the death or an alteration in the morphology of the organism. Since the embryological and larval stages of marine organisms are more sensitive to radiation than mature forms, these stages, as well as mature organisms, will be exposed to various doses of radiation to determine LD-50's. Irradiated organisms will also be observed for any morphological changes that might develop as a result of acute or chronic doses.

Organisms will be irradiated by either Cobalt-60 sources, an x-ray machine, radioactive food and medium, or force fed radionuclides. The organisms being used presently are marine teleost fishes which include Fundulus heteroclitus, Paralichthys dentatus, P. alboguttus, P. leptocephalus, Menidia menidia, and Eu- cinostomus sp.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0296, STUDIES ON MOLTING, GROWTH, AND DEVELOPMENT IN ACORN BARNACLES AND LARVAL DECAPODS

J.D. COSTLOW, Duke University, Graduate School, Durham, North Carolina 27706 (NONR)

Objective: The problem of barnacle fouling on Naval vessels and underwater structures involves a complex sequence of endogenous biological activities which are largely endocrinological in nature. A clearer understanding of the endocrine mechanisms involved in the barnacle life cycle may facilitate prevention of their occurrence in the future.

Approach: The origins of endocrine systems are being investigated in the developmental stages of barnacle (larvae) in an attempt to localize the regions and time of appearance of areas of endocrine activity. Additionally, the functional period of these sites of endocrine activity is being studied and the effects of experimental extirpations, injection, and implantation documented. Due to the minute size of the sites of endocrine activity, micro-laser techniques will be used to selectively destroy endocrine sites.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0297, SUBCELLULAR REACTION TO INJURY IN THE KIDNEY

B.F. TRUMP, Duke University, School of Medicine, Durham, North Carolina 27710

The principal research objective is the delineation, at the subcellular, supramolecular, and molecular levels, of the response of kidney cells to lethal as well as sub-lethal injury. The principal emphasis is on the structural and functional modulation of cellular membranes as they relate to modification of energy transduction by these systems. Complementary objectives include an understanding of the ultrastructural characteristics of human renal disease, methods of ultrastructural and cytochemical analysis, and the ultrastructural basis of active transport. Particular attention has been given to the study of systems such as isolated, perfused flounder tubules and toad bladders in Ussing chambers, where correlations between alterations of structure and function can be made.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0298, THE INFLUENCE OF ENVIRONMENTAL FACTORS UPON DEVELOPING MERISTIC STRUCTURES IN THE MARINE FISH, FUNDULUS MAJALIS (WALBAUM)

P.E. FERR, Univ. of North Carolina, Institute of Marine Science, Morehead City, North Carolina 28557

Physiologically ripe ova, developed naturally or induced by administration of chorionic gonadotropin hormone, are fertilized artificially with sperm from wild males in the laboratory at night using indirect fluorescent light. Embryos and larvae are reared in a unique salt-water circulating apparatus at recorded constant temperatures or alternating temperature regimes. Transfer of embryos and larvae from one temperature to another at different morphological stages are made to determine periods of response of the different structures (vertebrae, fin rays, basal support of fins, scales), those periods in development when response is greatest, and the extent and direction of responses. Fish are sacrificed at about 25 million-tons total length, fixed, cleared, stained in alizarinred and preserved in glycerine. Counts of different structures are made under a dissecting microscope and these counts are subsequently treated with appropriate statistical procedures that permit identification of means drawn from heterogeneous statistical populations. These experiments, utilizing temperature at first, will be expanded to include salinity, light, and dissolved gases, to obtain a fuller knowledge of the mechanisms involved in radiation among fish species.

SUPPORTED BY University of North Carolina

5.0299, THE EFFECTS OF ENVIRONMENTAL CONDITIONS ON THE SPAWNING AND SURVIVAL OF FRY OF THE WALLEYE

J.C. APPLEGATE, U.S. Dept. of Interior, Biological Station, Sandusky, Ohio

The recent decline of walleye stocks in Lake Erie following a man induced acceleration of the eutrophic process in the lake demands investigation of the many environmental factors which might influence the survival of young walleyes. Temperature monitoring stations have been established on three known walleye spawning grounds (reefs) in the western basin with the object of determining the effect of temperature regimes during spawning and fry development in the success of walleye hatches. These records will also be used to determine the effects of temperature on the timing and abundance of food organisms that may be essential to the survival of walleye fry when they first begin feeding.

Walleye fry have proved elusive and difficult to capture during their first 6 weeks of life. Measurement and recording of the direction and velocity of water currents on these reefs during the walleye spawning season have been instituted with the objective of casting some light on the dispersal of the fry.

Subsequently, automatic devices for the regular and periodic sampling of plankton organisms on and near the reefs will be devised and incorporated into this experiment. Qualitative and quantitative examination of these samples will be compared with the planktonic diet of fry captured during their first weeks after hatching.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0300, THE EVOLUTION AND CAUSATION OF SOCIAL BEHAVIOR IN ANABANTOID FISHES

R.J. MILLER, Okla. St. Univ. of Agr. & Sci., Graduate School, Stillwater, Oklahoma 74075

Brief Description of Research Project: This grant is for continuing and expanding studies on the social behavior of anabantoid fishes, currently being supported under GB-1989. Under the present grant, qualitative descriptions of the courtship and reproductive behaviors of Trichogaster trichopterus, T. leeri, Macropodus opercularis, and Betta splendens have been completed, and a comparative paper is being prepared for publication. A quantitative description and causal analysis of the reproductive behavior of T. leeri is in preparation, and data for similar analyses in the other species are still being collected. Long-term fluctuations in behaviors of several functional types are being compared in T. trichopterus and M. opercularis, and studies attempting to correlate such fluctuations with environmental cues are in progress.

Under the new grant several lines of work will be initiated as soon as possible. Descriptive and quantitative studies on several new species will be undertaken. Experimental westing, transfer of fry and test fish will be carried out to test hypotheses based on observational studies already completed. Mathematical indexes will be
developed for comparing activity levels within and between species and individuals. These studies should provide objective data for evaluating the nature of evolutionary changes in behavior patterns in the group, and contribute to our knowledge of causation of aggression, reproductive actions, and parental behavior.

SUPPORTED BY U.S. National Science Foundation

5.0301, IONOCYTE FORMATION IN GILL EPITHELIUM OF FISHES
F.P. COTE, Oregon State University, Graduate School, Corvallis, Oregon 97331

The proposed study is concerned with the developmental pattern of proteins and nucleic acids involved in the cellular differentiation of salt-secretory cells in the gill epithelium of fishes. Kinetic studies by Conte and Lin (1967) have shown that increased salinities of the environment induces a rapid turnover of epithelial cells in gill tissue. Ultrastructural studies by electron microscopy (Newstead and Conte, 1967) support the hypothesis that the mitochondria-rich cells are the type of cells which are undergoing rapid synthesis and degeneration. Immunocytochemical study (Conte and Morita, 1967) of the gill filaments from saltwater and freshwater adapted fish have shown that levels of antigenic proteins are higher for the saltwater environment. Tripp (1967) investigating the succinic dehydrogenase-tyrosine-C-reductase in gill tissue found no change in enzymatic activity between the two types of environments. Current experiments with labeled substrates are being performed in order to determine the casual relationships between protein and nucleic acid synthesis with salt secretion.

SUPPORTED BY U.S. Atomic Energy Commission

5.0302, INFECTIOUS DISEASES OF SALMONID FISHES
J.L. FRYER, Oregon State University, Agricultural Experiment Sta., Corvallis, Oregon 97331

Objective: (1) Study the epidemiology and transmission of infectious diseases in populations of fishes with emphasis on certain bacterial agents. (2) Investigate the use of immunological methods for both prevention and diagnosis of fish diseases. (3) Determine the source of infection, life history and means of transmission of infectious protozoa.

Description of Work: This investigation is funded by the Fish Commission of Oregon and is designed to furnish information required for improved operation of their fish culture program. The objectives listed above cover the three key areas currently covered in the project and are believed to represent some of the most important disease problems related to fish hatcheries. The research will contain both basic and applied experimentation. The detection, prevention and control of fish diseases will be emphasized in all studies.

SUPPORTED BY Oregon State Government

5.0303, CRYOGENIC PRESERVATION OF VIABLE FISH SPERM
H.F. HORTON, Oregon State University, School of Agriculture, Corvallis, Oregon 97331

The investigation has four objectives: (1) to develop a suitable diluent(s) and a life protector(s) for fish spermatozoa; (2) to perfect a freezing and thawing procedure for the live preservation of fish sperm at temperatures of liquid nitrogen; (3) to compare the reproductive capacity of sperm cells stored at cryogenic temperatures to that of fresh spermatozoa; (4) to compare the vitality of progeny produced from stored spermatozoa to that of progeny produced from fresh spermatozoa.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0304, NUTRITION OF SALMONID FISHES
D.K. LAW, Oregon State University, Agricultural Experiment Sta., Corvallis, Oregon 97331

Objectives: (1) To investigate the fundamental nutrition of hatchery salmonids. (2) To further develop and improve, both nutritionally and economically, the Oregon Moist Pellet. (3) To develop a nutritionally adequate and physically available starter diet for young salmonids.

A completely purified diet for salmonid which will produce growth responses as good or better than the Oregon Moist Pellet (CMP) for investigation of the fundamental nutritional requirements of salmonids will be developed. Experiments will be conducted to expand the body of knowledge about the vitamin, mineral, amino acid, and fatty acid requirements of salmonids. The purified diet will be used to evaluate new, more nutritional and economical sources of protein for use in formulating the O.M.P. Modifications in the composition of the O.M.P. to enhance its manufacturing, feeding, and nutritional qualities will be investigated. Means of preserving the O.M.P. by methods other than freezing will be investigated. Basic methods of evaluating nutritive value and quality will be investigated to provide a more critical criteria for evaluating the quality of the O.M.P. A nutritionally sound and physically available starter diet for juvenile salmonids will be developed.

SUPPORTED BY Oregon State Government

5.0305, BIOCHEMISTRY AND PHYSIOLOGICAL ECOLOGY OF POISONED FISH
S.D. LU, Oregon State University, Agricultural Experiment Sta., Corvallis, Oregon 97331

Objectives: (1) The manner in which particular nerve enzymes are altered by selected toxic substances and how and to what extent this restricts the nervous performance of fish in terms of change resulting in patterns of social behavior will be determined. (2) The manner in which particular enzymes involved in muscle function are altered by selected toxic substances and how and to what extent this restricts the work performance of fish in terms of maximum short term swimming speed and length of time that this speed and also the maximum sustained swimming or 'cruising' speed can be maintained will be determined. (3) The manner in which particular digestive enzymes are altered by selected toxic substances and how and to what extent this restricts the utilization of food or energy resources in terms of growth and maintenance of fish will be determined. (4) The manner in which particular respiratory enzyme molecules are altered by selected toxic substances and how and to what extent this restricts the 'scope for activity' (expressed as the difference between standard and active metabolism) or capacity for nervous, work and growth performance of fish will be determined.

Description of Work: This investigation is concerned with the long term exposure of the organism to sub-lethal levels of toxicant. The nervous behavior and physiological function of the organism will be followed following exposure and the effect of the toxicant on specific enzymes assayed and related to the response. Studies on the long term effect of chemicals on the ecology of the fish will be evaluated. The mechanism of action of the poisons will be investigated.

SUPPORTED BY Oregon State Government

5.0306, EPIDEMIOLOGY OF SALMON POISONING DISEASE
R.E. MILLEMANN, Oregon State University, Agricultural Experiment Sta., Corvallis, Oregon 97331

To determine the natural definitive host(s) for the fluke and rickettsiae; and to determine whether animals, other than canids, experimentally infected with the trematode also harbor the rickettsiae. By examination of wild animals trapped in the field, and by controlled infection experiments in the laboratory.

To determine if fluke eggs and miracidia carry the rickettsiae and are capable of transmitting the disease to susceptible dogs; and attempt to locate the rickettsiae in various fluke stages. By injection of various stages of the fluke parasite into susceptible dogs; and by use of the fluorescent antibody technique.

To study the relationship between the parasite and fish with emphasis on: (a) the effect of changes in salinity on retention of the parasites and rickettsiae by anadromous salmonid fish; b. the susceptibility of non-salmonid fish to infection; c. the nutritive susceptibility of native and introduced species of salmonids; d. the effect of various levels of infection on the growth and swimming performance of salmonids under controlled conditions.

133
5. LIVING SYSTEMS (NON-HUMAN)

By examination of ocean-caught salmon and other fish; and by controlled infection experiments in the laboratory.

SUPPORTED BY Oregon State Government

5.0307, EPIDEMIOLOGY OF SALMON POISONING DISEASE
R.E. MILLERMAN, Oregon State University, Agricultural Experiment Sta., Corvallis, Oregon 97331

Studies on the effects of different infection levels with the 'salmon poisoning' trematode *Radophorus swiamsi* on the growth and swimming performance of salmonid fishes under controlled conditions are being continued. The chemical and physical factors necessary for development and hatching of the trematode eggs will be determined. Studies on the mechanism of pathogenicity of the trematode for its fish host are being continued. Studies on the in vitro cultivation and characterization of the 'salmon poisoning' disease agent *Neorickettsia helminthoea* are being continued.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0308, OCCURRENCE OF THE PROTOZOA PARASITE CERATOMYXUS IN ADULT PACIFIC SALMON AND STEELHEAD TROUT
K.S. PILCHER, Oregon State University, Agricultural Experiment Sta., Corvallis, Oregon 97331

Objective: To determine the best technique for diagnosing this disease in salmonids. By means of a survey determine the species of fish involved at selected locations and obtain an estimate of the number of animals infected at each. Describe the pathology and causative agent.

Description of Work Proposed: Experimental procedures, sampling techniques and study areas will be determined in consultation with Drs. Fryer and Pilcher, Department of Microbiology, O. S. U., and the graduate student working on this project. This survey is to be conducted from a rearranged schedule which will indicate the species, location and sample size. Techniques for detection of this agent in fish tissue will also be examined. Tissue smears will be used initially until better methods are developed.

SUPPORTED BY Oregon State Government

5.0309, FISH GENETICS AND ECOLOGY
R.C. SIMON, Oregon State University, Agricultural Experiment Sta., Corvallis, Oregon 97331

To conduct original research in fish genetics and ecology. To apply findings of research toward clarification of existing problems of race identification, hatchery improvement, evolution of fishes, and study of estuarine ecology. To incorporate graduate instruction and research into each of the above objectives. Life history studies of marine and estuarine fishes. Population genetics. Comparative biology studies. Cytogenetic and Mendelian genetic studies. Graduate level instruction in fish genetics.

SUPPORTED BY Oregon State Government

5.0310, CRYOGENIC PRESERVATION OF VIABLE FISH SPERM
J.A. NICK, Oregon State University, Agricultural Experiment Sta., Corvallis, Oregon 97331

Objectives: (1) To develop a suitable diluent(s) and a life protector(s) for fish spermatozoa. (2) To perfect a freezing and thawing procedure for the live preservation of fish sperm at temperatures of liquid nitrogen. (3) To compare the reproductive capacity of sperm cells stored at cryogenic temperatures to that of fresh spermatozoa. (4) To compare the vitality of progeny produced from stored spermatozoa to that of progeny produced from fresh spermatozoa. The long-term goal is to develop a method for the preservation of viable fish spermatozoa so that the costs of fish cultural operations can be reduced and research into fishery genetics can be advanced.

Description of Work Proposed: The development of a suitable extender will require the empirical testing of a number of promising chemicals. Sperm cells will be collected in the field, placed on ice, and brought to the laboratory. "Slow" to "rapid" rates of freezing the spermatozoa samples will be tested to determine the best procedure. The ampules of frozen semen will be stored at minus 196 C in a liquid nitrogen refrigerator. When a procedure has been developed that will yield a satisfactory percentage of active spermatozoa, the refrigeration time will be extended to 7, 30, and 90 days. Sperm cells which have survived 2 or 7 days of freezing should endure indefinite cryogenic preservation. In the second general phase of the research, the reproductive capacity of sperm cells that have been frozen for 7 days at minus 196 C will be compared to that of fresh spermatozoa. Techniques of fertilization and comparative vitality of offspring will also be studied.

SUPPORTED BY Oregon State Government

5.0311, EFFECTS OF KRAFT PULP MILL EFFLUENTS ON THE GROWTH AND PRODUCTION OF FISH
C.E. WARREN, Oregon State University, Agricultural Experiment Sta., Corvallis, Oregon 97331

Objective: The general objective of this work is to determine how and to what extent concentration of kraft pulp mill wastes that are neither acutely toxic nor severely oxygen depleting may influence the production of fish populations.

Description of Work: (1) Determine the influence of effluents from kraft pulp mills on the growth of juvenile salmonids in the laboratory when food consumption rates and metabolic requirements of the fish are similar to those of fish in nature. (2) Determine the influence of effluents from kraft pulp mills on the food consumption, growth, and production of salmonids and on the production of their food organisms in simplified biological communities in laboratory streams. (3) Determine the influence of kraft mill effluents on the food habits, food consumption, growth, and production of salmonids, and on the biological communities of controlled experimental streams in which the concentrations of these wastes are controlled at levels below those known to be toxic or seriously oxygen depleting. (4) Determine through sampling studies above and below the points of entry of kraft pulp mill effluents into rivers the food habits and growth rates of salmonids and other fish.

SUPPORTED BY Oregon State Government

5.0312, THERMALMETABOLIC RELATIONSHIPS OF STENOTHERMAL FISHES
R.W. MORRIS, Univ. of Oregon, Graduate School, Eugene, Oregon 97403

This renewal of GA-422 is for the purpose of investigating the otoliths of fishes to determine if otolith function as pressure transducers. Preliminary graduate studies of Antarctic fishes reveal that they lack a gas bladder or compressible vesicle that might serve as depth indicators. Observations of the effect of temperature and light gradients in depth stratification indicates that there are of minimal importance. X-ray diffraction of otolith structures prove that they are composed of aragonite, a cen-

SUPPORTED BY U.S. National Science Foundation

5.0313, PHOTOBIOLOGY OF MARINE ANIMALS
J.A. NICK, Univ. of Oregon, Graduate School, Eugene, Oregon 97403

The tapeta lucida of fishes reflect light passing through the retina and are important in vision. Organization of the reflecting layers is being studied and fine structure of the reflecting cells is being revealed by light and electron microscopy. Reflectance is produced by constructive interference in stacks of guanine crystals; arrangement, spacing and thicknesses of the crystals are
being determined. Values for reflectivity of the tapetum lucidum, spectrum reflectance curves, and transmission of the dioptric structures and of the retina are being sought to evaluate the complementary role of the tapetum lucidum in vision. Changes in all variable components during light and dark adaptation is being measured, using photoelectric recording. The pigments - purines and others - in the tapetum lucidum are being extracted, isolated, identified and measured by mechanical, enzymatic, spectrophotometric and chromatographic methods now being explored and developed. The investigation embraces selachians, chimaerids, and sturgeon, whose tapetum lucida exhibit interesting divergences related to habits and habitats.

SUPPORTED BY U.S. Dept. of Hith. Ed. & Wel. - P.H.S.

5.0314, EPIDERMAL PAPILLOMAS IN PLEURONECTID FISHES
S.R. WELLINGS, Univ. of Oregon, School of Medicine, Portland, Oregon

The general purposes of the project are: (1) determine the distribution of epidermal papillomas of pleuronectid fishes in Puget Sound, and relate this distribution to qualitative and quantitative features of the local ecology; and (2) establish in so far as possible the primary and secondary etiological factors involved, including a search for a possible viral agent.

SUPPORTED BY U.S. Dept. of Hith. Ed. & Wel. - P.H.S.

5.0315, ANALYSIS OF SALMONID SCALES
A.L. OAKLEY, State Fish Commission, Salem, Oregon

Purpose: To determine age of salmon and steelhead by analysis of scale samples collected throughout the state. To identify different races of salmon and steelhead in the Columbia River.

Methods: To interpret the age, from scale samples, of important anadromous salmonid species, and determine if racial identification is possible by using scale characteristics.

Results: An individual has been hired and trained for this work and has remained with the project since its beginning. Enlarging equipment, utilizing a microprojector and viewing screen, was constructed. The ages of over 75,000 salmonids caught by commercial fishermen have been interpreted from scale impressions. A study to determine racial composition of spring-run chinook salmon is in progress. Growth characteristics during fresh-water residence have also been used to determine hatchery or wild origin.

Reports: Annual Progress Reports.

SUPPORTED BY Oregon State Government

5.0316, DEVELOPMENTAL ANALYSIS OF FUNDULUS
J.M. OPPENHEIMER, Bryn Mawr College, Graduate School, Bryn Mawr, Pennsylvania 19010

Two projects will be undertaken: 1) transplation of portions of the fish, fundulus, embryonic shield after dis-and reaggregation of their cells at gastrula states; and 2) characterization and localization of lipids and phospholipids in the developing central nervous system of Fundulus. Thirds of the embryonic shield of Fundulus, obtained by dividing the shield along its anteroposterior axis, developed when grafted to extraembryonic membrane after being minced mechanically. The grafts resulted in the formation of surprisingly well-organized heads, trunks, or tails. It is proposed to extend these observations by grafting pellets of cells consisting of dis-and then reaggregated cells of portions of the embryonic shield. The portions of the shield to be tested will be 1) anterior, middle and posterior thirds of the shield, and 2) each germ-layer of the whole shield insofar as these have been separated at the stages at which the experiments are to be performed. It is also proposed to study the lipid, especially the phospholipid, composition of the developing brain of Fundulus at specified stages.

Studies will be qualitative and quantitative, and will include attempts to localize particular components. The major source of nutrition for the embryo during the stages to be studied is the yolk; this too will be examined to determine changes in its lipid and phospholipid spectrum. If time permits isotopic studies will be made to elucidate the transport of inorganic and organic phosphate from yolk to embryo.

SUPPORTED BY U.S. National Science Foundation

5.0317, NUTRITION AND PHYSIOLOGY OF MARINE FISH IN CONTROLLED GNOTOBIOTIC ENVIRONMENTS
H.A. DYMUSZ, Univ. of Rhode Island, Graduate School, Kingston, Rhode Island 02881

Since natural ecosystems are extremely complex and not readily unraveled, the objective of the gnotobiotic approach of this project is to study the nutritional ecology of simple marine systems as integrated wholes. The advantages of gnotobiology are an ability to create ecosystems of known composition and the control of important variables. To this end, a modular 3-tank recirculating artificial sea water, germfree-gnotobiotic aquarium has been constructed. The system has provision for control of temperature, light, water circulation, water filtration, oxygenation and air filtration and flow. Parameters which can be measured include temperature, pH, oxygen, sodium, chloride and nitrate contents. Concurrently, while the gnotobiotic system was being built, Artemia salina was reared under various environmental and gnotobiotic conditions. In these studies, sterile natural diets were found to be superior to sterile semi-purified diets. Additional experiments were concerned with incubating and hatching "clean" fish eggs. Procedures for egg decontamination and for sterility testing were also standardized.

SUPPORTED BY U.S. National Science Foundation

5.0318, ACOUSTICAL COMMUNICATION IN AQUATIC ORGANISMS
H.E. WINN, Univ. of Rhode Island, Graduate School, Kingston, Rhode Island 02881

It is proposed that we concentrate on several problems that have been exposed to date. One is the detailed functional properties of the calls of toadfish and squirrelfish. Playing back sounds organized in various ways will be emphasized. Hearing studies, both electrophysiological and behavioral, will be carried out. Through brain anatomical studies and brain stimulation, both fixed and under free conditions, certain of the areas that control sound production can be delineated. In this way sound communication in several species of fish can be better understood.

Also, in navigation the properties of the system with the component that will be studied and an attempt will be made to find the cues that allow eels to leave fresh water and locate the distant spawning grounds in the southern Atlantic.

SUPPORTED BY U.S. Dept. of Hith. Ed. & Wel. - P.H.S.

5.0319, BLOOD TYPES AS INDICATORS OF BLUEFISH RACES
P.H. EDMUNDS, U.S. Dept. of Interior, Marine Game Fish Research Lab., Narragansett, Rhode Island 02882

Blood types in fishes, as in higher vertebrate classes, are hereditary traits and are not subject to environmental modification.

The work plan is to use normal or immune animal sera, saline extracts of selected leguminous plants, or combinations of the three to detect red blood cell antigenic difference (blood types) among individual bluefish; to characterize and statistically compare bluefish populations separated in space and time with respect to proportions of populations exhibiting specific types; to classify related types into bluefish populations and attempt to deduce genetic basis for their control; to evaluate results in light of existing hypotheses about bluefish population structure, attempting to differentiate reproductively isolated groups.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0320, HEMOGLOBIN VARIATIONS AS INDICATORS OF BLUEFISH RACES
P.H. EDMUNDS, U.S. Dept. of Interior, Marine Game Fish Research Lab., Narragansett, Rhode Island 02882

135
5. LIVING SYSTEMS (NON-HUMAN)

Hemoglobin commonly occurs in multiple forms, each of which may have its own distinctive physical and chemical properties. In some species all individuals have the same forms, although modification of the series may occur during ontogenetic development. In other species certain individuals possess hemoglobin variants which other individuals lack. Since individual differences of this kind generally are genetically controlled, they may be useful in differentiating reproductively isolated subpopulations (races).

The work plan is to analyze bluefish hemoglobins with electrophoretic, chromatographic, spectroscopic, or immunological techniques; to detect differences in hemoglobin assemblages among individual bluefish and to deduce genetic basis for differences; to characterize and statistically compare bluefish populations separated in space or time with respect to proportions of populations exhibiting various hereditary forms; to evaluate results in light of existing hypotheses about bluefish population structure, attempting to differentiate reproductively isolated groups.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0321. BLOOD TYPES AS INDICATORS OF WHITE MARLIN RACES

P.H. EDMUNDS, U.S. Dept. of Interior, Marine Game Fish Research Lab., Narragansett, Rhode Island 02882

Blood types in fishes, as in higher vertebrate classes, are hereditary traits and are not subject to environmental modification. The work plan is: 1. To use normal or immune animal sera, saline extracts of selected leguminous plants, or combinations of the three to detect blood cell antigenic differences (blood types) among individual white marlin (Tetrapterus albidus). 2. To characterize and statistically compare marlin samples separated in space or time to determine the geographical distribution of blood types; 3. To evaluate, on the basis of these comparisons, existing hypotheses about white marlin population structure.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0322. HEMOGLOBIN VARIATIONS AS INDICATORS OF WHITE MARLIN RACES

P.H. EDMUNDS, U.S. Dept. of Interior, Marine Game Fish Research Lab., Narragansett, Rhode Island 02882

Hemoglobin commonly occurs in multiple forms, each of which may have its own distinctive physical and chemical properties. In some species all individuals have the same forms, although modification of the series may occur during ontogenetic development. In other species certain individuals possess hemoglobin variants which other individuals lack. Since individual differences of this kind generally are genetically controlled, they may be useful in differentiating reproductively isolated subpopulations (races).

The work plan is: 1. To analyze white marlin hemoglobins with electrophoretic techniques; 2. To detect any differences in hemoglobin assemblages among individual marlin and to deduce genetic basis for differences; 3. To characterize and statistically compare marlin samples separated in space or time with respect to proportions of populations exhibiting various hereditary forms, thus attempting to differentiate racial groups; 4. To evaluate, on the basis of these comparisons, existing hypotheses about white marlin population structure.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0323. HISTOPATHOLOGIC EFFECTS OF POLLUTANTS ON CELLS AND TISSUES OF MARINE FISHES


Histopathologic studies will be conducted on various species of marine fishes after exposure to pollutants. Studies presently are being conducted on mummichogs being exposed to Cd and Pb.

5. LIVING SYSTEMS (NON-HUMAN)

The objective is to obtain hard parts (scales, otoliths, etc.) from ground fish of potential industrial importance in the area between Cape May, N. J. and Cape Hatteras, N. C. The hard parts will be obtained from fish that are caught in other phases of the project. Attempts to determine age and rate of growth by counting annual rings and measuring increments will be begun immediately but the analysis will be incomplete at the end of the fiscal year. This phase will be continued in subsequent fiscal years.

Age-growth data will supplement information on seasonal distribution and abundance of fishes in assessing the feasibility of industrial utilization of the ground fishes of the Continental Shelf. These analyses must precede any attempt to derive mortality rates, which will be a subject of a later sub-project.

Part 6 of 6.


5.0331. FISH BEHAVIOR AND PHYSIOLOGY
A.B. GROVES, U.S. Dept. of Interior, Biological Laboratory, Seattle, Washington 98102

The essential purpose of this work is to acquire a knowledge of intrinsic physical and sensory abilities of fish which relate to specific environmental factors encountered in migration and fish passage situations: A broader purpose is to assess the adaptive ranges of these capacities in different migratory fish stocks. This information will be applied to help predict or anticipate the effects on migrant fish and to develop management programs which are creating numerous changes in the environments of native stocks of commercially valuable species.

Specifically the work is with salmonids and involves measurements of fish capacities against selected environmental variables. This includes measurements of swimming performance abilities of juvenile and adult fish and activity patterns and responses of salmonid species. Studies also are made of sensory responses which may relate to migration and homing behavior, of physical and hydraulic factors that can injure fish in power turbines, of responses that may aid in diverting fish away from dangerous areas in turbines, and of effects on migrants of thermal shock such as that encountered by passing through heated effluents from thermal power plants.

The work is now in the laboratory but is directed to the idea that the derived information can be applied directly to field problems.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0332. PACIFIC FISH PHYSIOLOGY AND BIOCHEMISTRY (SALMON IMMUNOCHEMISTRY)
H.O. HODGINS, U.S. Dept. of Interior, Biological Laboratory, Seattle, Washington 98102

Biochemical and immunochromehemical methods are being applied to identification of populations of Pacific salmon and other economically important Pacific fish species.

The process of maturation in Pacific salmon, particularly Oncorhynchus nerka, is under study, using specialized biochemical techniques to extract and purify hormones, certain immunochemical procedures to examine maturity-related antigens, and histochemistry and bioassays to correlate structure with function.

Limited studies on the physiology of stress in fish are also in progress. Particular emphasis will be on cause, effects, and significance of certain enzyme and hormone levels.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0333. IDENTIFICATION OF SOCKEYE SALMON STOCKS BY BONE MINERALS
R.L. MAJOR, U.S. Dept. of Interior, Biological Laboratory, Seattle, Washington 98102

A major objective of the Bureau of Commercial Fisheries' Seattle Biological Laboratory is to develop basic knowledge about Pacific Salmon (Oncorhynchus spp.). Because no two stocks of a particular species of salmon have identical life histories, it is important to first identify the various stocks and then to
5. LIVING SYSTEMS (NON-HUMAN)

collect the biological data for each stock. The objectives of this project are (1) to identify the important stocks of sockeye salmon by the chemical composition of their bony structures and (2) to use the chemical characters alone or together with other characters to quantitatively divide ichthyos containing mixed stocks into their component parts.

To date we have collected samples from inshore areas spanning the Pacific Coast of North America and explored various methods of sample preparation and analysis. X-ray diffraction analysis and emission spectro-photometry appear to be promising methods of analysis.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0334. GULF OF ALASKA SOCKEYE SALMON SCALES, PROTOCOL AREA SOCKEYE SALMON SCALES, AND GULF OF ALASKA PINK SALMON SCALES

R.L. MAJOR, U.S. Dept. of Interior, Biological Laboratory, Seattle, Washington 98102

A major objective of the Bureau of Commercial Fisheries' Seattle Biological Laboratory is to develop a basic knowledge about Pacific salmon ('Oncorhynchus spp.). Because no two stocks of a particular species of salmon have identical life histories, it is important to first identify the various stocks and then to collect the biological data for each stock. The objectives of this project are (1) to identify the important stocks of salmon by their scale patterns and (2) to quantitatively divide ichthyos containing mixed stocks into their component parts.

To date, differences noted in inshore samples of sockeye salmon from Asia and Western Alaska have been used to identify fish taken on the high seas as either Asian or Western Alaskan providing that the fish are maturing and that they are taken west of 175 degree W. longitude. We continue to study scales as a means of identifying the great number of sockeye salmon stocks inhabiting the Gulf of Alaska (East of 175 degree W.) and immature salmon in all areas.

Similarly, differences noted in the scale patterns of pink salmon from several North American areas have been used to classify samples taken in the Gulf of Alaska to their area of origin.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0335. BLOOD PARASITES OF NORTHWEST FISHES

M. KATZ, Univ. of Washington, Graduate School, Seattle, Washington 98122

This study is divided into two major sections. One section is devoted to the blood parasites of freshwater fish, primarily coccids found in various streams in the Green River watershed. At some stations certain coccids are infected with Cryptobia, Trypanosoma and Haemogregarina, while at other stations in the same stream the same fish species have no blood parasites or are infested with only one species. The ecological requirements of these fish, their food habits, behavioral patterns and migrations will be studied in an effort to determine the factors responsible for the variation in parasite infestation. It is hoped that an understanding will be gained of the life history of the parasite.

The second section of the project is a study of the life history, distribution of the blood fluke of the hake, Oportocotyle mar golos. The incidence of infection is being correlated with the age, sex, and size of the host fish. Large collections of hake from various locations in Puget Sound are being collected to determine the differences in distribution which may give some understanding of the life history of the parasite.

The food preferences of the hake are being studied to determine the invertebrates which may be the intermediate hosts of the nematodes.

Blood smears of the hake are being examined for the presence of blood protozoans. In addition, the other helminth parasites of the hake are being enumerated to see if there is any correlation between the infestation of the blood with, and the numbers and kinds of other parasites.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.
5.0339, SPATIAL ORIENTATION OF FISHES AND ITS SENSORY BASES
A.D. HASLER, Univ. of Wisconsin, Graduate School, Madison, Wisconsin

Brief description of research project: The investigator proposes to continue his studies on orientation of migratory fishes being conducted currently under grant GB-606. These studies have as their objective an understanding of directed movements of fishes with special emphasis upon the sensory bases of spatially oriented behavior of those fishes which undertake extensive migrations in rivers and at sea. He will extend these studies so that migration of the salmon at sea, based on detailed information and techniques which were developed from a model situation in Lake Mendota, Wisconsin. 2. Continuation of studies of orientation in pond and lake fishes. 3. Studies of physiology of vision and olfaction as it relates to orientation.

SUPPORTED BY U.S. National Science Foundation

SD. MOLLUSKS - CRUSTACEA
(see Also Food and Food Sanitation In Chapter 6a.)

5.0340, ADULT SHRIMP STUDIES
L. BARR, U.S. Dept. of Interior, Biological Laboratory, Auke Bay, Alaska

This project began in July 1962. The shrimp industry in Alaska has increased greatly and expanded from the traditional Southern Alaska fishing grounds to the Seward-Kodiak area of Central Alaska. There is a large growing foreign fishery being prosecuted by Japan and USSR. There is an almost complete lack of information on the ecology of the various commercial species of shrimp in Alaska.

The commercial shrimps in Alaska all belong to the family of Pandalidae. The pink shrimp Pandalus borealis is the most important species but Pandalopsis dispar, Pandalus gonatus, Pandalus platyurus, and Pandalus platyrostris are also harvested to a limited extent. The U.S. harvest of shrimp was about 30% larger in 1966 than during 1965.

The life histories of the commercial Pandalids are being studied in the Kachemak Bay area, Cook Inlet, Alaska. Sampling with 1/2 meter nets and Miller hi-speed samplers for larval shrimp and the associated zooplankton has been carried out every other week since the program began, except for times when the research vessel was inoperative. Temperature and salinity data are being taken in the bays and estuaries where the biological samples are taken.

The objectives of the current study are: (1) To determine the life histories of Pandalid shrimps in the Cook Inlet area. (2) To determine the diel behavior pattern of shrimps. (3) To determine the seasonal variation in abundance of Pandalid shrimps within restricted bays. (4) To determine the habitats of Pandalid shrimps. (5) To determine the role of nursery areas in the early life histories of the spot shrimp, Pandalus platyurus. Most of the field work will be done in Kachemak Bay, but some research will be conducted at Little Port Walter in Southeastern Alaska and at Auke Bay, Alaska.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0341, BERING SEA KING CRAB STUDIES
J.F. HEBARD, U.S. Dept. of Interior, Biological Laboratory, Auke Bay, Alaska

The intensified fisheries of Japan and USSR have affected the stock of king crab in the Bering Sea. During recent years, according to Japanese and Soviet catch statistics, catches per unit of effort have decreased and catches are made up of smaller crab. Currently, U.S. fishermen harvest few crabs from this area because fishing is better elsewhere. However, as the stocks south of the Alaskan Peninsula and the Aleutian Islands become fully exploited, we expect U.S. fishermen to move their operations to the Bering Sea, if the stock there is not in a depleted condition.

Systematic sampling and proven tagging methods are being employed to estimate population perimeters and the effects of fishing. These will be used to determine optimum sustainable yield. Since there is some evidence that the abundance of harvestable sized male crabs fluctuates from year to year, a major portion of our research effort is directed towards determining the causes of these fluctuations. We are therefore concerned with the ecological factors that may affect growth, migrations, etc. Therefore systematic oceanographic sampling procedures are being utilized to determine water temperatures, salinities, currents, etc.

Objectives of the program include: (1) To determine the maximum sustained yield which the stock can support. (2) To develop a method of forecasting stock size. (3) To determine the distribution of the Eastern Bering Sea king crab stock with respect to abundance, age, sex, and size during the period of the study. (4) To determine reproductive rates, growth rates, mortality rates, and migration patterns. (5) To determine the effect of environmental conditions on distribution, abundance, reproduction, and growth of various king crab populations. (6) To compare results obtained during this study with results obtained during the previous study in 1954-1962.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0342, GULF-PENINSULA KING CRAB STUDIES
D.T. HOOPES, U.S. Dept. of Interior, Biological Laboratory, Auke Bay, Alaska

The rapidly increasing harvest of king crabs south of the Alaska Peninsula and Aleutian Islands has continued for several years. The effect of this harvest, by U.S. fishermen, on the various stocks of king crabs is unknown, partly because the geographic ranges of the separate stocks have not been determined.

Systematic sampling and proven tagging methods are being employed to estimate population parameters and the effects of fishing. The first step is to delimit the distribution of king crabs in waters of the study areas. This distributional information will then be used to define stock units. Finally, the stock units will be individually studied to make estimates of optimum yield.

Objectives of the program include: (1) To determine the relationships among inshore-offshore (national-international) populations of king crab. (2) To estimate optimum fishing intensity. (3) To collect comparative data on population parameters and biology of king crabs from different geographical areas. (4) To collect oceanographic data for correlation with crab distribution and abundance information.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0343, EARLY LIFE HISTORY DECAPOD CRUSTACEANS
D.T. HOOPES, U.S. Dept. of Interior, Biological Laboratory, Auke Bay, Alaska

Most of the research on pandalid shrimps and lithodid crabs by the Bureau of Commercial Fisheries has been concerned with the population dynamics and biology of adult animals. The information available on the biology, ecology, and dynamics of the early life stages of the commercially important species of king crabs and shrimps is extremely limited. It is important that we understand these early life stages in order to predict abundances of harvestable sized crabs and shrimps.

The objectives of this project are: (1) To describe the early life history stages of Pandalus gonatus, P. Hypsinosus, P. platyurus, and Pandalopsis dispar. (2) To determine the distribution of larval and juvenile king crab and pandalid shrimp species in respect to bottom types, depth of water, and other environmental factors. (3) To determine growth and age and size and maturity of young king crabs. (4) To determine reproductive potential of lithodid crab and pandalid shrimp species. (5) To relate environmental factors such as temperature, salinity, sediment types, associated species, etc., to abundance, growth, and natural mortality of larval and juvenile crabs. (6) To determine the energy requirements for growth, respiration, molting, and regeneration of larval and juvenile crabs; and reproduction of adult crabs. (7) To develop a method of marking small crabs.

Not all of the objectives included in this project will be worked on during any particular year because of limited funds and personnel but, since all of the objectives are important, the
5. LIVING SYSTEMS (NON-HUMAN)

first objectives to be included in the field work and laboratory experiments will be those that mesh best with other Shellfish Investigation programs. The environmental measurements such as salinity and temperature and the zooplankton data which will be collected on this project may serve as background data for other fishery or oceanographic research in the laboratory.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0344, ORGANISMS RESPONSIBLE FOR TOXICITY OF ALASKAN CLAMS

M.B. ALLEN, Univ. of Alaska, Inst. of Marine Sciences, College, Alaska 99701

The aims of this project are: (1) to identify the organism(s) responsible for toxicity of clams and mussels in Southeast Alaska. (2) To isolate these organisms in axenic culture and study the effect of environmental variables on their growth and toxicity, with the aim of being able to predict when clams might or might not be toxic, or hopefully, eventually to control toxicity in the shellfish population.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0345, INVESTIGATION OF ECOLOGICAL FACTORS LIMITING PRODUCTION OF THE ALASKAN PANDALID SHRIMP

J.B. BEALS, State Dept. of Fish & Game, Juneau, Alaska

The objectives of this study are to provide life history information, ecological data, growth rates, periods of sexual reproduction, sex and species composition, bottom distribution, bottom types, length frequency data, size weight relationships, etc. of the commercially important Pandalid shrimp of Alaska. Additional collection of non-commercial species will be collected incidental to the regular sampling and will be incorporated into a key for the identification of these species. Information of fishery factors, e.g., sizes of mesh, type of trawl, duration of drags, bottom type, depth and location, etc., will also be obtained.

Sampling will consist of extracting a two to four pound sample directly from the commercial trawls after completion of a drag. Sampling will be conducted by Fish and Game Aides and Supervisory Project Leader. Sampling will be conducted throughout the year in the Wrangell- Petersburg area and in the Kodiak Island area.

Technical personnel will include James B. Beals, Jerry McCrory and Fish and Game Aides.


5.0346, DUNGENESS CRAB POPULATION DYNAMICS STUDY

C.W. LEHMANN, State Dept. of Fish & Game, Juneau, Alaska

Objectives: To determine the effects of log rafting practices on dungeness crab grounds (preliminary investigations). Starting in 1965 crab fishermen will be interviewed for their opinions on the effect of log rafting on crab grounds, with reference to specific instances of crab ground damage.

On the basis of these interviews, specific areas will be checked for gross changes through the use of SCUBA gear. These areas will be compared to adjacent untouched areas to assess possible damage to existing crab grounds by future log booming activities.


5.0347, EFFECTS OF LOG RAFTING ON DUNGENESS CRAB

C.W. LEHMANN, State Dept. of Fish & Game, Juneau, Alaska

Objectives: To determine the effects of log rafting practices on dungeness crab grounds (preliminary investigations). Starting in 1965, crab fishermen will be interviewed for their opinions on the effect of log rafting on crab grounds, with reference to specific instances of crab ground damage.


5.0348, KODIAK KING CRAB ENVIRONMENTAL ZONE SURVEY

G.C. POWELL, State Dept. of Fish & Game, Juneau, Alaska

The foremost objective of this phase of a long range study of the reproduction of king crab in the Kodiak Island area is to delineate the major environmental zones of the continental shelf near the island. The various zones will be plotted using marine charts and available trawling records so that the relative composition of the continental shelf can be related to a sampling program to facilitate the determination of possible breeding relationships. Each of the major environmental zones will be sampled so that true king crab distribution indices can be obtained. Nonfeeding, non-migrating crabs will be collected as well as those actively feeding and migrating.


5.0349, OCEAN ENGINEERING

B.F. JONES, U.S. Dept. of Interior, Exptl. Fish & Gear Res. Base, Juneau, Alaska 99801

The preliminary planning or research: Exploratory Fishing and Gear Research surveys have indicated substantial populations of Pandalid shrimp throughout Alaskan waters. To date, expansion of the shrimp fishery has been primarily for the pink shrimp Pandalus borealis. In southeastern Alaska, expansion of the pink shrimp fishery has been restricted primarily by the market demand, as most of the shrimp are hand-peeled for a limited high price specialty market. In other areas, the economics and processing problems are probably the most significant limiting factors. Up to this time, only minor emphasis has been placed on the development of fisheries for the prawn shrimp - Pandalus platyceros, Pandalus hypsinotus, and Pandalopsis dispar.

Utilization of Alaska shrimp stocks to date has been concentrated on small shrimp for canning and frozen 'logs' - products of low relative value having severe technological limitations. These quality problems are under study at the Bureau's Technological Laboratory at Ketchikan. Finally, quality defects resulting from vessel handling and preservation techniques are responsible for the limited scope and acceptance of present Alaska shrimp products.

Objectives: 1. To promote and assist in the development of a prawn fishery in southeastern Alaska. 2. To develop specific shrimp gear which more effectively selects and harvests the several species of Alaska shrimp. 3. To publish and release, to the fishing industry, all pertinent information as it becomes available. 4. To develop shipboard handling and preservation techniques for larger Alaska shrimp species - shrimp primarily destined for the frozen market and usually used individually. 5. To develop shipboard handling and preservation techniques for smaller Alaska shrimp species - shrimp primarily destined for canned, block, or log products and usually used in bulk.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0350, PROCESS-INDUCED CHANGES IN CRUSTACEAN MUSCLE TISSUE

R.W. PORTER, U.S. Dept. of Interior, Technological Laboratory, Ketchikan, Alaska

A unique feature in processing many shellfish as contrasted with processing vertebrate animals is that the meat is cooked in the first stage to facilitate removal of the shell. Consequently, the normal post-mortem changes in the bio-chemical and physical properties of raw meat do not occur in processed shellfish. Instead, the cooked shellfish meat undergoes other changes, mainly in flavor and texture. These result from losses in flavor con-
stues, moisture, and many water soluble constituents. These losses are affected by pre-processing handling (crabs are held alive in salt water tanks before processing) and the initial cooking process (time and temperature).

The nucleotides of king crab have been characterized and the results will soon be published. The next phase of this study will be to alter processing conditions to allow maximum accumulation of IMP, a known flavor enhancing compound and correlate this with flavor panel scores. If these factors are directly correlated the king crab quality could benefit by incorporation of these changes into commercial processing of king crab.

In addition, cooking time and temperature will be varied to assess their effects on the losses of muscle tissue constituents following freezing and thawing. In particular we are going to check the amount of nucleotides, free amino acids and undersmoothed protein which is lost in the fluids freed after thawing as influenced by prior cooking time and temperature. King crab (Paralithodes cantabricus) will be used as the experimental animal, however, the principles involved will be applicable to most crustacean tissue.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0351, PREDATOR PEEY RELATIONSHIPS BETWEEN ECHINODERMS AND MOLLUSCE
A.S. MARGOLIN, Phoenix College, Undergraduate School, Phoenix, Arizona 85013

The recognition of predators by prey species and the reactions of the prey, which in many cases, appear to function as escape mechanisms, is an aspect of the behavior of marine invertebrate animals which has not been well studied. The occurrence of a considerable number of such behavioral patterns among molluscs in the presence of echinoderms presents excellent opportunities.

It is planned to work with animals from the northern end of the Gulf of California. Molluscan and echinoderm species will be collected and checked for reactions. Field observations will be made to learn whether interacting species live together, and whether there is evidence of significant predation. The collected specimens will be maintained alive in a recirculating seawater system at Phoenix College. Responses will be observed, descriptions written, and records made by still and motion pictures. Experimental situations will be planned to determine whether actual contact is necessary or whether stimulation can occur at a distance. The nature and source of the stimulating material will be studied.

During the summers, work will be done at the Friday Harbor Laboratories to determine whether the seastar Pisa ler ochraceus is repelled by the raised mantle of Diadora aspera, and if so, what the nature of the repelling substance is. Work will also be done on the effect of extracts of the seastar Pocillopora helianthus on the snail Buccinum polum.

SUPPORTED BY U.S. National Science Foundation

5.0352, TEMPERATURE NEEDS FOR GONADAL DEVELOPMENT AND SPAWNING OF DIFFERENT PHYSIOLOGICAL RACES OF THE AMERICAN OYSTER, CRASSOSTREA VIRGINICA
V.L. LOOSANOFF, Univ. of The Pacific, Graduate School, Dillon Beach, California 94929

Chief aim of the proposed studies is to evaluate the differences in temperature requirements for maturation of gonads and some aspects of the spawning behavior of different physiological races of the American oyster, C. virginica. These studies will be based on the results of experiments designed to ascertain the number of days required for oysters of different geographical races, kept at different but constant temperatures, to develop the first mature sex cells, and the number of days before these oysters can be induced to spawn.

Studies are based on large samples of oysters which originated in the waters of Long Island Sound, Connecticut, New Jersey, Virginia, South Carolina and Florida.

SUPPORTED BY U.S. National Science Foundation

5.0353, THE EPICARIDEA OF THE EASTERN PACIFIC
C.G. DANFORTH, Glendale College, Undergraduate School, Glendale, California 91208

NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE
SUPPORTED BY Society of The Sigma Xi

5.0354, PORCELLANID CRABS OF AUSTRALIA
J.S. GARTH, Univ. of Southern California, Graduate School, Los Angeles, California 90007

The Porcellanidae, a family of marine crabs belonging to suborder Anomura, are found in the littoral and sublittoral zones of all but the coldest seas. As part of a long-term revisionary study of the Porcellanidae of the world, the Co-Investigator has become involved in a series of projects dealing with Indo-west Pacific members of the family with assistance from grant NSF GB-3225.

Thirty-three species of Porcellanidae have been reported from Australia, but at least ten more, not recorded in the literature, are known to occur there; a thorough survey may reveal the presence of still others. The relationships of the porcellanid fauna of Australia with that of other areas are not fully understood, and the status of a few species is doubtful. Very little attention has been paid to the Australian Porcellanidae from the standpoint of habits and ecology. Even routine identifications are difficult in many cases because of inadequate descriptions, lack of illustrations, and scattered literature.

The object of the proposed research is to attempt to solve the problems relating to this fauna, through review of the literature pertaining to Porcellanidae of Australia, examination of Porcellanidae in several Australian museums, and collection and study of fresh material.

SUPPORTED BY U.S. National Science Foundation

5.0355, GROWTH LAYERING IN BIVALVED MOLLUSKS - AN AID IN PALEOBIOGEOGRAPHIC INTERPRETATION
C.A. HALL, Univ. of California, Graduate School, Los Angeles - U.C.L.A., California 90024

A systematic study of the microtextures of the same or similar year classes of Tivela stultorum will be made throughout its range. The presence of annual growth bands or rings on this species has been documented by others. (A) The mean thicknesses of the 'daily' or fourth-order layers in the second to fourth annual band will be determined. (B) The number and kind of growth layers in (i) the summer and (ii) winter (second-order layers) will be counted. The following questions will be asked: (1) Are there 360 to 365 daily or fourth-order growth layers present between the annual bands or in the first-order layer in Tivela collected at different sites and latitudes. (2) Are there differences in the thicknesses of fourth-order layers that can be correlated with latitude or some other factors. (3) Other than Tivela, which taxa have annual or seasonal growth layers and at what latitudes and in what temperature of water do these forms with such bands occur? (4) Do taxa from high polar latitudes have slow shell growth, are there 360 to 365 'daily' growth increments as have been noted in taxa from temperate and outer tropical latitudes? (5) Do taxa from near-equator latitudes have seasonal growth bands or layers.

SUPPORTED BY U.S. National Science Foundation

5.0356, PORT SAMPLING - CRESENT CITY, BROOKINGS, PORT ORFORD
H.G. ORMUTT, State Dept. of Fish & Game, Menlo Park, California

The work planned for this project (January 1, 1966-June 20, 1966) is the continuation of the monitoring and sampling of landings of crab, shrimp, and bottomfish initiated in January, 1966. The work includes collecting and analysing catch and life history data for the Ports of Crescent City, Port Orford, and Brookings. The data and observations are necessary to determine changes in population size, age composition, and stock status as prerequisites to proper management of the crab, shrimp, and bottomfish resources.

1. During the period January through April, the work is primarily with the crab fishery. 2. During the period May through
5. LIVING SYSTEMS (NON-HUMAN)

June, work is primarily with the shrimp fishery. During the entire period, the second priority is to monitor the otter trawl fishery at Crescent City and Brookings.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish. California State Government

5.0357, SHELLFISH AND BOTTOMFISH DATA
H.G. ORCUTT, State Dept. of Fish & Game, Menlo Park, California

Using crab resource data, the effects of continually increasing fishing pressure, the efficiency of saving gear, the adequacy of size limits and seasons, the values of harvesting males only, the recruitment and mortality rates, the wide variations in landings, and the extended period of low yield will be studied to determine how to improve commercial fishing.

From shrimp data, the methods of population estimation, the optimum catch per shrimp bed, the season for greatest return for effort, the exhaustion of shrimp beds in one season, and recruitment and mortality rates will be studied to evaluate the fishing methods.

By study of bottomfish data, the trends of a fishery developing from one based on a few flatfish species to one of many flatfish, other benthic, and other species will be traced. The possible inter-relationships of sub-populations disclosed by tagging data will be examined. The value of savings gear in the multiple species fishery and economical means to increase the catch per unit of effort will be studied. Evidences of latent resources and discarded fish will be examined to determine need of more full utilization of fish readily taken.

The work schedule for July 1, 1966-June 30, 1967 is for the study of crab, shrimp, and bottomfish data at the Fish & Game Laboratory at Menlo Park. This includes: (1) Compilation of data on hand (2) Key-punching data for computer use and (3) Design a program for electronic data computers.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish. California State Government

5.0358, SHELLFISH EMBRYOLOGY AND LARVAE DEVELOPMENT STUDY
P.M. ROEDEL, State Dept. of Fish & Game, Menlo Park, California

Objectives: To study the techniques of previous investigators of shellfish culture: To attend training sessions in shellfish culture methodology and procedures: To initiate laboratory and equipment designs designs for a shellfish laboratory.

Procedure: Research of shellfish culture and shellfish embryology literature will be initiated and continued. The biologist in charge will be sent to the Milford, Conn. laboratory of the U.S. Bureau of Commercial Fisheries for training in methodology and procedures. Work on laboratory design and plans for obtaining necessary equipment will be initiated.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish. California State Government

5.0359, SYSTEMATICS OF THE ANTARCTIC AND SUB-ANTARCTIC GAMMARIDAE AMPHIPODA
J.L. BARNARD, Beaudette Fdn. Trust, Moss Landing, California

The primary purpose of this study is to interrelate abyssal and bathyal Amphipoda of antarctic and subantarctic seas to those of other ocean basins and to those of sublittoral antarctic depths. Sublittoral collections at hand were obtained in the Magellan area of South America by R/S Vema and deep-sea collections were obtained from South America westward and southward by Vema and R/S El Tanin. Most of the funds are to be devoted to illustration and description of new and poorly known species in the deep-sea collections. Only benthic Gammaridea will be studied. Examination of histological preparations in screening pigment. Examination of histological preparations in screening pigment. Examination of histological preparations in screening pigment. Examination of histological preparations in screening pigment. Examination of histological preparations in screening pigment. Examination of histological preparations in screening pigment.

SUPPORTED BY U.S. National Science Foundation

5.0360, INVESTIGATE THE CAUSE OF MORTALITY OF PACIFIC OYSTERS ALONG THE CALIFORNIA COAST
P.M. ROEDEL, State Dept. of Fish & Game, Sacramento, California (14-17-0001-1382)

To conduct studies of normal and abnormal oysters to determine pathological conditions and causative factors and relate these factors to mortalities.

The first phase of the project will include three weeks of specialist training to the project leader at the Bureau of Commercial Fisheries Laboratory, Oxford, Md., and at the Oyster Disease Laboratory at the University of Washington.

The next and continuing phase is the establishment of a sampling and study program. Oyster producing areas of California will be sampled monthly to determine endemic diseases, causes of mass mortalities, and survival of oysters in varying environmental conditions. This study will include the marine bays and species as indicated below: Morro Bay-Crassostrea gigas; Eilhorn Slough-C. gigas; Drakes Eterno-C. gigas; Tomales Bay-C. gigas, C. virginica; Humboldt Bay-C. gigas. O. lurida

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0361, ECOLOGICAL, EXPERIMENTAL AND COMPUTER STUDIES OF ENDOGENOUS RHYTHMICITY
J.T. ENRIGHT, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

This proposal requests support for research on endogenous physiological rhythmicity in marine crustaceans. The research involves three general lines of approach: (1) laboratory experimentation designed to evaluate the sensitivity of tidal and circadian rhythms of crustaceans to phase-shifting by mechanical stimuli, light and chemicals; (2) laboratory and semi-controlled field experimentation to determine the relationships between rhythmicity in locomotor activity and orientation to light stimuli; and (3) computer studies to extend the, phenotype and test a mathematical model for endogenous rhythmicity in locomotor activity, a model which is based on the hypothesis that simple couplings between elements of the central nervous system underlie the rhythms.

SUPPORTED BY U.S. National Science Foundation

5.0362, STUDIES IN MICRONEUROPHYSIOLOGY
S. HAGIWARA, Univ. of California, Scripps Inst. of Oceanography, San Diego - La Jolla, California 92038

Membrane mechanisms as well as excitation contraction coupling in giant muscle fibre in a barnacle will be studied by using voltage clamp technique, ion flux measurement, etc. Similar lines of work will also be done in multi-ionic mechanisms of Aplysia ganglion and photo receptor cells in a barnacle.

SUPPORTED BY U.S. Dept. of Hith. Ed. & Wel. - P.H.S.

5.0363, THE STRUCTURE AND FUNCTION OF CRUSTACEAN EYES
E.M. KAMPA, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

The eyes of crustaceans that inhabit the open ocean and undertake extensive diurnal vertical migrations differ vastly in structure, developmental pattern, photomechanical changes, pigments and spectral sensitivity from those of inshore bottom-dwellers. In certain pelagic crustaceans, development is an outward growth of retinular cells which secrete a hyaline filament distal to the rhomb. This filament acts as a light guide and ommatidia. Other pelagic forms examined recently have structures homologous with the bottom-dwellers, but show no photomechanical changes in screening pigment. Examination of histological preparations indicates that in these a light guide may be occasioned by a modification of the proximal section of the cone stalk. All of the Crustacea that have so far yielded to spectral sensitivity studies (by electrotroretinograms) or to visual pigments extraction show a marked adaptation to photointervention. During September-December, 1965, we examined intensively the photointerventional, vertical distribution and spectral sensitivities of animals in the upper 1000 meters of water in a selected small area of ocean. Specimens were also preserved for histological analysis. It is the purpose of the proposed project to correlate the various facets of
5. LIVING SYSTEMS (NON-HUMAN)

This proposed research program would shed light on the mechanisms used in demineralization and decalcification by marine organisms, calcification mechanisms and make up, and the role of the protective periostracum.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0367, SYSTEMATICS, BIOLOGY, AND HYDROGRAPHIC RELATIONS OF SOME SPECIES OF CALANUS (CRUSTACEA, COPEPODA)
B.M. BART, Univ. of British Columbia, Graduate School, Vancouver - British Columbia, Canada

This research is concerned with a definitive analysis of the distribution and morphological variation of the copepod genus Calanus, an animal which occupies a primary position among planktonic populations; often dominating a community and covering large areas of the upper sea layers. The investigator is attempting to determine the hydrographic water mass factors which support and/or limit the distinct populations of this animal.

An understanding of the biological and ecological factors that influence distribution of organisms is essential in hydrobiological studies. With information gained from these kinds of studies predictions can be obtained relating to the dispersal and occurrence of pelagic forms of boring and fouling organisms, those capable of acoustic interference and/or luminescence, and those forms which constitute toxic hazards to personnel.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0368, COPEPOD CRUSTACEANS PARASITIC ON FISHES
A.G. LEWIS, Univ. of British Columbia, Graduate School, Vancouver - British Columbia, Canada

The purpose of the project is to study the collections of copepod fish parasites from Eniwetok Atoll and from Indian Ocean fishes both from a taxonomic and a zoogeographic standpoint. The hydrographic data from cruise 2 of the Anton Bruun will be used in the distribution of the copepod parasites of the pelagic fishes collected during this cruise. The distribution of these copepods, as well as others collected during cruise 2, will be compared with their distribution throughout the world.

SUPPORTED BY U.S. National Science Foundation

5.0369, ION TRANSPORT MECHANISM IN GIANT AXON
E. ROJAS, Univ. De Chile, Santiago, Chile

I. A parallel study between biochemical properties of the enzyme system ATP-ase isolated from cell membrane fraction of the squid giant axons and transport of sodium, potassium and calcium ions by giant axons under continuous intracellular perfusion.

II. A parallel study between ion-exchange properties of the cell membrane fraction and ion-exchange properties of the axonal membrane under continuous intracellular perfusion.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0370, ECOLOGY OF MARINE BIVALVE MOLLUSCAN LARVAE
T.A. GAUCHER, General Dynamics Corporation, Groton, Connecticut (N00014-66-C-0302)

This program is a study of the causative mechanisms which may explain why larval molluscs, specifically Mya arenaria, are found in clustered, discontinuous distributions. The ecosystem of which the larval molluscs is a part is being examined for the possible effects of intraspecific behavior, mass mortality, and hydrographic factors upon the site of attachment of these molluscs. In addition, the hypothetical exhibition of preference by molluscs of one substratum type over another on which to set is being investigated.

One of the most interesting biological problems faced by Navy planners concerns the ability of artifacts placed in the sea to attract organisms. The proposed study explores the problem and relates especially to the behavior of sessile and burrowing animals, including boring, fouling, and the undercutting of bottom...
5. LIVING SYSTEMS (NON-HUMAN)

tom sediments on which oysters are resting, since the Navy is moving more and more towards operations requiring long-term submergence, it is desirable to examine their attraction in an attempt to avoid or control it.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0371. LARVAL STUDY OF THE LOBSTER
W.A. LUND, State Board of Fish. & Game, Hartford, Connecticut

Plankton tows will be taken in Long Island, Fishers Island, and Block Island Sounds in the Atlantic Ocean off Block Island and Long Island in an attempt to locate larval lobsters. A few towns taken during 1965 have been examined for larval lobsters. Some larvae were collected in the Sounds, but better results were obtained in the Atlantic off Montauk.

Information available from the former Lobster Hatchery at Naank, Connecticut, indicates that the majority of lobster eggs hatched in June and early July. It is proposed to closely observe egg development on buried females during the spring. This can be accomplished by fishing our own pots or by sailing with certain commercial lobstermen.

Weekly plankton tows will be initiated in the inshore waters during the latter part of May. The periodicity and duration of the tows will be increased as information is gathered. Day and night tows will be made to evaluate which is the better time to sample. Only surface tows will be made during 1966.

Of the plankton tows are believed to be necessary if we hope to delineate the population to which the Fishers Island and Long Island Sound lobsters belong. It will be necessary to determine the areas of origin, the transport of the larvae and the probable areas of settlement before we are able to understand the ecology of this animal in this area. An offshore cruise made on August 5, 1966, yielded six lobster larvae (three 1st stage, one 3rd stage and two 4th stage). The area sampled is approximately 40 to 55 miles SSE off Montauk, Long Island. This is the only evidence we have on the occurrence of larvae in the Atlantic off Block Island and Long Island. Periodic cruises will begin in June and continue until additional positive evidence is gathered on the offshore occurrence of the larvae.

Part 1 of 3.


5.0372. TAGGING PROGRAM
W.A. LUND, State Board of Fish. & Game, Hartford, Connecticut

The major emphasis on this phase will not take place until 1967 and 1968. It is believed that basic information of the size composition and distribution of the population is needed prior to the initiation of this phase.

The type tag to be used will not be selected until other researchers have completed their evaluation of tags and methods of attachment.

Objective: 1. Determine the movements of lobsters in and from Long Island and Fishers Island Sounds. 2. Define the population to which these lobsters belong. 3. Determine the rate of exploitation.

Procedure: It is planned to use three procedures for securing lobsters. These are: 1. Scuba divers collecting and tagging under water. 2. Fish our own pots. 3. Buy directly from the lobster boats. It is believed that divers will be able to collect lobsters more efficiently than with any type gear. Experience to date indicated that smaller lobsters are easily found in daytime, but larger lobsters are more accessible at night. The additional advantage of using divers is that more accurate information can be gathered on local movements by revising areas previously worked.

We plan to establish a limited number of pots in an attempt to evaluate the most efficient method of catching lobsters. These pots must be unbuooyed and checked by divers. Experience has shown that the probability of boyed pots being disturbed is extremely high.

Several lobster fishermen have promised complete cooperation in this program. It is planned to secure lobsters, tag and release them at times inaccessible to divers. These areas are, in general, deep and have fast currents. This procedure will be discontinued if returns indicate extensive movements of lobsters from shallow to deep waters.

Part 3 of 3.


5.0373. PHYSIOLOGY AND BEHAVIOR OF LARVAE
(Physiologie and Shellfish Program)
H.C. DAVIS, U.S. Dept. of Interior, Biological Laboratory, Milford, Connecticut

The development of routine methods for rearing bivalve larvae has enabled us to determine the effect of various ecological factors on larval development, recruitment in the plankton, and growth. Studies have been made of the effect of the type of substratum on the distribution of temperature, turbidity, pH, and of various pesticides and deterrents on embryonic development and on growth of the larvae of these two species. In some studies we have observed the combined effect of varying two or more of these factors simultaneously.

We are currently experimenting to determine the pH range for spawning of oysters and the effect of the pH at spawning on viability of the sperm and eggs. We are also currently studying the effect of keeping oysters at lowered salinities, during gonad development and spawning, on subsequent embryonic development and larval growth at different salinities. We expect to soon have methods developed for studying the behavior of larvae and the effect of light, gravity, temperature, salinity and currents on the behavior of larvae of different ages and sizes. Such studies are urgently needed to develop an informational basis for field work on distribution of larvae.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0374. ECOLOGICAL FACTORS AFFECTING REPRODUCTION OF SHELLFISH
(Physiologie and Shellfish Program)
H.C. DAVIS, U.S. Dept. of Interior, Biological Laboratory, Milford, Connecticut

This project has developed largely in an attempt to discover the origin and distribution pattern of the oyster larvae that set in Long Island Sound. Studies of the intensity of setting in the Bridgeport-Milford-New Haven area have shown that, while certain sections are more likely to get a heavier set than others, setting is usually very spotty, i.e., some sections may get a heavy set while nearby sections receive almost none at all. Plankton samples have shown that, even during the spawning season, oyster larvae are not numerous and that the earlier stages, 75-250 microns in length, are rarely encountered. The 250-325 micron larvae appear suddenly in the plankton samples and setting starts immediately.

At present we are attempting to locate the 'nursery areas' where these larvae develop to the 250-325 micron stage before they appear in Long Island Sound. Once these 'nursery areas' have been discovered, we shall attempt to determine the attributes that enable the larvae to develop there and to increase recruitment by replenishing the spawning stock in these areas.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0375. HYBRIDIZATION STUDIES ON THE AMERICAN OYSTER, CRASSOSTREA VIRGINICA (GENETICS OF SHELLFISH PROGRAM)
A.C. LONGWELL, U.S. Dept. of Interior, Biological Laboratory, Milford, Connecticut

It might be suspected that the effects of heterosis in the American oyster, Crassostrea virginica, would be inversely proportional to the additive gene variance of different traits. Such estimates of heritability are underway.

Trial hybridizations between numerous local and non-local American oyster populations are being made as tests for heterosis, and for desirable combinations of characteristics displayed by oysters from different ecological conditions. Numerous inbreeding lines shall be test-crossed in the F3 for heterosis. Breeding plans have been made for determining the merit of reciprocal recurrent selection for developing the combining ability of parent oysters used for making hybrids. By selection of each generation of oysters on the ability of individuals to cross well with each
The similarity of the chromosomes of six species of oysters of two different genera indicate that there may be no gross chromosomes barrier to the production of fertile species hybrids. Chromosome analysis of hybrid eggs could provide important clues as to the evolutionary relationships of our present-day commercial and non-commercial oysters.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0376, SELECTIVE BREEDING OF THE AMERICAN OYSTER, CRASSOSTREA VIRGINICA (GENETICS OF SHELLFISH PROGRAM) A.C. LONGWELL, U.S. Dept. of Interior, Biological Laboratory, Milford, Connecticut

Sexual reproduction in the American oyster, Crassostrea virginica, occurs with the usual genetic recombination and crossing-over. There are ten gene linkage groups. Its outbreeding system

SHELLFISH PROGRAM)

OYSTER, CRASSOSTREA VIRGINICA (GENETICS OF

Chromosome analysis of hybrid eggs could provide important information on the heritability estimates of commercially important traits with attendant predictions of annual progress by selection. Phenotypic and genetic correlations are to be made between commercial characters with the ultimate intention of establishing a selection index. Current emphasis is on growth rate for which two-way selection experiments are to be set up. Out-crosses to increase genetic variance are being made prior to long-range selection of commercial strains.

Mutation studies have been initiated in C. virginica using ionizing radiation and chemical mutagens. The purpose of this work is to (1) obtain useful, marker gene and chromosome mutants, and commercially valuable mutations; (2) test the value of mutation breeding in the mussels; (3) establish background information essential to future work, such as the transposition of chromatin following radiation-induced chromosome breakage for transfer of specific characters from a non-commercial to a commercial oyster.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0377, NATURAL HISTORY OF PREDATORS AND COMPETITORS (PREDATOR CONTROL PROGRAM) C.L. MACKENZIE, U.S. Dept. of Interior, Biological Laboratory, Milford, Connecticut

Because of a scarcity of seed oysters in Long Island Sound, more efficient control of predators and competitors becomes imperative.

Control of oyster drills and starfish has been achieved. To make control methods more efficient, however, we are presently studying various aspects of the biology of both predators. Particular emphasis has been placed on studying feeding rates of each at various salinities and temperatures, and also on the behavior of these and other enemies on oyster beds as observed by SCUBA divers.

Divers have observed that young starfish hid underneath shells during the day. We are presently attempting to determine the reason they do this.

To better equip the shellfish producer to apply more efficient control methods for Styllocus, Crepidula and barnacles, the principal competitors of oysters, we plan to study various stages of their life cycles.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0378, METHODS OF CONTROL OF PREDATORS AND COMPETITORS (PREDATOR CONTROL PROGRAM) C.L. MACKENZIE, U.S. Dept. of Interior, Biological Laboratory, Milford, Connecticut

In Long Island Sound, the chemical Polystream is now used routinely by oyster companies to control oyster drills on their seed beds. Losses owing to predation by oyster drills have been reduced to less than 2 percent a year. Companies using lime to control adult starfish and Polystream to control oyster drills lose less than 10 percent of their oysters a year to these predators.

We have discovered that there is no 'winter kill' of oysters. Actually, a layer of silt which settles over a bed during the winter smothers oysters near the bottom when they become inactive in April and May. Losses range from 0 to 50 percent. In 1968, most oyster companies transplanted their seed in March and early April to avoid smiting losses.

By controlling predators and avoiding spring sifting losses, companies have reduced overall losses of young seed oysters from 99% to 70%, and of one-year-old oysters from 90% to 30%, thereby increasing yields from 1 to 1, to 10 or 15 to 1.

Presently, we are studying ways to reduce losses even further. The largest losses result from (1) Crepidula which smothers young oysters, (2) smothering against the bottom, and (3) mechanical breakage while dredging.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0379, STRUCTURE AND FUNCTION OF EYES W.H. MILLER, Yale University, School of Medicine, New Haven, Connecticut 06520

The proposed investigation is to study the neural structure of primitive eyes and it's relation to their function. The function is known. Where it is unknown the functional organization will be investigated using electrophysiological means.

In particular, for the anatomical part of this study, synaptic interrelations between neural elements will be investigated (1) in the compound eye and optic ganglion of the horseshoe crab, Limulus, where the relations between structure and the inhibitory interaction in the eye and structure and the complex neural responses of the optic ganglia will be investigated; (2) the eyes of the scallop, Pecten, where the relation between structure and the 'off' response will be explored; and (3) the frontal organ (third eye) of the frog, Rana, where the relation between structure and the excitatory and inhibitory optic nerve responses will be studied.

For the physiological studies the electrical responses of single ganglion cells of the frog's frontal organ will be investigated to determine as yet unknown functional properties of the receptive fields of these cells.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0380, CALORIC STUDIES OF SPARTINA AND THE MARSH CRAB SESARMA RETICULATUM F.C. DAIBER, State Board of Game & Fish, Dover, Delaware

Objective: To evaluate the energy transfer from the marsh grass Spartina alterniflora through the marsh crab Sesarma reticulatum.

Procedures: For the past several summers we have been gathering life history information on one of the important inhabitants of our tidal marshes, the marsh crab Sesarma. These studies have included food habit studies and estimates of population densities. The marsh grass Spartina is an important item in the diet of this crab. We have estimates of production of this grass during the growing season.

The individual crabs that are not carrying egg masses and preferably males will be weighed and then placed in containers where they can keep their gills moist but can get out of the water. Temperature will be maintained at 20 degrees C. Each crab will receive weighed portions of fresh grass. Each 24 hour period the grass remaining in the container will be weighed and replaced with fresh grass. The fecal pellets will be collected each 24 hour period, dried, weighed and prepared for the bomb caloriometer.

Subsamples of the crabs will be weighed, sacrificed, dried to constant weight and prepared for the bomb caloriometer shortly after returning from field collecting. Those crabs that have been fed grass in the laboratory will be reweighed after one week of feeding, sacrificed and prepared for the bomb caloriometer.

This procedure will yield the following information -- (1) total energy in the grass, (2) energy ingested, (3) energy consumed in respiration, (4) energy egested in the feces and (5) energy going into new crab flesh. This data will give a measure of gross growth efficiency new protoplasm per unit time energy consumed as well as net growth efficiency energy consumed - energy egested per unit time for the crab.

5. LIVING SYSTEMS (NON-HUMAN)
5. LIVING SYSTEMS (NON-HUMAN)

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish. Delaware State Government

5.0381, LOCATING AND MAPPING THE EXISTING SEED OYSTER BEDS IN DELAWARE BAY
T.P. RITCHIE, State Comm. on Shell Fisheries, Dover, Delaware 19901

The excellent report and map of the seed oyster beds which was prepared by Moore in 1910 will be used as a guide in locating and evaluating the extent of the existing seed oyster beds in Delaware Bay. The peripheral boundaries of each existing natural oyster bed will be located and marked with the aid of a commercial oyster dredge boat. Sextant and/or radar bearings will be taken at several locations on each natural oyster bed. The outline of each natural oyster bed will be ascertained by stakes and buoys. Accurate measurements of the total area of each oyster bed will be made.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish. Delaware State Government

5.0382, BIOLOGICAL EVALUATION OF EACH EXISTING SEED OYSTER BED IN DELAWARE BAY
T.P. RITCHIE, State Comm. on Shell Fisheries, Dover, Delaware 19901

The objective of this phase is to make a thorough biological examination of each individual natural seed oyster bed. Bottom samples will be collected by using a special oyster sampling dredge of measured width. The sampling dredge will be pulled along selected transits for a specified distance or time. All of the material dredged up will be examined in order to determine the ratio of oysters to shells. The total number of the various sized oysters in each sample will be counted. The relative abundance of oyster predators and fouling organisms will be noted. Relative oyster density per square yard and per square acre can be determined by simple calculation.

Part 2 of 4.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish. Delaware State Government

5.0383, SHELLFISHERIES RESEARCH
D.L. MAURER, Univ. of Delaware, Graduate School, Newark, Delaware 19711

The purpose of this investigation is to study the history and fluctuations of commercially important shellfish, e.g., the oyster, blue crab, hard clam, etc. This research deals with those aspects of the biology, ecology, environment of shellfish, and methods of increasing the shellfishery crop yields. Top priority has been given to research upon propagation of disease resistant strains of oysters. MSX disease and its relation to salinity has been studied, but at present there is insufficient data to be able to draw any conclusions. Studies to anticipate the time of maximum spawning of the oyster have also been started to determine the most opportune time to plant the oyster cultch. This information will be invaluable for local shellfishermen, but will take time to determine. An oyster survey of the Delaware Bay region has been undertaken to determine the extent and condition of natural oyster beds.

SUPPORTED BY Delaware State Government

5.0384, ABYSSAL AND BATHYAL SYNOPIIDAE OF WORLD
J.L. BARNARD, Smithsonian Institution, Washington, District of Columbia 20560

This project, supported originally by an NSF Grant (GB 3285), commenced as a taxonomic appraisal of this family (and many others) in Antarctic Seas. Synopids (tironids) have proved to be a diverse deep-sea faunule poorly explored and worthy of extensive study. The family will be treated in its entirety including the few sublittoral species in order to illuminate general problems of deep-sea speciation, endemism and pandemism to whatever degree they prove to be determinable. Numerous materials (Antarctica, Mesoamerica, Oregon and Bermuda transects, New Zealand, IOE) and others available through 1970 will be treated. In 1966 the family comprised 46 spp. in 11 genera. Revision of 14 genera at least is required and MS for 30 new spp. is already in hand and being amplified steadily.

SUPPORTED BY Smithsonian Institution

5.0385, OSTRACODA OF THE INDIAN OCEAN
R.H. BENSON, Smithsonian Institution, Washington, District of Columbia 20560

Taxonomic description and biogeographic mapping of the Recent podocopid ostracode fauna of the Indian Ocean as a basis for future exploration of the fossil faunal provinces.

SUPPORTED BY Smithsonian Institution

5.0386, ABYSSAL OSTRACODES OF THE WORLD
R.H. BENSON, Smithsonian Institution, Washington, District of Columbia 20560

Description and biogeographic mapping of the Cytherocorean ostracodes occurring below 500 meters in the world ocean and their history as recorded as fossils in sediment cores.

SUPPORTED BY Smithsonian Institution

5.0387, HYPERIID AMPHIPODS FROM THE GULF OF GUINEA
T.E. BOWMAN, Smithsonian Institution, Washington, District of Columbia 20560

Analysis of hyperiid amphipods collected by Crosnier in the Gulf of Guinea and the relationship of distribution patterns to oceanographic variables.

SUPPORTED BY Smithsonian Institution

5.0388, RELICT COPEPODS FROM LAKE TUBORG, ELISMIERE ISLAND
T.E. BOWMAN, Smithsonian Institution, Washington, District of Columbia 20560

Identification and enumeration of 2 spp. of calanoid copepods collected in a plankton tow in partly brackish Lake Tuborg. Both species are not now known from coastal waters of the Canadian Arctic islands, and are believed to be relics of a formerly more widespread brackish water fauna now restricted mainly to Siberian Arctic coastal waters. Suggestions concerning their origin in Lake Tuborg are given, using information on the age of the lake determined by C14 dating of the lake water carbonates.

SUPPORTED BY Smithsonian Institution

5.0389, COPEPODS PARASITIC ON NEEDLEFISHES
R.F. CRESSEY, Smithsonian Institution, Washington, District of Columbia 20560

In connection with a revision of the fish family Belonidae Dr. Collette has collected many parasitic copepods. In order to further understand the biology of needlefishes I am studying their copepod parasites for possible insights into the ecology and phylogeny of the hosts.

SUPPORTED BY Smithsonian Institution

5.0390, RELATIONSHIP BETWEEN WATER TEMPERATURE AND SIZE OF PARASITIC COPEPODS
R.F. CRESSEY, Smithsonian Institution, Washington, District of Columbia 20560

Preliminary evidence indicates a relationship between surface temperature of the water at the station from which parasitic copepods are collected and the size of the adult copepod when collections of the same species of copepod from the same species of host from different stations are compared. Possible implications as to the biology of the hosts are being investigated.

SUPPORTED BY Smithsonian Institution
5. LIVING SYSTEMS (NON-HUMAN)

A review of the approximately 35 species of stomatopod crustaceans occurring in the eastern Pacific region to accompany studies on the stomatopods of the eastern and western Atlantic.

SUPPORTED BY Smithsonian Institution

5.0398, A BIBLIOGRAPHY OF THE MARINE MOLLUSKS OF THE INDO-PACIFIC REGION

H.A. REHDER, Smithsonian Institution, Washington, District of Columbia 20560

This project, originally started as an integral part of my project on Polynesian malacology, is now listed as an independent project for obvious reasons. Each publication dealing with Indo-Pacific mollusks - whether descriptive, faunal, taxonomic, morphological - is entered in a Royal-McBee Keysort Card, and the relevant information punched out on each card. In addition to papers dealing strictly with the Indo-Pacific marine fauna publications dealing with the classification, morphology and physiology of molluscan groups found in the Indo-Pacific region are also included. As this bibliography approaches completion, its value as a research tool will increase in that a worker can sort out the relevant literature for any geographical area and/or any particular group of mollusks. He will also be able to dig out with relative ease the information available on any phase of the physiology or morphology of any group of mollusks. It is planned to investigate the possibility of converting this card system to a more rapid scanning system.

The preparation of this bibliography is being carried out by a technical assistant under the supervision of the principal investigator.

SUPPORTED BY Smithsonian Institution

5.0399, THE CEPHALOPODS OF THE CENTRAL PACIFIC

C.F. ROPER, Smithsonian Institution, Washington, District of Columbia 20560

A faunistic study of the cephalopods of the Central Pacific is being conducted in conjunction with the Pacific Ocean Biological Survey Program. The distribution and the regional and seasonal abundance of the species in relation to oceanographic parameters are being worked out.

SUPPORTED BY Smithsonian Institution

5.0400, THE SYSTEMATICS AND DISTRIBUTION OF THE WORLD-WIDE SQUID FAMILY BATHYTEUTHIDAE

C.F. ROPER, Smithsonian Institution, Washington, District of Columbia 20560

The systematic problems in the Bathyteuthidae are worked out. The geographical and bathyal distributions in relation to biological and oceanographic parameters are presented. The regional and seasonal abundance and the life histories of the species are shown. This work is in the final stages of manuscript and will be submitted to the publisher (Arctic Research Series) in FY67.

SUPPORTED BY Smithsonian Institution

5.0401, SYSTEMATIC REVISION OF THE FAMILY PERIPLATMATIDAE

J. ROSEWATER, Smithsonian Institution, Washington, District of Columbia 20560

The classification of the family Periplomatidae is being revised. Generic groups are being reconsidered and information will be given concerning the systematics and zoogeography of this group.

SUPPORTED BY Smithsonian Institution

5.0402, SYSTEMATIC STUDIES ON MOLLUSKS FROM WALTERS SHOALS, INDIAN OCEAN

J. ROSEWATER, Smithsonian Institution, Washington, District of Columbia 20560
5. LIVING SYSTEMS (NON-HUMAN)

During the International Indian Ocean Expedition 1964, a collection of mollusks was obtained from Walter’s Shoals, south of Madagascar. This locality is essentially an isolated sea mount. The mollusks will be classified and studied to determine their systematic and zoogeographical relationships. In view of the unique locale, the results may yield interesting information on species distribution in the Indian Ocean.

SUPPORTED BY Smithsonian Institution

5.0403, EASTERN PACIFIC SHRIMPS OF THE GENUS PENEAEUS
I.C. CANET, U.S. Dept. of Interior, Systematics Laboratory, Washington, District of Columbia 20560

Investigations of the systematics and geographical and bathymetrical distribution of Peneaus shrimps from Pacific America, where 5 species are known to occur. This will include biometric studies to determine ranges of variations and their spatial distribution, full descriptions, and illustrations of each shrimp. Findings will be submitted to ecology and life history are being critically reviewed and summarized.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0404, BENTHIC PENAEID SHRIMPS (OTHER THAN PENEAEUS) FROM THE WESTERN ATLANTIC
I.C. CANET, U.S. Dept. of Interior, Systematics Laboratory, Washington, District of Columbia 20560

Investigations of the taxonomy and distribution of benthic penaeid shrimps (other than Peneaus) collected by the research vessels Oregon, Silver Bay and Calypso on the continental shelf of eastern North America, Central America and South America. The collections appear to contain at least 16 genera and 45 species. The work will include descriptions and those illustrations necessary for the proper understanding of each taxonomic category.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0405, DIAGNOSTIC CHARACTERS & DEVELOPMENT OF EXTERNAL GENITALIA IN JUVENILE GROOVED SHRIMPS OF GENUS PENEAEUS FROM WESTERN ATLANTIC
I.C. CANET, U.S. Dept. of Interior, Systematics Laboratory, Washington, District of Columbia 20560

Studies of the characteristics and development of the external genitalia in juvenile 'grooved shrimps' (consisting of 2 species and 4 subspecies) of the genus Peneaus from the western Atlantic. Much attention has been accorded to juvenile growth ecology, habits, movements, and tolerances to temperature and salinity; however, little progress has been made in ascertaining their identification. The peculiar characters of the petasma of the males and the typhlocum of the females of each taxon at various body lengths will be listed in Tables and illustrated. Continuing.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0406, AN ANALYSIS OF DEVELOPMENT IN ARTEMIA SALINA EMBRYOS
J.S. CLEGG, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124

A study is being made of the regulation of protein and RNA synthesis in the embryos of Artemia salina, a crustacean. The emphasis is placed on analysis of polysomes and ribosomes by sucrose gradient density centrifugation, on the various species of RNA present, on the incorporation of radioactive precursors into RNA and protein, and on in vitro protein synthesizing systems. Some work is also being done on lactic dehydrogenase isozymes, and on ultrastructural changes which occur during development. Particular attention is being paid to a period in the development of these embryos during which embryonic differentiation occurs in the complete absence of cell division.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0407, IONIC REGULATION IN THE QUEEN CONCH, STROMBUS GIGAS LINNAEUS
C. LITTLE, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124

The proposed work is an investigation of the composition of the blood of the queen conch, and of the relations that this composition bears to that of the seawater in which the conch lives. When this basic knowledge is acquired, it is intended to examine the mechanisms by which these relations are maintained; or in other words to examine the various routes by which salt, water and possibly nitrogenous matter enter and leave the body, and to try to decide what factors exercise control over these exchanges. The three sites of exchange to be examined in detail are the kidney, the alimentary canal and the single ctenidium; but the possibility of exchange through the general body surface and through acclimatization will also be examined.

SUPPORTED BY U.S. National Science Foundation

5.0408, SYSTEMATIC STUDIES ON HERMIT CRABS AND OTHER DECAPOD CRUSTACEANS
A.J. PROVENZANO, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124

The marine decapod Crustacea constitute one of the most important orders of invertebrates in the sea. Many of them such as shrimps, lobsters and crabs are exploited directly by man as food species, but the group is vastly more important in the general economy of the sea as food for other organisms, especially fishes. Most decapod crustaceans have pelagic larval stages which serve to distribute the younger generation. It is these larval forms which play an important role in marine food chains, perhaps more important in some ways than the adults.

It is planned to continue studies on the taxonomy of hermit crabs (GB-1304 and GB-4888) with special reference to tropical Atlantic forms with a specific goal of attempting to complete our knowledge of this fauna; to continue studies on the larval development of pagurid anomura based on laboratory rearing in order to utilize ontogenetic information in evaluating phylogenetic relationships within the group; to continue studies on the larval development of other decapod crustaceans of particular importance in systematics with a view towards being able to utilize information on larvae to advance understanding of the systematics of decapod crustaceans; and to summarize the accumulated data on decapod life histories to make possible familial, generic, and for some groups, specific identifications for the West Indian faunal region.

SUPPORTED BY U.S. National Science Foundation

5.0409, LARVAL DEVELOPMENT OF SCYLLARIDEAN LOBSTERS
A.J. PROVENZANO, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124

The aims of this project include: identification and detailed description of the larvae of Western Atlantic lobsters of the families Scyllaridae and Palinuridae; the establishment of specific and generic characters of phyllosoma and early post-larval stages and evaluation of the significance of larval characters as indicators of natural relationships between species; the initiation of studies on the effects of nutritional and physical environmental factors upon growth and development of phyllosoma larvae in the laboratory. Larvae will be reared from eggs hatched in the laboratory. Live material captured at sea will be returned to the laboratory to provide an opportunity to study pelagic forms hitherto not observed under laboratory conditions.

SUPPORTED BY U.S. National Science Foundation

5.0410, LARVAL DEVELOPMENT OF DECAPOD CRUSTACEANS
A.J. PROVENZANO, Univ. of Miami, Institute of Marine Science, Miami - Coral Gables, Florida 33124

This is a continuation of a project to study the larval development of a wide variety of tropical marine decapod crustaceans. Most of the effort in the coming year will be devoted to preparing...
especially from a comparative point of view and with regard to past four years on the development of for publication some of the major museums of both the U. S. and Europe. The approach is North Atlantic ocean as a whole and not by local areas heretofore. Florida 33124

This project is designed to review the cephalopods of the North Atlantic ocean as a whole and not by local areas as heretofore. The study is based upon very large collections of open ocean species supplemented by smaller but important collections in the major museums of both the U. S. and Europe. The approach is revisionary and monographic. Strong emphasis is placed upon the hydrographic features of the ocean and distribution of the organisms in relation to salinity, temperature, light and depth. Types of most of the species are being examined in the hope of clarifying the present difficult nomenclatural problems in this group of animals.

Supported by U.S. National Science Foundation

5.0411, MONOGRAPH OF THE CEPHALOPODS OF THE NORTH ATLANTIC
G.L. VOSS, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124

The research proposed by the University of Miami is a continuation of field and laboratory work which has been supported over the past four years under GA-103, GA-253 and GA-709.

The objectives of this proposal are basically unchanged from the earlier ones: the completion of a monograph on the systematics of Antarctic cephalopods. The research entails collection of Antarctic specimens, and for first hand observation of characteristics and behavior of fresh specimens. In addition to these materials, all cephalopod specimens obtained under the United States Antarctic Research Program are forwarded to the principal investigator through the Smithsonian Oceanographic Sorting Center. The shipboard studies on Eilat and data analysis at the University are carried out by graduate assistants who apply their experience and knowledge toward graduate research.

This project requires Eilat participation by one graduate assistant on Cruises 32 and 35, with the possibility of further participation in Tasman Sea and Indian Ocean cruises.

Supported by U.S. National Science Foundation

5.0412, SYSTEMATICS AND ZOOGEOGRAPHY OF ANTARCTIC CEPHALOPODS
G.L. VOSS, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124

The research proposed by the University of Miami is a continuation of field and laboratory work which has been supported over the past four years under GA-103, GA-253 and GA-709.

The objectives of this proposal are basically unchanged from the earlier ones: the completion of a monograph on the systematics of Antarctic cephalopods. The research entails collection of Antarctic specimens, and for first hand observation of characteristics and behavior of fresh specimens. In addition to these materials, all cephalopod specimens obtained under the United States Antarctic Research Program are forwarded to the principal investigator through the Smithsonian Oceanographic Sorting Center. The shipboard studies on Eilat and data analysis at the University are carried out by graduate assistants who apply their experience and knowledge toward graduate research.

This project requires Eilat participation by one graduate assistant on Cruises 32 and 35, with the possibility of further participation in Tasman Sea and Indian Ocean cruises.

Supported by U.S. National Science Foundation

5.0413, CYTOTAXONOMY OF SPECIES OF RELATED PELECYPOD MOLLUSKS
R.W. MENZEL, Florida State University, Graduate School, Tallahassee, Florida 32306

The taxonomic and genetic relationships of closely related species of pelecypod mollusks will be studied both by morphological comparisons of the shells from museums and field collections with the shells of laboratory-reared hybrids (when possible) and by investigations of chromosomal behavior at meiosis and mitosis in hybrids, F2's and backcrosses. If it is possible to raise the F2's they will be examined for genetic segregation. Particular emphasis will be given to the species of the quahog (Mercenaria) and to oysters (Crassostrea).

Supported by U.S. National Science Foundation

5.0414, REPRODUCTIVE RELATIONSHIPS AMONG POPULATIONS OF A MARINE WOOD-BORING ISOPOD
R.J. MENZIES, Florida State University, Graduate School, Tallahassee, Florida 32306

Most biologists now accept the genetical species concept (Mayr, 1940, et seq.) which defines a species as 'groups of actually or potentially interbreeding natural populations which are reproductively isolated from other such groups.' This concept has not been extensively applied in systematics due to the practical difficulties involved in testing the reproductive relationships of populations. Therefore, almost all species of marine organisms have been distinguished solely on the basis of their morphological distinctness from other groups of populations.

Morphological distinctness, however, has been shown to be inadequate for the recognition of 'genetic species' within a taxon. On one hand, populations in some taxa have been shown to be reproductively isolated from each other although they differ only minutely in their morphology. Some knowledge of the reproductive relationships of populations is necessary for the recognition of 'genetic species' within a taxon.

The immediate objectives of this research are: 1) to evaluate the reproductive relationships among populations of a widely distributed marine species, Limnoria tripunctata Menzies; 2) to provide a relatively complete analysis of the geographic variability of this species; and 3) to establish criteria useful in the determination of species differences. It is hoped that the proposed research will also contribute toward the elucidation of criteria for the recognition of 'genetic species' in marine isopods.

Supported by U.S. National Science Foundation

5.0415, THE OSTRACODA OF THE BAY OF NAPLES
H.S. PURI, State Geol. Survey, Tallahassee, Florida

G.W. Muller's classic monograph on the Ostracoda of the Gulf of Naples is also one of the basic works on the ecology of Ostracoda and has been extensively used by later workers. During the spring and summer months of 1961, 1962, and 1963 the principal investigator occupied Muller's Stations. The Zoological Station Naples obtained on loan Muller's syntype material deposited in the Zoological Museum of Greifswald, East Germany for examination in Naples. Some Syntype material of Muller is deposited in Humboldt University, Berlin, and this material is also being utilized in preparation of a revised monograph on the sediments, ecology, and microfauna of the Bay of Naples. It is hoped that the monograph will include not only a revision of Muller's ostracods but also a study on the hydrography, sediments and ecology of the Bay of Naples based both on foraminifers and ostracods. It has been found that nomenclature and taxonomy of ostracods as described by Muller has undergone drastic changes and also that before species could be used in ecology they needed to be stabilized. It became increasingly obvious that both carapace morphology and soft parts are essential to a natural classification of ostracods.

Environments were established and these environments have characteristic faunas. It is proposed to study these eight environments rather thoroughly and studies of the life cycles and morphology will produce a comprehensive and useful work.

Supported by U.S. National Science Foundation

5.0416, ESTIMATE OF STANDING CROP OF OYSTERS AND SURVEY OF OYSTER PREDATORS IN GEORGIA
T. LINTON, Univ. of Georgia, Graduate School, Athens, Georgia 30602

Objectives: 1. To initiate an inventory and standing crop estimate of oysters on the Georgia coast. 2. To survey the oyster predators, diseases, and competitors present in Georgia waters.

Procedure: A combined technique of statistical sampling and aerial photography will be utilized in estimating the standing crop of Georgia oysters.

Established field and laboratory procedures will be utilized in surveying oyster predators, diseases and competitors present in Georgia waters.

Supported by U.S. Dept. of Interior - Bu. Comm. Fish. Georgia State Government

5. LIVING SYSTEMS (NON-HUMAN)
5. LIVING SYSTEMS (NON-HUMAN)

5.0417, INVESTIGATIONS OF THE INDUCING CAPACIT-  
ITY OF THE POLAR LOBE IN THE DEVELOPMENT OF  
THE MARINE GASTROPOD LYNANSSA OBSOLETA  
J.W. ATKINSON, Emory University, Graduate School, Atlanta,  
Georgia 30322  
No Summary has been provided for use of Science Information Exchange.  
SUPPORTED BY Society of The Sigma Xi

5.0418, ECOLOGICAL AND EVOLUTIONARY IMPLICATIONS OF  
THE ECOTYPES OF ESTUARINE CRUSTACEA  
W.D. BURBANK, Emory University, Graduate School, Atlanta,  
Georgia 30322  
Estuaries are of unusual interest to ecologist because they  
represent tension zones between marine and freshwater environments. Organisms from adjoining communities may be found there along with the biota normally restricted to such zones. The burrowing isopod, Cyathura polita, a typical and very tolerant inhabitant of the Atlantic and Gulf Coast estuaries has been the subject of study by Dr. Burbank for many years (under grants NSF- G-7138 and G-21145). This organism is a key animal in food chains of tidal marshes and estuaries, and represents a large reservoir of potential energy in many of the estuarine ecosystems; however, our knowledge of Cyathura ecology and distribution and its role in the estuarine ecosystem still remains relatively incomplete.  
The proposed work will pursue several lines of ecological inv-  
vestigation in an effort to distinguish ecotypes, to establish definitive characteristics of the taxa within the genus Cyathura, and to prove or disprove the theory of continuing evolution within the genus. Cyathurans from geographically separated populations will be tested for their tolerances and abilities to regulate their metabolism under conditions of external stress. Morphological variations will be noted, and chromatographic analysis is to be employed for delineation of ecotypes. Searches are to be made along the Atlantic Coast for new marine species of Cyathura and new locations of the recently discovered C. burbanki. Finally, museum specimens of Cyathura and animals associated with them are to be examined in order to develop an understanding of the degree to which the biocenosis varies within the geographical range of Cyathura and how this may influence the occurrence of ecological races.  
SUPPORTED BY U.S. National Science Foundation

5.0419, SEASONAL ABUNDANCE AND BIOLOGICAL STAGES OF THE COMMERCIAL SHRIMP OF GEORGIA  
C.M. FRISBIE, State Game & Fish Commission, Atlanta, Georgia  
Objectives: 1) To determine seasonal and relative abundance of adult and postlarval shrimp populations. 2) To secure general life history data such as size distribution, maturity, sex ratios, apparent growth, etc. 3) To collect ecological data throughout the shrimp's habitat. 4) To determine relative abundance of competing vertebrates and invertebrates.  
Procedures: Adult and juvenile shrimp will be sampled by trawls and cast nets from 21 sampling areas, covering a wide range of habitats. Relative and seasonal abundance of these populations will be determined as well as other aspects of their life history such as sex ratio, stages of sexual maturity, size ranges, and species composition.  
Post larval abundance will be monitored with plankton net sampling in order to evaluate spawning success. Environmental parameters will be studied in relation to shrimp populations, to include salinity, temperature, and presence of competitors.  
SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.  
Georgia State Government

5.0420, SURVEY OF A POTENTIAL HARD CLAM FISHERY  
W.F. GODWIN, State Game & Fish Commission, Atlanta, Georgia  
Objectives: 1. To determine the distribution and density of hard clams in Georgia waters. 2. To test several existing techniques for hard clam harvesting, such as small towed dredges, hydraulic rakes, and others. 3. To publicize the results of the project to include distribution data, harvesting techniques, expected harvesting cost, and returns.  
Procedures: Estuarine areas of Georgia will be surveyed, primarily with a towed dredge, to determine the extent and distribution of hard clam beds. Clam density data and habitat requirements will be determined, as well as estimates of potential reproduction.  
Various harvesting techniques will be reviewed and their applicability to the area will be determined. If a commercially feasible clam fishery exists, outfitting and harvesting costs will be developed and be made available to interested parties.  
SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.  
Georgia State Government

5.0421, CONTRIBUTIONS TO THE BIOLOGY OF THE ROYAL RED SHRIMP, HYMENOPENAEUS ROBUSTUS  
W.W. ANDERSON, U.S. Dept. of Interior, Biological Laboratory, Brunswick, Georgia  
Over the past ten years data on size frequencies by sex, stage of sexual development, and relative abundance of the royal red shrimp, Hymenopenaeus robustus, have been collected as opportunity occurred during cruises of the Bureau's exploratory vessels off the coast of the South Atlantic states. These data will be the basis of the first paper dealing with the biology of this deep-water, potentially important commercial species.  
SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0422, MANAGEMENT INVESTIGATIONS OF TWO SPECIES OF SPINY LOBSTERS PANULIRUS JAPONICUS AND P. PENICILLATUS  
The objective of this project is to compile biological information on two species of spiny lobsters, Panulirus japonicus and P. penicillatus, for the eventual scientific management of this resource.  
Commercial catch statistics that have been accumulated for almost two decades will be analyzed for trends in fishing effort, catch per unit effort, catch by fishing area, and seasonal abundance.  
Biological data collected during a tagging and sampling program, conducted from 1960 to 1962, will be analyzed for information pertaining to growth, movement, population estimates, reproductive habits, and length-weight relationships. Additional biological data needed to complete the study will be acquired through a tagging and sampling program.  
Juvenile lobsters will be reared in tanks at the Koichi Fishery Station, Honolulu, in order to compile data on growth and molting and to test methods of tagging or marking small lobsters in the field.  
Experimental trapping and tagging of deep water stocks of lobsters will be attempted for purposes of evaluating the composition and extent of these stocks. The successful development of suitable gear for sampling deep water lobster stocks may result in the expansion of the commercial lobster fishery into areas that are not presently fished.  
SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.  
Hawaii State Government

5.0423, CONTINUED STUDIES ON THE INFLUENCE OF THE EGG CORTEX ON THE DEVELOPMENT OF THE MOLLUSCAN EMBRYO  
J.M. ARNOLD, Univ. of Hawaii, Pacific Biomedical Res. Center, Honolulu, Hawaii 96822  
Brief Description of Research Project: The role of the egg cortex in development and differentiation of the mollusc egg has been recently reemphasized. It appears that this layer, which is made up of a plasma membrane and a very thin layer of cytoplasm which lies directly over the yolk platelets, plays an important role in dictating the eventual fate of the cells which come to contain this cortex. Exactly how and where this 'developmental informa-
Lion' is located and how it is transcribed
J.M. ARNOLD, Univ. of Hawaii, Pacific Biomedical Res. Center, Honolulu, Hawaii 96822
SUPPORTED BY U.S. National Science Foundation

This investigation is concerned with the development of the cephalopod lens. The lens develops by fusion of many cytoplasmic processes which grow out into the optic vesicle from a group of specialized cells (lentigenic cells). The definitive lens material is elaborated in the lens primordium by fusion of Golgi derived vesicles. Apparently microtubules are in some way involved in the transport and outgrowth of the lentigenic processes. Currently a study is being made of the mechanism of outgrowth of the lentigenic processes, the chemical nature of the adult lens, the steps in synthesis of the lens substance and the causes of aggregation of the cellular processes.

SUPPORTED BY U.S. Dept. of Hith. Ed. & Wel. - P.H.S.

5.0425, THE ALPHEID SHRIMP OF AUSTRALIA
A.H. BANNER, Univ. of Hawaii, Hawaii Inst. of Marine Biology, Honolulu, Hawaii 96822
It is proposed to supplement the information and collections now available on the alpheid shrimp of Australia with the view towards monographing the family for Australian waters, as part of our zoogeographic studies in the Indo-Pacific. Presently available, and studied, are collections from various Australian museums; the investigators will study Australian collections and type specimens of Indo-Pacific species in European museums, and then make as many extensive collections as is possible in Australia for subsequent study at the University of Hawaii.

SUPPORTED BY U.S. National Science Foundation

5.0426, NEUROENDOCRINE REGULATION
F.I. KAMEMOTO, Univ. of Hawaii, Graduate School, Honolulu, Hawaii 96822
Dr. Kamemoto proposes to investigate the neuroendocrine regulation of salt and water balance in crustaceans. Studies have indicated that salt balance in crustaceans is under the influence of a factor or factors from the central nervous system. The secretory site, the role(s) of the secretions, the sites of regulation and the nature of the secretions will be investigated.

SUPPORTED BY U.S. National Science Foundation

5.0427, NEUROENDOCRINE PATHWAYS IN OSMOREGULATION IN CRUSTACEANS
F.I. KAMEMOTO, Univ. of Hawaii, Graduate School, Honolulu, Hawaii 96822
Dr. Kamemoto plans to spend a year in Japan working with Seisaku Utida, Ocean Research Institute, University of Tokyo, and Takaaki Ishibashi, Biological Laboratory, Fukuoka University. Studies will be undertaken on the euryhaline shrimp Peneaus and the freshwater crab Potamum to elucidate the problem of the differences in neuroendocrine pathways involved in osmoregulation in various crustaceans, depending upon the natural environment in which the animals are found. These studies will be compared with current studies on the freshwater crayfish Procambarus and the estuarine crab Metopograpus.

SUPPORTED BY U.S. National Science Foundation

5. LIVING SYSTEMS (NON-HUMAN)

5.0428, PHYSIOLOGICAL MECHANISMS UNDERLYING THE BEHAVIOR OF MARINE CRUSTACEA
E.S. REESE, Univ. of Hawaii, Graduate School, Honolulu, Hawaii 96822
The behavior patterns of marine crustacea are studied in the field and in the laboratory. The general stimulus situations, the releasing stimuli, the time and sequence relationships of the movements constituting the behavior, and the resultant effects on the behaving organism and other organisms, when the behavior is in a social context, are measured utilizing direct observations, motion picture analysis, models and other experimental devices. A multiple channel event recorder operated by the investigator provides a record of the behavior in terms of frequency, sequence, and coincidence of occurrence. Analysis of these records permits the formulation of a quantitative statement of the behavior which can be treated with standard statistical methods.

Then by rearing the animals in the laboratory under various conditions of isolation and deprivation, the development of the behavior patterns is measured in terms of the same parameters and by the same means as indicated above. By comparing the quantitative expressions of the behavior of inexperienced young animals with those of wild experienced animals, it is possible to evaluate the role of early experience in the development of behavior.

To date the studies have dealt mainly with the shell selection behavior of hermit crabs, and it has been possible to demonstrate that the shell preferences of the adult animals are not dependent upon their having had past experience with the stimulus objects. Inexperienced, young animals are able to discriminate shells upon their first encounter with them. These studies are continuing with respect to aggressive behavior. In addition, studies on shrimps, particularly with respect to the specialized functions of the appendages, are beginning to develop very nicely. Some preliminary studies have been started on brachyuran coral commensals.

SUPPORTED BY U.S. National Science Foundation

5.0429, POPULATION GENETICS AND LARVAL ECOLOGY OF HAWAIIAN LITTORINA
J.W. STRUHSAKER, Univ. of Hawaii, Hawaii Inst. of Marine Biology, Honolulu, Hawaii 96822
The shell sculpture polymorphism in the periwinkle, Littorina picta Philippi, and variation in color and color pattern of L. picta and Littorina scabra (Linnaeus) from the Hawaiian Islands will be primarily studied. The research will be designed to study this polymorphism and to ascertain the relative influence of genotypic and environmental factors. Variation in the other Hawaiian species will also be examined in this manner. In approaching these problems, cytogenetic studies and breeding experiments will be combined with rearing and acclimation experiments under different environmental regimes.

The techniques developed for breeding, larval rearing and maintenance of Littorina in the laboratory should be of value to the development of marine larval centers in other parts of the world. By determining if Littorina species as potential subjects for genetic experimentation could be of greatest importance to the field of marine genetics.

SUPPORTED BY U.S. National Science Foundation

5.0430, VISUAL AND ACOUSTICAL COMMUNICATION IN CERTAIN MARINE CRUSTACEANS
M. SALMON, Univ. of Illinois, Graduate School, Urbana, Illinois
This grant is for the continuation of studies conducted under GS 3430 at De Paul University.

The purpose of this study is to investigate the role of waving display and sound production as communicative signals in North Atlantic species of fiddler crabs. More specifically, the movements involved in waving display and sound production by males will be filmed and described under a variety of conditions found in the field. Waving display and sound production in populations found in Florida will be compared to that in populations in North Carolina and New York to determine if latitudinal variation in the signal systems exists. The stimuli critical in the elicitation of waving display and sound production will be determined from field observations and via experimental procedures. Sound playbacks,
5. LIVING SYSTEMS (NON-HUMAN)

introduction experiments, and other tests will be carried out with males and females at various times of the day and night and the response of the test crabs quantified. These tests will be designed to determine how the crabs respond to signals used in communication and to one another.

SUPPORTED BY U.S. National Science Foundation

5.0431  OIL CONTAMINATION OF OYSTERS FROM OIL WELL DRILLING MUDS
A.F. NOVAK, Louisiana State University, Agricultural Experiment Sta., Baton Rouge, Louisiana 70803

Objectives: 1. To determine the amount of diesel oil present in contaminated oysters. 2. To determine the threshold amount of oil which can be detected by taste or organoleptically. 3. In what areas or organs of oysters the oil is concentrated. 4. The relationship between concentration of drilling mud in sea water to the oil concentration in the oysters.

At times drilling mud has been released into the surrounding areas. If oyster beds are in the vicinity where drilling muds are released such material can slowly settle over the oyster beds. This may cause the oysters to have an oily taste or if the concentration is high enough death of the oysters.

Oysters will be placed in tanks containing bottom mud mixed with oil drilling mud containing tagged hexadecane C14. Samples of oysters will be removed at regular intervals and the amount of oil from the drilling will be removed at regular intervals and the amount of oil from the drilling mud will be determined by liquid scintillation spectrometry. This is a cooperative project with the La. Wild Life and Fisheries Commission. The Grand Terre Laboratory will conduct the biological work. The extraction of the oil will be conducted in this Department. The spectrometry will be carried out in the Nuclear Science Center at La. State University.

SUPPORTED BY Louisiana State Government

5.0432  CULTURE OF RED SWAMP CRAWFISH, PROCAMBARUS CLARKI, IN BRACKISH WATER PONDS
W.G. PERRY, Rockefeller Wildlife Refuge, Grand Chenier, Louisiana 70434

The freshwater crawfish is a highly valued food source. Crawfish farms are springing up everywhere. However, persons in brackish water areas of our coastal states are a bit hesitant in investing money into such a venture not knowing if they will receive a profit.

It is the purpose of this project to evaluate crawfish production in saline waters and to determine the maximum salinities in which the crawfish may be cultured.

SUPPORTED BY Louisiana State Government

5.0433  ECOLOGICAL STUDIES OF THE BLUE CRAB, CALLINECTES SAPIDUS
W.G. PERRY, Rockefeller Wildlife Refuge, Grand Chenier, Louisiana 70434

This project is designed that we may better understand the life history of the blue crab in the estuaries of Southwest Louisiana.

SUPPORTED BY Louisiana State Government

5.0434  LAKE BORGNO - CHANDELEUR SOUND SYSTEM
J.G. BROOM, State Wildlife & Fish Comm., New Orleans, Louisiana

Objectives: Develop, coordinate and increase the knowledge about the Gulf shrimp fishery by: (1) postlarval shrimp sampling, (2) juvenile sampling, (3) sampling of over-wintering populations, (4) collection of hydrographic information and (5) processing of data.

Program and Work Schedule: (1) Weekly postlarval shrimp sampling in the major passes with 6-foot beam plankton net. (2) Weekly juvenile shrimp sampling throughout the major nursery areas with 6 foot 1/4 in mesh trawls on a seasonal basis.

(3) Periodic sampling of over-wintering stocks of shrimp in the coastal marshes and near offshore Gulf waters with shrimp trawls. (4) Collection of hydrographic information including salinity, temperature and tidal data by use of continuous recording meters and portable units. (5) The processing, tabulating and summarizing of collections and raw data, which are to be transmitted to the project leader at the marine laboratory for compilation, analysis and interpretation.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish. Louisiana State Government

5.0435  SHRIMP PRODUCTION IN LOUISIANA SALT-MARSH IMPOUNDMENTS UNDER EXISTING AND MANAGED CONDITIONS
A.H. HARRIS, Francis T. Nicholls State Coll, Graduate School, Thibodaux, Louisiana 70301

This project is to determine the feasibility of shrimp farming in the impounded marshes and lagoons of Louisiana. The existing productivity of impounded nursery areas already producing shrimp is to be determined and then compared with another area operated under experimental conditions. Natural nursery areas will be encompassed with levees, and water control structures will be used to provide control over movement of tides and shrimp into and out of the impoundments. Both impoundments will be stocked by natural recruitment of the brown (Penaeus aztecus and white (P. setiferus) young shrimp from flood tides.

The second phase of the program is to develop methods of management and harvesting that will determine the economic feasibility of shrimp farming in the Louisiana marsh. To do this, patterns of ingestion and agression, population fluctuations, growth rates, natural mortality, and food habits of both species will be investigated. The effects of predators and parasites also will be determined. The Louisiana Land the Exploration Company, a private owner of extensive marshland acreage, is providing free of charge, the use of some of their land for this research and some of the financial support for the project.

SUPPORTED BY U.S. National Science Foundation

5.0436  LOBSTER RESEARCH
B.E. SKUD, U.S. Dept. of Interior, Biological Laboratory, Boothbay Harbor, Maine 04538

Two objectives: learn whether there are any biological connections between the inshore and offshore fisheries; determine the essential population characteristics and the environmental requirements for maintaining a maximum catch.

Approaches: 1) Obtain catch records. State of Maine has extensive present and past data on the inshore fishery, so our effort is concentrated on the offshore fishery which takes place along the edge of the continental slope. 2) Study lobster movements. Test a tag which will persist through several molts. Use to determine local, seasonal, and long-distance movements. 3) Develop means of distinguishing discrete groups of lobsters. Utilize studies of morphology, growth, blood-types, and parasites for this purpose. 4) Obtain first-hand and specific knowledge of lobster habitat and behavior through use of SCUBA divers. 5) Study lobster life history. Include studies of fecundity, larval and juvenile stages, growth, and mortality. Investigate relationships of various developmental states to harvestable population. 6) Determine environmental requirements of lobsters, including optimum levels and extremes of tolerance. 7) Utilize output of all studies to make abundance or availability predictions and to establish safe maximum levels of harvesting.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0437  TEMPERATURE AND SALINITY TOLERANCE OF THE SAND SHRIMP, CRANGON SEPTEMPINSA
P.A. HAEPNER, Univ. of Maine, Graduate School, Orono, Maine 04473

This is a continuation of GB-5228. All organisms are subject to a complex of environmental variables. Their response is to the net effect of all stresses applied. The investigator is studying the
interaction of temperature and salinity stresses on non-genetic adaptation of an estuarine animal that normally encounters a wide variation in these factors. Laboratory studies have shown the limits imposed by various temperature-salinity interactions. Field studies now in progress will relate the laboratory findings to survival and distribution of the shrimp in nature.

SUPPORTED BY U.S. National Science Foundation

5.0438. EXCITATION-CONTRACTION COUPLING IN MUSCLE
H. GAINER, Univ. of Maryland, Graduate School, College Park, Maryland

This investigation will attempt to further analyse the mechanism whereby the excitation process in the surface plasma membrane of muscle fibers brings about the initiation of contraction even in the deepest myofibrillar layers. The hypothesis that a transverse tubular network with specific membrane properties is the site of the coupling mechanism, will be tested in several crustacean muscle fibers by various electrophysiological and physicochemical experiments. The crustacean species presently under investigation are Homarus americanus, and the blue crab (Callinectes sapidus). Several other species of crab will also be studied with regard to their excitation-contraction coupling processes. It is hoped, that through a comparative approach to excitation-contraction coupling further insights into the general problems of this process will be provided.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0439. A NON-DESTRUCTIVE METHOD FOR ESTIMATING POPULATION DENSITY AND DISTANCE TO NEAREST NEIGHBOR FOR ESTUARINE MOLLUSCS
A.J. McERLEAN, Univ. of Maryland, Natural Resources Institute, College Park, Maryland

SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY Society of The Sigma Xi

5.0440. PARASITOLOGY
J.A. COUCH, U.S. Dept. of Interior, Biological Laboratory, Oxford, Maryland

Systematic, epizootiological, and zoogeographical studies of significant parasites and commensals of commercial shellfish and associated species are being carried out. Several life history stages of parasites (Minchinia nelsoni and M. costalis) of oysters have been found and identified. A three-year study of the epizootics caused by both of these parasites has been completed for Chincoteague Bay, Virginia.

Oysters from estuarine waters of the Middle Atlantic and Southern States are being examined for M. nelsoni (MSX) and M. costalis (SSO) and other potentially pathogenic organisms. This study has given us an incomplete but valuable conception of the possible presence or absence of these parasites in significant oyster producing areas on the eastern coast. Thus far it has been learned that the range of M. nelsoni extends at least as far north as New Haven, Connecticut, and as far south as the New River, North Carolina, 036.

Blue crabs are being examined from several areas in Chesapeake Bay and east coast of the southern United States severe oyster mortalities have been reported. Parasites were identified and one gill commensal, Lagenophrys (a peritrichous ciliate), has been described and is being studied as a contributor to the mortalities. Further studies are planned on the 'Grey Crab disease' believed to be caused by an amoeboid organism.

The long-range goal of the project is to better understand the roles that parasites and commensals play as limiting factors in the abundance and utilization of shellfish.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0441. PATHOLOGY - EPIZOOTIOLOGY
C.A. FARLEY, U.S. Dept. of Interior, Biological Laboratory, Oxford, Maryland

5. LIVING SYSTEMS (NON-HUMAN)

The pathological, parasitological, epizootiological, and cytochemical relationships of diseases in oysters are being studied. Receiving greatest attention with regard to the above is the haplosporidian, Minchinia nelsoni, an oyster parasite associated with massive oyster mortalities in Delaware and Chesapeake Bays. With the repeated discovery of definitive life cycle stages, its life history within the oyster has now been proposed. A system for determining stages of infection has been developed and is being utilized for interpretation of epizootiological data. Comparative studies are being made of epizootiological patterns in two populations of oysters in Pocomoke Sound, Maryland. Methods are being developed for determining DNA-RNA patterns in hosts and parasites and is receiving intensive study. Studies are also being made of causes of mortality in oysters from the west coast of the United States, British Columbia, and France and are being compared with local mortality causes.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0442. PACIFIC OYSTER MORTALITY STUDIES
A. ROSENFIELD, U.S. Dept. of Interior, Biological Laboratory, Oxford, Maryland

Efforts are being made to identify or discover those factors, particularly disease agents, responsible for shellfish mortalities on the west coast of the United States and Canada. Epizootiology and pathologic studies are being conducted to determine timing, patterns, and possible causes of mortalities, and to determine pathogenicity of disease agents. Shellfish from exotic and domestic 'seed' supply areas are screened for microorganisms or disease organisms before introduction or importation of these shellfish into west coast growing areas.

Shellfish from several Far East potential 'seed' sources have been and are being examined microscopically for the presence of microparasites, micropathogens, and disease conditions. Many patterns of disease agents, responsible for shellfish mortalities have been found and identified. A three-year study of the epizootics caused by both of these parasites has been completed for Chincoteague Bay, Virginia.

Oysters from estuarine waters of the Middle Atlantic and Southern States are being examined for M. nelsoni (MSX) and M. costalis (SSO) and other potentially pathogenic organisms. This study has given us an incomplete but valuable conception of the possible presence or absence of these parasites in significant oyster producing areas on the eastern coast. Thus far it has been learned that the range of M. nelsoni extends at least as far north as New Haven, Connecticut, and as far south as the New River, North Carolina, 036.

The pathological, parasitological, epizootiological, and cytochemical relationships of diseases in oysters are being studied. Receiving greatest attention with regard to the above is the haplosporidian, Minchinia nelsoni, an oyster parasite associated with massive oyster mortalities in Delaware and Chesapeake Bays. With the repeated discovery of definitive life cycle stages, its life history within the oyster has now been proposed. A system for determining stages of infection has been developed and is being utilized for interpretation of epizootiological data. Comparative studies are being made of epizootiological patterns in two populations of oysters in Pocomoke Sound, Maryland. Methods are being developed for determining DNA-RNA patterns in hosts and parasites and is receiving intensive study. Studies are also being made of causes of mortality in oysters from the west coast of the United States, British Columbia, and France and are being compared with local mortality causes.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0443. PROTOZOOLOGY
T.K. SAYEY, U.S. Dept. of Interior, Biological Laboratory, Oxford, Maryland

Methods and procedures are being developed to establish protozoan parasites from oysters and other shellfish in xenic and axenic culture. Techniques such as enzyme dissociation, gradient centrifugation, and selective filtration for the isolation of protozoans from oyster tissue and the environment are being investigated. Isolates are grown on special nutrient media in the presence of various food sources to determine survival periods and 'growth' potential of the organisms. Nuclear division and morphology of trophic forms are being studied by phase contrast, and with the use of differential stains. Taxonomic studies are in progress using fluorescent antibody techniques.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0444. CULTURE OF SHELLFISH IN ARTIFICIAL AND NATURAL SALT PONDS
W.N. SHAW, U.S. Dept. of Interior, Biological Laboratory, Oxford, Maryland

Early in 1964, four one-quarter acre artificial ponds were completed near the laboratory at Oxford, Maryland. Studies are being conducted on the growth and survival of oysters in these ponds. Studies are being conducted in one of the ponds for catching oyster set and fattening oysters. Attempts to fertilize the ponds to increase productivity are underway.

Studies are planned on the growth and survival of oysters suspended from a rigid structure on the Tred Avon River adjacent to the laboratory. Preliminary studies indicate that the river is favorable for good oyster growth. Strings of oysters will be suspended and their growth and survival studied.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
5. LIVING SYSTEMS (NON-HUMAN)

5.0445. POTENTIAL OYSTER SETTING CAPACITY - LOCAL AREAS

W.N. SHAW, U.S. Dept. of Interior, Biological Laboratory, Oxford, Maryland

This project is concerned with the setting capacity of oysters in local waters, principally the Tred Avon River, Broad Creek, and Harris Creek, on the Eastern Shore of Chesapeake Bay in Maryland. Yearly stations are established in each area, and during the oyster setting season (June to October) collectors in the form of oyster shells and asbestos flexboards are put out at each station. Total amount of setting and period of setting intensity are measured by counting daily and weekly the number of oyster spat on these collectors. In addition, the amount of fouling competitors for space is studied.

Studies on the rafting of shells to catch seed oysters are being conducted. Rafts are being placed in areas where setting intensity has been high. Shells on strings and in bags are being suspended from the rafts during the setting season. Once the seed is caught they are removed from the rafts and suspended from a rigid structure to grow to market size. The long line method to catch and grow seed oysters is to be tested in several areas.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0446. ECOLOGY AND DISTRIBUTION OF OYSTERS AND CLAMS

W.N. SHAW, U.S. Dept. of Interior, Biological Laboratory, Oxford, Maryland

The natural populations of commercial shellfish in local areas have been delimited. Zooplankton and phytoplankton levels in shellfish producing areas are being determined and the organisms involved are being identified. The effects of physical and chemical factors on plankton, and on larval, juvenile, and adult stages of commercial shellfish are being determined. Qualitative and quantitative observations are being made on the invertebrate animals in local areas, and numbers and living habits related to effects on commercial species. Food webs, within the small estuarine tributaries of Chesapeake Bay, are being established. Ecological studies in large man-made salt water ponds have been undertaken, and all information, from natural and artificial situations, will be related to maintenance of shellfish in these ponds.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0447. GROWTH, CONDITION, AND SURVIVAL OF SHELLFISH

W.N. SHAW, U.S. Dept. of Interior, Biological Laboratory, Oxford, Maryland

In recent years the oyster industry in Chincoteague Bay has been importing oysters from other regions into the bay to hold for future marketing. At present, studies are being conducted to see if these oysters adapt to this new environment. Oysters from low salinity waters are suspended in trays in Chincoteague Bay. Their growth, condition, and survival are monitored.

Monthly, a comparative analysis is made on the conditions, percentage of solids, of oysters on two natural bars—one in broad Creek and one in the Tred Avon River. At each locality the effects of crowding and fouling are being studied.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0448. SURF CLAM POPULATION DYNAMICS

R.M. YANCEY, U.S. Dept. of Interior, Biological Laboratory, Oxford, Maryland

The commercial hydraulic jet dredge has been modified to sample clams without bias in sizes larger than two inches.

Clam occurrence on the Atlantic coastal shelf between the Hudson Canyon and Cape Charles will be determined. Clam abundance in time and place will be described according to commonly understood measures.

The normal yearly recruitment of juvenile clams to the major populations will be determined. Variations in year class abundance will be estimated, with special attention to probable dominant year classes. The rate of clam survival before the size and age when they are harvested commercially (about four inches long) will be determined. The rate at which clams usually become available to the commercial fishery as a function of their size (or age) will be estimated. Such availability will be related to mortality, including fishery removals. The effects of fishing upon population composition, natural survival, and natural recruitment will be determined. The rate of repopulation of depleted grounds will be estimated.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0449. SURF CLAM BIOLOGY

R.M. YANCEY, U.S. Dept. of Interior, Biological Laboratory, Oxford, Maryland

As a part of the life history project, samples of surf clam, Spisula solidissima, gonads are routinely collected from New Jersey ports of landing and from other areas along the Atlantic Coast. The gonads are prepared for microscopic examinations of gametogenesis to determine the frequency, duration, and times of spawning. Since the gonad samples are taken from large mature clams, other gonads will be collected from smaller clams to determine sexual maturity. These observations will provide basic knowledge useful in studies of recruitment, repopulation, and the extent of the spawning population of this commercial shellfish.

Studies are being conducted to develop reliable aging techniques and to determine the growth rate of surf clams, since little is known about the length of time it takes for these clams to reach a marketable size. Frequency distributions of shell length measurements will be collected from samples taken at sea, port landings, and beaches. The feasibility of marking and tagging clams is being explored to provide direct evidence of clam age and growth.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0450. FREEZING AND DRYING OF LIVING CELLS

H. MERTYMAN, U.S. Navy, Medical Research Inst., Washington-Bethesda, Maryland

Objective: a. Problem: To investigate the mechanisms whereby freezing and drying affects living cells. b. Application: Determination of methods of protection of cells under severe environmental conditions. c. Injury to cells subjected to freezing can be either mechanical (ice crystal edges cutting into cell components) or chemical (chemical reactions and/or concentrations of chemicals due to dehydration).

Approach: The work will include pertinent studies and completion of studies on the freezing resistance of nematodes. Further studies will begin on freezing resistance and sensitivity on intertidal mollusks. Other work will be conducted on thermal analysis as a means for observing the development of phase changes during temperature cycling. Work will also continue on the effect of survival of storage of evaluated temperature under varying equilibrium water vapor pressures and subjected to gamma radiation. Additional work will be performed to investigate reported degradation of biological materials in liquid nitrogen.

Progress: A close correlation has been found between the onset of injury in freezing and the proportion of water frozen for several biological materials with widely divergent temperatures of injury.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

5.0451. PARASITIC COPEPODA %CRUSTACEA ROM INVERTEBRATES AND FISHES

A.G. HUMES, Boston University, Graduate School, Boston, Massachusetts 02115

Large collections of copepods, all parasites or associates of marine fishes or invertebrates, will be studied with emphasis upon morphology and systematics. These copepods come from mainly the West Indies and Madagascar, those from the latter area having been collected during the International Indian Ocean Expedition in 1963-64.
5. LIVING SYSTEMS (NON-HUMAN)

SUPPORTED BY U.S. National Science Foundation

5.0452. COASTAL LOBSTER FISHERY
A.E. Peterson, State Dept. of Nat. Resources, Boston, Massachusetts

Objective: To obtain accurate lobster landing statistics, including location, catch, effort, and gear used from the licensed Massachusetts lobster fishermen.

Procedure: All licensed lobster fishermen are required to submit annual reports before new licenses are issued. The license holders will be divided into commercial and non-commercial categories. The commercial lobster fishermen will then be required to submit monthly catch reports. The accuracy of the reports will be checked by interviewing a random sample of the license holders. This information will then be compared and correlated with individual, annual, and/or monthly reports. An attempt will be made to improve catch reports, and it is anticipated that it will be possible to utilize weigh-out slips when the fisherman sells his lobsters to the dealer. With both parties retaining a copy of this slip, further verification of reports can be made through comparison.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish. Massachusetts State Government

5.0453. OFFSHORE LOBSTER FISHERY
A.E. Peterson, State Div. of Marine Fisheries, Boston, Massachusetts

Objective: To obtain accurate lobster landing statistics, including location, catch, and effort, from the otter trawl draggers catching lobsters.

Procedure: A survey of the Massachusetts ports where draggers land their catches will be made to ascertain the extent of lobster landings at each port. It is proposed that weigh-out slips will then be utilized as a source of catch statistics. Both the fishermen and the dealer will be required to submit monthly reports. Interview sampling will be used to verify the reports.

Time: This phase will not be initiated during the first year of operation, since the Bureau of Commercial Fisheries, Boothbay Laboratory, is currently engaged in a similar project under their offshore lobster investigations.

It is planned to perform this phase in subsequent sub projects.

Part 2 of 6.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish. Massachusetts State Government

5.0454. BIOLOGY OF THE ANTARCTIC BRACHIOPOD
FAUNA
B. KummeL, Harvard University, Graduate School, Cambridge, Massachusetts 02138

Support is provided to Harvard University for the third and final year of a project on the systematic and qualitative studies on Antarctic brachiopod taxa. This will complete studies of the soft part anatomy and sections of shell for taxonomic and evolutionary characters, determine skeletal support through x-ray techniques and utilize electron probe for information on elemental variations. The overall objective is to provide a modern biological study of Antarctic brachiopods, essential to an understanding of brachiopods in general, with information on the ecology and zoogeography of Antarctic genera and species. The support will assist in the preparation of a manuscript for publication.

Under GA-430, the investigators have incorporated data on 39 genera and 78 species reported in the literature of the Antarctic Region. These have been projected in a series of charts with appropriate text for publication in the marine biology volume of the Antarctic Map Folio Series. Species representing 12 genera and 78 species have been assembled on lean from foreign and domestic museums for study of regional differences. Visits have been made or are planned to New Zealand, Australian and British Museums for examination of type specimens. Material in excess of 10,000 specimens has been collected through participation in Elinan cruises 27 and 32. This provided fresh specimens for observation on feeding and reproduction and for histological and systematic information on structure and function. This data study will be conducted at Harvard University; there are no requirements for field work.

5.0455. HISTOCHEMICAL STUDIES OF MUCOSUBSTANCES IN THE MANTLE OF THE NORTHERN QUAHOG, MERCENARIA MERCENARIA
R.E. Hillman, William F. Clapp Laboratories, Duxbury, Massachusetts 02332

The objective of this study is to localize and describe mucopolysaccharides and mucoproteins in the mantle edge of the quahog clam, Mercenaria mercenaria. These mucosubstances vary in chemical composition from area to area within the mantle edge. It is reasonable to assume they are performing relatively sophisticated physiological functions because of the variations in structure and the fact that similar mucosubstances in higher forms have specific physiological roles. By localizing and identifying the various mucosubstances in the clam one might be able to correlate the functions of these substances in the clam with those in the higher forms. It might then be possible to learn more about the mechanism of action of these substances. For example, a comparison of the glycosaminoglycans aiding in shell deposition in the clam with similar dermatan sulfate found associated with calcification in higher organisms might provide information as to glycosaminoglycans function in the overall mechanism of calcification.

SUPPORTED BY Battelle Memorial Institute

5.0456. SEA CLAM EXPLORATIONS
P.S. Parker, U.S. Dept. of Interior, Exptl. Fish & Gear Res. Base, Gloucestere, Massachusetts 01930

Detailed systematic area clam surveys along the North Atlantic coast of the United States are conducted. The purpose of the surveys is to gather information on the abundance, distribution and size of surf clams (Spisula solidissima) and other species found with a potential commercial use and to determine from this information if the surf clam and other species populations located are suitable for commercial exploitation. It is anticipated that this information will be used by the surf clam industry to make future management plans for maintaining a healthy growing natural population.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0457. NORTHERN SHRIMP EXPLORATIONS
P.S. Parker, U.S. Dept. of Interior, Exptl. Fish & Gear Res. Base, Gloucester, Massachusetts 01930

Seasonal exploratory fishing surveys are being conducted in Gulf of Maine and Georges Bank waters to locate and delineate populations of northern shrimp (Pandalus sp.) that may be available in sufficient quantities to support expansion of the commercial fishery for this species. Special trawls and shrimp handling equipment are being developed to promote the most efficient harvesting of shrimp and rapid handling aboard ship.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0458. SYSTEMATICS MORPHOLOGY AND ECOLOGY OF THE GENUS ERVILIA (MOLLUSCA: PELECYPODA) IN THE WESTERN ATLANTIC
J.D. Davis, Smith College, Graduate School, Northampton, Massachusetts 01060

... NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY Society of The Sigma Xi

5.0459. DEMINERALIZATION-BORING MECHANISMS OF MOLLUSKS
M.R. Carriker, Marine Biolog. Laboratory, Woods Hole, Massachusetts 02543

Continue studies of the degree of penetration of the ABO* secretion into the surface of shell in the bone hole of Urosalpinx during boring by means of microradiography (titanium radiation), and by means of the scanning electron microscope.
5. LIVING SYSTEMS (NON-HUMAN)

Continue studies to elucidate the metabolic pathways in the Urosalpinx ABO which may control the action of carbonic anhydrase activity in decalcification.

Continuous preparation of manuscripts on (a) behavior of shell penetration by Urosalpinx cinerea fyllonyis, and (b) comparative functional morphology of the ABO of muricid gastropods.

Continue organization of international symposium on the penetration of calcareous subtrates by invertebrates and lower plants for the AAAS Meetings in 1968 under major sponsorship of the American Society of Zoologists. A B O is the accessory boring organ of the muricid boring snail Urosalpinx cinerea fyllonyis (Baker).

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0460, THE POPULATION ECOLOGY OF GEMMA GEMMA (PELECYPODA, VENERIDAE), A DOMINANT SPECIES IN BARNSTABLE HARBOR, MASS
R.H. GREEN, Marine Biolog. Laboratory, Woods Hole, Massachusetts 02543

The definitive taxonomic treatment of Antarctic calanoid copepods from Eltanin zooplankton will be carried out at Woods Hole Oceanographic Institution. Preliminary sampling of zooplankton and mid-water trawls made on Eltanin Cruise 17 reveals 53 species: these have been analyzed for size variations, species composition and numerical abundance. Continuation of this systematic study, using materials from selected stations made by Eltanin in earlier cruises in the Southern Ocean, will permit a complete faunistic treatment of all samples. In addition, an attempt will be made to determine the biological significance of the Antarctic convergence and the hydrology of the entire Southern Ocean in the habit and distributional pattern of pelagic copepods.

The calanoid copepods will be studied in terms of comparative anatomy, biometry, and distribution with the ultimate objectives of producing a comprehensive monograph, including illustrated keys to species. The samples required in this study will be provided through the Smithsonian Oceanographic Sorting Center where the zooplankton hauls and midwater collections are rough sorted and curated. Labelled specimens will be returned by the principal investigator at the conclusion of the work to the SOSC. All type specimens will be deposited at the U. S. National Museum. It is planned tentatively to participate in one Eltanin cruise.

SUPPORTED BY Whitehall Foundation

5.0461, SYSTEMATIC STUDIES OF ANTARCTIC COPEPODS
T.S. PARK, Woods Hole Oceanographic Inst. , Woods Hole, Massachusetts 02543

To establish dissolved oxygen, temperature, and pH requirements for various species of aquatic insects and crustaceans which have been found to be important in the food chain of brook, rainbow, and lake trout. Two species of Lake Superior crustaceans, Mysis relicta and Ponteporeia affinis, and five species of aquatic insects, Anceonera lycorias, Taeneopteryx maura, Brachycentrus americanus, Hydropisycbe betteni, and Ephemerella subvaria, will be used as test organisms. The work will consist of determining the Ti(mLD50) values for 96 hours and 30 days, and longer if possible, for high temperatures, low oxygen, and low and high pH.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0462, CUES INVOLVED IN VERTICAL MOVEMENT AND STATIC ORIENTATION OF GASTROPODS
A. MCCLARY, Michigan State University, Graduate School, East Lansing, Michigan 48824

Brief Description of Research Project: The relative importance of several potential cues to vertical movement of Helix pomatia and Pomacea paludosa will be investigated. This will be done by depriving various groups of snails of one or more of these cues and then testing their ability to travel upwards on slopes or vertical surfaces. Statocyst stimulation as a cue will be abolished by removing statocysts as done in previous work. Some snails will also be shamped to provide a check for the effects of simple operative incision as compared to incision plus statocyst removal. Light as a cue will be abolished by blinding, shell muscle proprioceptors by floats or strings attached to shell apices. In the case of Pomacea, two other potential cues, namely oxygen gradients and long gas, will also be abolished.

In a similar manner, substrate contact, statocyst stimulation, and light will be investigated as potential cues for static orientation.

SUPPORTED BY U.S. National Science Foundation

5.0463, PHYSIOLOGY OF THE LIMULUS HEART
R.A. PAX, Michigan State University, Graduate School, East Lansing, Michigan 48824

The rhythmically active neural tissues of neurogenic hearts present simple systems for study of problems of initiation, maintenance, and regulation of neurogenic rhythms in general. The decapod crustacean heart has been intensively studied in recent years but the basic questions concerning neurogenic rhythms have not yet been answered. It is proposed here that a neurogenic rhythm in different classes of animals be studied. The neurogenic rhythm proposed for this study is that of the heart of Limulus, the horse-shoe crab. This study, entailing histological, electrophysiological and pharmacological experiments, is expected to answer the question of whether mechanisms by which neurogenic rhythms arise are the same in different animal groups and whether the Limulus heart is a more favorable preparation for an attack on the problem of how such rhythms are initiated.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0464, EFFECTS OF HIGH TEMPERATURE, LOW OXYGEN, AND PH EXTREMES ON THE SURVIVAL OF AQUATIC INSECTS AND CRUSTACEA IMPORTANT AS TRIBUT FOOD
A.V. NEBEKER, U.S. Dept. of Interior, Natl. Water Quality Lab., Duluth, Minnesota

To establish dissolved oxygen, temperature, and pH requirements for various species of aquatic insects and crustaceans which have been found to be important in the food chain of brook, rainbow, and lake trout. Two species of Lake Superior crustaceans, Mysis relicta and Ponteporeia affinis, and five species of aquatic insects, Acroneuria lycorias, Taeneopteryx maura, Brachycentrus americanus, Hydropisycbe betteni, and Ephemerella subvaria, will be used as test organisms. The work will consist of determining the Ti(mLD50) values for 96 hours and 30 days, and longer if possible, for high temperatures, low oxygen, and low and high pH.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0465, A STUDY OF COLIFORM BACTERIA AND ESCHERICHIA COLI ON POLLUTED AND UNPOLLUTED OYSTER BOTTOMS OF MISSISSIPPI
G. GUNTER, State Marine Conserv. Comm., Biloxi, Mississippi

Objectives: 1) To establish a regular sampling program on transects across Mississippi Sound and extending from fresh water to the Gulf of Mexico and on selected polluted and unpolluted oyster reefs. 2) To perfect technique for collecting comparable samples. 3) To complete bacterial analyses of collected samples. 4) To compare the bacterial flora from polluted and unpolluted areas of Mississippi Sound and adjacent waters, especially as it relates to sewage polluted oyster beds.

Procedures: 1) Field - (a) Surface, mid-water and bottom samples will be collected at established stations where there is sufficient depth of water. Additional samples will be collected as necessary. (b) Techniques to insure the collection of samples under sterile conditions will be established. (c) Temperature and salinity will be determined at all stations. (d) Collected samples will be refrigerated and returned to the laboratory for analysis. 2) Laboratory - (a) The Most Probable Number of coliform organisms and of Escherichia coli of presumptive human fecal origin will be determined by competent bacteriologists. (b) Additional studies will be carried out where feasible.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish. Mississippi State Government

5.0466, POPULATION STUDIES OF HAUSTORIIDAE AND GAMMARIDAE FROM NEW ENGLAND AND ON INFANAL AND EPIFAUNAL MARINE AMPHIPODS AT ENIWETOK
R.A. CROKER, Univ. of New Hampshire, Graduate School, Durham, New Hampshire 03824
I. This research focuses on two families of marine amphipods: 1) Gammaridae, with epifaunal, boreal-subarctic species of wide ecological valence, that presently show different morphological and population characteristics when coastal and estuarine populations are compared, and 2) infra specific variation as related to ecological specialization, 2) population structure, including clines, isolates, peripheral populations, fluctuations, intergradations, and dispersal, 3) breeding systems including ecological, reproductive and chromosomal factors, and 4) environmental factors acting on populations.

II. This research concerns studies on marine amphipods of tropical Pacific sand substrata and was designed primarily to provide knowledge concerning zoogeography and life histories of Micronesian species. The research emphasizes collecting in fine calcareous lagoon sediments of Pacific atolls to provide population data on: distribution, density, specific composition, reproductive cycles, fecundity, sex ratio, growth, and food. Particular stress is placed on life history aspects, distributional ecology and infra specific variation.

SUPPORTED BY University of New Hampshire U.S. Atomic Energy Commission

5.0467, PURIFICATION OF HARD CLAMS FROM POLUTED WATERS

H.H. HASKIN, Rutgers The State University, Graduate School, New Brunswick, New Jersey 08903

This project is designed to define optimal conditions for maximum clam activity. The activities of greatest interest are those which purify (depurate) the clams of bacterial and viral contaminants. Since purification experiments are lengthy and involved, other indicators of clam activity will be used in a study of such environmental parameters as temperature, salinity, turbidity, food levels, light, oxygen levels, etc. Uptake and disposal of bacterial and viral-chromogen contaminants will be further studied in the laboratory and the results of these studies will be related to bacterial and, hopefully, enteric viral levels in the Raritan Bay estuary and its clam populations.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0468, BIOCHEMICAL CHARACTERIZATION OF CHOLINESTERASES IN THE BLOOD AND CENTRAL NERVOUS SYSTEM OF LIMULUS POLYPHEMUS


Acetylcholine-cholinesterase systems have been found in all arthropods studied. However, information is lacking on Limulus polyphemus. This organism has the additional interest of being considered a living fossil. Therefore, from a comparative as well as a phylogenetic point of view, an attempt is being made to characterize the pseudo and true cholinesterases in the blood and central nervous system of adult organisms. The technique involves the rate of enzymatic acid production as measured by an autoburette in response to specific substrates. Work is being conducted at Montefiore Hospital and should be completed by 1969.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0469, NEUROPHYSIOLOGICAL INVESTIGATIONS OF LIMULUS CENTRAL NERVOUS SYSTEM

R. VONBURG, Fordham University, Graduate School, New York, New York 10458

The circumesophageal collar, haemal nerves and ventral cord were investigated for controlling influences on the heart rate of Limulus polyphemus. Electrical stimulation and surgical lesions were the principal techniques. Recordings were made by means of oscilloscope and polygraph.

The forebrain was found to exert a contralateral driving force on the haemal nerves 7 and 8 which are known to control the heart rate. However, contrary to Pax and Sanborn (1964) the output of these nerves was found to be only inhibitory.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5. LIVING SYSTEMS (NON-HUMAN)

The ventral cord was also found to control cardiac rate.

The control resides within the abdominal ganglia and there appears to be a functional hierarchy that begins with the first abdominal ganglion and diminishes with each successive ganglion. Here again, there appears to be a contralateral driving influence on an inhibitory output. Several models of Limulus e.g.n.a. are possible. In an effort to eliminate some of these possibilities, single fiber analysis of the outputs of the abdominal ganglia will be attempted.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

5.0470, THE EFFECT OF SOME NEUROTRANSMITTERS ON THE CENTRAL NERVOUS SYSTEM OF LIMULUS POLYPHEMUS

R. VONBURG, Fordham University, Graduate School, New York, New York 10458

Acetylcholine bromide, gamma-amino butyric acid, 5 hydroxtryptamine, 3 hydroxytryptamine, histamine, L-glutamine, epinephrine, nor epinephrine and the inhibitors, curare, atropine, reserpine, eserine and picrotoxin were studied.

Application of the drugs was accomplished by cannulating the ventral cord connecting tissue sheath with a polyethylene needle. Cardiac rate and nerve firing rate were recorded by an oscilloscope and polygraph.

Acetylcholine bromide and gamma-amino butyric acid at 0.01 molar concentrations appear to be the only substances tested that were able to produce consistent changes. Acetylicholine increased nerve activity and enhanced the heart rate while the reverse was true with gamma amino butyric acid. Only eserine and picrotoxin were effective as inhibitors. Other agents are currently being tested.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

5.0471, MECHANISMS OF VENTILATORY CONTROL

M. MENDELSON, New York University, School of Medicine, New York, New York 10003

A system of interneurons and motorneurons in the subesophageal ganglion of the hermit crab is to be studied further. This system, which controls the ventilatory appendage of the crab has been found to operate in essentially normal fashion in vitro for considerable periods. Interaction among the inter- and motorneurons are being analyzed.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0472, PHYSIOLOGICAL VARIATION AND ECOLOGY OF MOLLUSCS

W.D. HUNTER, Syracuse University, Graduate School, Syracuse, New York 13210

The proposed work continues and extends the field and laboratory studies on the physiological ecology of molluscs previously carried out by the principal investigator. The major long-term studies involve field investigations of respiratory behaviour, growth, reproductive pattern, and population dynamics in selected natural populations of fresh-water and marine littoral molluscs. There are two main objectives in these studies: (a) to determine the extent and nature of physiological variation among natural populations of the same species, for example, in respiration and in reproduction, and (b) to attempt to produce population 'balance sheets,' that is, assessments of population turnover in relation to total species biomass, including field estimates of metabolic rates and energy flow through the populations concerned. The long-term field work on natural populations is supplemented by cognate experimental studies, mostly short-term, on specific aspects of physiology or ecology in molluscs. Examples include studies on control of diapause and onset of breeding in snails, on respiratory adaptations, on locomotion, on water control, on methods of assessment of population density and dispersal, and on the ecology of closely related species.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.
5. LIVING SYSTEMS (NON-HUMAN)

5.0473. EFFECT OF ENVIRONMENTAL CHANGES ON BLUE CRAB ABUNDANCE
M.H. JUDY, U.S. Dept. of Interior, Biological Laboratory, Beaufort, North Carolina 28516

This project the following studies are planned or are in progress in North Carolina waters: (1) relative abundance and distribution of all life history stages. (2) migratory movements of adult blue crabs. (3) species composition of crab population. (4) development of methods to estimate adult crab population size. (5) relationship between size of spawning population and resulting marketable size progeny.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0474, ACCUMULATION OF RADIOACTIVITY BY INVERTEBRATES (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION)
T.J. PRICE, U.S. Dept. of Interior, Radiobiological Lab., Beaufort, North Carolina 28516

The rapid growth of atomic energy industries and the increased use of nuclear reactors for power production has increased the possibility of the contamination of the marine environment with radioactive materials. Also, radioisotopes used in research and medicine may be disposed of in coastal waters, which are habitats for many species of commercial marine invertebrates.

Since many invertebrates are filter-feeders, omnivorous predators, and scavengers, it is probable that these animals come in contact with most components of the ecosystem. If one or more of these components contain radionuclides, it is probable that this radioactivity eventually would become associated with these animals.

Laboratory research is being done to determine the uptake, accumulation, and retention of specific radioisotopes (zinc-65, iron-59, iodine-131 and others) by marine invertebrates, including clams, oysters, scallops, and crabs. From these experiments, one can ascertain the importance of various factors which may affect accumulation; observe the metabolism of specific elements by invertebrates through the use of radioactive tracers; and study the foods and feeding activities of marine invertebrates.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0475, SURVIVAL REQUIREMENTS OF JUVENILE AND ADULT BLUE CRABS
M.E. TAGATZ, U.S. Dept. of Interior, Biological Laboratory, Beaufort, North Carolina 28516

The project has three phases, which will be undertaken in the order in which they are listed. Phase 1. Determine the nature of and the capacity for osmotic and ionic regulation in juvenile and adult blue crabs. Phase 2. Determine factors affecting length of intermolt period and percentage increase in size at time of molt. Phase 3. Analyze responses of juveniles and adults to environmental stresses such as salinity, temperature, pH, dissolved oxygen, etc., under controlled laboratory conditions. To establish parameters within which survival is possible. Within these parameters, determine optimum conditions for growth and reproduction.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0476, CONTROLLED ENVIRONMENTAL FACTORS ON THE DEVELOPMENT OF ESTUARINE AND OCEANIC CRUSTACEAE
J.D. COSTLOW, Duke University, Graduate School, Durham, North Carolina 27706

The research program has the following objectives: 1. To study, under controlled laboratory conditions, the larval development of crabs which are found in estuaries and oceanic waters in the vicinity of Beaufort, North Carolina. 2. To determine the effect of temperature, salinity, and pressure on larval development. 3. To determine whether daily changes in temperature and salinity affect molting frequency, duration of larval life and survival in the same manner as these factors are kept constant throughout larval life. 4. To determine the larval development of a few crabs which have a broad geographical distribution and determine whether larvae of the same species from different latitudes and longitudes of the geographical range exhibit the same or different tolerances to common environmental factors.

SUPPORTED BY U.S. National Science Foundation

5.0477, RELATIONSHIPS AMONG POPULATIONS OF LIMNORIA TRIPUNCTATA
R.J. MENZIES, Duke University, Graduate School, Durham, North Carolina 27706

Most biologists now accept the genetical species concept (Mayr, 1940, et seq.) which defines a species as 'groups of actually or potentially interbreeding natural populations which are reproductively isolated from other such groups.' This concept has not been extensively applied in systematics due to the practical difficulties involved in testing the reproductive relationships of populations. It is especially difficult to evaluate marine species with respect to the interbreeding criterion, particularly those which are widely distributed or which come from the deep sea. If almost all species of marine organisms have been distinguished solely on the basis of their morphological distinctness from other groups of populations, many marine organisms require stringent laboratory conditions for their cultivation. In most marine species even the culture requirements are not known. This is not the case with Limnoria which is among the easiest marine invertebrates to culture.

Morphological distinctness, however, has been shown to be inadequate for the recognition of 'genetic species in many organisms. On one hand, populations in some taxa have been shown to be reproductively isolated from each other although they differ only minutely in their morphology. Some knowledge of the reproductive relationships of populations is necessary for the recognition of 'genetic species' within a taxon.

The immediate objectives of this research are: 1) to evaluate the reproductive relationships among populations of a widely distributed marine species, Limnoria tripunctata Menzies; 2) to provide a relatively complete analysis of the geographic variability of this species; and 3) to establish criteria useful in the determination of species differences. It is hoped that the proposed research will also contribute toward the elucidation of criteria for the recognition of 'genetic' species in marine isopods.

SUPPORTED BY U.S. National Science Foundation

5.0478, GAMETOGENESIS AND FERTILIZATION IN THE BLUE CRAB, Callinectes sapidus Rathbun, AND OTHER CRABS
E.P. RYAN, East Carolina University, Graduate School, Greenville, North Carolina 27835

The proposed research includes a detailed study of gametogenesis, fertilization and cleavage in the blue crab, Callinectes sapidus. Examination by light and electron microscopy will accompany cytochemical techniques to reveal the modifications of organelles in the maturation of the flagellate sperm. Of particular importance is the functional morphology of the elaborate acrosomal complex. Development of a technique of artificial insemination will permit an appraisal of changes of the varied organelles and their function in the fertilization process. Comparison will be made of these structures and processes in related Brachyura to reveal basic patterns in sperm morphology and function which indicate phylogenetic relationships within the Decapoda. The research will be conducted at East Carolina College and at the Duke Marine Laboratory.

SUPPORTED BY U.S. National Science Foundation

5.0479, MORPHOLOGY, PHYSIOLOGY AND ECOLOGY OF MARINE LAMELLIBRANCHS
A.F. CHESTNUT, Univ. of North Carolina, Institute of Marine Science, Morehead City, North Carolina 28557

Morphology, physiology and ecology of marine lamellibranchs. Studies are in progress of early development, setting behavior and feeding mechanisms.

SUPPORTED BY University of North Carolina
5.0480, COLLECTION AND SURVEY OF NORTH CAROLINA MARINE AND ESTUARINE MOLLUSCA
H.J. PORTER, Univ. of North Carolina, Institute of Marine Science, Morehead City, North Carolina 28557
A curated and catalogued collection of North Carolina mollusks is being developed and maintained. Specimens are procured primarily from surveys conducted in North Carolina estuarine and marine waters. Purpose of the long term project is to document occurrence and extent of the North Carolina molluscan fauna, provide a permanent repository for examples of this fauna and provide an available systematic study collection for teaching and/or ecological research.
SUPPORTED BY University of North Carolina

5.0481, CRUSTACEAN COLLECTION OF EAST COAST OF UNITED STATES
A.B. WILLIAMS, Univ. of North Carolina, Institute of Marine Science, Morehead City, North Carolina 28557
A curated and catalogued collection of crustaceans is maintained for research, teaching and systematic use. Species consist of estuarine and ocean crustaceans with emphasis on the North Carolina coastal waters.
SUPPORTED BY University of North Carolina

5.0482, ENERGETICS OF PALAEMONETES PUGIO AND THE WEEDBED COMMUNITY OF SOUTH CREEK ESTUARY
L.W. WOOD, Univ. of North Carolina, Graduate School, Raleigh, North Carolina 27600
Summary has been provided to the Science Information Exchange.
SUPPORTED BY Society of The Sigma Xi

5.0483, THE DEVELOPMENT OF HATCHERY TECHNIQUES TO AID IN THE PRODUCTION OF ECONOMIC MOLLUSKS
W.P. BREESE, Oregon State University, Agricultural Experiment Station, Corvallis, Oregon 97331
Objectives—(1) To develop methods for the culture of larval clams and oysters in hatcheries. (2) To determine the optimum conditions for artificial seeding of clam and oyster grounds. (3) To utilize the hatchery techniques developed for the propagation of exotic bivalves for introduction into selected habitats. (4) To train shellfish biologists for careers in the culture and production of economic mollusks.

Initially, attempts will be made to spawn, fertilize and rear native clams and oysters from the egg to the seed stage. Subsequently, attempts will be made to isolate and culture exotic and native bivalve seed. Each planting procedure will be evaluated by survival and growth studies. In the conduct of this research, graduate students will receive training that will assist them in the preparation for careers as shellfish biologists.
SUPPORTED BY Oregon State Government

5.0484, ECONOMICS OF MARKETING DUNGENES CRAB
J.G. YOUDE, Oregon State University, Agricultural Experiment Station, Corvallis, Oregon 97331
Objectives: 1. Describe the marketing channels for Dungeness crab. 2. Recommend changes that would increase efficiency in Dungeness crab marketing. 3. Determine relations between the Pacific Coast Dungeness crab industry and the Alaska King crab industry. 4. Specify relations between levels of production, products marketed, and prices received by fishermen and processors. 5. Evaluate the potential for industry promotion programs.
Procedure: A descriptive study will be conducted to determine the salient characteristics of the Dungeness crab industry. Data from that industry and from the Alaska King crab industry will be analyzed to determine relations between production prices, promotional activities, and other selected variables in the two industries.
SUPPORTED BY Oregon State Government

5.0485, NEURAL MECHANISMS OF LEARNING AND BEHAVIOR
M.E. LICK, Univ. of Oregon, Graduate School, Eugene, Oregon 97403
The project consists of a combined program of behavioral and neurophysiological experiments focused on the problem of learning. The strategy is to exploit the comparatively simple nervous system of the marine gastropod Aplysia for the purpose of achieving a fine grained analysis of neural systems mediating learned behaviors. In one group of experiments we are studying a circadian rhythm of activity in a single identifiable neuron in the parieto-visceral ganglion. Of primary interest is the extent to which the rhythm can be entrained to various environmental photoperiods and the extent to which the rhythm is endogenous to a single cell. In another group of experiments we are attempting a synaptic analysis of a behavior which has been shown to be susceptible to modulation by past experience. Specifically, it has been found that the food selection responses of Aplysia are governed to some extent by the animal's past experience. We are now trying to identify specific neurons which are involved in this response with the hope of eventually detecting changes in neuronal physiology which are the result of the training experience.
SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0486, CONTROLLED REARING OF DUNGENES CRAB LARVAE
P.H. REED, State Fish Commission, Newport, Oregon 97365
The objective of this phase is to develop methods for hatching and rearing crab larvae under controlled laboratory conditions and describing their larval stages. A trip to California will be made to view the systems used by California Department of Fish & Game biologists to raise both crab and shrimp larvae and problems will be discussed. Equipment will first be purchased and tested. Egg bearing female crabs will be obtained and held in aquaria. As the eggs near hatching stage and animals will be transferred to self-contained sea-water systems to avoid larval loss. Antibiotics and ultra-violet light will be tried for control of bacteria. Separate groups will be fed brine shrimp larvae, mussel larvae, or nauple larvae, and growth and survival compared. Each stage of crab egg and larval development will be photographed and described. This phase should be completed by June 30, 1966. The research will be done at the Oregon State University Marine Science Center, Newport, Oregon.

5.0487, STUDY ON THE DISTRIBUTION AND ABUNDANCE OF PINK SHRIMP, PANDALUS JORDANI, OFF THE OREGON COAST
G. MILBURN, State Fish Commission, Portland, Oregon 97201
This study will undertake to locate and define the major pink shrimp (Pandalus jordani) populations off the Oregon coast, to collect information on the biology and life history of these shrimp, and to develop techniques for studying population dynamics that will be usable in maintaining the maximum level of shrimp production compatible with sound management principles.
Offshore cruises of 30 days duration will be made during March of each year to delimit areas and numerical abundance of pink shrimp, and to collect biological data on age composition, fecundity, and sex composition prior to commencement of fishing. During the commercial fishing season, interviews and intensive sampling of catches will be made to monitor and correct any changes to the resource caused by fishing. Post-season cruises during October will be made to gather data to compare with the spring and summer samples and to use as a method of predicting abundance for the following year. Both commercial and experimental gear will be used to collect field data.
5. LIVING SYSTEMS (NON-HUMAN)

During the cruises and field season, fish stomachs will be examined to determine the extent of predation of the pink shrimp.

The project will take place off the coast of Oregon between the Columbia River and the Oregon-California border and at the ports of Astoria, Newport, Coos Bay, and Brookings. Personnel directly involved will be Jack Robinson, Aquatic Biologist 2, and an unlisted Senior Aquatic Biologist 1.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
Oregon State Government

5.0488. MASS MORTALITY OF OYSTERS ALONG THE OREGON COAST
C.D. SNOW, State Fish Commission, Portland, Oregon 97201 (14-17-0001-1895)

Summary of Proposed Work: The Oregon Fish Commission is continuing the oyster mortality monitoring program begin in 1966 with slight changes to concur with the recommendations of the panel of experts which reviewed the program in 1968. Sampling stations will be maintained in Tillamook, Yaquina and Coos Bays.

In Yaquina Bay, the number of sampling stations will be reduced from six to three to permit more intensive monitoring of both native and Pacific oysters. Observations will be made every two weeks, and samples will be collected every 4 weeks. Those and dead or abnormal oysters will be sent to the University of Washington for histological examination.

In addition to the sampling stations in Yaquina Bay, an observation station will be established at the dock of the Marine Science Center. Observations will be made each working day. Dead or moribund animals will be collected for histological examination.

There will be one station at Tillamook and Coos Bays. Sampling will be monthly with collections for histological examination from the control lots and the adjacent beds.

Water quality measurements at Yaquina Bay will include temperature, salinity, dissolved oxygen and turbidity plus supplementary information from the Federal Water Pollution Control Administration and Oregon State University. At Tillamook and Coos Bays measurements of temperature, salinity and dissolved oxygen will be taken during each sampling visit.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0489. MANAGEMENT OF OREGON DUNGENESS CRABS
C.D. SNOW, State Fish Commission, Salem, Oregon

Purpose: Regulation of commercial and personal-use fisheries to obtain maximum sustained yields.

Location: Headquarters are at Newport, Oregon. Work is done along the entire Oregon coast.

Methods: Crab landings are sampled at all major ports for condition, size, landing trends and fishing effort. Small populations of adult and immature crabs have been tagged annually to obtain information on life history and migration of this species.

Results: Results are applied to regulating harvest and to increase our basic knowledge of life history of Dungeness crab.

SUPPORTED BY Oregon State Government

5.0490. NEUROPHYSIOLOGICAL MECHANISMS IN BEHAVIOR
S.B. BARBER, Lehigh University, Graduate School, Bethlehem, Pennsylvania 18015

The ultimate aim of this study is a complete analysis of a variety of mechanisms of arthropod behavior. Arthropod behavior is sufficiently complex for the analysis to be relevant to man yet largely stereotyped and thus more readily analyzed. The work will deal with all aspects of behavior: input mechanisms, integration, output and effector mechanisms. It will also probe structural and ultrastructural aspects as they are pertinent to the physiological analysis.

Initially the study will concentrate on two different organisms and on different aspects of the over-all problem in each. One of these will be the effect of walking leg proprioceptors on locomotory behavior in Limulus polyphemus, the horseshoe crab. Most of these proprioceptors were found and characterized by the senior investigator and his co-workers and this information will be the starting point for the investigation. The other study will be on mechanisms of flight in giant water bugs (Heteroptera, Belostomatidae). Because they are unusually large insects the flight muscles, nerves and ganglia are generally readily accessible for experimentation. This was found to be true in an earlier study of these organisms by the senior investigator.

SUPPORTED BY U.S. Dept. of Hth. Ed. & Wel. - P.H.S.

5.0491. LEARNING IN OCTOPUS
A. BITTERMAN, Bryn Mawr College, Graduate School, Bryn Mawr, Pennsylvania 19010

Brief Description of Research Project: Learning in Octopus will be studied with improved techniques. One set of experiments will deal with the effects of certain drive and reward variables on the acquisition and extinction of a single instrumental response. A second set of experiments will deal with habit-reversal and probability learning in choice-situations. The grant provides for two round trips of the principal investigator and his research assistant to the Stazione Zoologica in Naples.

SUPPORTED BY U.S. National Science Foundation

5.0492. A SYSTEMATIC STUDY OF ENTOCYTHERID OSTRACODS
C.W. HART, Acad. of Nat. Sci. of Phila., Philadelphia, Pennsylvania 19103

The investigators have been engaged on studies of entocytherid ostracods (grants NSF GB-1436 and GB-4197). Entocytherid ostracods, insofar as is known, inhabit the Noarctic region, where they and branchiobdellid oligochaetes are epizoic on freshwater crayfishes; the Palaarctic region, where they are epizoic on freshwater isopods; Australian region, where they are found on crayfishes and isopods; and the coastal waters of India, where one new species has been found on wood-boring isopods. Littie is known concerning the affinities of entocytherid ostracods with free-living ostracods. Four genera of the family have now been monographed and published.

It is anticipated that the proposed study will result in monographic treatments of the remaining genera of the family. Monographic revisions (although somewhat out of date) and several subsequent regional or generic studies have been published in crayfishes and branchiobdellids, but few comparable works exist for the commensal ostracods. There is a need for a number of investigators to describe new entocytherids from various parts of North America, but most of these ostracods are known from fewer than a half-dozen localities, and the ranges of only four genera have been accurately delimited. In addition to collections already available, it is planned to obtain specimens from crayfish in South America, New Zealand, and Madagascar for comparative studies.

SUPPORTED BY U.S. National Science Foundation

5.0493. THE RHODE ISLAND HARD CLAM - QUARAUG - INDUSTRY
A. HOLMSEN, Univ. of Rhode Island, Agricultural Experiment Sta., Kingston, Rhode Island 02881

a) Determine the cost and returns in handraking and dredging, and analyze the labor force and its return per unit of effort.
b) A study of dealers and wholesalers, their functions cost and returns, and marketing margins.
c) An analysis to determine the price elasticity of demand at wholesale and ex-vessel by grade and season.
d) Determine the cost of alternative methods of depurating and the cost of a hatchery program for seedling purposes.

160
5.0494. EVALUATE THE RESEARCH TECHNIQUES WHICH WILL BE EMPLOYED TO STUDY THE BASIC LIFE HISTORY OF THE RED CRAB (GERYON QUINQUEDENS)

G.W. GRAY, State Dept. of Nat. Resources, Providence, Rhode Island

The objectives of this phase of the red crab study are to evaluate the following techniques: (1) Measurements (2) Ageing of carapace (3) Holding studies (4) Mark experiments (5) Egg and larval studies (6) Sampling studies.

State of Rhode Island, Department of Natural Resources, Division of Conservation, Marine Fisheries Unit, 150 Fowler Street, North Kingstown, Rhode Island will be the location where most of this phase work will take place.

SUPPORTED BY Rhode Island State Government

5.0495. PRELIMINARY MODIFICATIONS AND CONTROL OF NATURAL GROWING AREA ENVIRONMENTS

S.B. SAILA, State Dept. of Nat. Resources, Providence, Rhode Island

Objectives: 1. Design and execute appropriate field plots to determine effects of mineral nutrients and substrate composition on the growth of juvenile hard clams (Mercenaria mercenaria), soft clams (Mya arenaria) and oysters (Crassostrea virginica). 2. Critically evaluate use of predator control fence, chemical predator control, and various culture techniques on survival.

Procedure: 1. Three factors, nitrogen, phosphorus and calcium are to be included in 8 treatment combinations in 3 replicates. 2. Plot size is 1/100 acre for each 8 plots in 3 substrates. 3. All organisms will be individually marked for growth increment comparisons. 4. A complete analysis of various treatment combinations will be carried out.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish. Rhode Island State Government

5.0496. REARING AND SENSITIVITY STUDIES OF VARIOUS LIFE STAGES OF MARINE MACROINVERTEBRATES


The goal of this project is to determine the relative sensitivity of various stages of marine macroinvertebrates to specific materials and the evaluation of marine invertebrates as indicators of extreme levels of known toxicants over extended periods. This work will eventually be incorporated in broader areas of research to determine the effects of these toxicants upon growth, reproduction, activity, metabolism, and the activity of hormones and enzymes.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0497. HISTOPATHOLOGIC EFFECTS OF POLLUTANTS ON CELLS AND TISSUES OF MARINE INVERTEBRATES


Histopathologic studies will be conducted on various species of marine invertebrates: quahogs, soft shell clams, oysters, lobsters, shrimp, blue crab, etc. after exposure to various pollutants. Studies are presently being conducted in cooperation with the Northeast Marine Health Sciences Laboratory on quahogs (Mercenaria mercenaria) which have been exposed to 0.05 and 0.025 ppm of Cu, 0.2 ppm of Zn, 0.2 and 0.1 ppm of Cd and 0.05 and 0.1 ppm of Cr.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0498. STUDIES ON THE PROTISTAN CAUSING MALPEQUE DISEASE

J.G. MACKIN, Texas A & M University System, Graduate School, College Station, Texas 77843

Previous studies of the organism causing Malpeque disease of oysters have shown (1) that the causative agent is complex of species of Labyrinthomyxa Duboscq. (2) none of the species has been described, and (3) experimentation has shown that all are highly pathogenic to oysters and can be transmitted. Studies in progress now are aimed at development of knowledge of distribution, characterization of species, and studies on pathogenicity to the several oyster hosts.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0499. PREDICTING COMMERCIAL SHRIMP ABUNDANCE (SHRIMP DYNAMICS PROGRAM)

K.N. BAXTER, U.S. Dept. of Interior, Biological Laboratory, Fort Crockett - Galveston, Texas

Measures of the relative abundance of postlarval and juvenile brown and white shrimp have been obtained from Galveston Bay, Texas, since 1960. Analyses of these data have shown that predictions of commercial supplies are possible, but improvements in past measures are needed. Research objectives are to examine and define the relations between the density of postlarval shrimp, the abundance of juveniles, and the size of the mature crop available to the commercial fishery.

Studies are underway to (1) develop a pumping system that will obtain small samples of postlarvae at frequent intervals or continuously and thereby produce the variable of postlarval indices; and (2) collect postlarval brown shrimp offshore in winter months in an attempt to develop an earlier index to the crop of adult shrimp available between May and July.

Laboratory studies include experiments to determine behavioral characteristics of postlarvae that may affect their vulnerability to sampling gear, including preferred bottom material for burrowing when temperatures are low, and vertical movements related to changes in temperature, light, and salinity.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0500, 131.116B - LARVAL CULTURE (SHRIMP AQUACULTURE PROGRAM)

H.L. COOK, U.S. Dept. of Interior, Biological Laboratory, Fort Crockett - Galveston, Texas

There are four native species of penaeid shrimp—white, pink, brown, and the seahog—that appear suitable for culture. All have been hatched and reared to the postlarval stage from females that were fertilized naturally offshore, but spawned in the laboratory. The principal problem remaining is that of growing algal food for larval shrimp. Research is in progress that includes development of a technique to permit large-scale culture of algae used as food for larval shrimp.

161
5. LIVING SYSTEMS (NON-HUMAN)

Also, laboratory-hatched and reared penaeid larvae are being held under controlled conditions to determine the effects of various factors (i.e., food, light, temperature, and salinity) on their growth and survival.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0501, EXPERIMENTAL SEEDING (SHRIMP AQUACULTURE PROGRAM)
T.J. COSTELLO, U.S. Dept. of Interior, Biological Laboratory, Fort Crockett - Galveston, Texas

Following a 3-year study of the ecology of the waters in Florida Bay and Keys, it is apparent that only a portion of the suitable nursery areas are used by shrimp. Project objectives are to rear large numbers of shrimp from eggs spawned in the laboratory and seed underutilized nursery grounds. Selected areas will be enclosed and stocked with laboratory-reared postlarvae. By systematic measurements of shrimp populations and physical features, rates of growth and survival of shrimp in different population densities will be related to physical conditions. The ultimate goal will be to determine the carrying capacities of nursery grounds and maintain an optimum level of shrimp population by seeding.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0502, RECONNAISSANCE ECOLOGIC SURVEY OF THE CONTINENTAL SHELF AND UPPER SLOPE (GULF OCEANOGRAPHY PROGRAM)
J.R. GRADY, U.S. Dept. of Interior, Biological Laboratory, Fort Crockett - Galveston, Texas

To better understand the behavior of shrimp, their migration, and abundance, it is essential to acquire a thorough knowledge of the natural environment. Any ability to predict crop abundance and distribution depends not only on an extensive knowledge of the variables in the natural environment of the estuaries and the waters overlying the continental shelf, but also of the character of the sea floor.

It is the purpose of this project to define the fundamental properties of the physical and chemical sedimentary environment on the shelf, and to determine what features of the sediments and bottom water are relevant to the prediction of shrimp populations. Data will be correlated with all available information on shrimp distribution and abundance to evolve a formula, in conjunction with Circulation Dynamics Project and the Shrimp Dynamics Program, to aid in forecasting the marine environment over the shelf.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0503, POPULATION DYNAMICS (SHRIMP DYNAMICS PROGRAM)
R.A. NEAL, U.S. Dept. of Interior, Biological Laboratory, Fort Crockett - Galveston, Texas

Present means for managing shrimp fisheries in the Gulf of Mexico have evolved without the benefit of a firm knowledge of the population dynamics of the species. Project objectives are to obtain direct measures of shrimp growth, mortality, and movements, by means of mark-recapture experiments, and to determine the feasibility of deriving indirect estimates of fishing mortality from measures of total mortality and fishing intensity. Additionally, the relation between the rates of fishing and stock size as well as the optimum levels of fishing are being investigated using commercial fishing statistics.

Studies on the comparative fishing power of shrimp vessels are formulated to more accurately assess mortality generated by commercial shrimp fleets. The selective characteristics of commercial shrimp trawls and the comparative fishing mortality that would result from mesh regulations will be examined in an effort to develop models to predict short- and long-term effects of regulations.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0504, JUVENILE AND ADULT CULTURE (SHRIMP AQUACULTURE PROGRAM)
R.S. WHEELER, U.S. Dept. of Interior, Biological Laboratory, Fort Crockett - Galveston, Texas

The rapid growth rate and high economic value of shrimp has led to considerable interest in the possibility of pond-type shrimp culture. Research is designed to determine the feasibility of growing shrimp economically under seminatural conditions. More specifically, studies are being made to determine those ecological factors that affect growth and survival of shrimp in ponds. Once determined, methods will be developed for controlling or modifying those factors to insure maximum production of shrimp.

Additional efforts are being made to determine and create conditions essential for mating and spawning of shrimp under laboratory conditions. The ultimate goal will be to initiate studies that will result in a fast-growing, hardy shrimp suitable for pond culture.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0505, FOOD AND EXPERIMENTAL ENVIRONMENTS (SHRIMP AQUACULTURE PROGRAM)
Z.P. ZEINELDIN, U.S. Dept. of Interior, Biological Laboratory, Fort Crockett - Galveston, Texas

By means of controlled experiments, project objectives are to determine optimum conditions for growth, survival, and reproduction of shrimp in artificial environments. Activities include (1) development of a prepared food for use in shrimp culture; (2) determination of the digestive enzymes of shrimp; (3) documentation of which naturally occurring food organisms shrimp prefer; and (4) development of methods of culturing food organisms that support favorable shrimp growth.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0506, NITROGEN METABOLISM IN MOLLUSCS
J.W. CAMPBELL, Rice University, Graduate School, Houston, Texas 77001

An investigation of excretory nitrogen metabolism in terrestrial and aquatic pulmonate gastropods. In addition to acquiring basic information on the biology of these organisms, some of which are important vectors of parasitic diseases, the project has as an objective the elucidation of the basic metabolic adaptations that have occurred in the evolutionary transition between the terrestrial and aquatic environments. Of specific concern are the physiological roles of the pathways for purine biosynthesis, arginine biosynthesis and arginine degradation.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0507, REAR AND DESCRIBE LARVAE OF BIVALVES
P. CHANLEY, Virginia Inst. of Marine Sci., Gloucester Point, Virginia 23062

The larval development of most bivalve species has never been described. The purpose of this project is to describe as many as possible. Thus far descriptions of 4 species (Barnea truncata, Rangia cuneata, Noetia ponderosa, Lyonsia hyalina) have been published. Descriptions of two more (Cyrtopleura costata and Donax variabilis) are in press. A detailed comparative description of 23 species is also in press. Laboratory culture of two more species (Montacuta percompressa and Amygdalum papryria) has been completed. Another species, Brachidontes recurvus, is currently being cultured.

Larvae of several other species have also been cultured but not successfully reared to metamorphosis (Tagelus plebeius, Macoma tenta, Macoma phanex, Anadara ovalis).

Future plans involve continued work with local species and also with selected exotic species that are of particular interest.

SUPPORTED BY Virginia State Government

5.0508, DISTRIBUTION AND ABUNDANCE OF OYSTER DRILLS (ULROSAFLPINX CINEREA) IN THE JAMES RIVER, VIRGINIA
D.S. HAVEN, Virginia Inst. of Marine Sci., Gloucester Point, Virginia 23062
Using drill traps, dredged samples, and caged drills, data have been obtained on distribution and mortality rates of oyster distribution in relation to temperature and salinity, in the James River, Virginia.

SUPPORTED BY Virginia State Government


F. W. Perkins, Virginia Inst. of Marine Sci., Gloucester Point, Virginia 23062

The fine structural changes in fertilized eggs of Lymnaea sp. prior to and during first and second cleavages was investigated. Microtubular involvement in the cortical region and branching microtubules were observed. Yolk platelet biogenesis and degradation was described.

SUPPORTED BY Virginia State Government

5.0510. Mass Mortality of Pacific Oysters Along the Washington Coast.

C. Lindsay, State Dept. of Fisheries, Olympia, Washington (14-17-0001-1900)


SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0511. Inspection of Oyster Seed - New Asiatic Sources

C. Lindsay, State Dept. of Fisheries, Olympia, Washington

Phase I - Objectives: Investigate possibilities of obtaining disease from Pacific oyster seed, where present Japanese sources are insufficient to maintain Washington's oyster industry at present levels.

Procedures: Investigator experienced in Japanese oyster seed inspection will proceed to Japan, Korea, and Taiwan, and ascertain prospects for obtaining seed from new sources. Prospects for quantity collection of oyster seed meeting Washington specifications will be reviewed with Asiatic oyster growers. Where likely seed sources are found, sample shipments will be made to Washington's Point Whitney Shellfish Laboratory for quarantine for further determination of disease status. Information on results and general overall prospects of new seed sources will be circulated to oyster industry of the Pacific Coast.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0512. Oyster Fatness Study

C. S. Sayce, State Dept. of Fisheries, Olympia, Washington

The objective of this phase is the development of fat oysters thereby increasing the production of oysters, through supplemental feeding techniques. This phase will be a laboratory study using trays of oysters divided into two groups of experimentally fed and non-fed controls with two control stations of oysters on tidelands near the laboratory. Each experiment will use 400 oysters in the laboratory, 200 oysters at each of two outside control stations, and will be of 32 days duration. The experimental design was developed with the aid of Dr. Douglas G. Chapman, University of Washington, statistical consultant for the project. Data collections will include temperature salinity turbidity, pH, and concentrations of the supplemental food as intake and output. Growth of oysters will be followed by volumetric observations every four days and condition of oysters will be determined by 5.0513. Collection of Juvenile Migrants from Rivers and Streams


Anticipating that certain types of hydro-electric developments may either destroy large numbers of young migrant fish or may be impassable, a major research effort is being made to find practical and economical methods of collecting these young fish from rivers and streams before they reach the areas of danger. Methods of fish guidance and collection presently in use are only partially successful, or not applicable to large projects, or overly expensive. Research will be directed toward improving the efficiency of guiding techniques that have shown promise in the past, such as electricity, louvers, and lights; exploring the possibilities of more effective combinations of techniques; and developing new concepts of fish guidance and collection that would use a minimum of structures. Facilities and methods for holding, handling, and transporting fingerlings will be investigated.

Four field stations are now in operation for such testing. Primary features of these stations are the flume installations which provide flexibility, wide range of velocity control, ease of observation and enumeration, and the testing of wild fish in as near to natural conditions as possible. Since the beginning of this project considerable advance has been made in the deflection or guidance of young migrants by means of flow accelerations and decelerations.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0514. Shellfish Explorations

C.R. Hitz, U.S. Dept. of Interior, Exptl. Fish & Gear Res. Base, Seattle, Washington 98102

Shellfish exploration is concerned with benthic invertebrate populations. The objectives are to define, in time and space, the quantitative and qualitative distribution of aquatic benthic invertebrate resources having a potential for commercial utilization, and to provide an appraisal of these resources. Preliminary work was begun in FY 1966 to develop a suitable clam dredge for assessment studies. Emphasis in FY 1969 will be...
5. LIVING SYSTEMS (NON-HUMAN)

to continue to assist the gear research unit in developing a clam dredge which can be used in offshore areas. Assessment of clam stocks off Oregon and Washington will follow. Marine Invertebrate Explorations, FY 1969.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0518, BARNACLES OF THE EASTERN PACIFIC

D.P. HENRY, Univ. of Washington, Graduate School, Seattle, Washington 98122

This investigation is a continuation of the studies on the barnacles of the Panama-Pacific Province initiated with assistance from NSF grant GB-1684. The Panamic-Pacific Province is now generally recognized as that region between the head of the Gulf of California and Cabo Blanco in northwestern Peru.

The barnacle fauna of the Panama-Pacific Province has been investigated with indications of aberrant sexual development will be pursued. The proposed research also includes provision for the completion of the study of the genus Chthamalus from the Eastern Pacific.

An attempt will be made to determine what, if any, relationship the barnacle fauna of the Panama-Pacific Province has with that of the Antillan and/or Indo-West Pacific Provinces.

SUPPORTED BY U.S. National Science Foundation

5.0516, SYSTEMATICS OF MARINE SYMBIOTIC CRUSTACEA FROM INVERTEBRATES

P.L. LLLG, Univ. of Washington, Graduate School, Seattle, Washington 98122

The parasitic forms of the Copepoda, running now to several thousand species described, present a significant systematic problem. The broad purpose of this proposal is to continue explorations in expanding approaches in the systematics of copepods. Basic monographic studies have been proceeding and it is proposed to continue these. Since all the forms studied are associated in symbiosis with various invertebrates and the assemblage shows a graduated series of interactions between the symbionts, some basic questions in symbiosis and parasitism are also raised. Extended studies of life histories are involved and comparisons through all the types of taxonomic data are being accumulated with a long-range view to critical evaluation of taxonomic concepts. A recently extended is similar study of a local member of the Cirripedia (Ascothoracica) with a principal objective evaluation of claims of higher levels of relationship, particularly between Copepoda and Cirripedia.

SUPPORTED BY U.S. National Science Foundation

5.0517, RESEARCH ON INDO-WEST PACIFIC MARINE MOLLUSKS OF THE FAMILY CONIIDA

A.J. KOHN, Univ. of Washington, Graduate School, Seattle, Washington 98122

The next three years of research on this long-term study of systematics and biology of Conus will concentrate on natural populations of tropical Indian Ocean Islands, where large numbers of sympatric species occur, and on continuation of studies of the type specimens and identity of the described species. Field data and material derive from participation of the principal investigator in the Yale Seychelles Expedition and International Indian Ocean Expedition. The taxonomic studies will be pursued primarily at the U.S. National Museum.

The main aspects to be investigated are: 1) classification, population density, species and habitat diversity, relative abundance, and interspecific differences in ecological characteristics of Conus populations on Indian Ocean coral reefs; 2) comparative morphology and morphometry of radula teeth; 3) chronological study of type specimens and identity of species of Conus described during the last century; 4) application of objective methods to the taxonomic study of the genus; 5) taxonomic studies of material submitted for identification from collections of the International Indian Ocean Expedition and other sources.

SUPPORTED BY U.S. National Science Foundation

5.0519, STUDIES IN OYSTER PATHOLOGY

A.K. SPARKS, Univ. of Washington, Graduate School, Seattle, Washington 98122 (14-17-0001-1377)

The Oyster Pathology Laboratory of the College of Fisheries will process and examine tissue from the expanded field study of the Washington State Shellfish Laboratory and the Oregon Fish Commission oyster mortality field investigation in order to investigate the reaction of oyster tissue to various types of injury.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0520, EPIZOOTICS IN EXPERIMENTAL MARINE SHELLFISH POPULATIONS

A.K. SPARKS, Univ. of Washington, Graduate School, Seattle, Washington 98122

Maintenance of experimental populations of Pacific oysters, native oysters, and bay mussels in float and bed stations will be continued in California, Oregon and Washington for determination of mortality and growth rates in the various species at the different locations. Living and dying bivalves will continue to be fixed and processed for microscopic examination for the presence and pathological effects of possible pathogenic organisms and a more sophisticated computer program will be utilized to determine the relationships of possible pathogens and mortalities.

Attempts will be made to culture in vitro the microorganisms, particularly Vahlkampfia sp., responsible for heavy mortalities of Pacific oysters in Humboldt Bay, California to elucidate: its life history, facilitate specific identification, and enable us to initiate infection experiments. Life history studies, through in vitro culture, of Mytilopsis orientalis will be continued, particularly to determine the infective stage.

SUPPORTED BY U.S. Dept. of Hith. Ed. & Wel. - P.H.S.
5. LIVING SYSTEMS (NON-HUMAN)

5E. ANIMALS, OTHER

(Birds, Mammals, and Unspecified Invertebrates and Vertebrates)

5.0521. MARINE BIOLOGICAL INVESTIGATIONS - NEKTON OF INSIDE WATERS OF SOUTHEASTERN ALASKA

J.C. QUAST, U.S. Dept. of Interior, Biological Laboratory, Auke Bay, Alaska

Objectives: 1. To obtain current information about the magnitudes, species composition, and characteristics of the nekton in southeast Alaska as part of a continuing effort to determine status and trend of this resource. 2. To obtain environmental conditions affecting abundance and distribution of the various species. 3. To continue obtaining as much information concerning the natural history of the species, as possible. 4. To try to identify the environmental conditions affecting abundance and distribution of the various species. 5. To determine patterns of dispersal and obtain known age specimens. 6. To continue with the work of locating harbor seal population centers and attempting to determine patterns of dispersal.

Procedures: 1. Information on the present nekton population status and trend will be obtained from aerial surveys, examination of fishery catches, and from commercial fishing operations. 2. To obtain information on nekton distribution throughout the year, especially during the winter months, and attempt to more accurately determine the important factors affecting distribution. 3. To investigate the various facets of walrus biology and behavior that would enhance our present knowledge of the various aspects of reproduction. 5. To continue to collect and compare data on various aspects of the biology and behavior of the various species of the herd during Fiscal Year 1967.

Procedures: 1. Information on the present walrus population status and trend will be obtained through observation of the herds at the major walrus hunting sites, by evaluating records of hunting effort and success, by obtaining information on the proportion of animals in the various age and sex groups, by selective sampling of walrus taken by the hunters, and by evaluating the results of the proposed aerial surveys (Objective No. 5). 2. Observation throughout the year, at the different hunting sites, will provide current information about herd composition, distribution, movements, and the factors affecting movements. 3. Attempts will be made to analyze behavior of the various segments of the herd during 1) the spring migration of nursery herds through the Bering Strait area and 2) the adult male walrus utilizing the Walrus Islands during July and August. 4. Continued effort will be devoted to the study of walrus biology, especially reproduction. Information will be obtained from biological specimens acquired at the field stations, in conjunction with Job F-2. 5. Pending cooperation from the U.S.F.W.S., an aerial survey will be undertaken during the late winter or early spring of 1968.

SUPPORTED BY: U.S. Dept. of Interior - Bu. Sport Fish. Alaska State Government

5.0524. BREEDING AND MATERNAL BEHAVIOR AMONG THE STELLER SEA LION

D.R. KLEIN, State Dept. of Fish & Game, Juneau, Alaska

Objectives: 1. To investigate aspects of the breeding biology and behavior of the sea lion with particular emphasis on the timing of breeding in relation to parturition. 2. To study the behavior of cows and pups on breeding rookeries as related to pup desertion and survival, frequency of nursing and development of pups. Procedures: 1. Observations will be made on breeding rookeries prior to, during and following parturition to fulfill the above listed objectives. 2. Wherever possible, attempts will be made to determine the effects of commercial harvest of sea lions on breeding patterns, pup desertion and survival and general behavior at the rookeries.

SUPPORTED BY: U.S. Dept. of Interior - Bu. Sport Fish. Alaska State Government

5.0525. HAIR SEALS

E. KLINGHART, State Dept. of Fish & Game, Juneau, Alaska

Objectives: 1. To obtain information on the timing of the molt. 2. To determine patterns of dispersal and obtain known age specimens. 3. To determine the current abundance and location of major pupping areas. 4. To monitor commercial operations engaged in the harvesting of seals. 5. To maintain current information on the response of hair seal populations to harvesting.

Procedures: 1. Seal hunters and buyers will be interviewed to determine the general period of the molt and hide quality. Pelage samples will be collected from hunters and buyers and selective collecting will be employed to gain a better understanding of the molting process. 2. Seal pups will be tagged on specific rookeries to secure data on movements and known age specimen material for productivity and aging studies. This phase is of relatively long duration due to the tagging and recovery activities involved. 3. Aerial surveys and hunter and buyer interviews will be utilized to determine the current abundance and location of pupping areas and seal populations. Various aerial survey techniques will be investigated to establish methods for accurate population counts. 4. Harvest operations on pupping areas at Tugidak Island and along the Alaska Peninsula will be monitored. The harvest of adult seals will be monitored by accompanying seal hunters aboard sea going vessels. Specimens will be collected for breeding biology information. 5. Extent and location of harvest will be reconstructed from bounty records and buyer interviews and then related to present seal populations and current harvest trends.

SUPPORTED BY: U.S. Dept. of Interior - Bu. Sport Fish. Alaska State Government

5.0526. SEA LIONS

J. VANIA, State Dept. of Fish & Game, Juneau, Alaska

Objectives: 1. To determine factors relating to the breeding biology and productivity of sea lions. 2. To classify rookery and hauling out grounds in accordance with the type of animals frequenting them. 3. To obtain data on the movement of sea lions. 4. To obtain information on the timing of the first molt of pups. 5. To monitor all commercial operations engaged in the harvesting of sea lion pups and adults.

Procedures: 1. Reproductive tracts of females will be collected during commercial harvesting activities. Large numbers of pups will be tagged in order to obtain known age specimens. 2. Classifications of pupping rookeries, bachelor humping grounds, nursery and breeding rookeries will be accomplished by ground and aerial surveys. 3. Detailed observations will be made on specific pupping rookeries where pups and adults will be tagged for the purpose of observing their subsequent dispersal. 4. Pelage specimens from pups will be collected at intervals during the year to determine the timing of the first molt. 5. Harvest operations on
5. LIVING SYSTEMS (NON-HUMAN)

rorkers will be monitored to assure wise utilization of the resource and to prevent overharvesting. Reproductive tracts and lower jaws of adult animals harvested will be collected for breeding biology information.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish. Alaska State Government

5.0527. BELUGA WHALES

J. VANA, State Dept. of Fish & Game, Juneau, Alaska

Objectives: To study the reaction of belugas to various types of underwater sound transmissions. To gather basic life history data.

Procedures: 1. Tape recordings of killer whale sounds and ultra high frequency sounds will be transmitted under water to determine if the movement of belugas can be influenced by such transmissions. 2. Selective collections of reproductive tracts and stomachs will be made to provide information on age, breeding biology and food habits.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish. Alaska State Government

5.0528. SEA OTTER

J. VANA, State Dept. of Fish & Game, Juneau, Alaska

Objectives: 1. To determine population abundance, distribution and trends of sea otter in the coastal areas from Prince William Sound to the Shumagin Islands. 2. To obtain information relating to the molt process, breeding biology and food habits of the sea otter in selected parts of its range. 3. To refine techniques already developed for transplanting sea otters and to transplant animals to various sites in Southeastern Alaska.

Procedures: 1. Aerial surveys will be conducted to determine the general abundance and distribution of sea otter in the general areas indicated. Surface observations will be employed for more detailed studies in selected areas. 2. Direct observation and selective collecting will be employed. Pelt specimens will be collected to gain a better understanding of the time and nature of the molting process; and collections and examinations of the reproductive tracts will provide information on the breeding biology. Food habits will provide information on the breeding biology. Food habits will be studied by direct observations and by examination of stomachs. 3. Pens of various designs will be tested to determine the one best suited for holding sea otters while in transit. Several experimental releases of up to 30 animals will be made at selected sites in Southeastern Alaska.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish. Alaska State Government

5.0529. THE MORPHOLOGY, HISTOCHEMISTRY, AND MODE OF SECRETION IN THE VENOM GLAND OF SEA SNAKES

C.E. MAYS, Arizona State University, Graduate School, Tempe, Arizona 85281

NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY Society of The Sigma Xi

5.0530. MORPHOLOGY AND PHYSIOLOGY OF THE HEART OF ECТЕINASCIDIA TУRINATА

J.C. JONES, Bermuda Biol. Sta. For Res., Saint George, Bermuda

The present proposal is for spending approximately 45 days per summer at the Bermuda Biological Station for Research in order to study the following problems in the ascidian Ecteinascidia turbinata: (1) the histology of the heart and pericardium with different fixatives and stains, with special reference to inervation, (2) the relationship of body size to heart rate, (3) the influence of age after captivity on the heart rate, (4) the effects of differential pressure on different regions of the intact heart, (5) the effects of strong body contraction and prolonged siphonal closure on the heart rates, (6) the effects of puncturing different regions of the heart, (7) the effects of selected drugs on the heart rates, and (8) the effects of electrically stimulating the 'naturally' arrested hearts of otherwise normal and healthy tunicates.

SUPPORTED BY U.S. National Science Foundation

5.0531. TELEMETRY STUDIES ON MARINE BIRDS

H.H. VOGEL, Bermuda Biol. Sta. For Res., Saint George, Bermuda

Our knowledge of the distribution, migration routes, homing ability, feeding areas, etc. of most of the marine birds is extremely deficient. During the past few years, the use of telemetry and radio-tracking of both birds and mammals has advanced considerably, both in instrumentation, electronics, and methodology. The Yellow-billed Tropic Bird is the only common marine birds nesting on the island of Bermuda. Last spring we studied this species, using radioactive bands, to determine nesting and incubation habits of the adults. The method proved successful and will be continued this spring in further studies on care and feeding of the young. The objective of the present study is to place small radio transmitters on a small sample of the adult birds and follow them from their burrows in the limestone cliffs, by boat and/or plane, to determine their distribution, feeding grounds, homing abilities, and time at sea away from the nesting area.

The telemetry method, together with the radioactive work, should provide much useful information for this and other species. This proposal is fundamentally ecological, but has important contributions in the problems of homing and communication.

If the method proves successful on the Tropic-bird, we plan to place a small, disposable, radio-transmitter on one or more young Bermuda Cahows, petrels that are now almost extinct (23 pairs living). These birds nest only on Bermuda. The young leave their burrows at night, after long incubation periods, and do not return to land to nest for a period of four years. Little is known of where they go or what they do during this long pelagic life. Wingate has been studying their species for many years. We hope eventually to save the rahow from becoming another extinct bird.

SUPPORTED BY U.S. Dept. of Hith. Ed. & Wel. - P.H.S.

5.0532. ECOLOGY OF STORM PETRELS

S. HARRIS, Humboldt State College, Graduate School, Arcata, California 95521

A project involving the banding of various species of Petrels mainly on nesting islands off shore of Trinidad, California. Included is a study of the recapture of previously banded birds at the same nesting site.

This project has been carried on for four years and will continue indefinitely.

SUPPORTED BY No Formal Support Reported

5.0533. SAND DOLLAR COMMUNITIES

E.S. HOBSO, U.S. Dept. of Interior, Tiburon Marine Lab., Belvedere - Tiburon, California 94920

This study concerns animal communities inhabiting the sandy bottom offshore from California beaches - one of the most widespread, but least studied California inshore marine habitats.

The work is centered on aggregations of the sand dollar, Dendraster excentricus, the most prominent macro-organism in this region, and the main feature of a habitat supporting a rich and varied fauna of invertebrates and fishes, including many species important to the surf fisherman.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0534. AVIFAUNAL ECOLOGY OF LIMANTOUR ESTERO

C.J. RALPH, Point Reyes Bird Observatory, Bolinas, California 94924

To determine the overall importance of the Upper Limantour Estero, Point Reyes National Seashore, to the avifauna of the Drake's Bay area. Work to be carried out includes assessing the relative importance of habitat types to the different bird species and determining the nature and quantity of food available in the substrate in the estero.

SUPPORTED BY U.S. Dept. of Interior - Natl. Park Serv.
5.0535. EXPERIMENTAL AND BIOMATHEMATICAL ANALYSIS OF THE PHENOMENON OF ATTACK
K.E. WATT, Univ. of California, Graduate School, Davis, California 95616

We will continue research on warm freshwater fish predator-prey systems in large tanks and indoor ponds to determine how specific characteristics of the predators, prey and environment interact to determine the efficiency of attack. Many different physiological and ethological parameters are being measured using cinematography. Efficiency of attack will be measured in three ways: 1. the number of prey eaten per predator per unit time; 2. the biomass of prey eaten per unit biomass of predator per unit time; 3. the weight gain of predators per unit time.

A mathematical model is being developed from analytical experiments and computer simulation studies are being conducted to determine if we can mimic the history of populational experiments. Simulation will be conducted on the history of populational experiments. Simulation will be conducted on the computer to determine the factors most important in regulating attack efficiency. Finally, experiments will be performed to check on the findings from the computer sensitivity analyses.

The principal predators used are largemouth bass and bluegill sunfish, the prey are guppies and minnows.

SUPPORTED BY U.S. National Science Foundation

5.0536. THE DISEASES OF INVERTEBRATE ANIMALS
E.A. STEINHAUS, Univ. of California, Graduate School, Irvine, California 92664

Studies are continuing in three principal areas coming within the framework of this project on the diseases of invertebrate animals. Immunological reactions of six widely separated species of marine invertebrates are being investigated using six different species of nonspecific typing bacteria. Some of the animals (for example, the sea hare and the sand dollar) have shown little, if any, bactericidal activity in their normal coelomic fluid. Others, such as the coelomic fluid of sipunculid worms, are lethal to the bacteria. The fluids of some animals, such as that of the sea urchin, fail somewhere in between as far as their natural bacterial inhibiting properties are concerned. Included in the study of the immune properties are those of marine invertebrates is an electrophoretic investigation of the bactericidal substances involved.

In another part of the project, 'tumors' produced in the cockroach Leucophaea maderae by using the Scharrer techniques of severing the recurrent nerve, chemical carcinogens, strontium-89, X-irradiation, and decapitation are being intensively studied. Detailed histopathological as well as thorough electron-microscope examinations of the 'tumors' and 'inflammation' are being made. Attempts to confirm certain aspects of the work of the French scientist, Matz, who claims to have found an infectious tumor-inducing material in 'tumorous' locusts have as yet not succeeded. Histopathological studies, as well as studies of the endocrine system of wax-moth larvae (Galleria) treated with carcinogenic chemicals and irradiations, have yielded interesting results, the pathological significance of which has not yet been determined.

An extensive investigation of the teratologies of the beetle Tenebrio molitor is underway. Already discovered are some rather spectacular changes in ultrastructures (mitochondria, glycogen granules, etc.) of the deformed insects, which constitute over 20% of our continuing culture.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0537. PROTEIN SYNTHESIS DURING THE EARLY DEVELOPMENT OF THE SEA UCHIN EMBRYO
H. TIMOURIAN, Univ. of California, Lawrence Radiation Laboratory, Livermore, California 94551

To develop techniques for the study of the biological and physical changes in the ribosomes and polymers during early development in order to determine whether damage by small doses of radiation to the machinery for protein synthesis can be detected in the sea urchin embryo. The first hours of development are ideally suited, for there is no dependence on the genetic material and any effects can be completely divorced from those imposed on the nuclear genome. Biological changes are monitored by the ribosome capacity to participate in protein synthesis and physico-chemical changes are monitored by density gradient centrifugation and by their capacity to bind metal ions and to be digested by various enzymes.

Changes that take place in eggs at the time of fertilization have been determined in ribosomes and supernatant fractions by comparison of subcellular fractions from fertilized and unfertilized eggs.

SUPPORTED BY U.S. Atomic Energy Commission

5.0538. WHISTLE CONTOURS IN ODONTOCET CETACEANS
D.K. CALDWELL, Los Angeles Co. Museum, Los Angeles, California (N00014-67-C-0358)

The investigators will attempt to prove their hypothesis that individual porpoises of the group they are studying produce an identifiable whistle 'signature' which varies in only certain prescribed directions and which is different for each animal. They will study the information content and the behavioral significance of the whistles, as well as those other vocalizations under a variety of social situations, to determine to what extent the sounds are purposeful, and what degree of importance may be attached to vocalization in comparison with tactile, visual, and other means of communication.

Studies of signalling methods among schooling marine animals can provide valuable ideas for new and improved communication techniques based on evolved biological systems. In addition, acoustic signaling for training purposes must be thoroughly explored if the Navy is to utilize porpoises as aids to divers in such operations as SEALAB, rescue missions, and salvage activities.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0539. THE PORIFERA OF FANNING ISLAND, CENTRAL PACIFIC
G.J. BAKES, Univ. of Southern California, Graduate School, Los Angeles, California 90007

The present research will complete a study of the marine sponges of Fanning Island, Line Islands, central Pacific. The major goals of this third year of work are:

1) To complete descriptions and identifications of the numerous species collected.
2) To determine the effectiveness of the East Pacific Barrier in preventing dispersal of sponges from Central America to the Line Islands, and the reciprocal.
3) To evaluate the effects of sedimentation (specifically siltation) on the distribution and survival of certain sponges at Fanning Island.

SUPPORTED BY U.S. National Science Foundation

5.0540. DEEP WATER BENTHIC POLYCHAETES
O. HARTMAN, Univ. of Southern California, Graduate School, Los Angeles, California 90007

Precise knowledge of benthic life in these depths remains almost unknown, and until a few years ago it was impossible to take, measure and identify the animals inhibiting these areas. A few studies have shown that the organisms differ wholly from those in shallower bottoms. Quantitative studies of oceanographic deep areas became realizable only where ocean floors had been sonically charted, and after adequate instrumentation had been devised. Deep sea photography has shown the abundance of bell-shaped, depressions, trails and other surface irregularities, believed made by subsurface animals. Submersible vessels and TV cameras have revealed the activity of such forms. Tens of thousands of photographs are available from widely scattered places; many clearly show the surface features presumably made by benthic animals. Unfortunately the organisms constructing these ripples and holes cannot be identified even to major group from surface features alone. The few quantitative biological programs which have been pursued have shown that benthic life is remarkably diverse and abundant, and that it differs from one place to the next, according to depth and other physical features; specific components within a sample are unpredictably diversified.

5. LIVING SYSTEMS (NON-HUMAN)
5. LIVING SYSTEMS (NON-HUMAN)

Analyses of quantitative samples off Southern California have shown the presence of a highly endemic fauna, existing at all depths examined, and varying measurably within narrow depth classes. Based on faunal composition the basins may be grouped according to latitude, proximity to land or open sea, and the animal kinds differ from one basin to the next, and from those in new basin areas.

SUPPORTED BY U.S. National Science Foundation

5.0541. SYSTEMATIC STUDIES OF CERTAIN MARINE PARASITIC WORMS

W.E. MARTIN, Univ. of Southern California, Graduate School, Los Angeles, Calif. 90007

This investigation has three quite separate aims within the broad field of marine helminth parasitology. First, life histories of species of the taxonomically enigmatic trematode genus Renicola will be studied, and the results should provide a firm base for identifying species within the family. The second aim concerns a nematode that is a spirouid but with the habitat of heliothoid. Spirooids are obtained by ingesting infective stages in intermediate hosts, perhaps always arthropods. The third aim is to determine the nature of the inhibition to the system in the hand, the response will be investigated at the molecular level, which result in the fully active protein synthesis system.

SUPPORTED BY U.S. National Science Foundation

5.0542. THE SYSTEMATICS AND ZOOGEOGRAPHY OF THE BRYOZOAN FAUNA OF THE HAWAIIAN ISLANDS

J.D. SOULE, Univ. of Southern California, Graduate School, Los Angeles, California 90007

This investigation is concerned with the taxonomy and zoogeography of the Hawaiian fauna of Entoprocta (Bryozoa). The chief objectives of the study involve extensive collecting in the region of the mid-Pacific area not previously collected or only poorly represented in existing collections, systematic study of the bryozoan fauna of the mid-Pacific area, correlation of data on the known distribution of tropical bryozoan species with those of the Hawaiian Island species, and the assembling of data relevant to the question of endemism among bryozoans.

SUPPORTED BY U.S. National Science Foundation

5.0543. PROTEIN SYNTHESIS ACTIVATION IN SEA URCHIN EGGS

P.C. DENNY, Univ. of California, Graduate School, Los Angeles - U.C.L.A., California 90024

The broad objective of this research is to find out the sequence and kinds of regulatory events which are responsible for the initiation of development in the sea urchin egg. The protein synthesis system contained in these eggs will serve as the basis for the investigation. It is especially advantageous for this purpose because first of all its activity is fairly easy and accurate to measure and secondly it changes in activity at fertilization parallel the changes in the egg. The general changes in the egg. Specifically, the objective is to follow step by step, beginning with sperm penetration, the events which result in the fully active protein synthesis system. On one hand, the response will be investigated at the molecular level, starting with the active system in the fertilized egg and from there determining the nature of the inhibition to the system in the unfertilized egg. On the other, the activation sequence will be investigated at the initial step, sperm penetration, by examining the pattern of regulation of the protein synthesis system in the egg and the localization of activity at various intervals shortly after fertilization.

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Another objective which now can be realized is the electrohydrodyanamic characterization of the proteins which are actually being synthesized in those periods immediately following fertilization or parthenogenetic activation of anucleate fragments. To do this a new approach has been developed which is based upon the in vitro synthesis and release of the proteins by polyribosomes taken from the eggs or fragments. Using this technique, the developmental stage in which a given protein is being synthesized can be easily pinpointed, and any interference in synthesis or characterization by the large amount of endogenous protein present in the egg can be avoided.

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5.0544. CETACEA OF TIERRA DEL FUEGO

K.S. NORRIS, Univ. of California, Graduate School, Los Angeles - U.C.L.A., California 90024

Under GA-1420 research plans for use of R/V Hero were approved for conducting a survey of the small cetaceans found in the waters of the Inland Passage, Chile, and in the Straits of Magellan, Chile-Argentina, and off-shore waters of Tierra del Fuego, Argentina-Chile. In reviewing field plans, the principal investigator found need for a number of unanticipated but essential items necessary for the normal development of the field work. Because these will not be p-ovided as standard shipboard supplies, the items, as listed in the supplement budget, will be purchased in the United States for delivery to R/V Hero prior to her departure for South American waters.

International travel will be provided under USARP for five persons (Schevill, McFarland, Harvey, Schallenberg and M. Barrett); Norris, Bloom, and R. Barrett will be in Chile under the exchange program between the University of California and the University of Chile. There is an increase in the shipboard party from six (6) to nine (9) members plus a Chilean scientist. Otherwise, the basic plan of research approved under GA-1420, the shipboard arrangements, time schedules, and embarkation from Puerto Montt, Chile, remain unchanged.

SUPPORTED BY U.S. National Science Foundation

5.0545. STUDIES OF SOUND PRODUCTION

K.S. NORRIS, Univ. of California, Graduate School, Los Angeles - U.C.L.A., California 90024

The program is designed to illuminate sound production and projection in the toothed whales, and the use of these signals in discrimination. In addition the structure of emitted signals and signal trains is to be studied. The integration of emitted signals and returned echoes is also to be studied by various means. In totality the object is to learn how porpoises emit and utilize clicks and click trains to determine features of their environment, what the limits of discrimination ability under various circumstances might be, and how sounds are received and transmitted to the inner ear.

SUPPORTED BY U.S. National Science Foundation

5.0546. ECHO RANGING SIGNALS

T.C. POULTER, Stanford Research Institute, Menlo Park, Califonia

The echo ranging signals of seals and sea lions are being studied in captivity and in their natural surroundings. Recording techniques have been developed for tracking animals under ice and laboratory facilities built for behavioral tests of pinniped sonar abilities.

Analyses of pinniped signals has included conversion to visual display allowing identification of some acoustic characteristics of the signals. Further studies will investigate the use of computer technology in fine analysis of these signals.

Maintaining a colony of captive animals for sonar and related experiments has lead to integrated research centered on the health and care of pinnipeds. Fur seal, California sea lion, Steller sea lion, elephant seal and harbor seal pups are being raised in the laboratory setting and insights have been gained into some health problems of infant and adult animals.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.
5.0547, PERCEPTUAL VOCAL, AND ECHO-RANGING BEHAVIOR OF SEALS AND SEA LIONS
R.J. SCHUSTERMAN, Stanford Research Institute, Menlo Park, California

The investigator will continue work begun under earlier grants (GB-1437, GB-4349) on the perceptual, vocal, and echolocation behavior of seals and sea lions.

Earlier studies have pointed to the need of obtaining further data of a comparative nature concerning the avenues by which seals and sea lions gain information about their environment, and organize their information in a meaningful way for successful adaptation to both a marine and terrestrial existence. The investigator has outlined the following research problems: 1. The measurement of various aspects of aerial and underwater visual acuity under several conditions of illumination. 2. The discrimination and classification of shapes in different spatial orientations. 3. The determination of sound detection thresholds, and the degree to which sound patterns can be discriminated. 4. The types of vocalization, the conditions under which they occur, and the behavioral displays with which they are associated.

SUPPORTED BY U.S. National Science Foundation

5.0548, PHYSIOLOGICAL VARIATION IN SUBTIDAL AND INTERTIDAL MARINE INVERTEBRATES
E. SEGAL, San Fernando Valley State Coll, Graduate School, Northridge, California 91326

SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY Society of The Sigma Xi

5.0549, INFECTIONS IN MARINE MAMMALS USED AS LABORATORY ANIMALS
D.G. JOHNSTON, Saint Johns Hosp., Oxnard, California 93032

The objective of this research is to isolate, and characterize morphologically and biochemically, microorganisms obtained from various tissues of marine mammals. Standard microbiological techniques will be employed initially. When this primary objective is obtained, the response of sea mammals to human pathogens and to the use of antibiotic and chemical therapy will be studied.

The information derived from this study will be valuable in providing care for marine mammals kept in captivity for scientific purposes. Some of the infections of porpoises, for instance, have been attributed to Erysipelothrix insidiosa, Diploroccus pneumoniae, and Pseudomonas aeruginosa. This project is in support of the behavioral studies on porpoises at the U.S. Naval Missile Center, Point Mugu, California. The investigator will remain cognizant of the possibility that microorganisms infectious for marine mammals may also be hazardous to man under certain circumstances as for instance during prolonged periods of deep submergence involving frequent physical contact with ocean water.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0550, BIOCHEMISTRY OF FERTILIZATION AND EARLY DEVELOPMENT
D. EPEL, Stanford University, Graduate School, Palo Alto - Stanford, California 94305

A continuation of Research Project: Based on the premise that the activation of sea urchin eggs upon fertilization can be traced back to a primary biochemical reaction, studies are concentrated upon reactions involving TPNH (NADPH)* His reason for choosing this substance is that the steps in protein synthesis seem to be intact in the unfertilized egg, except perhaps, for the activation of transfer RNA, and DPN kinase activity is increased 5-6 fold after fertilization.

Approaches to biosynthetic activation will concentrate on 1) the role of post-fertilization increases in TPNH in changing rate of pattern of biosynthesis and 2) the role of changes in energy production on the changing biosynthesis. The second phase of the investigation will be a comparative biochemical study of fertilization, using other invertebrate and vertebrate eggs.

SUPPORTED BY U.S. National Science Foundation

5.0551, MARINE WASTE DISPOSAL AND SEA URCHIN ECOLOGY
W.J. NORTH, Calif. Inst. of Technology, Graduate School, Pasedena, California 91109

Southern California communities are growing rapidly and depend intimately on the ocean for food, recreation, and waste disposal. At times the varied human activities seriously interfere with each other and with the natural environment. Unless preventive measures can be developed, metropolitan growth will clearly disrupt nearshore ecology to the point where few marine biological resources will survive. Our broadest objective is to alleviate this situation to the greatest extent possible.

The principal area of our concern has been the California kelp beds because of their high productivity, and richness of species and biomass. Mans impact has drastically reduced kelp beds in certain areas. The project is divided into two sections: one section emphasizes development of techniques for controlling and improving kelp communities while the other concentrates on gathering basic ecological knowledge that provides the background for intelligent control. This proposal is in the second category. Interactions between these two sections are outlined in an addendum enclosed herewith.

One of the chief factors affecting the kelp communities adversely is apparently an imbalance resulting from overgrazing by sea urchins. We suspect that there is a nutritional link between discharged sewage and the dense urchin populations. The proposed investigation should confirm or disprove the existence of the suspected link. If such a relation is verified, future planning of many seaside municipalities will benefit from the information.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol.Ctl

5.0552, CARDIOVASCULAR ADJUSTMENT TO DIVING ASPHYXIA
R. ELSNER, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

This continuing support is for a second year of investigation of cardiovascular adjustment in Antarctic seals to diving asphyxiat. The studies are of three types: (1) the determination of natural diving time in females and young seals; (2) the elucidation of circulatory changes by instrumentation of female seals; and (3) the investigations of properties of seal fetal and maternal blood with particular reference to oxygen transport mechanisms. This first year of work provided familiarity with Antarctic field conditions. It established safe dosage of drugs used in tranquilization and immobilization of experimental animals; and techniques and safe use of surgical anesthesia. It permitted successful implantation of Doppler ultrasonic blood flow transducers using aseptic surgery; and the measurement of free-diving time and depths in seals. In addition, studies were begun on the respiratory properties of blood of Weddell seals. It is proposed to extend these studies during the 1968-69 field season.

The field work will be conducted at McMurdo Station under the direction of the principal investigator, with three assistants from 1 September - mid-November 1968. Winter flight participation is anticipated.

SUPPORTED BY U.S. National Science Foundation

5.0553, CIRCULATORY REACTIONS TO ASPHYXIA
R.W. ELSNER, Univ. of California, Scripps Inst. of Oceanography, San Diego - La Jolla, California 92038

Some features of the circulation peculiar to marine mammals are under study. Profound alterations of cardiac output and blood flow distribution have been investigated during experimental underwater diving. These changes are adaptive in nature and lead to effective prolongation of diving time by circulatory redistribution ensuring adequate perfusion of myocardium and brain while other organs are made ischemic by widespread vessel constriction. Blood flow often fell to zero in renal, mesenteric, muscle and skin circuits. Cardiac output decreased, while arterial pressure was well maintained. Demonstration of similar, but not usually as profound, responses in terrestrial animals, including man, suggests that the reaction of diving mammals is a special instance of a more general response to asphyxia. On the basis of these findings new studies are being initiated in an attempt to clarify further responses to asphyxia. Preliminary experiments have demon-
5. LIVING SYSTEMS (NON-HUMAN)

stratified the feasibility of instumenting fetal sheep in utero and subsequent recording of blood flow in the unanesthetized, unrestrained animal. Such measurements have been obtained from lambs during birth. Blood flow distribution and responses of both fetal and maternal circulations will be systematically investigated during birth and induced asphyxia in both sheep and seals. A primary long term goal of these studies will be the understanding of control mechanisms specifically involved in the cardio-vascular responses to asphyxia. Other investigations into special aspects of marine mammal circulation are being continued. These include X-ray angiographic and flowmeter studies of circulation as it relates to temperature regulation.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0554, MARINE VERTEBRATES OF THE CALIFORNIA "PENINSULA"
J.L. HUBBS, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

The research, on the marine vertibrate fauna of the 'California Peninsular' (Cape San Lucas to Pt. Conception) is to be done in systematic, zoogeography, oceanography, and ecology. Mapping of fish distribution is underway; systematic reviews of fishes are completed, being completed, or are underway. Studies of marine turtles, birds, and reptiles are also in progress, and these are being integrated with oceanographic work, particularly the analysis of inshore sea surface temperatures.

SUPPORTED BY U.S. National Science Foundation

5.0555, DEEP DIVING ANTARCTIC BIRDS AND MAMMALS
G.L. KOOYMAN, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

This is a program in hyperbaric physiology on the deep diving behavior of bird and mammal species using restrained and unrestrained experimental animals. Because seals have tolerance for great hydrostatic pressures, they are valuable experimental subjects in elucidating mechanisms of adaptation to high pressure and rapid pressure changes. Less pressure-tolerant diving birds will be used for comparison. The Weddell seal and emperor penguin are the most suitable animals for the planned field experiments; preliminary testing of equipment and techniques will be made at the University with locally procured harbor seals. Physiological measurements will include heart rate, metabolic rate, total lung capacity, tidal volume, gas volume during the dive, and alveolar gas composition before and after the dive. Instrument packs developed and used for the unrestrained study techniques. Two portable high pressure chambers will be constructed at Scripps Institution of Oceanography for use at McMurdo Station.

The program utilizes the winter flight to McMurdo Station for field work, beginning September and completing mid-December 1968. The principal investigator will require scuba qualifications, he will be assisted at the biolab by Dr. Lenfant and one graduate student. Animal Lift required for two Weddell Seals.

SUPPORTED BY U.S. National Science Foundation

5.0556, THE COMPARATIVE IMMUNOLOGY OF LOWER ORGANISMS
J.E. CUSHING, Univ. of California, Graduate School, Santa Barbara, California 93018

The research objective of the present proposal is to investigate two areas concerned with the immunology of marine organisms. The first of these is the immune responses of marine invertebrates with the purpose of learning more concerning the background against which the immune mechanisms of higher vertebrates evolved. The second of these is concerned with the blood groups and related substances of marine invertebrates with the view of learning more of the variations and evolutionary relationships of these substances among these forms. These objectives are of growing biological interest as the knowledge of the mechanism of antibody production increases and needs to be related to a general biological background.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0557, CYTOTOLOGICAL CHARACTERISTICS
T.L. SIMPSON, Univ. of Hartford, Graduate School, Hartford - West Hartford, Connecticut 06117

An initial study of marine, chthridiid sponges has shown that cytological characteristics when employed as taxonomic criteria allow the development of a natural classification which cannot be arrived at solely by the employment of traditionally-utilized characteristics: the skeletal elements. The object of the present study is twofold. First, additional species of chthridiid sponges will be examined cytologically, where possible, by explanation in order to obtain a more complete picture of the cytology of genera within this group of sponges. Secondly, an intensive study of the functional and developmental physiology of Microciona prolifera will be initiated in order to develop methods whereby the functions and developmental roles of the mesenchymal cell types can be elucidated. If fruitful, this will add a new dimension to the use of cytological features for sponge systematics. Namely, it will make possible comparative studies based not only on cytological characteristics but also on the functional and developmental role of sponge cells.

SUPPORTED BY U.S. National Science Foundation

5.0558, SYSTEMATIC STUDIES OF SPONGES OF THE JAMAICAN FORE-REEF SLOPE
W.D. HARTMAN, Yale University, Peabody Museum of Nat. Hist., New Haven, Connecticut 06520

It is proposed to study the systematics of the rich sponge fauna living in the fore-reef slope environment of Jamaica by both classical morphological methods and biochemical techniques. The material available for the study was collected by SCUBA divers at depths ranging from 25 to 80 meters. In the more classical studies emphasis will be placed on useful characters in other genera such as Agelas, Xestospongia and its relatives, and Veronginia. Every attempt will be made to refer to original type material in an effort to clarify nomenclatural problems. The collections of such early authors as Duchassagne and Michelotti and Schmidt have already been studied, and it is hoped that Carter's material may be examined in Liverpool.

As a means of obtaining additional characters for a re-examination of sponge relationships at the familial and generic levels, application of a series of biochemical techniques will be undertaken on the keratan sponges in the first instance, since they lack the sclerites that provide useful characters in other genera such as Agelas, Xestospongia and its relatives, and Veronginia. The spatial separation of deposit and suspension feeding types to food source availability, i.e. deposited or suspended. This hypothesis is inadequate, however, to explain low diversity of suspension feeding sponges on deposit feeder dominated muds in Buzzards Bay, Massachusetts that have an abundant food supply suspended over the bottom. An alternative exclusion mechanism is suggested. Intensive sediment surface reworking activities of deposit feeders produce a granular, uncompacted, high water content interface easily suspended by weak tidal currents. The physical instability of this reworked bottom type is effective in decreasing suspension feeder diversity and biomass by: 1) clogging filtering mechanisms, and 2) resuspending and burying newly settled suspension feeding larvae. Instability of the reworked interface is also limiting to sessile epifauna unable to maintain a firm connection with the bottom.

SUPPORTED BY U.S. National Science Foundation

5.0559, THE INFLUENCE OF DEPOSIT FEEDING BENTHOS ON THE STABILITY OF BOTTOM SEDIMENTS AND COMMUNITY TROPHIC STRUCTURE
D.C. RHoads, Yale University, Graduate School, New Haven, Connecticut 06520

The spatial separation of deposit and suspension feeding benthos is a major ecological phenomenon of the marine environment. Existing hypotheses relate the occurrence and relative abundance of these feeding types to food source availability, i.e. deposited or suspended. This hypothesis is inadequate, however, to explain low diversity of suspension feeding benthos on deposit feeder dominated muds in Buzzards Bay, Massachusetts that have an abundant food supply suspended over the bottom. An alternative exclusion mechanism is suggested. Intensive sediment surface reworking activities of deposit feeders produce a granular, uncompacted, high water content interface easily suspended by weak tidal currents. The physical instability of this reworked bottom type is effective in decreasing suspension feeder diversity and biomass by: 1) clogging filtering mechanisms, and 2) resuspending and burying newly settled suspension feeding larvae. Instability of the reworked interface is also limiting to sessile epifauna unable to maintain a firm connection with the bottom.
5.0564, PATTERNS OF SPECIES DIVERSITY - TERTIARY-RECENT
M.A. BUZAS, Smithsonian Institution, Washington, District of Columbia 20560

The relative abundance and number of species of Foraminifera in Bay's, nearshore open ocean and offshore open ocean are being examined from Greenland to the Gulf of Mexico by means of the information function. Several Tertiary sections of the east coast are also being studied to examine the relationship between the recent pattern and patterns in the past.

SUPPORTED BY Smithsonian Institution

5.0565, POPULATION DYNAMICS OF FREE-LIVING MARINE NEMATODES INHABITING THE BENTHOS OF HADLEY HARBOR COMPLEX, WOODS HOLE, MASS.
W.D. HOPE, Smithsonian Institution, Washington, District of Columbia 20560

There is no detailed information available on the seasonal changes in the population structure and population density of free-living marine nematodes during an annual cycle in a given habitat. Such information will contribute to a better understanding of the ecological relationships of nematodes.

Specifically, this study was undertaken to determine the following: 1.) What changes, if any, occur in the numbers of individuals for each species of marine nematode inhabiting the sediment at two stations in Hadley Harbor during one annual cycle. 2.) How often and how long each species breeds. 3.) The time required for maturation of juveniles. 4.) Mortality rate for at least the dominant species. 5.) Whether or not there are correlations between changes in the populations of nematodes and changes in the physical and chemical parameters of the environment. 6.) Gut contents of macro-invertebrates from these stations will be examined to determine what organisms may be preying on nematodes.

SUPPORTED BY Smithsonian Institution

5.0566, MARINE NEMATODES OF THE CAPE COD AREA
W.D. HOPE, Smithsonian Institution, Washington, District of Columbia 20560

Marine nematodes of the Cape Cod Area are virtually unknown except for a few species described, but not illustrated, by Cobb (1933). Research on this group of animals in the Cape Cod area has been prohibitive because of taxonomic difficulties. Yet, they are a very important, if not the most important, constituent of the meiofauna.

For this reason, a survey of the marine nematodes of the Cape Cod Area was conducted during the winter and summer of 1965 which will lead to a series of publications describing and illustrating specimens that were collected. It is intended that keys and habitat data will also be included.

The specimens are presently being sorted and mounted for study and all type specimens of marine nematodes originally collected c : mid and Northern shores of the East Coast of the United States have been gathered at the Museum of Natural History for comparative studies.

SUPPORTED BY Smithsonian Institution

5.0567, COMPARATIVE MORPHOLOGY OF MARINE NEMATODES
W.D. HOPE, Smithsonian Institution, Washington, District of Columbia 20560

Detailed anatomical studies of marine nematodes are limited to very few reports in which histological techniques for light microscopy have been employed and almost no information is available from electronmicroscope studies.

Histological studies of selected marine nematodes will be conducted to obtain more detailed information on the relationships of marine nematodes and functions of their various organs. Studies have been initiated on Deonostoma californicum Steiner and Albin, 1933 with particular emphasis on the nervous system, and during FY 1968 I will spend six months at Toronto Universi-
5. LIVING SYSTEMS (NON-HUMAN)

5.0568, PACIFIC OCEAN BIOLOGICAL SURVEY PROGRAM
P.S. Humphrey, Smithsonian Institution, Washington, District of Columbia 20560

This program is a biological survey of the central Pacific islands, concentrating mostly on seabirds. Emphasis is on the pelagic distribution of birds in relation to oceanographic and meteorological factors.

SUPPORTED BY Smithsonian Institution

M.L. Jones, Smithsonian Institution, Washington, District of Columbia 20560

The basic purpose of this project is to make a study of the polychaetous annelids of the Gulf of Mexico and the Caribbean Sea. Though widely distributed throughout this area and rather easily collected, it remains that the polychaetes of the Gulf and Caribbean are rather poorly known, and it is hoped that the present collections (approximately 450 localities from 17 general locations), as well as future collections, will, when processed, show more light on this relatively neglected group.

Present collections come from or near Veracruz and Tuxpan, Mexico; Port Arkansas, Texas; St. Andrew Bay, offshore at Panama City, Alligator Harbor, Apalachicola Bay, Cedar Key, Tampa Bay, Cape Haze, Naples, Tavernier Key, Key West, and Biscayne Bay, Florida; Bimini and Andros, Bahamas; Jamaica and Barbados, West Indies; Puerto Rico; and Margarita Island, Venezuela. In the future, further collections will be made along the Antillean chain, through the Bahamas, and along the Central and South American coasts.

Ultimately, comparisons will be made with the polychaete fauna of adjacent areas and those of other tropical and subtropical regions.

SUPPORTED BY Smithsonian Institution

5.0570, THE TAXONOMY AND ZOOGEOGRAPHY OF THE MAGELONIDAE OF THE WORLD
M.L. Jones, Smithsonian Institution, Washington, District of Columbia 20560

The family Mageloniidae (Polychaeta: Annelida) has been known for somewhat over 100 years. In this period of time, 26 species have been described, all of which have been assigned to Magelona, the only genus of the family.

Recent collections from Texas, Puerto Rico, and offshore from Georgia, suggest that there is reason for the erection of at least two new genera. Collections from Santa Catarina Island, Brazil, the type locality of the type species of the genus Magelona, have provided material of M. papillicornis, the original species of the genus; redescription of this species will necessitate the renaming of certain European mageloniids which have been erroneously referred to M. papillicornis, and the resurrection of a former synonym of Magelona.

On the basis of loans from the museums of the world and material presently in the collections of a number of marine laboratories of the world, it is intended that the family be monographed, both from a taxonomic, as well as a zoogeographic standpoint.

SUPPORTED BY Smithsonian Institution

5.0571, ECOLOGY OF ECHINODIDS
P.M. Kier, Smithsonian Institution, Washington, District of Columbia 20560

Study of the living habits of echinoids in particular relative to the bottom substrate.

SUPPORTED BY Smithsonian Institution

5.0572, A SYSTEMATIC REVISION OF THE HOLOTHURIAN FAMILY PSOLIDAE - ECHINODERMATA - HOLOTHUROIDEA
D.L. Pawson, Smithsonian Institution, Washington, District of Columbia 20560

At present, 77 nominal species are known in this family of solitary holothurians. Six genera are known, and the group is being revisited genus by genus. Revision of two genera is now complete. Some species share important anatomical features with certain groups of Paleozoic echinoderms, and an attempt will be made to interpret the anatomy of the psolide in the light of the fossil record.

SUPPORTED BY Smithsonian Institution

5.0573, DISTRIBUTION MAPS OF ANTARCTIC HOLOTHURIANS AND ECHINODERS - ECHINODERMATA
D.L. Pawson, Smithsonian Institution, Washington, District of Columbia 20560

Under the aegis of the American Geographical Society, charts showing the distribution about the Antarctic and Subantarctic regions of echinoids and holothurians have been prepared. Approximately 80 species of holothurians and 50 species of echinoids are known from the area. Some attempt has been made to explain the patterns of distribution in relation to physical factors of the environment.

SUPPORTED BY Smithsonian Institution

5.0574, MARINE POLYCHAETE WORMS OF THE NEW ENGLAND REGION (GULF OF ST. LAWRENCE TO CHESAPEAKE BAY)
M.H. Pettibone, Smithsonian Institution, Washington, District of Columbia 20560

The polychaete worms of the New England region (or Gulf of St. Lawrence to Chesapeake Bay) are being worked up by Families, including synopses of the Families, Keys to the Families, Genera and Species. Included for each species are brief description, figures, notes on its biology, known geographic and bathymetric distribution, and selected synonymies and references. The first half of the study has been completed. Work continues on completion of the project. New species and revisions are worked up separately.

SUPPORTED BY Smithsonian Institution

5.0575, MARINE POLYCHAETE WORMS OFF THE COLUMBIA RIVER, OREGON
M.H. Pettibone, Smithsonian Institution, Washington, District of Columbia 20560

A collection of polychaetes, obtained by deep-water trawling operations off the mouth of the Columbia River, Oregon, during cruises carried out by the Bureau of Commercial Fisheries, aboard M/V Commando and M/V John N. Cobb, 1961 to 1964, is in process of being worked up. Included in the study are the following: a. A new genus of species of Aphroditidae, including a review of the genera of the family (completed). b. A new genus and species of bathypelagic Polynoidae, including a review of some related genera (completed). c. A study of a species of Polynoidae commensal with three species of sea stars.

SUPPORTED BY Smithsonian Institution

5.0576, CANADIAN ARCTIC AND SUBARCTIC POLYCHAETES COLLECTED BY E. H. Grainger
M.H. Pettibone, Smithsonian Institution, Washington, District of Columbia 20560

A large collection of polychaetes, obtained by E. H. Grainger on the Calanus Expeditions during 1953 to 1964, serve as a basis for a study on the Canadian Arctic and subarctic polychaetae. The collection has been separated to families. The species are being worked up by families.

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172
5.0577. THE BIOLOGY OF ROCK-BORING SIPUNCULIDS
M.E. RICE, Smithsonian Institution, Washington, District of Columbia 20560

Species of Phascolosoma, Aspidosiphon, Lithacrosiphon, and Clioneosiphon are commonly found associated with coral reefs where they are known to burrow into coral rock and beachrock. Preliminary observations have been carried out on the coral reefs of the Maldives and it is hoped that these studies can be continued with the sipunculids of the Caribbean. The object of the study will be twofold: to determine whether the boring habit is associated with nutrition and to investigate the mechanism of boring. It is planned to begin work in the Caribbean in the spring of 1971.

In the study of nutrition, analyses would be made and compared of gut contents, fecal pellets, and the rock inhabited by the animal. Dr. Karl M. Wilbur of Duke University has tentatively agreed to cooperate in some of the chemical analyses.

An investigation of the boring mechanism would include observations on the behavior of living animals in the laboratory, an examination of the burrows, and a histophysiological study of the skin papillae in an attempt to determine the nature of their secretion.

SUPPORTED BY Smithsonian Institution

5.0578. SYSTEMATICS OF ANTARCTIC SIPUNCULIDS AND ECHIURIDS COLLECTED BY THE ELTANIN EXPEDITION
M.E. RICE, Smithsonian Institution, Washington, District of Columbia 20560

This project involves a study of the systematics of the sipunculids and echiurids collected in the Antarctic by the Eltanin Expedition. Over 500 specimens have been received thus far and more are expected. The specimens were dredged from 300 to 5400 meters and many are from areas in which no previous collections have been made. The specific identification of the specimens is at present in progress; any new species will be described.

SUPPORTED BY Smithsonian Institution

5.0579. REPRODUCTIVE BIOLOGY, DEVELOPMENT, AND SYSTEMATICS OF THE SIPUNCULIDS OF THE CARIBBEAN
M.E. RICE, Smithsonian Institution, Washington, District of Columbia 20560

A comparative study of the development of several species of tropical sipunculids belonging to the genera Lithacrosiphon, Aspidosiphon, Phascolosoma, Sipunculus, and Siphonosoma will be started in the spring of 1967. Such information, not now available, is important both to an understanding of the phylogenetic relationships of the phylum, and to an insight into the zoogeographical distribution of these species.

Data will be accumulated on spawning and breeding seasons and on embryogenesis, larval morphology and behavior. This study will involve observations on living animals and embryos in field laboratories and, in addition, histological work, including the technique of embedding in epoxy resins and sectioning at 1 micron on a Porter-Blum ultramicrotome.

One of the considerations will be to relate the findings to those of Dr. Scheltema (WHOI) who, having collected sipunculid larvae of unknown species in great numbers in the North Atlantic Ocean, has proposed that they may be transported by currents from the Caribbean to the Azores and the West Coast of Africa.

Since the Caribbean sipunculids are not well known, the study will of necessity include an investigation of the systematics of the sipunculids of this area. Dr. F. M. Bayer and Dr. G. Voss (University of Miami), currently engaged in a faunal survey of the Caribbean, are interested in this aspect of the study and will make available to me their collection of sipunculids.

SUPPORTED BY Smithsonian Institution

5.0580. SYNECOLOGY OF CARIBBEAN SPONGES
K. RUTZLER, Smithsonian Institution, Washington, District of Columbia 20560

5. LIVING SYSTEMS (NON-HUMAN)

Studies are to be made on the interspecific relationships among sponges, competition for space, microanatomical and biochemical aspects of overgrowth, interspecific relationships between sponges and other organisms, and the biological and biochemical problems involved with symbiotic algae and epizoans.

SUPPORTED BY Smithsonian Institution

5.0581. COOPERATIVE SYSTEMATICS STUDIES IN ANTARCTIC BIOLOGY
I.E. WALLEN, Smithsonian Institution, Washington, District of Columbia 20560

The Smithsonian Oceanographic Sorting Center will continue the cooperative systematic program begun under GA-261 for the study, determination, and description of Antarctic biological materials and particularly neglected marine invertebrate groups accruing from past and current United States Antarctic Research Programs. Non-staff, qualified taxonomists of unique competence will be considered for the analyses of biological specimens appropriate to their specialties. The SOSC will make available all essential laboratory and library facilities; the proposal provides for stipends, travel expenses and necessary items of specialized equipment. In all instances, a completed and acceptable manuscript will terminate the successful cooperative systematic study.

With the exception of Heron (S.I.), all cooperating systematists will be provided with laboratory quarters, equipment and library facilities at their resident institutions, i.e., Bayer - University of Minnesota; Mather - University of Pennsylvania; Newman - University of California, San Diego; Pawson - Victoria University; Clark - Dominion Museum; Marumo - Texas A&M.

SUPPORTED BY U.S. National Science Foundation

5.0582. SYSTEMATICS AND ECOCOLOGY OF MARINE BIRDS
G.E. WATSON, Smithsonian Institution, Washington, District of Columbia 20560

Various minor projects are underway to provide data on the systematics, ecology and distribution of seabirds. These include ecological studies of the rare Audouin's Gull in the Mediterranean, distribution of seabirds in the tropical Atlantic Ocean, and the systematics of Antarctic and Indian Ocean birds. Some of the results of this research will be fed into other existing projects and others to be developed. Under this category is also included preparation of the section of Sylviinae for Peters' Checklist of Birds of the World and the genus Alectoris for the Handbook of North American birds.

SUPPORTED BY Smithsonian Institution

5.0583. MOVEMENTS OF SEABIRDS IN THE HUMBOLDT CURRENT
G.E. WATSON, Smithsonian Institution, Washington, District of Columbia 20560

Little is known about the movements and abundance of marine guano birds in the Humboldt Current off Western South America. Through the use of micro-transmitters it will be possible to track the daily movements of individual birds on automatic receiving equipment placed on coastal mountains. Color marking large numbers of birds will review populations movements. The combined radio telemetric and observational approaches should yield much new data on both diurnal and seasonal movements of this commercially important bird.

SUPPORTED BY Smithsonian Institution

5.0584. FIELD STUDY - CAPE COD, MASS.

Obtain information on the distribution, reproduction, and early development of sedentary and seadling marine animals in relation to bottom temperature, sediments, and other environmental factors. The study area is off Cape Cod (Highland) Light on the outer coast of Cape Cod, Massachusetts. The observations are
5. LIVING SYSTEMS (NON-HUMAN)

made along a line extending from shallow to deep water. Self con-
tained temperature and temperature-pressure recorders are
mounted in the mooring blocks of five large navigation-type
buoys specially stationed by the Coast Guard at 5 different depths
along this line.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0585. ANTIGEN DISTRIBUTION OF DEVELOPING SEA
URCHIN EMBRYOS
J.W. BROOKBANK, Univ. of Florida, Graduate School,
Gainesville, Florida 32601
The uptake of radio-phosphate by isolated ento-mesoderm
and ectoderm of developing echinoid embryos is proposed, along
with a serological analysis of the tissue associated antigens of
these germ layers.

In addition, the time of appearance of paternal antigens in
hybrid sea urchins (Lytechinus X Tripneustes) will be in-
vigated during the early development of this cross. Subcellular
fractions (various RNA's) will also be studied should the informa-
tion on appearance of protein antigens warrant this investigation.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0586. THE ECOLOGY, MIGRATIONS AND BEHAVIOR
OF MARINE TURTLES
A.F. CARR, Univ. of Florida, Graduate School, Gainesville,
Florida 32601
Description of the Research Project: The research has in-
volved a group of related projects, all aimed at filling gaps in the
life cycles of the five genera of marine turtles. A long-term
tagging project has been under way continuously at Tortuguero,
Costa Rica, since NSF-sponsored studies proved in 1955 that
Chelonia is a migratory animal. Data accumulating there has al-
lowed the increasingly refined delineation of the area served by
the Tortuguero nesting grounds of Chelonia, and has shed light on
changes in population size; on remigration and remigration cycles,
on nesting-site tenacity, on the significance of clumped emer-
gence on the nesting beach, and on the question of separate ver-
sus aggregated travel between nesting and feeding grounds. A
detailed study of the latter was begun during the 1968 grant
season and will be continued for three years. Grant personnel has
carried out or collaborated in other projects which, together with
the Tortuguero program, have tagged about eight thousand tur-
tles in various parts of the world. Tag returns from these should
continue to advance knowledge of the natural history of sea tur-
tles for years to come. When the Ascension Island tagging project
proved Chelonia to have an extraordinary capacity for open-
cean navigation the Office of Naval Research began furnishing
support for tracking experiments to plot migratory courses as a
basis from which to investigate navigation cues and senses. Facili-
ties and personnel provided by NSF have been jointly involved in
some of this work, and during the 1968 season successful tracking
of female turtles in migration was carried out by both optical and
radio tracking devices.

Field reconnaissance of nesting and feeding ranges of all the
sea turtles has revealed that all the marine turtles are to some
degree migratory, and is piecing out the still imperfectly known
ecologic geography of the group. A continuing series of field stu-
dies of the comparative behavioral ecology of the genera and spe-
cies is in progress.

SUPPORTED BY U.S. National Science Foundation

5.0587. COMMUNICATIONS STUDIES ON TURSIOPS
TRUNCATUS AND OTHER DELPHINIDS
J.C. LILLY, Communication Research Inst., Miami - Coconut
Grove, Florida 33133
Objective: This research is a segment of a continuing pro-
gram of the vocalization and vocalization capabilities of the bottle
nosed dolphin Tursiops truncatus. A study of the physical proper-
ties of their emissions is in progress. It is the intention of this study
to explore the formal structure of vocal exchanges between two
animals connected only by an acoustic path. These exchanges will
be recorded on separate channels of high speed magnetic tape
which will then be fed into computers for auto-and cross-correla-
tional analyses. It is expected that this and other studies on the
communications between simpler forms of life will contribute
much to our basic understanding of transfer and interpretation of
information. Detailed analyses are being made of the communica-
tive abilities of the dolphin. The understanding of the communi-
cation capabilities of a species other than man and one having
such a large and complex brain as the dolphin is of great theoretic-
all value for understanding human communication and forms a
basis for relating such studies to brain structure and function.

SUPPORTED BY U.S. Dept. of Defense - Air Force

5.0588, PHYSIOLOGICAL STUDIES IN THE BOT-
tLENOSE DOLPHIN TURSIOPS TRUNCATUS
E.L. NAGEL, Communication Research Inst., Miami - Coconut
Grove, Florida 33133
The Cetacea which include the great whales, dolphins, and
porpoises, are highly specialized aquatic mammals which show
many adaptations and specializations for life in the sea, including
the ability to dive deeply and submerge for prolonged periods.
The investigations in these animals have been and are concerned
primarily with three major organ systems: central nervous, car-
diovascular, and pulmonary. On the basis of the principal in-
vestigator's studies, to date, it appears that the dolphin's ability to
adapt to the aquatic environment and function therein depends in
large part on hemodynamic and cardiopulmonary specializations
and the special functional relationship these systems establish
with the brain via the rete mirabile system. For this reason, these
system complexes and their relationships have received emphasis
in their studies and in these proposed investigations.

SUPPORTED BY U.S. National Science Foundation

5.0589, GENERAL SYSTEMATIC STUDIES OF THE OC-
tOCORALLIA OF THE TROPICAL ATLANTIC
F.M. BAYER, Univ. of Miami, Graduate School, Miami - Coral
Gables, Florida 33124
The proposed research deals with the systematics of tropical
Atlantic octocorals. These coelenterates are one of the most im-
portant groups of sessile animals in the reef habitat and in many
bottom communities of deeper water. Knowledge of the syste-
matics of the West Indian forms has been put seriously out of date
by rich collections obtained in the past five years by dredging,
trawling and SCUBA diving, and the East Atlantic tropical fauna
is very incompletely known. Material from the Straits of Florida,
Bahamas, West Indies, Gulf of Mexico, Caribbean Sea, Brazil,
and the Gulf of Guinea, now numbering about 900 lots and steadily
increasing, will be studied systematically, described, and illus-
trated, toward two final goals: (1) a revision of the Octocorallia of
the continental shelf and slopes of the tropical West Atlantic, and
(2) a general account of the octocorals of tropical West Africa.
These will include zoogeographical studies to reveal the degree
and nature of the faunal relationship of the eastern and western
Atlantic; information on geographical and ecological variation of
individual species; and studies of the anatomy and histology of as
many species as possible, in order to clarify basic questions of
classification of higher taxa. The studies now undertaken are the
first step toward a thorough modernization of the systematics of
the Octocorallia in general, and are preliminary to the investiga-
tions of the more complicated (and taxonomically confused)
Indo-Pacific fauna. In the two-year period of the present grant,
research will be concentrated upon the West Atlantic fauna, and
it is anticipated that approximately one-half of the revision of that
area can be completed.

SUPPORTED BY U.S. National Science Foundation

5.0590, FERTILIZATION MECHANISMS AND GAME TE
PHYSIOLOGY IN MARINE INVERTEBRATES
C.B. ME77, Univ. of Miami, Graduate School, Miami - Coral Ga-
bles, Florida 33124
Mechanisms involved in the initial events of fertilization in-
cluding the sperm acrosome reaction, penetration of egg mem-
branes, attachment of the sperm to the egg, membrane fusion and

174
activation of the egg are under investigation. Specifically, the fol-
lowing areas are under attack: 1) Dr. Hinch is continuing his stu-
dies on Libinia with special attention given to ultrastructural
aspects of egg and sperm morphology, sperm-egg interaction in
naturally spawned eggs, some aspects of oogenesis and sper-
matogenesis, the nature of the 'skein fibers' in the arms of the
and the spermatozoan; 2) a study on sperm and egg antigens in sea
urchin fertilization; 3) a completion of the rabbit seminal particle
study including the ultrastructure of the male accessory glands
and the origin of the seminal particles. The uncapacitated,
capacitated and capacitated rabbit sperms will be compared
immunologically. 4) Studies on the relation of non-nuclear
(mitochondrial) RNA to DNA and protein synthesis in sea urchin
eggs will continue. And, finally 5) an investigation of sea urchin
egg antigens, particularly those released at fertilization, will be
carried out.

SUPPORTED BY U.S. National Science Foundation

5.0591. UTILIZATION OF ENVIRONMENTAL NUTRI-
TIONAL RESOURCES BY STARFISH
J.C. BRIGGS, Univer. of South Florida, Graduate School, Tampa,
Florida 33620

This is a continuation of GB-4994 in which it was shown that
epidermal cells could take up free amino acids and glucose from
dilute solutions in sea water. The investigator is now determining
whether the epidermal cells can also take up dissolved proteins
and suspended microorganisms. The importance of such nutri-
tional sources is being evaluated. Special water-pumping respon-
ses have been noticed in the presence of dissolved materials.
There will be further studies in relation to the concentration and
kinds of materials that will stimulate pumping. The studies will be
comparative for several species.

SUPPORTED BY U.S. National Science Foundation

5.0592, ENVIRONMENTAL SIGNIFICANCE OF SABEL-
LARID REEFS
W.F. TANNER, Florida State University, Graduate School, Tall-
ahassee, Florida 33306

A study of the influence of worm (Sabellariid) reefs on
coastal morphology, erosion and sedimentation. Unlike corals
(which require warm, clear, shallow, turbulent marine water),
and vermetid (gastropod) reefs (which develop in warm, clear,
shallow, quiet marine water), the sabellariids thrive in warm-to-
cool, shallow translucent marine waters in which an appreciable
load of clastic sediment (sand, silt) is in transit. The sabellariids
have a profound influence on lithification of beach materials (to
make beach-rock), and hence on rates and processes of erosion
deposition. They incorporate sand-sized particles in their
empty tubes, and thus deplete the supply of sand in transit toward
coastal erosion and sediment transport, must now be revised
for use in areas where Sabellariids make reefs.

SUPPORTED BY U.S. National Science Foundation

5.0593, MARINE ZOOGEOGRAPHY
J.C. BRIGGS, Univer. of South Florida, Graduate School, Tampa,
Florida 33620

In September, 1962, work was begun on a study of the
generically classification of marine fishes. The coverage was then
broadened to cover other groups of marine animals and the
manuscript entitled MARINE ZOOGEOGRAPHY. As the result of
this enlargement of the original task, about two more years will
be required for its completion. Eight chapters out of a projected
number of twelve are now ready. Preliminary work of this nature has
been done and, during the past three years, a total of twelve smaller
papers was published. Several of the latter are of zoogeog-
graphic importance. National Science Foundation support has
now been received for the final two years of the project.

SUPPORTED BY U.S. National Science Foundation

5. LIVING SYSTEMS (NON-HUMAN)

5.0594, DEVELOPMENT IN ILYANASSA
A.C. CLEMENT, Emory University, Graduate School, Atlanta,
Georgia 30322

The program deals with the regulation of early embryonic
differentiation in the marine small fish Ilyanassa obsoleta (Nassarius
obsoletus). Interest centers around the polar lobe in the eggs of this
animal. The investigator is now studying the role of the polar lobe
in the regulation of early differentiation and the general course of
differentiation. Techniques to be employed include microscopy,
metabolic inhibitors, centrifugal force, and other appropriate
procedures. The cytoplasmic basis of the polar lobe influence, as
well as its mode of operation, is the problem of greatest interest.

SUPPORTED BY U.S. National Science Foundation

5.0595, SENSORY PROCESSES
G. VONBEKESY, Univ. of Hawaii, Laboratory of Sensory
Sciences, Honolulu, Hawaii 96822

The laboratory's broad interest is in the sense organs and
transmission pathways of man and other animals, particularly the
marine animals. Different sense modalities will be studied and
compared for common general sensory principles as well as for
principles specific to particular senses.

Initial investigations will study the amplifying mechanism in
sensory transducers, the role of inhibition in localization and sen-
sory magnitude, inhibition between point sources in the eye,
nerve membrane permeability, the role of free radicals in nerve
impulse conduction and sensory changes with neurological dis-
iceases. A variety of experimental techniques will be employed, such
as electrophysiological recording, electron spin resonance,
psychophysical 'average error' matching and psychophysical lo-
calization.

The support requested for these initial investigations should
provide the base for a continued program in each of these areas. It
is hoped that the different approaches employed in the same
laboratory will not only provide a broad analysis of sensory func-
tioning but will also result in new interdisciplinary questions not
easily conceived in 'single-discipline' laboratories. It is further
hoped that the geographic location of Hawaii will attract in-
vistigators from various parts of the world, and the Pacific Basin
area in particular, to mix their ideas and techniques in the same
laboratory.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0596, BEHAVIORAL STUDIES OF CETACEANS
K.S. NORRIS, Oceanic Foundation, Oahu, Hawaii (NON-H-
HUMAN) 5.0596

The principal investigator is studying the behavior of free
swimming cetaceans with current emphasis on the Kiko porpoise,
Stenella attenuata, and the Pacific pilot whale, Globicephala
macrurus. The open-sea data will be obtained through the use of
the unique Mobile Observation Chamber (MOC) which is a submerged
15-foot observation vessel designed and field tested by the prin-
cipal investigator under this contract. Preliminary tests indicate
that the animals are undisturbed by the 'insinuation' of the
Chamber into their midsts, and the investigator is comparing
reactions of wild and trained porpoises to a variety of stimuli. He
will now attempt to determine the effect on the behavior of the
wild population of a trained porpoise added to their school. The
courses of schooling and school break up will also be studied.

Underwater communication by cetaceans has important
Naval applications. Certain whales have been found by the in-
vestigator to possess echolocation capabilities of remarkable
precision. The limits of this ability, the conditions under which it
operates best, and in fact, the underlying mechanism remains
undefined.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0597, AGING IN HYDROIDS
E.E. PALINCSCAR, Loyola University, Graduate School, Chicago,
Illinois 60611 (NONR)

The investigator is studying cell development, particularly
senescence and death and the physical and chemical changes that
5. LIVING SYSTEMS (NON-HUMAN)

take place in the cell which result in or accompany aging. The animal under study, Campanularia flexuosa, is a colonial coelenterate, a group which includes the most long-lived animals known. To determine what factors initiate the aging process, the investigator is altering experimentally various internal and external environmental parameters and is making comparisons with other forms. He will also compare senescence and death of cells and tissues with that of entire organisms.

Effective attempts to eliminate or control biological pests that interfere with Naval operations by fouling and deterioration of equipment must be based on a thorough knowledge of the biology of the organisms involved. The determination of the death processes of these forms will provide clues to likely methods of attack for such pests. The information is also relevant to the development of cells of higher animals and will contribute to advances in medical science as well.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0598, STATOLITH DIFFERENTIATION IN AURELIA (JELLYFISH)
D.B. SPANGENBERG, Indiana University, Graduate School, Bloomington, Indiana 47405

To obtain valuable information concerning mechanisms that regulate cellular differentiation and factors which may alter normal differentiation of cells using the newly developed test system of metamorphosing Aurelia for investigation.

To relate wherever possible the data obtained from these studies to problems of cellular differentiation in growth systems of higher animals, including man and through this application, to provide new approaches, and new information which will be useful in understanding normal cellular differentiation and which will be of value in preventing stigmated cellular differentiation in higher animals.

To use the differentiation of statocysts in Aurelia during metamorphosis as a model differentiation system to determine mechanisms by which differentiating or differentiated cells concentrate calcium during development.

SUPPORTED BY U.S. Dept. of Hth. Ed. & Wel. - P.H.S.

5.0599, INITIATION OF METAMORPHOSIS IN AURELIA
D.B. SPANGENBERG, Indiana University, Graduate School, Bloomington, Indiana 47405

Research is in progress to determine the primary factors which are involved in the initiation of metamorphosis in Aurelia. Environmental factors being studied are the effects of low temperature preconditioning and light on this process. Chemical factors also under investigation are iodine and iodinated hormones. Additional research is planned to determine whether neurosecretory materials are involved in the initiation of atrophylation. The results of these studies could lead to an understanding of the basic mechanisms involved in the initiation of new growth as polyps undergo extensive mitotic activity and cellular differentiation during metamorphosis. An understanding of such mechanisms in this simple organism could be important in understanding similar mechanisms which may control the initiation of new growth (often abnormal) in higher organisms.

SUPPORTED BY U.S. Dept. of Hth. Ed. & Wel. - P.H.S.

5.0600, REPRODUCTION AND EMBRYONIC SURVIVAL IN ASCIDIA NIGRA (SAGYNY)
I.M. GOODBODY, Univ. of The West Indies, Kingston, Jamaica

Previous studies on Ascidia nigra have illustrated the pattern of growth and survival in natural populations of adults and juveniles, and have shown that larvae are settling throughout the year in the tropical environment of Jamaica. The intensity of larval settlement varies at different seasons of the year and it is not clear whether this is due to differences in the intensity of spawning or is due to differences in the pattern of embryonic and larval survival.

The present program aims to study the patterns of spawning throughout the year in laboratory reared populations of ascidians and also to study the seasonal pattern of embryonic survival in laboratory reared cultures. Weekly samples of eggs are fertilized and reared under constant conditions of temperature and in sea water from three different marine environments. A. nigra occurs naturally in two of these environments but not in the third. It is anticipated that it may be possible to show whether the absence of the ascidian from the latter may be related to poor survival of embryos in these conditions.

SUPPORTED BY U.S. National Science Foundation

5.0601, GROWTH, DIFFERENTIATION AND NERVE TRANSMISSION IN THE HYDROID, CAMPANULARIA
C.R. WYTENBACH, Univ. of Kansas, Graduate School, Lawrence, Kansas 66045

BRIEF DESCRIPTION OF RESEARCH PROJECT: Studies of four related aspects of terminal elongation and differentiation in Campanularia colonies, a marine hydroid which exhibits a branching pattern, are continuing. Preliminary microscopic observations of living material indicate that stolon and pedicel elongation occurs in a cyclic manner, with alternating forward and backward surges (rather than in a uniform fashion) and that, associated with this, the epidermal cells at these growing tips undergo repeated, extensive changes in shape. The dynamics of this cyclic growth and the motive force behind it are being studied by determining the genetic and environmental effects on its pattern, as well as that of particular drugs. Phase and electron microscopy are being used to interpret the extensive structural changes which occur in the tip epidermal cells throughout the cycle. There is evidence that at or near these elongating tips there may be a zone in which cell destruction occurs. Tissue culture techniques are being used to study the time course of cellular differentiation during hydranth development by determining the developmental potencies of aggregates formed from completely disaggregated immature hydranths of successive developmental stages. Serotonin distribution will be followed in the hope of gaining insight into the nature and origin of neural coordination in these primitive forms.

SUPPORTED BY U.S. National Science Foundation

5.0602, CORRELATION BETWEEN ELECTRICAL PATTERNS AND MORPHOGENETIC PATTERNS DURING REGENERATION
S.M. ROSE, Tulane University of Louisiana, School of Medicine, New Orleans, Louisiana 70118

Isolated pieces of stem of the marine hydroid, Tubularia, can transform to hydranths. Pieces too short to form a whole hydranth can often form an anterior portion. The general rule is that all regions form the most anterior structures not forming anterior to them. The agents of control seem to be regionally specific repressors which move in a polarized field. It has long been known that imposed electric fields can change the polarity of regenerating hydroids and worms. These two lines of approach to the problem, the electrical approach and the chemical, seem to be coming together. The natural repressors have been found to be positively charged in the pH range of 8.0 to 8.6 and move like histones.

The question under investigation is whether polarized control of differentiation results from the spread of regionally specific repressors in the bioelectric field. The control by repressors in applied fields has recently been demonstrated. Investigations are now directed to learn whether the various methods known to change morphogenetic polarity, including the induction of secondary structures, also change the bioelectric patterns.

SUPPORTED BY U.S. National Science Foundation

5.0603, POLYCHAETES AND ECHINODERMS IN THE LABRADOR SEA
D. DEAV, Univ. of Maine, Graduate School, Orono, Maine 04473

The initial scientific cruise of the research vessel Hero in northern Atlantic waters is proposed by the University of Maine as an opportunity to sample the poorly known benthic fauna of the region and to test certain biological concepts concerning the modes of reproduction of selected organisms. The particular in-
5. LIVING SYSTEMS (NON-HUMAN)

Objectives: 1. To determine the age, sex and species composition of the sea duck harvest. 2. To determine the distribution of the sea duck harvest and to gain some idea of the extent to which hunters south of New England are taking advantage of the vast sea duck hunting opportunity in this area. 3. To investigate a suspected age segregation in wintering flocks of sea ducks.

Procedures: Data has been gathered through the annual Waterfowl Parts Collection Survey from hunters throughout the coastal States of the Atlantic Flyway where sea duck hunting is permitted. The data will be analyzed by automatic data processing. Tables will be prepared to show species composition by area and time period, age ratios of each species by area and time period and the proportion of the total duck kill that was made up of sea ducks.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0607. THE BIOLOGY OF THE LAYSAN AND BLACK-FOOTED ALBATROSSES
C.S. ROBBINS, U.S. Dept. of Interior, Mig. Bird Population Station, Laurel, Maryland 20810

Objectives: In addition to testing effectiveness of scaring and repelling devices, studies include determining effects of habitat management in repelling or attracting birds; measuring repopulation in areas from which nesting birds have been removed; determining dispersal of birds whose nesting areas have been made unsuitable for nesting; determining the incidence of return of young to the place of origin to nest, the age when young return to land, and the length of time required for young to reach breeding age.

To determine age groups in the population, and to compute longevity. To determine the extent of movement of young, non-breeding and breeding birds between islands; and such related studies on the population dynamics, distribution, migration and behavior of the Laysan and Black-footed Albatross as will provide information needed for alleviation of threate aircraft hazard without unduly jeopardizing the world population of these seabird species.

Procedures: 1. Band representative samples of the nesting population and of chicks. Through annual recaptures of birds in specific areas, study composition of breeding population, dispersal, and recent settlement. 2. Study bird distribution over the runs and areas of bird strikes in relation to weather conditions, habitat, time of day and bird distribution. Test possible methods of reducing the strike rate.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0608. AN EXPERIMENTAL APPROACH TO THE GENETIC CONTROL OF MORPHOGENESIS IN ECHINODERMS
C.H. ELLIS. Amherst College, Graduate School, Amherst, Massachusetts 01002

The effects of various treatments, which induce morphological anomalies in sea urchin development will be examined. A study of these effects upon specific gene activities during development will be undertaken. Gene activities are inferred from the synthetic behavior of the several proteins which can be resolved chromatographically at various stages of embryonic development. Correlation between changes at this level and the appearance of visible anomalies will be made. In the case of the development of the larval skeleton, an effort will be made to trace the factors responsible for its appearance following the release of prolonged inhibition of gene activity by Actinomycin-D. A careful biochemical analysis of the processes of skeletogenesis is planned, which it is hoped will lead to the elucidation of a complete pathway from DNA-gene information, through specific protein synthesis, to a structural end-product.

SUPPORTED BY U.S. National Science Foundation

5.0609. ASCIDIAN SPECIES ON THE ATLANTIC CONTINENTAL SHELF
H.H. PLOUGH. Amherst College, Graduate School, Amherst, Massachusetts 01002

177
5. LIVING SYSTEMS (NON-HUMAN)

The Principal Investigator has undertaken the identification and classification of specimens of Ascidians collected by the Woods Hole Oceanographic Institution's Atlantic Continental Shelf Survey. This material along with other collected independently are accompanied by data which make it possible to plot accurate offshore geographic distributions for the more than forty species of Ascidians found in the Northeastern Atlantic Continental Shelf area, the oceanic area from Nova Scotia to Long Island and out to the edge of the Shelf.

The study of the material shows that there are certain inaccuracies in the distribution currently attributed to some species collected along the shore. In addition, the fragmentary or spotty nature of collecting in the past has given inaccurate limits to the geographic ranges for a number of the offshore Ascidian species. It seems probable also that certain changes in Ascidian distribution have occurred within the recent past, and probably are still going on. Finally, there seem to be quite marked differences in the numbers of individuals of certain species in particular areas and in the same season over the past fifty or more years.

Accurate taxonomic identifications and reasonably precise plotting of geographic ranges for sedentary marine species are much to be desired as more effective collecting methods become available. Such data lead to better understanding for marine animals of the determinative factors in the origin of new taxa.

SUPPORTED BY U.S. National Science Foundation

5.0610, PRIMARY STRUCTURE OF INVERTEBRATE HEMOGLOBINS
K.R. READ, Boston University, Graduate School, Boston, Massachusetts 02215

A tentative scheme for the evolution of dimeric myoglobins in gastropod subclasses and orders has been worked out. Work is in progress on the characterization of chiton myoglobins and on the subunit structure of the dimeric myoglobin of the gastropod Busycon canaliculatum.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0611, RNA SYNTHESIS DURING SEA URCHIN DEVELOPMENT
D.G. COMB, Harvard University, School of Medicine, Boston, Massachusetts 02138

On fertilization of sea urchin eggs, protein synthesis is initiated and much of this early protein synthesized is associated with the mitochondria. We have also demonstrated that a species of lysyl tRNA moves from the soluble fraction of the cell into the particulate fraction after fertilization. Experiments are underway to determine if this species of lysyl tRNA moves into the mitochondria after fertilization and if this may be involved in the activation of mitochondrial protein synthesis.

The second area of investigation is to determine the extent of transcription of mitochondrial and nuclear genes during pregastrula development. We wish to determine how much of the early messenger RNA that is synthesized during pregastrula development is coded for by mitochondrial genes as compared to nuclear genes. Furthermore, we wish to determine if mitochondrial DNA codes for a few or many species of tRNA.

SUPPORTED BY U.S. National Science Foundation

5.0612, COMPARATIVE PHYSIOLOGY OF RESPIRATORY MECHANICS IN MAMMALS
D.E. LEITI, Harvard University, School of Public Health, Boston, Massachusetts 02138

We propose to study the physiology of respiration in mammals over a wide range of size, behavior, and habitat, with emphasis upon the mechanics of the respiratory system. Our objectives are, fundamentally, two: first, to provide more complete comparative physiological descriptions of respiratory mechanics than are now available for laboratory, domestic, game, and other mammals; and second, to improve our understanding of general principles governing respiratory function through comparison of mechanical characteristics and response to experimen-
tal manipulation of species with different structure and functional requirements.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0613, REASSESSMENT OF TAXONOMY AND EVOLUTION OF ECHINODERMS
H.B. FELL, Harvard University, Museum of Comparative Zoology, Cambridge, Massachusetts 02138

The program aims at a reassessment of current views on the taxonomy and evolution of the echinoderms, utilizing modern methods of study of early embryos of pre-Cambrian fossils, and direct comparison of these with living counterparts. The methods used depend upon detailed stereoscopic investigation of structure as preserved in negative moulds in lower Paleozoic and earlier sediments, and comparison of the structures with those of the internal skeleton of extant forms.

Collateral studies will include research on sea-floor photographs from the U.S. Bathyscaph Trieste, and other sea-floor photographs and samples, their analysis for ecological information; systematic reports on expedition material, including U.S. expedition material previously referred to the principal investigator for study in New Zealand, and faunal analyses derived therefrom, leading to biogeographic inferences and (in the light of the junior investigator) an extension of work previously carried out by him in Antarctica, with the senior investigator's participation, to include taxonomic analyses of deep sea samples, especially those from the Vema expedition, and samples expected from the Elinatan and other cruises.

SUPPORTED BY U.S. National Science Foundation

5.0614, ANATOMICAL INVESTIGATIONS OF THE LOBODONTINAE
B. LAWRENCE, Harvard University, Museum of Comparative Zoology, Cambridge, Massachusetts 02138

Collection of specimens of seals of the genera Lobodon, Omomatomyphoca and Hydrurga involving embalming and latex injection of the blood visceral system. The specimens will be used for study of myogenic, anatomical and osteological characteristics essential to understanding phylogenetieal relationships of Antarctic seal family Lobodontinae.

Collecting will necessitate use of ice breaker and helicopter support in the Ross Sea region and will be supervised by the principal investigator's Field Assistant (Wilson).

SUPPORTED BY U.S. National Science Foundation

5.0615, ECOLOGICAL STUDIES ON TROPICAL INTERDIMAL BRITTLESTARS
A. SCHOENER, Harvard University, Graduate School, Cambridge, Massachusetts 02138

No Summary has been provided for use of Science Information Exchange.

SUPPORTED BY Society of The Sigma Xi

5.0616, CILIA DIFFERENTIATION IN THE SEA URCHIN EMBRYO
W. AUCLAIR, Marine Biolog. Laboratory, Woods Hole, Massachusetts 02543

One of the first morphological manifestations of differentiation in a number of marine invertebrate embryos is the appearance of cilia during the early blastula stage. The primary objective of the proposed project is to gain understanding at the molecular and cellular levels of the mechanisms leading to the differentiation of these organelles during early embryogenesis. More specifically, the work will deal with a study of the ciliary proteins to determine the number and types of proteins present in cilia, several of their properties, including their size and enzymatic activity, their organization into macromolecular components, and the underlying processes controlling their synthesis and organization in the tomato. The possible relationship of some of the ciliary proteins with the mitotic apparatus proteins, based on preliminary serological work, also will be explored, with the possibility that...
5. LIVING SYSTEMS (NON-HUMAN)

late sufficient amounts of ovarian extract in order to determine physical and chemical properties of the active components and to assess whether or not one or more of these characteristics are responsible for the different biological effects. Isolation, desalting and purification will be attempted with the physical-chemical methods of electrodialysis, chromatography and filtration. Biological assays will be utilized to trace the biological activity during the process of purification. Changes in oocyte DNA and RNA synthesis prior to and during germinal vesicle breakdown will be investigated in an effort to determine the site of action of the ovarian extracts on the oocyte. The possible existence of a gonadal intermediate (similar to that present in ovarian extracts) in testicular tissue will be investigated.

SUPPORTED BY U.S. National Science Foundation

5.0621. AMINO ACID & PROTEIN METABOLISM IN SCHISTOSOMES
A.W. SENFT, Marine Biolog. Laboratory, Woods Hole, Massachusetts 02543

Research into the biochemistry and physiology of the parasitic worm Schistosoma, directed toward finding a more effective treatment of the disease Schistosomiasis, and a greater understanding of this and other parasitic infestations.

SUPPORTED BY U.S. Lalor Foundation

5.0622. THE ROLE OF CALCIUM IONS IN THE MOTILITY OF SEA URCHIN AND OTHER SPERMATOZOA
J. TIBBS, Marine Biolog. Laboratory, Woods Hole, Massachusetts 02543

The effect of calcium ion concentration on the adenosine triphosphatase activity of tails isolated from sea urchin and other spermatozoa will be examined by the use of the complexing agent EGTA as a calcium buffer. Attempts will also be made to see whether or not such sperm tails show structural changes during adenosine triphosphate hydrolysis similar to those which have been observed by the author in 5th sperm tails (Perca fluviatilis) and whether these changes are dependent on calcium ions.

SUPPORTED BY Lalor Foundation

5.0623. STUDIES OF THE BENTHIC INVERTEBRATES OF THE ATLANTIC CONTINENTAL SHELF
R.L. WIGLEY, U.S. Dept. of Interior, Biological Laboratory, Woods Hole, Massachusetts

These studies are designed to describe the communities of benthic invertebrates on the Atlantic Continental Shelf primarily between Nova Scotia and New York; to determine their importance in the ecosystem, especially in relation to groundfish predators; and to determine the dynamics of the more important populations.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0624. PHYSIOLOGY OF MARINE MAMMALS
J.W. KANWISHER, Woods Hole Oceanographic Inst. , Woods Hole, Massachusetts 02543

Some of the thermal and respiratory problems faced by mammals living in the sea have been outlined in the previous application. As has been indicated, the animal is, to a great extent, a highly insulated animal with good heat retention properties. The present application is designed to describe the communities of benthic invertebrates on the Atlantic Continental Shelf primarily between Nova Scotia and New York; to determine their importance in the ecosystem, especially in relation to groundfish predators; and to determine the dynamics of the more important populations.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0620. ISOLATION AND FUNCTION OF OVARIAN EXTRACTS CAPABLE OF INDUCING COCYTE SHEDDING AND OCYTE NUCLEAR MATURATION IN STARFISH
A.W. SCHUETZ, Marine Biolog. Laboratory, Woods Hole, Massachusetts 02543

The experimental evidence indicates that shedding of oocytes and oocyte nuclear (germinal vesicle) maturation can be mediated by an ovarian extract. It is proposed to prepare and iso-
5. LIVING SYSTEMS (NON-HUMAN)

discussed separately although in any consideration of the living animal they are intimately interrelated. His past work has been on whales and porpoises so most of his thinking centers on the cetaceans. But the seals and sea lions have common physiological problems. And man, for compelling military and economic reasons, is entering the sea with increasing frequency. This research has been supported by NSF Grant GB-1198.

SUPPORTED BY U.S. National Science Foundation

5.0625. ACOUSTIC RECORDING OF MARINE MAMMALS OF NOVA SCOTIA AND NEWFOUNDLAND

J. W. SCHELL. Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543

Woods Hole Oceanographic Institution proposes to conduct a reconnaissance study on the R/V Hero during her shake-down cruise along the continental shelf off Nova Scotia and to St. John's, Newfoundland, via Cabot Straits off Bell Island.

The plan of work calls for a constant look-out during daylight hours for sighting of porpoises, whales, and seals along the cruise track. Sightings will require changes in ship course and speed to close in on the animals as needs dictate. The ship will either lay-to and go on silent conditions for hydrophone recording, or approach for photography or harpooning. In either case, the operation which may entail the launching of the whale boat, would consume from one-half to several hours of work per operation. The research is planned to obtain details on the distribution, seasonal and geographic, of marine animals at sea and particularly to obtain specimens and/or sound recordings of their calls which will enlarge on present pelagic records of cetacean and pinniped species. This work will, in addition, subject the R/V Hero and whale boat to rigorous requirements for underwater acoustic studies which will help in determining possible modifications or other necessary changes prior to the vessel's transfer to Antarctic water.

The principal investigator will be assisted by an acoustic analysis and electronics research associate from WHOI; and, by the Curator of Mammals, Harvard University, who will be responsible for anatomical dissections and photography.

SUPPORTED BY U.S. National Science Foundation

5.0626. RESEARCH ON THE MACROBENTHOS OF THE GREAT LAKES

J. K. Hiltunen, U.S. Dept. of Interior, Biological Laboratory, Ann Arbor, Michigan

The objective of this project is to determine the kinds of bottom dwelling invertebrates and their ecology in offshore areas of the Great Lakes.

Research on freshwater macrobenthos can yield data on the availability of fish food organisms and provide insights into the relationships between species and water quality. Studies of bottom fauna currently undertaken include Lakes Ontario and St. Clair and the Apostle Islands region of Lake Superior. In Lakes Michigan and Erie benthological research is confined mostly to the Curator of Mammals, Harvard University, who will be responsible for anatomical dissections and photography.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0627. REVISION OF GENERA AND SUBGENERA OF WATER MITES OF THE WORLD

D. R. Cook, Wayne State University, Graduate School, Detroit, Michigan 48202

This is in a sense three projects grouped administratively under the above title. (1) The presently known water mite genera and subgenera are being reviewed. Many of these are inadequately described and illustrated. Type material in Europe will be examined. A monograph, including illustrated keys, diagnoses, habitat and distribution, will be published in approximately three years. (2) Work on the taxonomy of North American water mites has been impeded by inadequate descriptions of many of the earlier species, especially those from standing water. Recollection of type localities plus work with the types will lead to published studies on several genera in which positive species identifications are now impossible. (3) Work on the taxonomy of water mite larvae will also be carried out. Gravid females of known species are isolated to obtain identified larvae. The lack of good illustrations has made almost all previous work on water mite larvae useless for taxonomic work. Many genera, subgenera and species, in which the larvae were previously unknown, will be illustrated and described. Also the redescription of known larvae will be carried out. Work on larvae should be of interest not only to Hydrachnologists, but to those working with aquatic insects which are so often parasitized by immature water mites. A knowledge of larvae is of great importance in the higher classification of water mites.

SUPPORTED BY U.S. National Science Foundation

5.0628. LAKE SUPERIOR CHEMICAL CONTROL OF SEA LAMPREY

R. A. Braem, U.S. Dept. of Interior, Biological Station, Marquette, Michigan

The Bureau of Commercial Fisheries, under the direction of the Great Lakes Fishery Commission, is using selective larvicides as an experimental method of control for sea lampreys in Lake Superior. The study is designed to eliminate all generations present in the streams tributary to the lake by treatment of these streams with chemical, and to determine if such a control effectively the parasitism on lake trout and other fish.

The control method requires a thorough knowledge of: the presence and distribution of ammocetes populations in tributaries; physical characteristics and flow data of infected streams; accurate bioassays and chemical analyses of the water; precise metering of the chemicals; and posttreatment surveys to measure and analyze the effectiveness of individual treatments.

There are 75 streams tributary to Lake Superior containing sea lampreys. The initial treatment of these streams was completed in 1961. The second application was finished in 1961. The second application was finished 1964. Since then treatments have been repeated at intervals determined from observations on the rate of reestablishment and growth of sea lamprey ammocetes.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0629. SEA LAMPREY AMMOCETE REESTABLISHMENT STUDIES

P. T. Manion, U.S. Dept. of Interior, Biological Station, Marquette, Michigan

The Bureau of Commercial Fisheries and the Fisheries Research Board of Canada, under contract with the Great Lakes Fishery Commission, are using specific larvicides in the experimental control of the parasitic sea lamprey in the Great Lakes. A complete and thorough knowledge of the larval life stage of sea lampreys is essential for the successful and efficient undertaking of this control program.

The ammocetes studies represent a discrete research project designed to provide important life history data. The investigation includes a study of populations reestablished after chemical treatment; magnitude and timing of downstream drift of ammocetes and newly metamorphosed individuals; deep-water populations inhabiting bays, estuarine waters, and inland lakes; and a known-age class of ammocetes isolated in a river free from interference from other age groups or species.

Specifically, the study should provide information on the size of reestablished populations; rate of growth of larvae; minimum duration of the larval stage; downstream drift or movement as influenced by physical and ecological characteristics of given streams; and the relative abundance and distribution of deep-water populations (currently uncontrollable) and some knowledge as to their contribution to the parasitic stocks.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0630. ELECTRIC BARRIER OPERATIONS

H. H. Moore, U.S. Dept. of Interior, Biological Station, Marquette, Michigan
The Bureau of Commercial Fisheries and the Fisheries Research Board of Canada, under contract with the Great Lakes Fishery Commission, are using specific larvicides in the experimental control of the parasitic sea lamprey in the Great Lakes. A means of securing immediate and positive data for evaluating and assessing the effectiveness and progress of the chemical control is essential. A system of electric barriers and traps installed on tributaries to Lakes Superior and Michigan is available for this purpose. These devices are operated during the upstream spawning migration.

The study is designed to provide data measure and abundance, or changes in the population, or sea lampreys; determine geographic distribution of mature adults; and to determine the biological characteristics of the spawning runs. The study also can provide data by which a precise measure of the progressive levels of suppression can be made as well as the best estimate of the final level of control that can be reached.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0631, EFFECTS OF CHEMICALS ON THE PHYSIOLOGY OF SEA LAMPROY AMMOCETES (PETROMYZON MARINUS)

Little is known of the physiology of the larval stage of the sea lamprey and still less of the effect of toxic principles on various physiological systems. The basic aims of research in this area are to define physiological norms, determine the mode of function of physiological systems, discover and define systems which are unique in the sea lamprey larvae and correlate this information with observable effects of various toxic principles. Studies are concerned mainly with the amount of physiological disruption which is necessary to produce a lethal response and the relationship of this response to the concentration of a toxic material in the environment. Information is also obtained on the acute and chronic effects of sublethal exposure and the possible role this may play in the development of defensive mechanisms. Where the physiology of sea lamprey ammocetes can be demonstrated to be unique from that of other animals inhabiting the same environment an attempt is made to take advantage of this uniqueness in developing methods for the selective control of these animals.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0632, BIOASSAY

Research is directed toward the discovery of chemicals which, when a stream environment or lamprey will be selectively toxic to larval sea lamprey (Petromyzon marinus). The procedure consists of bioassaying a wide variety of organic compounds, representing most of the basic structural classes, under standard conditions against lamprey larvae and rainbow trout (Salmo gairdnerii). The discovery of a chemical possessing the desired biological activity (toxicity and selectivity for larval lamprey) results in the testing of structurally related compounds. The relation between molecular structure and biological activity are studied and compounds custom synthesized to produce the best possible biological activity. Chemicals selected for field use are tested to determine what effect environmental factors such as water chemistry, temperature, turbidity and light have on their biological activity. Tests are run on promising compounds to determine their toxicity to a variety of game and nongame fish species as well as aquatic invertebrates. Methods are devised for preparing concentrated stock solutions of compounds being considered for field use. Analysis techniques, which are fast and accurate are developed. A chemical's potential as a sea lamprey control agent is evaluated under simulated stream conditions and in carefully controlled experimental stream treatments.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0633, BIOLOGY OF THE LARVAL SEA LAMPROY

A complete knowledge of the biology of larval lampreys is necessary to take full advantage of control techniques which are directed toward this life history stage of the sea lamprey. Evaluation of control methods requires a thorough knowledge of the factors which control the size, growth and transformation of larval populations. Studies are being conducted or planned to determine the effect of environmental factors such as temperature and water chemistry on developing sea lamprey embryos. Also being investigated is the effect of biologically active chemicals on the sequence and success of embryological development. Taxonomic studies are under way on young-of-the-year ammocetes of the five species found in the Great Lakes. These studies utilize individuals of known parentage. The effects of environmental factors such as temperature and food on ammocete growth and transformation are being studied. This information is vital to an understanding of ammocete distribution and their reaction to an abnormal or hostile environment.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0634, POPULATION DYNAMICS OF ANTARCTIC SEALS
A.W. ERICKSON, Univ. of Minnesota, Graduate School, Minneapolis, Minnesota 55455

This proposal is a five-year study on the status of the leopar, crabeater, Ross and Weddell seals of Antarctica. The objectives are to: (1) determine abundance, distribution and migrational characteristics of the four seal species; (2) determine their present population dynamics; (3) obtain basic information on sex ratios, age structure, discreteness of population boundaries and breeding biology for determining corrective management adjustments.

Preliminary review and evaluation of existing data, development of methodology, particularly of census procedures applicable to Antarctica and its environmental conditions, and devising and testing statistically valid procedures of Antarctic seal species will be carried out in a systematic manner. Experimentation will be carried out with aerial photographic methods, utilizing low and high altitude aircraft; infrared sensing systems with possible satellite applications will be investigated when appropriate to this research.

Two participants will conduct ship and aerial census experiments on USCGC Glacier during the International Weddell Sea Oceanographic Expedition of 1967-68; four participants will begin general reconnaissance and individual species studies in the Ross Sea in 1968-69.

SUPPORTED BY U.S. National Science Foundation

5.0635, STUDIES ON INTEGRATIVE MECHANISMS OF NEURONS
R.L. PURPLE, Univ. of Minnesota, School of Medicine, Minneapolis, Minnesota 55455

Studies on integrative mechanisms of neurons will be pursued on neurons which process visual information within the brain of L. minus, on the receptor field organization (extent and nature of overlapping visual fields) of vertebrate retinal ganglion cells, and on the effects of central feedback (effector control) on the vertebrate retina. The broad goal of these studies is to provide information on neural organization and mechanisms underlying pattern recognition in sensory systems. To this end the above projects will concentrate, where possible, on approaches developed in systems analysis, communication theory, etc., for defining temporal and spatial signal processing capabilities of the units studied.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0636, TREPOMADES OF FISHES OCCURRING ON THE WEST COAST OF NORTH AMERICA.
M.H. PRITCHARD, Univ. of Nebraska, Graduate School, Lincoln, Nebraska 68508

This project proposes first to complete the study of a collection of trematodes from South African marine fishes. Later, there are plans for a new collection from the southern California-Baja California region of the Pacific Ocean. Comparative and zooge-
5. LIVING SYSTEMS (NON-HUMAN)

graphical studies will be made with trematodes from many parts of the world which are available in the H. W. Manter Collection at the University of Nebraska.

SUPPORTED BY U.S. National Science Foundation

5.0637, APPLICATION OF BIOTELEMETRY TO THE STUDY OF MARINE VERTEBRATES
H.R. SKUTT, Univ. of New Hampshire, School of Engineering, Durham, New Hampshire 03824

Members of the Engineering Design and Analysis Laboratory are working on a research project involving telemetry of electrical activity from the brain of a free-swimming fish. This research project involves the perfection of the physiological technique of implanting electrodes within the gustatory centers of the brains of fishes, and the perfection of an underwater biotelemetry system.

It is possible to record from the unanesthetized fish by means of a direct wire connection. Such techniques produce technical problems. Direct wire recs based on moving animals produces distorting of the record of neural activity. Movement of the animal also produces an entanglement of his leads. It is for these reasons that teleresponses from the animals are desirable.

These progress to date are aimed at two problems: the establishment of a stereotaxic atlas, and the development of techniques to allow surgery in the fish.

Progress in the engineering aspects have included construction of miniature biotelemetry units, investigation of encapsulation techniques, investigation of methods of attaching telemetry units to fish and successful transmission of physiological signals from a fish in a tank of water.

SUPPORTED BY New Hampshire State Government
University of New Hampshire

5.0638, SUCCESSION, SPACIAL AND TEMPORAL DISTRIBUTION, AND BIOLOGY OF BENTHIC ORGANISMS
J. PEARCE, U.S. Dept. of Interior, Sandy Hook Marine Lab., Highlands, New Jersey

Measure rate of larval settlement, colonization and succession of invertebrate epifauna and flora on various surfaces of artificial and natural reefs; the effects of such reef communities on the distribution and ecology of bottom-dwelling infaunal organisms and fish, and the variations in distribution of invertebrates at latitudinally separated reef sites. The investigation will employ traditional sampling gear such as the Smith-McIntyre Bottom Suction, and plankton nets, and plankton collecting devices as well as the 'Multiple Disc Sampling Apparatus' recently developed at Sandy Hook Marine Laboratory. The latter consists of a frame supporting concrete, metal, glass, rubber and wood discs to measure settling rates on different materials. Standardized collecting, preserving and laboratory procedures have been established to insure highly quantitative results.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0639, CARDIOVASCULAR STUDIES ON DIVING MAMMALS
F.L. FERRANTE, New Jersey Coll. Med. & Dent., School of Medicine, Jersey City, New Jersey 07304

This is based on the hypothesis that vagally mediated bradycardia is an essential component of the cardiovascular pattern of adaptation to protracted apnea displayed by diving mammals such as the seal. The present proposal describes experiments designed to establish the nature and extent of hemodynamic disadvantage produced during submergence apnea when the heart is prevented from slowing. Unanesthetized nutria will be tethered to a platform and apnea will be produced by tilting the assembly enough to completely immerse the head under water. Nutria tolerate this procedure since submergence is a natural event for this species.

The normal pattern of onset and intensity of isometric and chronotropic cardiac changes during submergence apnea will be established as well as the concurrent alterations in aortic flow and resistance. The degree of derangement of the normal pattern by thoracic vagotomy will be established. In other animals the vagi will be left intact and bradycardia will be reversed by electrical pacing of the SA node. The following criteria will be employed to signify hemodynamic disadvantage: a) a more rapid rate of decline of arterial p02 than normally found during submergence. b) a marked rise in right atrial pressure concurrent with a fall in cardiac output. c) marked cardiac dilation concurrent with a reduced force of contraction.

Shifts in the onset and intensity of the selected criteria will be noted.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0640, ULTRASTRUCTURE OF VARIOUS MARINE AND BRACKISH WATER ORGANISMS
F.L. SCHUSTER, City University of New York, Graduate School, Brooklyn - Brooklyn College, New York 11210

Investigations have and are being carried out, using the electron microscope, on ultrastructure of various marine and brackish water organisms. Particular emphasis is being placed on various aspects of development and differentiation, both at the organismic and cellular level.

SUPPORTED BY Brooklyn College

5.0641, THE CETACEAN BRAIN - A COMPARATIVE STUDY
M.S. JACOBS, New York Zoological Society, New York, New York

Continuing studies of the cetacean brain will be based on a series of gross dissections, on the analysis of five serially sectioned and stained delphinid brains, on additional quantitation of fibers in peripheral nerves and on an investigation of the visual system in Tursiops truncatus, the bottlenose dolphin, using Nauta fiber degeneration staining methods.

Such continuing investigations constitute a variety of approaches to substantiating, in terms of the brain of present day Cetacea, the concept that the brain - through an evolutionary process of addition of new structure upon previously existing structure - has come to consist of, in priimates, rhinic, limbic and suprarhmic lobes. Having already completed an investigation of the rhinic lobe (paleocortex and archicortex) in Cetacea in general and in the bottlenose dolphin in particular, the next subdivision of the forebrain that will be concentrated on is the limbic lobe.

In the dolphin, as in primates, the limbic lobe consists of a series of lobular configurations whose rostro-caudal trajectory is grouped in an arch that coincides with the course of the corpus callosum (parolfactory lobule, supracallosal lobule, retrosplenial lobule and parahippocampal gyrus). The relationship of limbic lobe structures to the surrounding cortical formations will be evaluated chiefly by cyto- and myelo-architectonic means.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0642, SYMBIOSIS OF TROPICAL ZOANTHIDEA AND ZOANTHUS
T.F. GOREAU, State University of New York, Graduate School, Stony Brook, New York 11790

This investigation deals with the metabolic interactions between Zoanthus (Zoantharia, Anthozoa) and its endosymbiotic zooxanthellae. Z. sociatus is abundant and widespread in Jamaican coral reefs. The species has five major ecospecies, or physiological races, which differ from each other in habitat distribution, size, colour and extent of nutritional dependence upon their contained zooxanthellae. These zooxanthellae are themselves may be of more than one species. Biochemical investigations have shown that the zooxanthellae from Z. sociatus secrete between about 30 and 90 per cent of their total photosynthetic production in the form of organic compounds that are incorporated into the metabolic system of the animal host. The quantitative and qualitative composition of the zooxanthellae photosynthetic products consists according to the type of Zoanthus.

Amont the substances produced by the zooxanthellae are nucleoside polyphosphates, which raises the question whether the phenotype of Z. sociatus is under partial control of the algal-
societies through genetic information passed to the animal host by means of complex nucleoside 'messengers'. A reverse feed-back could occur in the event of the endo-symbionts becoming dependent upon the host for certain metabolites. One such case has been found: the zooxanthellae of Z. sociatus cannot synthesize glycine which they obtain from the animal host. Investigations on the metabolite exchanges between the various Zoanthus types and their zooxanthellae are being continued to elucidate their effect on morphological, physiological and ecological diversification of the host species.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0643, THERMAL ACCLIMATION PATTERNS IN PARASITES AND HOSTS
W.B. VERNBERG, Duke University, Graduate School, Beaufort, North Carolina 28516

One of the basic problems in biology is to understand the mechanisms by which organisms adjust and survive fluctuations in their environment. During the evolution of parasite-host interrelationships, both species have had to be able to adjust to each other as well as to survive fluctuations in physical factors. The comparative influence of temperature on metabolism and enzymatic activity is being studied in both the hosts and different stages in the life cycle of the trematode, Zoogonous iastus. The first intermediate host is the mud-flat small, Nassaarius obtuus, the second intermediate host is the polychaete, Leanereis culveri, and the definitive host is the toadfish, Opsanus tau. It appears that while the parasite does markedly influence the response of the two intermediate hosts, the response of the parasite is distinctive from that of any of the hosts. Although the thermal lethal limits of the parasite in all stages is approximately the same as that of the definitive host, there is much physiological variation in the response to temperature in different stages of the life cycle.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0644, STUDIES ON MOLTING, GROWTH, AND DEVELOPMENT IN ACORN BARNACLES AND LARVAL DECAPODS
J.D. COSTLOW, Duke University, Graduate School, Durham, North Carolina 27706 (NONR)

Objective: The problem of barnacle fouling on Naval vessels and underwater structures involves a complex sequence of endogenous biological activities which are largely endocrinological in nature. A clearer understanding of the endocrine mechanisms involved in the barnacle life cycle may facilitate prevention of their occurrence in the future.

Approach: The origins of endocrine systems are being investigated in the developmental stages of barnacle (larvae) in an attempt to localize the regions and time of appearance of areas of endocrine activity. Additionally, the functional period of these sites of endocrine activity is being studied and the effects of experimental extractions, injection, and implantation documented. Due to the minute size of the sites of endocrine activity, microscopy techniques will be used to selectively destroy endocrine sites.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0645, STRUCTURAL ANALYSIS OF CELL DIVISION
P.J. HARRIS, Oregon State University, Graduate School, Corvallis, Oregon 97331

The main focus of work now in progress is the study of structural changes occurring in the sea urchin egg between the time of the maturation divisions and the first cleavage division. The object is to identify those changes which are involved with larval development as opposed to those which are primarily concerned with cell division, and to relate these changes with biochemical events during this period. If time permits, these studies of nuclear, nucleolar and cortical changes will be extended to cover the development of the blastula up to the time of gastrulation.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0646, SYSTEMATICS OF DEEP SEA TREMATODES
J.E. MCCAULEY, Oregon State University, Graduate School, Corvallis, Oregon 97331

A study is being made of the trematode parasites of fishes from the deep sea. Although three-fifths of the surface of the earth is covered with at least 1000 meters of water we know almost nothing about the trematode parasites from this region. A preliminary investigation suggests that the deep-sea trematode fauna may be almost as diverse as that from shallower waters. More than 2,300 species are already in the collection, and more will be collected. Systematic, distributional, and evolutionary studies will be made.

SUPPORTED BY U.S. National Science Foundation

5.0647, PYCNOGONIDA OF THE ANTARCTIC REGIONS
J.W. HEDGPETH, Oregon State University, Graduate School, Newport, Oregon 97365

This systematic research on Pycnogonids continues earlier studies of one of the more numerous elements of the benthic Antarctic fauna. The major effort is to taxonomically treat 2,000 specimens accumulated through United States Antarctic Research Program and New Zealand collecting activities. The result of this work will appear in a taxonomic monograph. This supplement will provide for unanticipated costs to work at Palmer Station and Hero.

The principal investigator and two assistants (McCauley and Stout) will join Hero at Palmer Station for collecting enroute to and at Deception Island during the period December - March 1968/69. Scuba collecting will be carried out by the two assistants.

SUPPORTED BY U.S. National Science Foundation

5.0648, WATER AND SALT REGULATION IN NEREID POLYCHAETES
L.C. OGLESBY, Reed College, Graduate School, Portland, Oregon 97202

The proposed study will be concerned with the mechanisms involved in water and salt regulation (osmotic and ionic regulation) in certain nereid polychaetes anamels which seem to be in the evolutionary process of developing the ability to live in waters of low salt concentration. Emphasis will be placed on the investigation into three processes of osmotic regulation which are known to occur in certain other organisms, but which so far are only postulated in the polychaetes: 1) reduction of the permeability of the body surface to salts and to water; 2) active transport of salt from the medium; and 3) the production of a urine hypo-osmotic to the blood or coelomic fluids, by the nephridia. Radioisotope techniques will be the most used. Comparisons will be made among species of nereids in which osmoregulatory ability is differently developed, in order to determine which features of the experimental results are of importance in osmotic regulation in low external salt concentrations, and which are more generally present. The study of comparative aspects of water and salt regulation may illuminate basic mechanisms of osmoregulation, a phenomenon found in most higher organisms.

SUPPORTED BY U.S. National Science Foundation

5.0649, SHALLOW WATER MEIOBENTHOS OF THE BERMUDA PLATFORM
B.C. COULL, Lehigh University, Graduate School, Bethlehem, Pennsylvania 18015

A preliminary investigation suggests that the deep-sea trematode fauna may be almost as diverse as that from shallower waters. More than 2,300 species are already in the collection, and more will be collected. Systematic, distributional, and evolutionary studies will be made.

SUPPORTED BY Society of The Sigma Xi

5.0650, SYSTEMATIC AND DISTRIBUTIONAL STUDY OF DEEP-SEA ECTOPODRCY (BRYOZOA)
J.T. SCHOFF, Lehigh University, Graduate School, Bethlehem, Pennsylvania 18015

The proposed study is directed toward obtaining a better understanding of the biogeography, special environmental adapta-
5. LIVING SYSTEMS (NON-HUMAN)

The long-term research objective of this project is to delineate the applicability of biochemical techniques to taxonomic problems. As a starting point we have chosen to study the taxonomic relationships within a single phylum, the echinodermata. Although this group of organisms, which includes starfish, brittle stars, sea urchins, sea cucumbers and sea lilies, has been the subject of considerable investigation by classical taxonomic techniques such as morphological comparisons, little has been firmly resolved of their relationships to one another. It is hoped that a comparison of enzyme properties and structure may prove useful in clarifying the relatedness of these organisms.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0655, DEEP SEA BENTHOS IN THE GULF OF MEXICO
W.E. PEQUEGNAT, Texas A & M University System, Graduate School, College Station, Texas 77843

The purpose of this project is the characterization and qualification of the zoo-benthonic organisms comprising the assemblages found at and below 2000 meters in the Gulf of Mexico. Collectors will be made primarily by a newly designed epifaunal skimmer which allows for a quantitative sampling of the upper 5 cm. of the sediments over an area of seven square meters. Further definition of the physical-chemical environment of the benthonic communities will be attained through the use of a wide variety of deep-sea-sampling and recording equipment, including specially designed current monitors and high pressure cameras. The semiannual cruises will cover the depth regimes from 2000 meters to the greatest depth in the Gulf of Mexico, 3800 meters, in 300 meter increments. As protracted operations from fixed facilities in the oceanic depths become more feasible, so does the need for knowledge of the nature and organization of marine biota in this unknown environment become more crucial. Present concepts are based largely on predictions and extrapolation from shallower waters and from very few actual samplings. Although historically thought to be a biological desert, the depths are now known to be populated by a moderate number of organisms, but representing a relatively large number of species and displaying many bizarre characteristics.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0656, STUDY OF LIFE HISTORY AND ECOLOGY OF SERPULIDAE IN TEXAS COASTAL WATERS
D.E. WOHLHSLAG, Univ. of Texas, Graduate School, Port Aransas, Texas 78373

No Summary Has Been Provided To The Science Information Exchange

SUPPORTED BY University of Texas

5.0657, REFERENCE COLLECTION OF GULF MARINE ANIMALS
D.E. WOHLHSLAG, Univ. of Texas, Graduate School, Port Aransas, Texas 78373

No Summary Has Been Provided To The Science Information Exchange

SUPPORTED BY University of Texas

5.0658, PARASITES OF ANTARCTIC VERTEBRATES AND INVERTEBRATES
W.J. HARGIS, Virginia Inst. of Marine Sci., Gloucester Point, Virginia 23062

The Virginia Institute of Marine Science proposes to conduct laboratory studies for the determination of ecto- and endoparasites collected from Antarctic vertebrate and invertebrate hosts. The collections were made over the austral winter at Palmer Station, Antarctica under GA-684, and GA-684.1. The follow-up laboratory research will consist of curating the material and selection of appropriate specimens which will be fixed, stained and sectioned in preparation for morphological studies essential for the completion of the systematic reports.

There is no Antarctic field work planned; the research will be conducted at the Virginia Institute of Marine Science by Staff and graduate assistants.
F. O. Perkins, Virginia Inst. of Marine Sci., Gloucester Point, Virginia 23062

The fine structural changes which occur during relaxation and contraction of jellyfish tentacle muscle are being investigated. N-butanol is used to mechanically and chemically relax the tentacles. The musculature of the ectoderm is under special consideration.

Supported by Virginia State Government

5.0660, BENTHIC MARINE FAUNA OF THE UPPER SHELF OFF VIRGINIA
M. L. Wass, Virginia Inst. of Marine Sci., Gloucester Point, Virginia 23062

A total of 70 samples were taken with a 1/5 sq. m. Van Veen grab off the Eastern Shore of Virginia in October, 1967. Sorting, identification and enumeration of fauna was completed in June, 1968. Several communities were sampled and much new information was added to that obtained from four earlier cruises in which a much smaller grab had been used.

Supported by Virginia State Government

5.0661, INFANNA OF LOWER CHESAPEAKE BAY
M. L. Wass, Virginia Inst. of Marine Sci., Gloucester Point, Virginia 23062

Study of composition and dynamics of communities, based on about 630 grabs from the Bay proper, 30 from the Rappahannock River, 200 from the York, 200 from the James and 100 from the Eastern Shore. A total of 70 samples were taken with a 1/5 sq. m. Van Veen grab in October, 1967. Sorting, identification and enumeration of fauna was completed in June, 1968. Several communities were sampled and much new information was added to that obtained from four earlier cruises in which a much smaller grab had been used.

Supported by Virginia State Government

5.0662, EVOLUTIONARY DIVERGENCE OF DEEP WATER MARINE ANNELIDS
C. P. Mangum, Coll. of William & Mary, Graduate School, Williamsburg, Virginia 23185

The proposed research is designed to elucidate basic aspects of the biology of deep-water marine polychaetes. Quantitative measurements of population density, temperature sensitivity, oxygen consumption, lethal limits of temperature and salinity, and the spontaneous activity of the whole animal will be compared to similar measurements on closely related intertidal species. Qualitative aspects of feeding will be examined, as well as the nature of stimuli which elicit the feeding response. It is believed that the comparison will indicate the course of evolutionary divergence of deep-water animals from their shallow-water ancestors.

Supported by U.S. National Science Foundation

5.0663, EVOLUTIONARY DIVERGENCE OF ONUPHID POLYCHAETES
C. P. Mangum, Coll. of William & Mary, Graduate School, Williamsburg, Virginia 23185

Aspects of the biology of onuphid polychaetes from the continental slope of North America are being compared with those of closely related shelf species.

The range of thermal tolerance by Hyalinoecia artifex, which lives in an extremely stable environment, is somewhat narrower than that of the shelf species H. tubicola and Didipatra cuprea; however, the divergence is not sufficient to explain patterns of distribution. Moreover, the effects of temperature change on metabolism reflect several compensatory mechanisms which would promote adaptation to thermal instability, which the slope species never experiences. We have found similar adaptations in arctic-boreal species (both annelids and crustaceans).

Population density of both H. artifex and D. cuprea is more highly correlated with current velocity than with the nature of the substratum. Since the worms feed by trapping particulate food particles, higher current velocities must increase the availability of food. The feeding response to chemical stimuli emanating from trapped food particles is currently under investigation.

Supported by U.S. National Science Foundation

5.0664, OPERANT OSMOTIC REGULATION IN A MARINE ANIMAL
M. E. Meyer, Western Washington State Coll., Graduate School, Bellingham, Washington 98225

Investigations indicate that rats are capable of regulating internal physiological homeostasis by various operant behaviors (Teitelbaum, 1966). For example, behavioral control by rats for food, water, and drugs has been reported (Epstein, 1966; Epstein & Teitelbaum, 1962a, b; Clark, Schuster & Brady, 1961). On the other hand, animals are capable, by means of an operant, of maintaining optimal environmental conditions such as thermoregulation (Weiss & Lattes, 1961) and oxygen regulation (Weinstein, 1966). A parallel to the above research involves osmotic or salinity regulation in marine invertebrates. The octopus is a very appropriate organism in that it has a very narrow range of salinity tolerance. Gunter (1920) reports that for the octopus native to the Atlantic Ocean and the Mediterranean Sea, the range of salinity tolerance is 30-35 g/kg. An additional feature of the octopus is the apparent ease of this animal to learn. Several studies utilizing the octopus have been reported but the research interest has focused mainly upon the visual, tactile and chemotactile senses (Boycott, 1965; Sutherland, 1959, 1961; Wells, 1962, 1964), and upon the neural basis of memory (Young, 1964). This study is concerned primarily with the concurrent operant regulation of salinity level by the octopus, and with a preliminary investigation of the physiological basis of this regulation.

Supported by U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0665, PHYLOGENETIC RELATIONS OF FOSSIL AND LIVING GYMNOLEMATES
J. P. Ross, Western Washington State Coll., Graduate School, Bellingham, Washington 98225

The evolutionary development of the gymnolaemates, one of the major groups of the Ectoprocta (moss animals) will be investigated. The moss animals, one of the main fouling organisms on the hulls of ships, have a long geologic history and a wide distribution along ancient and recent shore lines. The early fossil representatives, found in stratified rocks deposited 500 million years ago, evolved during the succeeding 300 million years into many diverse groups. At the end of this period widespread extinction greatly reduced the different groups, and in the succeeding 200 million years new groups evolved to give rise to the abundant and diverse recent bryozoans. By determining relationships of these different groups, based on comparative anatomical studies of recent and fossil forms from many parts of the world, the various lines of evolution within the moss animals will be delineated.

Supported by U.S. National Science Foundation

5.0666, CELL DIVISION AND MITOTIC APPARATUS PROTEINS
H. A. Went, Washington State University, Graduate School, Pullman, Washington 99163

The proposed work will encompass two aspects of the mitotic apparatus in sea urchin and sand dollar eggs. One is the molecular origin and fate of this complex and transient structure. This involves examination of the temporal relationship between the synthesis of certain molecular constituents of the mitotic apparatus and their assembly into the definitive structure. It is also expected that some of the constituents will not be synthesized since they will already be on hand in adequate quantities in the uninciliated egg. The second aspect involves the reproduction of centrioles. Some work has already been done on this, but a number of hypotheses must be tested and serious thought and effort must be given to isolation and electronmicroscopical studies of this organelle.

Supported by U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.
5. LIVING SYSTEMS (NON-HUMAN)

5.0667, FUR SEAL RESEARCH, PELAGIC INVESTIGATIONS

Pelagic research on fur seals by the Bureau of Commercial Fisheries is part of the program of the North Pacific Fur Seal Commission. Results are coordinated by the Commission. Research at near the current level is expected to continue until about 1970 during the term of the existing treaty.

The objectives are to determine the ocean distribution, by age and sex, of fur seals and the extent of intermingling of the populations from various islands, and the food habits with as much information as possible on their effect on other living resources. The program also gives the best data on the reproductive condition of seals by age and on bio-economic questions such as comparison of pelagic and land sealing.

Several hundred fur seals will be collected annually at sea by shooting. The ages, sex, presence of marks, measurements (size), reproductive condition, stomach contents, place of capture, and other details are determined, and tabulated or charted. From these data migration routes, intermingling rates, mortality rates, age of sexual maturity, pregnancy rates, food habits, predators, and related information are determined or estimated.

Collecting is done from chartered fishing vessels over the range from central California to the Bering Sea. Food organisms are collected simultaneously and the food species are identified from a comparative collection. Small boats, shoulder-held guns, 50 mm. harpoon guns, nets, and other equipment are used.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0668, ADMINISTRATION OF WHALING ACT, COMMERCIALLY UTILIZED WHALES

Research on commercially utilized species includes studies on blue, fin, sei, humpback, sperm, and bottlenose whales. Data are collected primarily at commercial whaling stations in California and are directed toward studies of age, growth, reproduction, food, and diseases. In addition whale marking is conducted off California and Mexico to obtain information on whale movements. Data from whaling stations and from marking will both contribute to population dynamics studies. These, in turn, will lead to recommendations of management practices intended to maintain the populations.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0669, ADMINISTRATION OF WHALING ACT, PROTECTED AND NON-COMMERCIAL WHALES

Research on protected and non-commercial whales will include studies of anatomy, growth, and reproduction of gray whales from small samples of the animals taken during both the northward and southward migrations and periodic counts from land of migrating gray whales to follow population changes. Incidentally, or when funds permit, studies of the bowhead whale in arctic Alaska, the killer whale, and other small cetaceans will be pursued.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0670, ADMINISTRATION OF WHALING ACT - DEVELOPMENT OF RESEARCH TOOLS

This project is directed first toward development of marks that are suitable for young nursing whales without excessive injury. Age studies of whales are handicapped by a total lack of known-age animals which must be marked as calves. Marks used for adult whales are not suitable. Secondarily, it is directed toward accumulation of information and development of tools that will improve the efficiency of collecting specimens such as ear plugs, ovaries, testes, etc., from whales at whaling stations.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0671, FUR SEAL RESEARCH, POPULATION DYNAMICS

Fur seal research on the Pribilof islands has the objective of searching out and bringing the Pribilof population to the level of maximum sustained yield.

By means of large scale marking experiments, age classification of the commercial kill, tag recoveries, and mortality and pregnancy rate determinations the number of pups born are estimated. Other estimates are made from marked to unmarked ratios among pups, adjusted by sample counts. Sources of error in estimates, such as mortality from tags, are investigated and the results are incorporated in succeeding estimates.

Related studies on body growth, molt and fur growth, behavior, embryology, and development of dentition in fur seals range from beginning to near completion. Studies of the reproductive status of young females and of males will be intensified.

Assistance in statistical analysis of population data is obtained by contract with the Laboratory of Statistical Research, University of Washington, Seattle, Washington.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0672, FUR SEAL RESEARCH, ANATOMY-BEHAVIOR-MORTALITY

Hair follicle patterns of pinnipeds to be studied by photographing plastic impressions of sheared skin. Hair fiber number per follicle of various species to be counted. Patterns and fiber number may identify genera. Effect of different sealskin processes to be tested by determining number of hair follicles per unit area and number fibers per follicle. Fur seal physiology, anatomy, and pathology, with emphasis on nutrition of the newborn and bacteriology. Assistance in food analysis given by Washington State University.

Data from three seasons of behavior observations to be analyzed and reported on. Some marked animals observed during three seasons.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0673, PHYSIOLOGY OF FERTILIZATION AND NUCLEOCYTOPLASMIC INTERACTIONS IN SEA URCHIN DEVELOPMENT
A.H. WHITELEY, Univ. of Washington, Graduate School, Seattle, Washington 98122

Brief Description of Research Project: A study of the chemical events in the early development of sea urchin eggs is underway. Two interrelated lines of research are proposed; one has to do with the change in the cortex of the egg upon fertilization whereby a carrier with enzymatic properties appears which carries orthophosphate into the egg, and the second has to do with messenger RNA appearance and assay during development. Experiments will be done to see if mRNA is involved with the appearance of the phosphate carrier and to see if this carrier is related to another carrying uridine into the egg and phosphorylating it.

One major section of the research, done in collaboration with Dr. Ozaki, is concerned with nucleocytoplasmic interactions in the control of genetic expression during development. Using interspecies hybrid sea urchin embryos where genetic information flow is interrupted at some level, the appearance of specific isomycin forms of certain enzymes will be examined. Enzymes specific for one species of sea urchin fail to differentiate in hybrid embryos. A detailed study is underway to determine whether the failure of these paternal enzymes to be formed is a result of failure in the conversion of the genetic information to active enzyme protein.

SUPPORTED BY U.S. National Science Foundation
5.0674, CARDIOVASCULAR ADJUSTMENTS IN DIVING MAMMALS
M.P. SPENCER, Virginia Mason Research Center, Seattle, Washington
(1) To explore special mechanisms of adaptation in comparative physiology and (2) applications of biomedical engineering. Out of these areas we hope to contribute to the broad field of physiological understanding and to find and develop clinically useful ideas.
SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0675, CARDIOVASCULAR ADJUSTMENTS IN DIVING MAMMALS
M.P. SPENCER, Virginia Mason Research Center, Seattle, Washington
(1) To explore special mechanisms of adaptation in comparative physiology and (2) applications of biomedical engineering. Out of these areas we hope to contribute to the broad field of physiological understanding and to find and develop clinically useful ideas.
SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0676, ECOLOGY AND NITROGEN CYCLE IN A MARINE PLANT COMMUNITY
J.J. GOERING, Univ. of Alaska, Inst. of Marine Sciences, College, Alaska 99735
The physiological ecology of eelgrass (Zostera marina) communities will be examined in concurrence with the dynamics of the nitrogen cycle in a lagoon on the Bering Sea coast of Alaska. A comparison of natural conditions will be made with an area receiving untreated sewage. This will include an examination of the relationship between the primary producers and nitrogen cycle, with emphasis on the role played by nitrogen in the total productivity of the community. Also to be included is the control of the environment on the growth and morphology of the dominant primary producer, eelgrass. The contribution of organic matter, particulate and dissolved, from the eelgrass communities near-shore oceanic food webs will also be investigated.
SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0677, ECOLOGY OF EELGRASS
C.P. MCROY, Univ. of Alaska, Inst. of Marine Sciences, College, Alaska 99735
Eelgrass (Zostera marina) meadows form an important portion of the food web in the lagoons and inlets of the Alaska Peninsula on the Bering Sea coast of Alaska. Research has included a geographical and quantitative comparison of eelgrass communities along the coast of Alaska, and intensive studies on the ecosystem of Izembek lagoon near Cold Bay on the Alaska Peninsula. The work at Izembek has monitored the annual cycle of eelgrass production and hydrographic features of the lagoon. This work began several years ago under the sponsorship of the Bureau of Sport Fisheries and Wildlife. More recently we have studied cycling of inorganic nutrients, especially nitrogen, in the lagoon and of the primary productivity of the phyto-plankton associated with the eelgrass community. In addition to the research on the lagoon, the portion of the Bering Sea adjacent to the lagoon has been surveyed for general oceanographic parameters. The following questions will be asked: (1) Are there 360 to 365 daily or fourth-order growth layers present between the annual bands or in the first-order layer in Tivela collected at different sites and latitudes. (2) Are there differences in the thicknesses of fourth-order layers that can be correlated with latitude or some other factors. (3) Other than Tivela, which taxa have annual or seasonal growth layers and at what latitudes and in what temperatures of water do those forms with such bands occur? (4) Do taxa from high polar latitudes have slow shell growth, are there 360 to 365 'daily' growth increments as have been noted in taxa from temperate and outer tropical latitudes? (5) Do taxa from near-equator latitudes have seasonal growth bands or layers.
SUPPORTED BY U.S. National Science Foundation

5.0678, FILM PROJECT (KELP FORESTS)
E.S. HOBSON, U.S. Dept. of Interior, Tiburon Marine Lab., Belvedere - Tiburon, California 94920
A film is being made that will provide the public with a better understanding of the marine life associated with the kelp forests of California, and the importance of this endangered habitat to the sport fishery.
SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0679, GROWTH LAYERING IN BIVALVED MOLLUSKS - AN AID IN PALEOBIOGEOGRAPHIC INTERPRETATION
C.A. HALL, Univ. of California, Graduate School, Los Angeles - U.C.L.A., California 90024
A systematic study of the microtexture of the same or similar year classes of Tivela stultorum will be made throughout its range. The presence of annual growth bands on this species has been documented by others. (A) The mean thicknesses of the 'daily' or fourth-order layers in the second to fourth annual band will be determined. (B) The number and kind of growth layers in (1) the summer and (ii) winter (second-order layers) will be counted. The following questions will be asked: (1) Are there 360 to 365 daily or fourth-order growth layers present between the annual bands or in the first-order layer in Tivela collected at different sites and latitudes. (2) Are there differences in the thicknesses of fourth-order layers that can be correlated with latitude or some other factors. (3) Other than Tivela, which taxa have annual or seasonal growth layers and at what latitudes and in what temperatures of water do those forms with such bands occur? (4) Do taxa from high polar latitudes have slow shell growth, are there 360 to 365 'daily' growth increments as have been noted in taxa from temperate and outer tropical latitudes? (5) Do taxa from near-equator latitudes have seasonal growth bands or layers.
SUPPORTED BY U.S. National Science Foundation

5.0680, RESTORATION, PROPAGATION, AND MANAGEMENT OF MARINE ALGAE
W.J. NORTH, Calif. Inst. of Technology, Graduate School, Pasadena, California 91109
The project proposes to develop techniques for establishing commercially valuable kelp beds in barren areas, starting with introduction of kelp spores. Preliminary investigation indicates that such techniques can be developed. Once feasibility is demonstrated, the project will attempt to extend the techniques to other useful algal species, with emphasis on species flourishing in relatively warm water so that such species may be available for growth in areas affected by thermal pollution.
To aid in the training of qualified persons for future work in this field, the project includes provision for a teaching program under Dr. North's Kelp Habitat Improvement Project, which resulted in re-establishment of significant kelp beds off Southern California by transplantation of mature plants and control of grazing organisms. The Habitat Improvement Project will continue under other sponsorship with the added Sea Grant elements clearly identifiable within the total effort.
SUPPORTED BY U.S. National Science Foundation

5.0681, DRAG-REDUCING ALGAE
J.W. HOYT, U.S. Navy, Undersea Warfare Center, Pasaden, California 91107
This investigator is studying exudates of algae and bacteria as they affect the measurement in towing tanks and at sea. Effort is also underway to determine the polysaccharide chemistry of a typical friction reducing species, and to explore the relationship of algal activity in the ocean.
SUPPORTED BY U.S. Dept. of Defense - Navy

5.0682, GENETIC REGULATION OF HEMOGLOBIN SYNTHESIS IN ARTEMIA
S.T. BOWEN, San Francisco State College, Graduate School, San Francisco, California 94132
This long-term goal of this research is to elucidate the role of structural and regulator genes in the synthesis of hemoglobin in the brine shrimp, Artemia salina. This may be an excellent system for the study of regulator genes in a metazoan because Artemia
5. LIVING SYSTEMS (NON-HUMAN)

Hemoglobin is an inducible protein which can be readily isolated and characterized and it occurs in a species which is suitable for intensive genetic studies. Shrimps mature in two weeks, making it possible to obtain more than 12 generations in one year. Females produce broods of about 50 nauplii every 6 days throughout their life span of 6 months. Of the nine single-locus mutations reported in this species, six have been found in our laboratory. Because Artemia races, when reared in the laboratory, initiate hemoglobin synthesis at different levels of oxygen deprivation, it is possible that they differ in regard to regulator genes.

There are three specific objectives: 1) We plan to determine which environmental factors are needed for maximum synthesis of each of the three hemoglobins. 2) We will determine the mode of inheritance of the three hemoglobins commonly found in wild populations in salterns on San Francisco Bay. More than 100 shrimps have been examined and it is evident that the hemolymph of one shrimp may contain any one hemoglobin, a combination of any two, all three hemoglobins, or none at all. There is a sex difference in the distribution of hemoglobins in the wild population. Hemoglobin synthesis will be studied in the progeny of single pair matings in our laboratory stocks which carry a marker on the sex chromosomes, in which crossing over is suppressed between the sex chromosomes. 3) We will characterize the hemolymph proteins by isolation into subunits, determination of molecular weights, and (if time permits) by fingerprinting and amino acid analyses.

SUPPORTED BY U.S. Dept. of Hlb. Ed. & Wel. - P.H.S.

5.0683, GROWTH AND DIFFERENTIATION OF PLASTIDS

A. GIBOR, Univ. of California, Graduate School, Santa Barbara, California 93018

Acetabularia, a large single celled green alga offers unusual advantages in understanding the role of the nucleus in the control of the synthesis of the DNA of the chloroplasts. Nuclei of these cells can be removed and the cell is able to carry out normal physiological processes including, presumably the replication of chloroplasts. Thus one may study the effect of the chloroplast DNA freed from control by the nucleus. Another approach that is being followed is to demonstrate the genetic role of the DNA in the plastids is to study the nature of the lesions induced in the process of ultraviolet light bleaching of Euglena.

Experiments will be carried out to provide further evidence for the metabolic functioning of an autonomous genetic system in plastids by studying the biosynthesis of their nucleic acids, especially DNA, and by studying the enzymes coded by this DNA. Experiments are planned to determine whether genetic differences occur among plastids or among mitochondria of the same cell.

Possible exchange of genetic material among plastids or mitochondria will be investigated by artifically establishing cell lines with mixed plastid or mixed mitochondrial populations. Micro-sprouted applications and labeled applications of mutagens such as U.V. and X-rays or combinations of these procedures will be attempted.

The search will be continued for proper isolation procedures and adequate nutrient media to carry on the development and multiplication of plastids in vitro.

SUPPORTED BY U.S. National Science Foundation

5.0684, EFFECTS OF DEPTH ON GROWTH AND REPRODUCTION OF BENTHIC MARINE ALGAE

M. NEUSHUL, Univ. of California, Graduate School, Santa Barbara, California 93018

Scuba-diving techniques were employed in the sea to follow the growth of benthic plants on substrate placed in underwater study areas. Laboratory culture was carried out in a sea water supplied greenhouse and in an aquarium facility where light and temperature levels were adjusted to simulate those encountered at depth in the sea. The growth and reproduction of plants in the sea and in the laboratory was compared. Plants in the laboratory under simulated depth conditions grew at rates comparable to, and sometimes in excess of those studied in the sea. Growth rates of red algae (Bosiella and Corallina) in the sea were within a factor of 2 of the laboratory estimates. In most cases plants showed an inhibition at high light intensities, and a wide range of saturation growth (at 3-14000 langley per day).

In some forms (i.e., Dictyopteris, coralline algalonirides) growth and reproduction appear to be closely correlated. In others seasonal and lunar periodicity was observed. Many simple, yet culitively important techniques have been developed for transplanting, measuring and handling larger benthic marine algae under laboratory conditions. It is possible to experimentally cultivate a wide range of larger, benthic marine plants. The results of this continuing program (since July, 1962) are presented more fully in published papers (12); in-press papers (10); and unpublished theses and manuscripts (6).

SUPPORTED BY U.S. National Science Foundation

5.0685, CIRCADIAN RHYTHM IN PHOTOSYNTHESIS IN THE MARINE ALGAE GONYAULAX AND ACETABULARIA

B.M. SWEENEY, Univ. of California, Graduate School, Santa Barbara, California 93018

The purpose of this investigation is to study the biochemistry of photosynthesis in Gonyaulax and Acetabularia, with the object of discovering through which of the component reactions of photosynthesis the control of the rhythm is exerted. The studies will be directed toward 1) a comparison of the kinetics of the partial reactions of photosynthesis in cell-free systems at different times in the diurnal cycle, and 2) measurement of photosynthesis in whole cells, utilizing flashing light and specific inhibitors as means of identifying partial reactions and detecting differences correlated with the time in the diurnal cycle. It is hoped that these studies will advance the understanding of the mechanism of timekeeping.

SUPPORTED BY U.S. National Science Foundation

5.0686, COPEPOD CRUSTACEANS PARASITIC ON FISHES

A.G. LEWIS, Univ. of British Columbia, Graduate School, Vancouver - British Columbia, Canada

The purpose of the project is to study the collections of copepod fish parasites from Eniwetok Atoll and from Indian Ocean fishes both from a taxonomic and a zoeographic standpoint. The hydrographic data from cruise 2 of the Anton Bruun will be used in the discussion of the distribution of the copepod parasites of the pelagic fishes collected during this cruise. The distribution of these copepods, as well as others collected during cruise 2, will be compared with their distribution throughout the world.

SUPPORTED BY U.S. National Science Foundation

5.0687, LARVAL STUDY OF THE LOBSTER

W.A. LUND, State Board of Fish. & Game, Hartford, Connecticut

Plankton tows will be taken in Long Island, Fishers Island, and Block Island Sounds in the Atlantic Ocean off Block Island and Long Island in an attempt to locate larval lobsters. A few tows taken during 1965 have been examined for larval lobsters. Some larvae were collected in the Sounds, but better results were obtained in the Atlantic off Montauk.

Information available from the former Lobster Hatchery at Nauk, Connecticut, indicates that the majority of lobster eggs hatched in June and early July. It is proposed to closely observe egg development on buried females during the spring. This can be accomplished by fishing our own pots or by sailling with certain commercial lobstermen.

Weekly plankton tows will be initiated in the inshore waters during the latter part of May. The periodicity and duration of the tows will be increased as information is gathered. Day and night tows will be made to evaluate which is the better time to sample. Only surface tows will be made during 1966.

Offshore plankton tows are believed to be necessary if we hope to delineate the population to which the Fishers Island and Long Island Sound lobsters belong. It will be necessary to determine the areas of origin, the transport of the larvae and the probable areas of settlement before we are able to understand the biology of this animal in this area. An offshore cruise made on
At, August 5, 1966, yielded six lobster larvae (three 1st stage, one 3rd stage and two 4th stage). The area sampled is approximately 40 to 55 miles SSE off Montauk, Long Island. This is the only evidence we have on the occurrence of larvae in the Atlantic off Block Island and Long Island. Periodic cruises will begin in June and continue until additional positive evidence is gathered on the offshore occurrence of the larvae.

Part 1 of 3.


5.0688. POPULATION STRUCTURE OF THE LOBSTER
W. A. LUND, State Board of Fish. & Game, Hartford, Connecticut

In order to prepare a plan for the rational exploitation of the lobster with the goal of achieving the best long-term yield, it will be necessary to have information on the structure of the existing population and its distribution. Vital data such as abundance of various sizes, sex ratio within groups, distribution of sexes and size of females at first maturity, are needed to estimate the best theoretical size to harvest the lobster.

The objectives of this sub-project are to investigate the composition of the lobster population in Long Island and Fishers Island Sounds throughout the year. It is proposed to examine this population in the following ways: 1. Examine in port, the catches of commercial lobstermen. 2. Examine the catches as they are hauled aboard certain commercial lobster boats. 3. Fish our own pots to catch, in particular, small lobsters not retained by legal pots. 4. Scuba dive in a few selected localities, on a systematic basis, to determine size structure during most of the year. Some type of identification (marking if necessary) will be made to identify lobsters.

The problems associated with an attempt to determine an unbiased estimate of catch per unit of effort are magnified in this populous area. In addition to the sources of bias enumerated by Hancock and Simpson, the disturbance of pots by legal pots. 4. Scuba divers in a few selected localities, on a systematic basis, to determine size structure during most of the year. Some type of identification (marking if necessary) will be made to identify lobsters.

The project is being conducted to investigate the role of cell organelles in growth and differentiation. Apart from direct electron microscopic observations and autoradiography on differentiating tissues, we believe that by experimentally manipulating cells in a predictable manner and correlating changes in growth or behavioral patterns with specific subcellular changes, we can gain significant insight into the general problems of morphogenesis. Embryogenesis in certain marine plants seem particularly amenable with these techniques and we are encouraged to believe from our early results that these relatively simple systems can provide fundamental new data on biochemical requirements, organelle ontology, and structural interactions during cell differentiation.


5.0689. STRUCTURAL AND FUNCTIONAL ORGANELLE INTERACTIONS
G.B. BOUCK, Yale University, Graduate School, New Haven, Connecticut 06520

This research is being conducted to investigate the role of cell organelles in growth and differentiation. Apart from direct electron microscopic observations and autoradiography on differentiating tissues, we believe that by experimentally manipulating cells in a predictable manner and correlating changes in growth or behavioral patterns with specific subcellular changes, we can gain significant insight into the general problems of morphogenesis. Embryogenesis in certain marine plants seem particularly amenable with these techniques and we are encouraged to believe from our early results that these relatively simple systems can provide fundamental new data on biochemical requirements, organelle ontology, and structural interactions during cell differentiation.

SUPPORTED BY U.S. Dept. of Int. Ed. & Wel. - P.H.S.

5.0690. ECOLOGY OF MARINE ENDOLITHIC ALGAE
S. GOLUBIC, Yale University, Graduate School, New Haven, Connecticut 06520

These results deal with the macroscopic marine algae living within hard calcareous substrate. It primarily concerns the following problems: 1. Study of differentiation of the thallus into epithelial and endolithic parts and its taxonomic significance. The question is, whether the endolithic forms represent ecologically influenced modifications or highly distinct specialized taxa. 2. The endolithic environment is colonized by two ecologically different groups of algae: those actively boring the carbonate substrate and those living in the already existing cavities. The study is aimed towards a recognition of the relationship between: a) the boring patterns and the organisms causing them, and b) the boring patterns and the mineralogical properties of the substrate. The results are expected to enable a characterization of the ecological role of different types of endoliths as well as to provide a basis for the interpretation of the boring patterns in fossil record.

SUPPORTED BY U.S. National Science Foundation

5.0691. BIOTA OF THE RED SEA AND EASTERN MEDITERRANEAN
W. ARON, Smithsonian Institution, Washington, District of Columbia 20560

It is proposed that a study of organisms of the Red Sea and Eastern Mediterranean with special reference to the movement of biotic species through the Suez Canal be continued. Surveys of the proposed organisms and studies in relation to their point of origin are being undertaken jointly by the Smithsonian Institution and the Hebrew University of Jerusalem. Both of the listed investigations incorporate, coordinate, and include research activities of other scientists in other agencies and organizations as necessary to accomplish the research.

SUPPORTED BY Smithsonian Institution

5.0692. CORAL ATOLL FLORA
F.R. FOSBERG, Smithsonian Institution, Washington, District of Columbia 20560

Descriptive flora of coral atolls, generally, with correct names, pertinent synonyms, descriptions, native names, if available; statements of distribution and occurrence, citation of specimens.

SUPPORTED BY Smithsonian Institution

5.0693. STUDIES WITH TROPICAL AND SUBTROPICAL MICROALGAE
I.S. BUNT, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124 (AT-401-3795)

The argument is presented that an extensive and ecologically significant benthic flora of microalgae may exist over much of the shallow continental shelf of southern Florida and the Bahama Banks. It is intended to test this proposition, to build a culture collection of microalgae and other microorganisms from the benthos and to study their physiology and general biology. There is a particular need to examine uptake of organic substrates both in the light and in the dark as well as the biological interactions between the algae themselves and the algae and other constituents of the microflora and microfauna of the benthos. Such an approach is prerequisite for meaningful assessments of primary production occurring at the surface of the continental shelf sediments. The program, further, should serve in some measure to enlarge our limited understanding of processes of primary production in tropical and subtropical waters and should be intrinsically relevant in the field of microbiology.

A survey cruise will be conducted during 1968 to collect core and other samples in transects across the Continental shelf of Florida and over into the Bahama Banks. These materials will be used to determine the types, abundance and distribution of microalgae especially in the superficial layers of shallow sediments. Cultures will also be set up for detailed lab study.

The collection of algae will be screened to identify species with heterotrophic characteristics and those which demonstrate a capacity to influence the growth rate and physiological activities of other species. Where this seems fruitful, attempts will be made to incorporate any bacteria and protozoa which lend themselves to isolation. Concurrently, studies will be initiated on the utilization of carbon-14 labelled organic substrates, wherever possible employing growth studies as well to serve as a guide and a check on short-term rate measurements.

5. LIVING SYSTEMS (NON-HUMAN)

189
5. LIVING SYSTEMS (NON-HUMAN)

SUPPORTED BY U.S. Atomic Energy Commission

5.0694. DISTRIBUTION OF ANTARCTIC MARINE FUNGI
J.W. FELL, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124

A renewal of GA-672 to continue the study on the systematics and ecology of Antarctic marine yeasts, phycomycetes on filamentous fungi aboard the Eltanin. The distribution of marine fungi will be made by sampling various water masses from the Subtropical Convergence to the Antarctic continent. Microbiological statistics will be taken every 2-3 degrees over cruise transects, and every 1-2 degrees at the Antarctic and Subtropic Convergences from the surface to bottom waters at standard hydrographic depths with biological samplers (Niskin). Fungal cultures will be prepared aboard ship and returned to the University laboratory for physiological characterization of marine yeasts and taxonomic study of asporogenous yeast and other fungal microorganisms.

Eltanin participation is planned in 1 to 2 cruises; Cruises 34-37 will involve two shipboard persons. Coordination with the Lamont Geological Observatory hydrographic program is essential since there are no provisions for hydrographers.

SUPPORTED BY U.S. National Science Foundation

5.0695. ECOLOGICAL STUDIES OF THE SOUTHEASTERN FLORIDA SEA GRASS COMMUNITY - PRIMARY PRODUCTION BY THALASSIA TESTUDINUM KONG
L.J. GREENFIELD, Univ. of Miami, Graduate School, Miami - Coastal Gables, Florida 33124

The objective of this study is to obtain estimates of both the normal and potential maximum contribution of the turtle grass, Thalassia testudinum, to the shallow coastal sea grass community in terms of oxygen and fixed carbon yields. To this end the rates of photosynthesis and respiration under normal conditions of field illumination intensities through the seasons and rates of photosynthesis and respiration at saturation and half-saturation illumination intensities will be determined. Comparisons of the relative contribution of plants having epiphytes with plants cleaned of epiphytes will be made. A study of plant growth under field and semi-controlled conditions may reveal some possible morphological and physiological changes in developing plants. An additional aim is to determine the sites of uptake, pathways and rates of translocation, and sites of accumulation of certain required inorganic nutrients and raw materials. It is hoped that the data obtained from this study, combined with the findings of our previous studies, will permit construction of a model of the dynamics of community interrelations and the food network of the sea grass communities of tropical shallow coastal waters.

SUPPORTED BY U.S. National Science Foundation

5.0696. CONTINUED STUDIES OF THE SYSTEMATICS AND ZOOGEOGRAPHY OF WESTERN ATLANTIC CAECIDAE
D.R. MOORE, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124

The Caecidae are minute marine gastropods. The distribution of the family is circumtropical, but some species are found in cool temperate waters. Approximately 100 species have been described for the Western Atlantic region, but most of the names are synonyms. It is proposed to monograph the Western Atlantic species. The biology of the living animal and the anatomy of the soft parts will be studied in addition to the study of the morphology of the shell. The generic classification of the family will be reviewed, and relationships with similar gastropods in other families will be considered. The vertical and geographical distribution of each species will also be plotted during the study.

SUPPORTED BY U.S. National Science Foundation

5.0697. COLLECTION AND EXTRACTION OF MARINE INVERTEBRATES AND PLANTS
UNKOWN, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124 (PH 84-36-1179)

Independently and not as an agent of the Government, the Contractor will exert its best efforts to: 1. Collect and identify various species of marine invertebrates and plants. 2. Extract and lyophilize in 4-gram quantities approximately 100 samples as directed by the Project Officer. 3. Samples prepared will be stored and shipped as required by the Project Officer. 4. Perform large recollections of materials demonstrating activity in the Government’s screening program. 5. Prepare and submit interim progress reports and a final comprehensive summary report acceptable to the Project Officer in format, quantity, and frequency.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0698. THE MARINE ALGAE OF VIRGINIA
H.J. HUMM, Univ. of South Florida, Marine Science Institute, Tampa, Florida 33701

Since 1942 the principal investigator has been making opportunistic collections of the marine algae of Virginia at various seasons of the year along virtually the entire coastline and Chesapeake Bay where salinity normally exceeds 15 o/oo. He has also received and worked over collections made by others. The work is now in completed manuscript form, includes records of about 130 species of benthic algae, keys, descriptions, and a general discussion of the coastal waters of Virginia. Illustrations are yet to be completed. The publication is intended as a guide to the identification of the benthic algae of Virginia as well as a species record and ecological study.

Most of the work has been done at the Virginia Institute of Marine Science, Gloucester Point, Virginia, and has been partially supported by that institution.

SUPPORTED BY University of South Florida Virginia Institute of Marine Science

5.0699. BIOLOGICAL ACTIVITIES OF MARINE FUNGI
M.S. FULLER, Univ. of Georgia, Graduate School, Athens, Georgia 30602

The fungi are common in the oceans as saprophytes, parasites of algae, and invertebrate animals. This research has as its primary objective the ascribing of more precise information on the role of fungi in marine ecology. A group of little known coccoideal organisms is to be examined morphologically, physiologically, and biochemically to determine both their evolutionary relationships and potential role in the marine environment. One such organism which may cause the gaping disease of oysters is being examined in greater detail. Two parasites each of marine algae and invertebrates are being subjected to detailed study to elucidate the (1) mechanism of host entry, (2) development of the parasites, and (3) the environmental and internal control of entry and development of the parasites.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0700. EFFECT OF EURASIAN WATERMILFOIL CONTROL PROCEDURES ON WILDLIFE AND OTHER ORGANISMS IN AQUATIC ENVIRONMENTS
J.H. STEENIS, U.S. Dept. of Interior, Patuxent Wildlife Res. Ctr., Laurel, Maryland

Evaluations on control of Eurasian watermilfoil with 2,4-D and diquat reveal that native species of plants are not adversely affected in tidal waters. In fact, these treatments have resulted in increased growth of native species, including the more desirable duck food plants. To date investigations of the Chesapeake Biological Laboratory and Virginia Institute of Marine Science reveal no direct adverse effects on commercial shellfish, crabs and fish, or other associated marine life from recommended treatments on Eurasian watermilfoil with 2,4-D or diquat. However, these toxicological studies are not complete.

Guide lines on residue studies of commercial fish conducted by the Chesapeake Biological Laboratory are incomplete.

SUPPORTED BY U.S. Dept. of Interior - Ba. Sport Fish
5.0701, SYSTEMATICS AND ECOLOGY OF SUBTIDAL BENTHIC MARINE ALGAE
R.T. WILCE, Univ. of Massachusetts, Graduate School, Amherst, Massachusetts 01003

There is a paucity of information on the subtidal attached algae vegetation from the Woods Hole area. Studies of seasonal succession, vegetative and reproductive periodicity of members of these communities are unknown. It is also true that we have only a general knowledge of which taxa constitute this flora. Previous studies of the sublittoral benthic algae vegetation have all been based on sporadic dredgings made especially during the warm months of the year. It is proposed to study the attached algae of four ecologically contrasting habitats in the Woods Hole area during a three year period, a program initiated in preliminary fashion by the Principal Investigator in 1966. Subtidal algal ecology will be studied at a site, described on tape and the algal communities photographed. Regular monthly and bimonthly sampling will be made at the four stations through the facility of SCUBA diving; this routine sampling will be made and data collected over a long period will provide much new information concerning these plants. This research will culminate in a systematic and ecological treatment of the subtidal flora of the area and inclusive line drawings and photographs, keys to the species and a thorough discussion of species distribution and bibliographic citations.

SUPPORTED BY U.S. National Science Foundation

5.0702, ENVIRONMENTAL EFFECTS ON THE METABOLISM OF MARINE ALGAE
J.A. HELLEBSTAD, Harvard University, Graduate School, Cambridge, Massachusetts 02138

The mechanism and specificity of uptake of organic substrates by marine phytoplankton algae, and the influence of exogenous substrates on their metabolism. The effects of exogenous substrates on the induction of transport systems or enzymes for substrate assimilation. Light and dark effects on transport systems. Light effects on pathways of amino acid synthesis.

The effect of light quality and intensity on the metabolism and action of glycolic acid, and the possible role of glycolic acid in the "light" respiration of marine phytoplankton. Effects of salinity on release of organic substrates by algae, and direct measurements of permeability constants for loss of specific algal metabolites.

The effects of light intensity on the composition and rate of synthesis of alginic acid in Laminaria digitata.

SUPPORTED BY U.S. National Science Foundation

5.0703, LIGHT REQUIREMENTS FOR MARINE ALGAE
G.C. MCLEOD, Tyco Laboratories Incorporated, Waltham, Massachusetts 02154

In contrast to the large amount of existing knowledge concerning the photosynthetic mechanisms of higher plants and green algae which contain chlorophyll a and b, little is known of photosynthesis occurring in marine algae which contain the accessory pigments chlorophyll c and either fucoxanthin or phyco- bilines. The proposed study will ascertain the spectral requirements of selected marine algae and determine the action spectra of the photosynthetic pigments. This information will aid in the design of a detector with responses equivalent to that of the phytoplankton. Information on existing algal indicator species capable of bacteria-free culture will be compiled and the spectral requirements of these species for growth and pigment synthesis will be studied.

To provide the insight concerning aquatic biological phenomena needed by formulators of Naval operational planning, a vast accumulation of definitive background data is essential. The study of biological population dynamics, for example, with limits and interrelationships defined, could lead to the explanation of many phenomena of potential trouble to the Navy, such as plankton blooms, bioluminescence and biological acoustic interference. Research of the type proposed in this study program should serve to eliminate the crucial gaps in our knowledge of factors affecting planktonic marine organisms.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0704, REVISION OF THE CLASSIFICATION AND PHYLOGENY OF THE SUBORDER BALANOMORPHA (CIRRIPECTA - THORACICA)
V.A. ZULLO, Marine Biolog. Laboratory, Woods Hole, Massachusetts 02543

It is proposed to undertake a revision of the supraspecific classification and phylogeny of the Suborder Balanomorpha (Cirripedia: Thoracica), or sessile barnacles. This goal will be approached in two ways: 1) through a re-evaluation of previous systematic literature and the examination of the collections upon which these earlier studies were based; and 2) through additional field collection and examination of unstudied collections in various museums. The results of this study will provide a more useful, more flexible, and up-to-date replacement for a classification which has not been examined critically in the last fifty years.

In addition to the revised classification, an annotated and illustrated catalog of the known species of Balanomorpha will be compiled, together with biogeographic data and aids for the non-specialists, including illustrated keys, glossary, and bibliography.

SUPPORTED BY U.S. National Science Foundation

5.0705, SEASONAL VARIATIONS OF ALGAL POPULATIONS
R. OGAWA, U.S. Dept. of Interior, Biological Laboratory, Ann Arbor, Michigan

The purpose of this project is to correlate seasonal variations in algal populations in the field with laboratory studies of their nutrient requirements.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish

5.0706, NUTRIENT REQUIREMENTS OF ALGAE
R. OGAWA, U.S. Dept. of Interior, Biological Laboratory, Ann Arbor, Michigan

The purpose of this project is to gain insight on the effect of increased levels of nitrates and phosphates on unialgal cultures. Present investigations are primarily concerned with blue-green algae.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish

5.0707, TAXONOMY AND ECOLOGY OF NEARSHORE MARINE OSTRACODA
F.M. SWAIN, Univ. of Minnesota, Graduate School, Minneapolis, Minnesota 55455

Many efforts have been made to determine environmental conditions of early geologic periods through study of fossil remains in sedimentary materials. Because certain living organisms are identical or closely related to fossil forms, it is possible to use knowledge of existing marine environmental conditions to speculate with some assurance regarding the conditions under which earlier organisms lived. Although recent observations suggest ostracodes to be suitable organisms for such studies, their value in paleoenvironmental work is hampered by incomplete knowledge of living coastal species and of their ecological associations and other biodynamic features.

The marine and freshwater ostracodes of the west coast of North and South America from Alaska to Nicaragua have been the subject of intensive investigation. Collections of recent ostracodes from Corinto Bay and Bahia San Juan de Sur, Nicaragua, Bay of Panama, and Cape San Lucas and Straits of Juan de Fuca are to be analyzed for distribution of species and development of biofacies, and correlated with environmental data. The establishment of nearshore ostracode biofacies should provide a basis for the recognition of similar biofacies in the geologic past. It is further proposed to complete a study of a large collection on hand of the late tertiaries from the Great Basin, to work out the environmental assemblages and to set up paleontological zones based on the Ostracoda. In order to make adequate comparisons, examination is to be made of museum collections of type species of freshwater ostracodes in London, Newcastle, and Leningrad. The investigation should shed some light on the evolutionary development of certain stocks of Ostracoda.

SUPPORTED BY U.S. National Science Foundation

191
5. LIVING SYSTEMS (NON-HUMAN)

5.0708, INDUCTION AND CONTROL OF DIFFERENTIATION IN ALGAE
H.W. NICHOLS, Washington University, Graduate School, Saint Louis, Missouri 63130

Basic biological properties of multicellular photosynthetic algae, in particular Chondrus crispus, Erythrocladia subintegra, Hildenbrandia rivularis and Polysiphonia urceolata are under investigation. Of major importance will be the elucidation of some aspects of the nutrition and general physiology of the experimental organisms. Secondly, the influence of photoperiod and temperature on the initiation of developmental phases will be examined. Periodic changes in light, coupled with fluctuations in temperature, appear to be directly related to the development of the experimental organisms. Such studies may also reveal some of the controlling mechanisms which govern natural changes in cellular morphology and organization.

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SUPPORTED BY U.S. National Science Foundation

5.0709, CHEMISTRY OF ALGAL TOXINS
M. IKAWA, Univ. of New Hampshire, School of Agriculture, Durham, New Hampshire 03824

A project is being undertaken to (a) study the occurrence of toxin-producing algae in local lake, estuarine and marine waters and (b) isolate and characterize toxic substances produced by algae. Toxicity is being determined through assays involving Bacillus megaterium spores, Chlorella pyrenoidosa, and mice. Initial studies are involved with the isolation of the toxic substances produced by the blue-green alga Aphanizomenon flos-aquae, which blooms profusely in certain of the lakes in New Hampshire and which is implicated in recent incidents of fish kills, and by the dinoflagellate Gymnodinium breve, which occurs in blooms in the Gulf of Mexico.

The project was started in fiscal year 1968-69. There is no anticipated completion date for the project.

SUPPORTED BY U.S. Dept. of Hith. Ed. & Wel. - F.H.S.

5.0710, ECOLOGICAL STUDIES OF THE MARINE RED ALGA CHONDrus CRISPUS STACKHOUSE
A.C. MATHIESON, Univ. of New Hampshire, School of Agriculture, Durham, New Ham; *03824

The ecology of the red marine alga, Chondrus crispus (Irish moss), will be investigated for the purpose of developing information which can be of use in expanding the amount of this valuable resource in American waters. This alga is one of the principal sources of the phycocolloid, carrageenan, which is widely used as an ingredient stabilizer in many food and pharmaceutical products. Regular observations and measurements will be made at each of four stations in the intertidal and subtidal zones, and the growth and reproduction of in situ plants of Chondrus crispus will be correlated with several environmental factors (temperature, light, salinity, nutrients, tides, substrate currents, precipitation, biological interrelationships, etc.). Some of the measurements will involve the use of SCUBA techniques. Also, the growth of cultured germ cells, and the photosynthesis and respiration of macroscopic plants will be determined in the laboratory. Other field studies will yield information on succession of the alga in demed areas, potential usefulness of artificial substrates, effects of grazing by animals regeneration and the propagation capacity following harvesting, and transplantation potential of this species.

SUPPORTED BY U.S. National Science Foundation

5.0711, PRELIMINARY INVESTIGATION OF GROWTH AND DIFFERENTIATION IN MARINE COENOCTIC ALGA, CAULERPA PROLIFERA
J.C. CHEN, Rutgers The State University, Graduate School, New Brunswick, New Jersey 08903

Caulerpa prolifera is a marine coenocytic alga, much larger than most coenocytic organisms, that exhibits interesting and strong abilities for differentiation. It is unicellular in nature and able to differentiate three different 'organs,' namely the rhizome, 'leaf,' and rhizoid cluster.

Two questions about growth and rhizome formation in this alga are being asked: (1) How is the conical shape of the rapidly growing rhizoid tip maintained in the face of the isotropic effects of turgor pressure, and (2) What is responsible for the specific changes that occur in certain regions of the rhizome which initiates the differentiation of rhizoidal clusters? Comparative measurements are being made of differential rhizome growth at different points of the rhizome. This will provide some measure of growth rates with respect to each region (point marked out by markers and time-lapse photography of growth). Two additional measurements will then be made (xyian content and bifurgence of the cell wall) of each region and these will be related to the specific growth rate to give physical-chemical parameter of that unit portion.

SUPPORTED BY U.S. National Science Foundation

5.0712, MORPHOGENESIS OF THE DIATOM SHELL
B.E. REIMANN, New Mexico State University, Graduate School, Las Cruces - University Park, New Mexico 88001

Diatoms are unicellular algae characterized by the presence of a silica shell that encases the cytoplasmic contents. At certain periods during the life cycle of a diatom, i.e., after cell division, during cell extension, and during the formation of the test, the cells form new shells by assimilating soluble silicic acid from their environment and depositing it, as polymerized opaline silica, within a membrane system formed inside the living cell. This particular cytoplasmic membrane apparently has the sole function of concentrating silica. Studies are underway concerned with the origin, structure, and function of this very specialized membrane.

The following experiments are underway: 1) electron microscopy of dividing cells to trace the morphology of silicious shell deposition; 2) morphogenetic effects of silicic acid deficiency; 3) relationship between sexual cycles and cell types; 4) effects of osmotic and mechanical pressure, pH, on shell morphology; and 5) localization of silica inside the cell before it is deposited.

SUPPORTED BY U.S. National Science Foundation

5.0713, SYMBIOSIS IN CONVOLUTA
L. PROVASOLI, Haskins Laboratories Inc., New York, New York

The main objective is to elucidate the nutritional relationships between the marine flat worm Convoluta roscoffensis and its algal symbionts and how the symbiotic relationships affect the biology of Convoluta.

To determine the specificity of the symbiosis, larvae of Convoluta, which are born devoid of symbionts, were infected artificially with a variety of algae. The algae selected were the natural symbionts isolated from Convoluta worms collected at Jersey Isl., Roscoff and Henday, France, and Pisa, Italy as well as 15 species of free living Platymonas and Prasiocladus; three strains of C. roscoffensis and one strain of C. psammophila (Pisa) were reinoculated. The natural symbiont of the 4 strains and 2 species of Convoluta was found to be always Platymonas convolutae, M. ton at Parke. But 5 Prasinocladus species (and so far no other species of Platymonas) can establish an artificial symbiosis which is almost as effective as the one with P. convolutae. However in competition experiments the natural symbiont wins over the others and can even replace completely the unnatural symbionts after they have established a functional symbiosis. This experimental supremacy of P. convolutae over other species of related algae parallels the ubiquity of this species as the natural symbiont in different strains and species of Convoluta worm. Studies are in progress to find a physiological explanation of this supremacy.

SUPPORTED BY U.S. Dept. of Hith. Ed. & Wel. - F.H.S.

5.0714, SYSTEMATICS, MORPHOLOGY, AND ECOLOGICAL DISTRIBUTION OF ALGAL AND WOOD-INHABITING MARINE AND FRESHWATER FUNGI OF SURTSEY AND ICELAND
T.W. JOHNSON, Duke University, Graduate School, Durham, North Carolina 27706 (AT-(40-1)-3556)

Since 1964, the aquatic fungi of Surtsey and Iceland have been under continuing investigation. Prior to 1964 only eleven

192
species had been reported from Iceland. Over two hundred have now been recovered from Iceland (including Surtsey). The purpose of the continuing study is basically ecological distribution, occurrence, and ecological succession of freshwater and marine fungi on the volcanic, submarine upthrust, Surtsey. Developmental morphology and its application to systematics constitute the secondary objective. Collecting-trapping sites have been selected and are being serviced periodically for yield. Standard mycological techniques including baiting of soils and water, and trapping by submerged wood panels are used.

Over two hundred species of aquatic fungi have been recovered. These represent new records, and several are species new to science. Three papers reporting on the occurrence and morphology of some species have been accepted for publication in 1968. Representatives of all classes of aquatic fungi, save for one, have been recovered from Surtsey or adjacent land and water masses.

SUPPORTED BY U.S. Atomic Energy Commission

5.0715, STUDIES OF THE PHAEOPHYCEAN ORDERS CHORDARIALES AND PUNCTARIALES
R.B. SEARLES, Duke University, Graduate School, Durham, North Carolina 27706

The work proposed will be a study of the brown algae in the orders Chordariales and Punctariales which occur along the mid-Atlantic coast. Many of the members of this complex have incompletely known life histories and have interesting seasonal and geographical distributions along this coast. Life histories, tolerance to environmental conditions, and responses to changes in conditions will be studied in the laboratory using cultures.

SUPPORTED BY U.S. National Science Foundation

5.0716, MORPHOLOGY AND TAXONOMY OF MARINE FUNGI
J.J. KOHLMeyer, Univ. of North Carolina, Institute of Marine Sciences, Morehead City, North Carolina 28557

A revision of all higher marine fungi described between 1840 and 1940 is planned. Most of these species were incompletely described and their systematic position in the modern system remains uncertain. A second goal of the proposed research is to continue investigations on tropical and subtropical marine fungi, especially composition of the marine mycota in mangrove habitats. In the mangroves, occurrence of terrestrial and marine fungi overlaps, and this study could serve as a basis for future ecological studies on mangrove fungi.

SUPPORTED BY U.S. National Science Foundation

5.0717, QUANTITATIVE AND QUALITATIVE MEASUREMENT OF AQUATIC VEGETATION-CURRITUCK SOUND
T.E. CROWELL, State Wildlife Resources Comm., Raleigh, North Carolina

The objective of this job is to determine the amount and distribution of aquatic vegetation in northern Currituck Sound with particular emphasis upon the apparent immediate and long-range effects upon that vegetation resulting from the salinity artificially created in Back Bay by the City of Virginia Beach, Virginia, and draining therefrom into Currituck Sound. Similar effects by sea-water intrusions resulting from natural breaks through the Outer Banks will be determined should such breaks occur.

To accomplish this objective, three samples of aquatic vegetation, each two square feet in area, will be collected with modified oyster tongs at 500-yard intervals across Transect H (Virginia-North Carolina State line), Transect I (Knotts Island to Bench Marsh), and Transect J (Knotts Island to Swan Island). These samples will be collected quarterly (August, November, February, and May).

The percentage volume of each species present in each sample will be determined by an ocular estimate and the total volume of aquatic vegetation in each sample will be obtained by displacement following soil removal. Data also will be compiled to provide: total milliliters displaced, species in each sample, foot basis, and the percent frequency of occurrence of each species.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0719, EXPERIMENTAL CULTURE OF CALCAREOUS GREEN ALGAE OF CORAL REEFS
L.H. COLINVAUX, Ohio State University, Graduate School, Columbus, Ohio 43210

5.0720, BIOSYNTHESIS OF 3-HYDROXYTYRAMINE IN MONOSTROMA FUSCUM
R.D. TOCHER, Portland State College, Graduate School, Portland, Oregon 97201

We are studying the biosynthesis of 3-hydroxytyramine (3-HT) in the marine alga Monostroma fuscum (Clorophyta). 3-HT makes up as much as three percent of the dry weight of the alga, or about 20% of the dry weight. This alga is, therefore, the richest plant source of this material. Our working hypothesis is that 3-HT is an end-product of the shikimate pathway, although no intermediates have been detected. Currently, we are attempting to characterize DOPA decarboxylase in this alga. Of interest is the relationship of the alga's tyrosinase (specifically, the tyrosine ortho-hydroxylase activity) to DOPA-decarboxylase. Tyrosinase would be expected to further oxidize the newly formed DOPA to DOPA-quinone leading to the production of melanos. Instead, DOPA is dehydrated and ordinarily does not fall prey to further oxidation by tyrosinase.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0718, TAXONOMY OF CALCAREOUS GREEN ALGAE
L.H. COLINVAUX, Ohio State University, Graduate School, Columbus, Ohio 43210

The work proposed is a taxonomic study of tropical marine algae, principally of the genus Halimeda, in the Indian Ocean. Extensive new collections were made by me as phycologist aboard the Te Vega on one of her cruises in the International Indian Ocean Expedition. Many additional collections obtained by other investigators participating in the International Indian Ocean Expedition have been sent for study.

The methods used for morphological study will include those found useful in my previous work on the genus Halimeda. Where important, comparisons will be made with related genera. Some cytological studies will be made of the fertile material and pertinent herbarium collections will be examined.

The complete program will provide additional knowledge of the morphology, reproduction, taxonomy and geographical distribution of Halimeda.

SUPPORTED BY U.S. National Science Foundation

5.0718, TAXONOMY OF CALCAREOUS GREEN ALGAE L.H. COLINVAUX, Ohio State University, Graduate School, Columbus, Ohio 43210

The work proposed is a taxonomic study of tropical marine algae, principally of the genus Halimeda, in the Indian Ocean. Extensive new collections were made by me as phycologist aboard the Te Vega on one of her cruises in the International Indian Ocean Expedition. Many additional collections obtained by other investigators participating in the International Indian Ocean Expedition have been sent for study.

The methods used for morphological study will include those found useful in my previous work on the genus Halimeda. Where important, comparisons will be made with related genera. Some cytological studies will be made of the fertile material and pertinent herbarium collections will be examined.

The complete program will provide additional knowledge of the morphology, reproduction, taxonomy and geographical distribution of Halimeda.

SUPPORTED BY U.S. National Science Foundation
5. LIVING SYSTEMS (NON-HUMAN)

5.0721. GROWTH AND CELLULAR MORPHOGENESIS IN NITELLA
P.B. GREEN, Univ. of Pennsylvania, Graduate School, Philadelphia, Pennsylvania 19104

Two projects are under investigation which attempt to capitalize technically on the fact that the young and growing Nitella internode is nonetheless a very large cell and thus suitable for physical manipulation. Project No. relation between a single cell's turgor pressure and its relative rate of elongation. Since turgor is believed to be the driving force for growth, its exact relation to the elongation rate is of theoretical interest. This relation has not been worked out for the single growing cell (except in a highly indirect manner) because turgor is traditionally measured by bringing cells into osmotic equilibrium with a known solution. Under these conditions -- no net movement of water -- the cell case must be maintained. The present method utilizes a intra-cellular manometer to measure turgor pressure regardless of whether the cell is in osmotic equilibrium or not. Project No. quantitatively measures the distortions taking place on the expanding curved surfaces of laterals during their initiation in Nitella. Laterals can be artificially induced on young internodes and the details of this process are to be compared with those of normal laterals and the apical cell. These structures express the immediate cause for change in cell shape. They must have their physical basis in the local structure and physiology of small regions of the cell. A tentative mechanism for the physics of the generation of a growth axis will be tested in the study of induced lateral initiation.

SUPPORTED BY U.S. National Science Foundation

5.0722. ECOLOGY OF TROPICAL DEEP WATER ALGAE
L.R. ALMODOVAR, Univ. of Puerto Rico, Institute of Marine Biology, Mayaguez, Puerto Rico (N00014-66-C-0330)

Objectives: Problems of bottom modification and biodeterioration are, in part, related to processes by which algae become attached to undrained substrates. The study of the ecology of algae and their succession on submerged structures will bring knowledge of the occurrence and distribution of these and other sedentary organisms to a predictive level.

Approach: Algae samples are being collected on a year-round basis by SCUBA divers in the 20-50 meter depth range and by dredge in the 50-75 meter range. Light, temperature, depth, and salinity data are being recorded for each sampling, as well as a description of each type of bottom encountered. Additionally, the ecological succession of algae on artificial substrates down to the 75 meter limit of algae growth is being studied. In both investigations, algae specimens are appropriately classified and analyzed with respect to the physical environmental data collected and their seasonal and vertical distributions.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0723. MARINE ALGAE OF THE MANGROVE ROOT COMMUNITY
L.R. ALMODOVAR, Univ. of Puerto Rico, Graduate School, Mayaguez, Puerto Rico

This grant supports ecological studies of the marine algae of the mangrove root community in Puerto Rico. Constituent organisms will be identified and their physical niche determined; growth rates and fruiting periods of dominant algae will be determined; factors influencing the occurrence and growth of characteristic mangrove species will be studied.

The emphasis will be on experimental ecological work. Apart from identification and determination, animals will be considered only if they affect the algae (by competing for space upon the roots, by providing surface for algal growth, or in feeding upon or living within the plants). Consideration will be given to the related community of the mud bottom of the mangrove shore and adjacent areas near the mangroves.

SUPPORTED BY U.S. National Science Foundation

5.0724. THE EFFECTS OF POLLUTION ON BENTHIC MARINE PLANT COMMUNITIES
J.T. CONOVER, Univ. of Rhode Island, Graduate School, King- ston, Rhode Island 02881

A concentration on algal community metabolism in coastal water at depths between 15 and 60 feet as related to 'good' and 'bad' waters is being conducted in the Narragansett Bay, Rhode Island to determine how concentrations of metabolites, and waste products in the bay effect plant growth. A modified McClosky method of plating out and obtaining colony counts is being used to determine animal-pollution gradients while OZR media is used to obtain counts on the natural populations of marine bacteria as an index to natural-pollution levels. Plastic hemispheres, equipped with temperature, light and oxygen probes are employed to obtain photosynthesis rates under certain conditions at various stations in the bay at various depths and pH and alkalinity data are taken to calculate the respiration rate. From these data a P/R ratio is obtained which has been shown to vary with animal pollution gradient. A search is now being made, for optimal and non-optimal growth enhancement habitats as related to the water quality. Incubator experiments will be continued to more precisely determine the effects of specific pollutants upon algal metabolism and to separate and clarify the role of salinity vs. pollution on plant growth. Studies are being continued on the meaning of epiphytes as an index to environmental stress on host plants along with a screening of epiphyte-host relationships morphologically and physiologically among many of the bentthic marine plants species. Some work will also be done on the effect of different 'energy levels' upon community metabolism in coastal waters by comparing habitats in slow moving water with those exposed to rapidly moving tidal currents and turbulence.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0725. ALGAL SUBSTANCES IN THE MARINE FOOL WEB
J.M. SIEBURTH, Univ. of Rhode Island, Graduate School, King- ston, Rhode Island 02891

The brown algae are being studied as a model for the role of attached algae in the microbial stages of the food chain. The rate and nature of the production of extracellular organic matter is being studied. Attempts will be made to characterize the phaeophyte polyphenols which seem to be directly involved in the formation of humic substances. The relationship of dissolved humic substances to particulate material will be investigated.

SUPPORTED BY U.S. National Science Foundation

5.0726. DEVELOPMENT OF A METHOD FOR CHRONIC TOXICITY BIOASSAY USING MARINE PLANKTONIC ALGAE

Objectives: To develop a method which will permit exposure of algal populations to constant low levels of test compounds, as well as monitoring of population dynamics or metabolic effects. Procedures: 1. Normal population dynamics and optimal medium exchange rates will be determined. 3. The utility of the apparatus will be tested by determining minimal requirements for a few known nutrients.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0727. STUDY OF NITROGEN METABOLISM IN MARINE ALGAE

Objectives: To develop a method based on in vivo enzymatic activity which can be used as a bioassay parameter in determining the biological effects of potential pollutants. Procedures: 1. An in vivo system for the assay of nitrate reductase activity in marine algae has been established. 2. Environmental factors which influence the expression of nitrite reductase activity will be investigated. 3. Cells preexposed to test compounds will be assayed for nitrite reductase activity. The results of such studies will be compared as indicators of biological effect with those of similar studies in which growth is measured.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl
5.0728, MEASUREMENT OF THE RATE OF CARBON DIOXIDE (C14) FIXATION INTO SUBCELLULAR FRACTIONS OF ALGAE

Objectives: To develop a rapid and sensitive method for detecting the metabolic effects of potential pollutants on cultures of marine algae.

Procedures: 1. Existing procedures for fractionating cells into classes of chemical constituents are being modified to permit processing of many small samples of algae. 2. Optimal labelling conditions and normal incorporation rates will be determined for each fraction. 3. Cultures preexposed to test substances will be allowed to fix Carbon-14 labeled CO2. The cells will then be fractionated, and rates of synthesis of each fraction will then be determined from isotope incorporation data. Results will be correlated with those of similar studies using growth rate as the measure of biological effect.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ct

5.0729, ORGANIC INFLUENCES ON CALCIUM CARBONATE CEMENTATION
R. REZAK, Texas A & M University System, Graduate School, College Station, Texas 77843

An investigation will be carried out on the role marine algae play in cementation of sediments. Initially a number of species will be collected and grown in pure cultures to allow identification of compounds present in their organic matrices. Correlation of these with the geometrics and crystallographic form of the secretions will be sought.

SUPPORTED BY U.S. National Science Foundation

5.0730, SYMBIOSIS BETWEEN MARINE ALGAE AND INVERTEBRATES
D.L. TAYLOR, Marine Biolog. Assn. of U.K., Plymouth - Citadel Hill, United Kingdom

The present work is a study of the physiology, biochemistry and ultrastructure of the symbiotic associations formed between marine algae and invertebrates. The specific purpose of this investigation is twofold, and consists of (1) a study of the taxonomy, distribution and ultrastructure of the organisms involved, and (2) an examination of how these associations are formed and a determination of their significance and potential value to the bioeconomy of the sea.

Previous work has shown that such associations may be divided into two distinct categories, (1) the zooxanthellae-invertebrate association of classical literature, which poses numerous problems of taxonomy, distribution, and significance which are still relatively unknown, and (2) the more recent discovery of chloroplast-containing symbiotic organelles in the digestive glands of several species of Opistobranchs belonging to the Order Saccoglossa. Both of these aspects are being investigated along similar lines, exploring new techniques of utilizing the electron microscope as an instrument of cytological and functional investigation by employing various methods of ultrastructural cytchemistry and autoradiography.

The results of the projected study should provide valuable information relating to the taxonomy and distribution of the species of microalgae involved in zooxanthellae-invertebrate associations, as well as reveal something of the nature and significance of these associations along with others involving chloroplasts as symbiotic organelles.

SUPPORTED BY U.S. National Science Foundation

5.0731, LACUSTRINE AND ESTUARINE FUNGI
R.A. PATTERSON, Virginia Polytechnic Institute, Graduate School, Blacksburg, Virginia 24061

The proposed research is a continuation of an investigation of lacustrine fungi presently supported by National Science Foundation (GB-2703). It is planned to continue studies on estuarine fungi initiated in September, 1963. Research on these organisms from both fresh and salt waters has two phases. The first is a taxonomic and morphological investigation of fungi which infest plankton. In addition it involves a study of host ranges, host-parasite relationships, and their significance to the taxonomy of the lower fungi. Current studies indicate that research on host ranges will be profitable in clarification of some chytridiaceous taxa. Another aspect of the work on planktonic fungi will be an investigation of the vertical and horizontal distribution of fungal parasites of phytoplankton.

The second part of this program is a study of the occurrence of benthic fungi. The investigator believes these fungi to be more important in the breakdown of dead organic matter in lake and estuarine bottoms than is presently recognized by most limnologists and marine biologists. Some studies of benthic fungi have been made in marine waters, but very few investigations have been conducted in fresh water with the specific purpose of finding benthic fungi. Previous investigation of bottom decomposers has dealt primarily with bacteria, or have employed only bacteriological techniques in studying fungi.

SUPPORTED BY U.S. National Science Foundation

5.0732, ALGAE AS FOOD FOR MARINE INVERTEBRATE LARVAE HELD IN THE LABORATORY

Shellfish explorations are primarily concerned with benthic invertebrate populations. Its ultimate objectives are to define, on a seasonal basis, the quantitative and qualitative distribution of aquatic invertebrate resources having a potential for commercial utilization and to provide an appraisal of those resources. In its full extent, shellfish explorations is a cataloging of benthic invertebrate fauna in time and space.

The area stressed in the Northeastern Pacific and primarily from northern California to southwestern Alaska. The explorations are carried out by the Seattle, Washington based research vessel John N. Cobb.

Shrimp explorations have been conducted in Alaskan waters and off the coasts of Washington and Oregon. Commercial concentrations of shrimp were discovered and the catch ratios were increased by introduction of new gear.

Scallop explorations, initiated in 1963, will be conducted for the next two years. Future explorations include clams, crabs, and reassessment of all commercial invertebrate areas. Biological observations will also be made.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0734, MORPHOGENESIS OF THE DIATOM SHELL
J. LEWIN, Univ. of Washington, Graduate School, Seattle, Washington 98122

Diatoms form new silica shells during vegetative cell division and also at other periods during their life cycle. The formation of new silica shells takes place inside the cell. While the silica shell is growing, it is tightly enveloped by a specialized membrane (the silicalemma), which apparently has the sole function of concentrating and solidifying the silica. The origin, structure and function of this very specialized membrane, as well as its relation to adjacent cell contents, will be investigated using cells of several different diatom species in various developmental stages. The research project consists of two closely associated parts, one mainly concerned with the cultural and physiological aspects of the investigation and the other with morphological aspects.

SUPPORTED BY U.S. National Science Foundation
5. LIVING SYSTEMS (NON-HUMAN)

5.0735, PHYSIOLOGY AND ECOLOGY OF MARINE DIATOMS
J.C. LEWIN, Univ. of Washington, Graduate School, Seattle, Washington 98122

Studies on the physiology, nutrition, and systematics of marine diatoms in relation to their ecology will be investigated. In particular, species belonging to the important marine genus Chaetoceros will be studied in cultures to clarify their systematics and their nutrient requirements and thus help to explain their natural occurrences. Special attention will also be given to the specific diatom microflora living on the surfaces of sand grains. The most important species will be identified and cultured, and will also be studied in their natural habitat.

Physiological studies which have a direct bearing on measurements of marine primary productivity will be made. These will involve critical investigations of respiration in marine diatoms and other phytoplankton organisms.

SUPPORTED BY U.S. National Science Foundation

5.0736, ASSESSMENT OF LAKE SUPERIOR LAKE TROUT
R.L. PYCHA, U.S. Dept. of Interior, Research Station, Ashland, Wisconsin

Control of the sea lamprey and large-scale plantings of lake trout in Lake Superior have brought about a rapid buildup of lake trout stocks. Close surveillance of the changes in the juvenile, legal sized, and spawning stocks is required for rational utilization in the future. Data currently utilized are collected by contract fishermen using conventional commercial gear and by the Bureau's research vessel Siscowet using experimental gill nets and trawls.

Present research, designed to assess the rehabilitation of the lake trout, includes inquiry into: changes in abundance of the size groups of the commercial portion of the artificially propagated lake trout to the commercial catch and the relative success of various hatchery plants; changes in age structure and growth rates of the populations; comprehensive evaluation of the effect of hatchery-reared fish on the juvenile and spawning populations; differences in the habits and distribution between hatchery-reared and native lake trout; the identities and biological features of discrete offshore populations; and the relationship between lamprey predation and the size of the lamprey population. Data on food habits and other features of the life history are collected incidentally to other studies.

Techniques and findings of research on lake trout in Lake Superior should aid similar studies on Lakes Michigan and Huron.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

SG. MICROORGANISMS—PLANKTON
(see also Chapter 8j For Marine Fouling and Microbial Corrosion)

5.0737, MARINE BIOLOGICAL INVESTIGATIONS—SURFACE ZOOPLANKTON PROJECT
J.C. QUAST, U.S. Dept. of Interior, Biological Laboratory, Auke Bay, Alaska

A two-year sampling period using Miller High Speed Samplers is completed, the samples have been analyzed, and a summary manuscript is in the terminal stages of completion. The project summarizes the identity and density distribution of common zooplankters in the upper water strata in the Auke Bay vicinity over the sampling period. The bay is regarded as representative of the northeastern part of the 'inside' marine waters of Southeastern Alaska.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0738, DEEP-WATER ZOOPLANKTON OF THE SARGASSO SEA
A.L. BROOKS, Bermuda Biol. Sta. For Res., Saint George, Bermuda

The investigators are collecting, at monthly intervals for one year, four samples over 500 meter depth ranges down to 2000 meters at Station 'S', 15 miles SE of Bermuda in 1600 fathoms of water. The zooplankton samples are being studied qualitatively and quantitatively. Hydrographic observations and chlorophyll a determinations are being done at the same time. The objective is to gain a better understanding of the plankton of deep water, how it changes through the year at a single station, both in species composition and in mass.

SUPPORTED BY U.S. National Science Foundation

5.0739, ZOOPLANKTON STUDIES IN BIG LAGOON, CALIFORNIA
G. CRANDELL, Humboldt State College, Graduate School, Arcata, California 95521

1) Temporal distribution based on biweekly samples taken with a Clarke-Bumpus plankton sampler.
2) Vertical distribution of zooplankton and vertical diurnal migration. Samples collected with a Clarke-Bumpus plankton sampler and water bottles.

Salinity, temperature and oxygen data taken concurrently with all plankton samples.

SUPPORTED BY No Formal Support Reported

5.0740, MICROBIOLOGICAL CONTROL IN NAVY AND MARINE CORPS OPERATING ENVIRONMENTS
N.A. VEDROS, Univ. of California, School of Public Health, Berkeley, California 94720

This research is concerned with microbiology as it applies to the Navy operating environment. Studies under this program will help establish which organisms are responsible for fouling and corrosion, or any other form of microbiological deterioration. Other studies will be concerned with performance of man and his equipment in the territorial environment. Research involving the effects of hypo-and hyperbaric conditions on the human microbial flora, in both static and aerolized state will be undertaken.

This effort is directly related to Navy problems in biodeterioration. It is closely associated with the study of problems encountered in closed environmental systems such as found in deep sea habitats.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0741, SYSTEMATIC STUDIES OF CERTAIN MARINE PARASITIC WORMS
W.E. MARTIN, Univ. of Southern California, Graduate School, Los Angeles, California 90007

This investigation has three quite separate aims within the broad field of marine helminth parasitology. First, life histories of species of the taxonomically enigmatic trematode genus Renicola will be studied, and the results should provide a firm base for identifying species within this group.

Second aim concerns a nematode that is a spiruroid but with L-3 simulans of filarioid. Spiruroids are obtained by ingesting infective stages in intermediate hosts, perhaps always arthropods, whereas filarioids are transmitted by the blood sucking activities of such hosts. Spiruroids localize in the vertebrate in places affording an exit for their eggs but the species in question seems to be an exception. The two groups form one order and helminthologists believe that the filarioids evolved from spiruroids in a manner paralleling that which apparently occurred in sporozoa and haemoflagellate protozoans. Hence the life history of these species would be of particular interest.

Thirdly, a new acanthocephalan worm from a marine fish will be studied from various approaches. Little is known concerning the life history of these thorny-headed worms.

SUPPORTED BY U.S. National Science Foundation

5.0742, CHONOTRICH CILIAE PROTOZOA
J.L. MOHR, Univ. of Southern California, Graduate School, Los Angeles, California 90007

Chonotrich ciliates, attached vaselike protozoans confined to crustaceans and apparently reflecting in their own evolution something of the evolution of the crustacean hosts, are under monographic study with emphasis on geographic and host dis-

196
5. LIVING SYSTEMS (NON-HUMAN)

5.074, ECODYNAMICS OF MARSH FORAMINIFERA
F.B. PHLEGER, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

This involves the quantitative measurement of features of marine environments which affect distributions of organisms. This should be supplemented by ecological laboratory experiments based on the results. Study of marine marshes is another area for investigation. Some data are presented to show the importance of measuring population variability as an index of the relative variation within natural environments. Other areas of investigation are productivity of benthonic foraminifera, re-investigation of depth assemblages, effect of low oxygen content on populations, depth of mixing of sediments, and concentration of trace elements in tests of foraminifera and its effect on the geochemistry of the sediments.

SUPPORTED BY U.S. National Science Foundation

5.0745, Ecology and Sedimentary Patterns of Foraminifera
F.B. PHLEGER, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

This involves the quantitative measurement of features of marine environments which affect distributions of organisms. This should be supplemented by ecological laboratory experiments based on the results. Study of marine marshes is another area for investigation. Some data are presented to show the importance of measuring population variability as an index of the relative variation within natural environments. Other areas of investigation are productivity of benthonic foraminifera, re-investigation of depth assemblages, effect of low oxygen content on populations, depth of mixing of sediments, and concentration of trace elements in tests of foraminifera and its effect on the geochemistry of the sediments.

SUPPORTED BY U.S. National Science Foundation

5.0746, Microzooplankters in the Marine Food Chain
J.D. STRICKLAND, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

Using a submersible sea water pumping system with deck-mounted plankton collecting unit, research under this grant includes: 1) an investigation of the vertical distribution of micro-zooplankton and their relationship to other seston components over the upper 200 m in several different marine environments; 2) a direct comparison of the relative abundance of micro-zooplankton and larger zooplankters; 3) a study of weekly changes over a five-month period in micro-zooplankton populations in relation to other biological parameters at three inshore locations; and 4) participation in EASTROPAC 76 (Eastern Tropical Pacific Biological Program) cruise during which the vertical distribution of micro-zooplankton at 12 sites in that little-studied ocean region was examined.

Efforts are being made to establish laboratory cultures of micro-zooplankters such as the tintinnid ciliates believed to be important in marine food chains so as to provide experimental animals for trophodynamic studies.

This work is a tripartite investigation using the facilities of the

SUPPORTED BY U.S. National Science Foundation

5.0747, Ecodynamics of Marsh Foraminifera
F.B. PHLEGER, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

Ecology of marsh foraminifera in marine marshes in several areas of the world has been undertaken. The patterns are interpreted in terms of relative rates of deposition of sediment, of organic productivity and of the dynamics of the lagoon or delta area in which the marsh is present.

SUPPORTED BY Amer. Chemical Society

5.0748, Microzooplankters in the Marine Food Chain
J.D. STRICKLAND, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

Using a submersible sea water pumping system with deck-mounted plankton collecting unit, research under this grant includes: 1) an investigation of the vertical distribution of micro-zooplankton and their relationship to other seston components over the upper 200 m in several different marine environments; 2) a direct comparison of the relative abundance of micro-zooplankton and larger zooplankters; 3) a study of weekly changes over a five-month period in micro-zooplankton populations in relation to other biological parameters at three inshore locations; and 4) participation in EASTROPAC 76 (Eastern Tropical Pacific Biological Program) cruise during which the vertical distribution of micro-zooplankton at 12 sites in that little-studied ocean region was examined.

Efforts are being made to establish laboratory cultures of micro-zooplankters such as the tintinnid ciliates believed to be important in marine food chains so as to provide experimental animals for trophodynamic studies.

This work is a tripartite investigation using the facilities of the

SUPPORTED BY U.S. National Science Foundation

5.0749, Standing Stock and Growth of Bacteria in the Sea
J.D. STRICKLAND, Univ. of California, Inst. of Marine Resources, San Diego - La Jolla, California 92038

Studies of the ATP assay have continued during the past year with investigations being made into the ATP content of several phytoplankton organisms as well as several species of marine bacteria. In addition, ATP profiles were obtained on two cruises. The existence of a large population of small, pigmented, flagellated organisms at great depths in the ocean has been confirmed. Some of these forms are presently in culture as are some unpigmented protozoans from the same samples. Also phytoplankton cells, typical of the euphotic zone, have been cultured from samples obtained from down to 900 meters. Work is in progress to attempt to ascertain how such cells can survive under prolonged deep sea conditions.
5. LIVING SYSTEMS (NON-HUMAN)

A detailed analysis was made of the glucose metabolism of a marine Pseudomonas sp. It is concluded that if one wishes to extend the 'relative heterotrophic potential' method to include such parameters as in situ velocity of substrate utilization and residence time of natural levels of substrate, the velocity of assimilation should not be used. It was found that the amount of C-14 labeled CO2 produced from C-1 and C-3,4 labelled glucose is a better estimate of substrate metabolism. It is believed that the 'relative heterotrophic potential' method should not be extended to include these parameters but should be applied as originally suggested, as a rough survey of heterotrophic activities in the sea.

SUPPORTED BY U.S. Dept. of Hith. Ed. & Wel. - P.H.S.

5.0750, BIOCHEMICAL STUDIES ON SILICEOUS SKELETAL FORMATION

B.E. VOLCANI, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

Electron microscopic studies on the morphogenesis of the wall of N. pelliculosa suggested that the Golgi apparatus give rise to a procession of vesicles which integrate as a compartmented structure in which silicon is concurrently deposited. The role of the Golgi in wall formation will be intensively investigated by histochemical and radiotographic techniques.

Biochemical studies on the formation of the organic material in the wall of N. pelliculosa showed that proteinaceous and polysaccharide materials are formed just prior to and during silicon uptake. Additional polysaccharides are formed after silicon uptake has ceased. The sequence according to which each of the polysaccharides is synthesized will be determined.

A system of sequential column chromatography was developed which enabled us to separate the many unknown ninhydrin-positive compounds found in the diatom wall. A number of pure compounds have thus been obtained, and their chemical characterization will be established.

SUPPORTED BY U.S. Dept. of Hith. Ed. & Wel. - P.H.S.

5.0751, COMPARATIVE PHYSIOLOGY OF BAROPHILIC BACTERIA

C.E. ZOBELL, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

This proposal provides for investigating the cultural requirements and comparative physiology of barophbic bacteria, meaning those which grow at deep-sea pressures. Such bacteria are to be compared with barophbic variants, which are adversely affected by increased pressures. Efforts will be made to obtain more species of barophbic bacteria. The most likely source of such bacteria is the deep sea, where pressures up to nearly 1100 atm prevail, but garden soil, shallow water sediments, and other materials will also be examined for the presence of barophiles. The nutrient requirements, osmotic pressure tolerance, temperature range of growth, and other cultural conditions will be considered in comparing barophbic with barophbic cultures.

Emphasis will be placed upon investigating the biochemistry and physiology of bacteria cultivated at increased pressure, with special reference to protein synthesis, nucleic acids, and various enzyme systems. Cell wall composition, saturation of lipids, and disulfide linkages will be compared.

SUPPORTED BY U.S. National Science Foundation

5.0752, ORGANIZATION OF THE ACADEMYS COLLECTION OF RECENT MARINE, TERRESTRIAL, AND FRESH-WATER INVERTEBRATES

A.G. SMITH, Calif. Academy of Science, San Francisco, California 94118

The Academy's Department of Invertebrate Zoology was established in 1960 to curate and maintain a large collection of preserved invertebrates and to make it available for scientific study by workers in invertebrate zoology. As a result of past work, about 14,000 lots representing approximately 150,000 specimens have been curated and arranged systematically on collection shelves. The present project is a continuation of this work on the remainder of the collection, which is estimated to contain 30,000 lots and 300,000 specimens on completion. Special attention is given to the care of many type specimens already in the collection. Lists of these types are now in press for general distribution.

The Academy's objective is to make this collection a permanent centralized repository of preserved invertebrates readily available for research.

SUPPORTED BY U.S. National Science Foundation

5.0753, MICROSTRATIFICATION OF MARINE ZOOPLANKTON

C.M. BOYD, Dalhousie University, Graduate School, Halifax - Nova Scotia, Canada

This is a study of physiological factors regulating growth and distribution of marine zooplankton. It attempts to correlate small scale clumping of zooplankters in the water column with environmental inhomogeneities. The non-random distribution of zooplankters may be associated with strata or boluses of thermally inhomogeneous water in a larger water column composed of many of these strata of varying size and duration. A electronic plankton counting device will be used to determine the spatial distribution and size of individual plankters and simultaneously record the temperature, depth and ambient light intensity at the point of capture. Analysis of this information will be aided by computers and plankton collections will be examined microscopically for correlation analysis.

SUPPORTED BY U.S. National Science Foundation

5.0754, ECOLOGICAL SIGNIFICANCE OF PARTICULATE MATTER IN THE SEA

G.A. RILEY, Dalhousie University, Graduate School, Halifax - Nova Scotia, Canada

The principal investigator and two associates on the project, Dr. Edward Batoosingh and Barbara Keshwar, completed a study of various factors involved in production of particulate organic matter in sea water by adsorption on bubbles. The paper is new in press in Deep-Sea Research. D. C. Gordon completed a doctoral thesis entitled 'Studies on the distribution and composition of non-living particulate organic matter in the North Atlantic Ocean'. Various projects are underway on relations of zooplankton and bacteria with organic matter, and a Research Associate, Dr. R. O. Fournier, is working on deepwater heterotrophic algae. The principal investigator is writing a review paper on particulate organic matter for 'Advances in Marine Biology'.

SUPPORTED BY U.S. National Science Foundation

5.0755, SYSTEMATICS, BIOLOGY, AND HYDROGRAPHIC RELATIONS OF SOME SPECIES OF CALANUS (CRUSTACEA, COPEPODA)

B.M. BARY, Univ. of British Columbia, Graduate School, Vancouver - British Columbia, Canada

This research is concerned with a definitive analysis of the distribution and morphological variation of the copepod genus Calanus, an animal which occupies a primary position among planktonic populations; often dominating a community and covering large areas of the upper sea layers. The investigator is attempting to determine the hydrographic water mass factors which support and/or limit the distinct populations of this animal.

An understanding of the biological and ecological factors which influence distribution of Calanus is essential in hydrobiological studies. With information gained from these kinds of studies predictions can be obtained relating to the dispersal and occurrence of pelagic forms of boring and fouling organisms, those capable of acoustic interference and/or luminescence, and those forms which constitute toxic hazards to personnel.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0756, ECOLOGICAL INVESTIGATIONS OF MCMURDO SOUND ZOOPLANKTON

J.L. LITTLEPAGE, Univ. of Victoria, Graduate School, Victoria - British Columbia, Canada

Quantitative discrete depth macrozooplankton samples and simultaneous detailed oceanographic observations taken from
5.0757. NEW APPROACHES TO BIOFOULING ASSAY
R.J. BENOIT, General Dynamics Corporation, Groton, Connecticut
A. Tests indicate that a simple, quick, laboratory bio-assay procedure can be developed for use in marine fouling research. B. The evaluation of anti-fouling coatings in granular form (a new approach) appears to be feasible. C. Three test organisms were evaluated as candidates for a laboratory bio-assay procedure. D. Leaching rates obtained in granular, copper base paints was in the order of 0.1 to 0.3 mg Cu per day from 0.5 gm of powder in 100 ml sea water. The rates were consistently higher in granular paints of small particle size, and increased slightly daily for three days. These leaching rates are comparable to about 100 micrograms Cu/cm²/day and are greater than rates reported in the literature. These leaching rates are comparable to about 100 micrograms Cu/cm²/day and are greater than rates reported in the literature. These leaching rates are comparable to about 100 micrograms Cu/cm²/day and are greater than rates reported in the literature. These leaching rates are comparable to about 100 micrograms Cu/cm²/day and are greater than rates reported in the literature.

SUPPORTED BY U.S. National Science Foundation

5.0758. MARINE SULFUR OXIDIZING BACTERIA
R.C. TILTON, Univ. of Connecticut, Graduate School, Hartford, Connecticut 06105
The project concerns the distribution and characterization of marine thiobacilli from waters off coastal New England. Organisms will be isolated and studied as to their environmental and nutritional requirements. New methods will be developed for studying autotrophic marine bacteria in their natural habitat. Representative thiobacilli will be studied intensively for mechanisms of pH regulation.

SUPPORTED BY General Dynamics Corporation

5.0759. ALGAL FOODS OF SHELLFISH (MICROORGANISMS AFFECTING SHELLFISH PROGRAM)
R. UKELES, U.S. Dept. of Interior, Biological Laboratory, Milford, Connecticut
Recent interest in aquaculture as a means of increasing the world food supply and saving commercially valuable species from extinction, has focused attention on the role of unicellular algae in the aquatic environment. The methods of shellfish culture being developed for commercial hatcheries make it necessary to devise means of raising food organisms, namely unicellular algae. We are providing large amounts of unialgal cultures for a pilot plant hatchery and also working on more efficient methods of culture, harvesting and storing algal cells. We have investigated the effects of pollutants found in the environment, as pesticides, herbicides and detergents, on algal growth. The nutritional requirements and effects of antimetabolites on growth of various species are under study, as well as physical factors important in growth, such as pH, temperature, and light.

SUPPORTED BY U.S. National Science Foundation

5.0760. LIGHT RECEPTOR CONTROL OF THE DIURNAL RHYTHM OF ENZYME SYNTHESIS IN THE BIOLUMINESCENT MARINE DINOFLAGELLATE GONYAULAX POLYEDRA
NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY National Council to Combat Blindness Inc.

5.0761. AN ANALYSIS OF PHOSPHORUS AND NITROGEN COMPOUNDS IN TIDAL MARSHLAND DRAINAGE - LABORATORY PROCEDURES
F.C. DAIBER, State Board of Game & Fish, Dover, Delaware
Objective: An evaluation of the effects of various types of marshland management on the diurnal and seasonal concentrations of phosphorus and nitrogen in tidal marshes. Procedures: The water samples collected in the field will be processed in the following manner. 1. Inorganic phosphorus - Reimold, R. J., 1965. An evaluation of inorganic phosphate concentrations of Canary Creek Marsh. This procedure requires that inorganic phosphorus determination be made immediately after sample collection to avoid errors due to sample storage. The determination, a spectrophotometric technique, requires electrical power. 2. Total phosphorus - Water samples for total phosphorus concentrations are processed upon return to the Bayade Laboratory. The sample is oxidized in an ordinary autoclave according to the technique of Menzel, D. and Corwin, N. 1965. This procedure converts all phosphorus to the inorganic form which can then be measured by the technique of Reimold as cited above. 3. Organic phosphorus concentration is determined by the difference between the initially measured inorganic form and the subsequent total phosphorus determination. 4. Nitrate nitrogen - Wood, E.D., F. A. J. Armstrong, and F. A. Richards. 1967. This technique offers extreme accuracy and is easily used in the field. In this new method nitrate is converted to nitrite and then measured. 5. Nitrite nitrogen - Strickland, J.D.H., and T. R. Parsons. 1960. A manual of sea water analysis. Fish Res. Bd. Can. 125:71-74. 6. Ammonia nitrogen - Roskan, R., and D. de Langen. 1964. A simple colorimetric method for the determination of ammonia in sea water. Anal. Chim. Acta 30: 56-59. 7. Salinity will be measured by the conductance method using an induction salinometer.

The results will be processed for computer evaluation of the various suspected relationships between the phosphorus and nitrogen concentrations and related physical parameters measured. The I.B.M. computer program STUFF (Sixteen Twenty Universal Function Fitter) will be used to determine significant relationships between organic phosphorus, inorganic phosphorus, total phosphorus, nitrate, nitrite, ammonia, salinity, water temperature, air temperature, tide state, time, lunar phase, day of year and weather. Other statistical and graphical techniques may also be employed to interpret the data.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish. Delaware State Government

5.0762. BIOCHEMICAL EFFECTS OF MICROORGANISMS UPON THE SAL- MARSH ENVIRONMENT - LABORATORY PROCEDURES
F.C. DAIBER, State Board of Game & Fish, Dover, Delaware
Objective: To enumerate and identify the microorganisms indigenous to various salt marsh environments, and to relate the known metabolic processes of these microorganisms to the chemical cycles currently under investigation in these marshes. Procedures: The sediment samples collected in the field will be processed in the following manner: 1. Weighed samples from each sediment horizon will be placed in dilution bottles containing the appropriate diluent, serial dilutions made and the final dilution will be selectively treated to enhance the growth of the organisms believed to be present in the sample. The number of bacteria in each sediment horizon will be ascertained by plating aliquots from each final dilution onto solid growth media. Replicate plates will be made for each sample. After incubation, the colonies growing on the plates will be counted. The number thus attained represents the number of bacteria in the sample when multiplied by the dilution factor. 2. Identification will be made of the more numerous bacteria growing on the enumeration plates. This will be done by standard bacteriological tests. These include biochemical reactions of the bacteria in specially formulated media and morphological reactions of the bacterial cull to selective stains. 3. Water pH will be measured by means of a pH meter. 4. Water salinity will be measured by the conductance method.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish. Delaware State Government
5. LIVING SYSTEMS (NON-HUMAN)

5.0763, BIOCHEMICAL EFFECTS OF MICROORGANISMS UPON THE SALT MARSH ENVIRONMENT - FIELD TECHNIQUES
F.C. DAIBER, State Board of Game & Fish, Dover, Delaware

Objective: To enumerate and identify the microorganisms indigenous to various salt marsh environments, and to relate the known metabolic processes of the principal organisms found to the chemical cycles currently under investigation in these marshes.

Procedures: Sediment samples for bacterial analysis will be collected at locations in Delaware tidal marshes which represent the following conditions: unditched marsh exposed to normal flooding, man-made low level impoundments, high level impoundments, and ditched marsh exposed to normal flooding.

Once every two weeks cores will be taken from each station to a depth which represents the sediment horizons of the station. The sample will immediately be removed from the corer and aseptically transferred to clean polyethylene boxes with tight-fitting lids.

The core samples will be transported immediately to the laboratory so that drying will be prevented or minimized before testing.

In addition, sediment temperatures at the time of sample collection will be measured, and water for salinity and pH determinations at each station will also be collected.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.
Delaware State Government

5.0764, STUDY OF NORTH AND EQUATORIAL ATLANTIC PLANKTONIC FORAMINIFERA
R. CIFELLI, Smithsonian Institution, Washington, District of Columbia 20560

The description and determination of abundance and distributional patterns of the present planktonic foraminiferal fauna in the surficial waters of the North and Equatorial Atlantic. Study of the relationship between foraminiferal and water mass distributions.

SUPPORTED BY Smithsonian Institution

5.0765, SYSTEMATICS AND MORPHOLOGY OF THE SIPUNCULID LARVAE OF THE INDIAN OCEAN
M.E. RICE, Smithsonian Institution, Washington, District of Columbia 20560

A comparative study will be made of the morphological features of planktonic sipunculid larvae, collected by the International Indian Ocean Expedition, and the findings will be related to the existing descriptions in the literature. Sipunculid larvae have been found in most of the oceans of the world, but in only one instance has it been possible to make a specific identification. Identification will be attempted in this study, but it is probable that final specific identifications will necessitate a study of development, with eggs and sperm of known adults. Sixty-six specimens have been received from the Smithsonian Oceanographic Sorting Center and work on them will commence some time in 1967.

SUPPORTED BY Smithsonian Institution

5.0766, BIOCHEMISTRY OF MARINE ORGANISMS
J.M. LEONARD, U.S. Navy, Research Laboratory, Washington, District of Columbia

The standard approach to marine biodeterioration, fouling included, has been to submerge a material in the sea and to observe some relatively gross result after an exposure of weeks or months, or even longer. This approach ignores the less conspicuous chemical and biological successions that are essential to the macro result. We propose laboratory and field studies in which the successions are carefully studied and correlated with the total ecology. Phytoplankton determinations generally have been slow laborious work, with station-by-station sampling as an inadequate substitute for rapid, continuous measurements. Continuous towing of a turbidity-sensing device afford a non-specific indicator of plankton distributions. Two novel spectrophotometric approaches offer promise of (1) rapid survey, from aircraft, perhaps, giving both qualitative and quantitative information, and (2) a laboratory method which avoids the delays and encumbrances of the conventional extraction-colorimetric procedures.

(1) Devise and develop methods for determining phytoplanktonic populations (a) in situ by optical scanning, and (b) in the laboratory by spectrophotometric measurements of planktonic deposits on filters. (2) Explore a novel approach to the direct measurement of the density of seawater. (3) Make preliminary measurements of adsorptions on submerged surfaces. (4) Explore means of controlling surface bioluminescence.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0767, BIOCHEMICAL AND BIOPHYSICAL STUDIES OF THE MARINE ENVIRONMENT
D.F. WILSON, U.S. Navy, Research Laboratory, Washington, District of Columbia

(a) To correlate the occurrence of specific planktonic microorganisms and their biological and biochemical activities and products with the occurrence and properties of peculiar distributions of matter or energy in the sea. (b) To describe, on an experimental basis, the nature, specific origins, and transformations of organic matter produced in the marine environment by selected microplankters through metabolic activity and by decomposition (autoxylotic and microbial). (c) To determine whether or not the copepods influence the marine environment significantly enough to necessitate their inclusion in future research on the sources and transformations of organic matter.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0768, TAXONOMY AND ECOLOGY OF INSHORE MARINE MICROBIOTA
J.L. JACOB, Individual Grants, Florida

This envisages publication of an illustrated account, with keys, of inshore marine and brackish water protozoa and microscopical algae, both planktonic and benthic. Their commonness or rareness, cosmopolitan or restrictive distribution will be covered by ecology, especially with reference to pollution, nutrient richness and water poor in nutrients. Regions covered to date are the Atlantic Coast, Florida to Woods Hole, Massachusetts; The Florida Gulf Coast; the California coast, the island of Oahu and Guanabara Bay, Brazil.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0769, MICROBIAL CORROSION IN THE MARINE ENVIRONMENT
P.L. GUGURO, Florida Atlantic University, Graduate School, Boca Raton, Florida

Objective: This research is a comparative examination of the activities of microorganisms related to chemical transformation. Information obtained can be applied to the mechanisms involved in microbial corrosion in the marine environments.

Approach: Research effort will be devoted to determining the metabolic means by which marine fungi degrade carbon under environmental conditions dissimilar to those of terrestrial fungi.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0770, DETERMINATION OF CHLOROPHYLL DERIVATIVES
C.S. TENTSCH, Nova University, Graduate School, Fort Lauderdale, Florida

As part of the more general study of the decomposition of plant matter in the ocean, the sequence of decomposition of chloroplastic pigments in marine phytoplankton is being investigated. Because of the general sparsity of pigments in oligotrophic waters, certain techniques had to be devised where very small quantities of chloroplastic material could be measured. One of the tools being utilized has been fluorescence.
technique has been indispensable for an examination of the total amount of pigment as well as some of the derivatives. The results to date indicate that chlorophyll derivatives are found throughout the euphotic zone in most water masses. Their percentages are much larger near the base of the euphotic zone than in the well-lighted portion. The principle decomposition product appears to be a phaeo-phase pigment. This pigment results from chlorophyll losing its magnesium. It is brought about by the action of either organic acids formed by the plants themselves during autolysis or the action of acids being grazed by benthonic zooplankton.

We have also developed a batch filtration device which has allowed us to concentrate large amounts of particulate matter. By thin-layer chromatography we have been able to separate chloroplastic pigments from the particulate and have found most of the major chlorophylls and the derivatives, phaeophaeophytin, phaeophorbide and chlorophyllide. The amounts of these pigments appear to be highly variable. Factors responsible for conversion of chlorophyll to the derivatives in situ are being investigated.

SUPPORTED BY U.S. National Science Foundation


Phase 1. Distribution of selected species of zooplankton in the surface mixed layer of the tropical Atlantic Ocean. The zoogeographical distributions of zooplankton will be studied. The distributions will be collated with the physical and chemical environment with special attention to areas of divergence, convergence, upwelling, river runoff, and water mass interaction. Seasonal variations in distributions will be examined wherever possible.

Phase 2. The vertical distribution of zooplankton in the Gulf of Guinea. I. The vertical extent of diurnal migrations 2. Modification of vertical distribution by such hydrographic features as undercurrents, thermocline, river effluent, etc. 3. The definition of surface and deep communities and their interactions 4. Variation in adult-to-juvenile ratios as an index to community production. 5. Non-random concentrations of zooplankton as a potential food pasture for tuna forage organisms.

Phase 3. Design and construction of a discrete depth zooplankton sampler. A multiple opening-closing plankton sampler to assess the vertical stratification of zooplankton in the upper 200 meters of the sea will be designed.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.


Ecology and taxonomy of scombrid larvae in the Gulf of Guinea. The material from EQUILANT II and III already reported on. Phase 3. Distribution and ecology of scombrid larvae from the western Atlantic. The material from GERONIMO cruises 6, 7, and 8 and UNDAUNTED cruises 2 through 10 will comprise the basis for this study. This study will commence following solution of the problems of identification (Phase 7-9). The material from GERONIMO 8 has been analyzed and a report completed in FY 1967. Phase 4. Food of scombrid larvae. The larval period, from the hatching as well as some of the most critical in the life of the tunas. Therefore, it is essential to know which trophic levels are being preyed upon by these larvae. Phase 5. Distribution and ecology of scombrid eggs. Eggs do not actively move through the water, thus their distribution and numbers will give more finite answer to the abundance and location of tuna spawning than the distribution of larvae. Inherent difficulties in the identification of tuna eggs delays the start of this phase until reliable methods of identification can be formulated. Phase 6. Ecology of important species other than scombrids, fish eggs, and larvae to be studied from abundant existing material. To commence as opportunity and needs demand. Phase 7. Analysis of external larval characters to define the scombrid types. Phase 8. Analysis of internal micro-anatomical characters of larvae to delineate types and confirm species' identities with larval types. Phase 9. Taxonomic investigation of scombrid eggs to associate types of eggs with species.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0773. GENERAL SYSTEMATIC STUDIES OF THE OCTOCORALLIA OF THE TROPICAL ATLANTIC F. M. BAYER, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124

The proposed research deals with the systematics of tropical Atlantic octocorals. These coelenterates are one of the most important groups of sessile animals in the reef habitat and in many benthic communities. Reliable methods of identification can be formulated. Phase 1. Identification, distribution, and ecology of larvae of the Octocorallia in general, and are preliminary to the investigations of the more complicated (and taxonomically confused) Indo-Pacific fauna. In the two-year period of the present grant, research will be concentrated upon the West Atlantic fauna, and it is anticipated that approximately one-half of the revision of that area can be completed.

SUPPORTED BY U.S. National Science Foundation

5.0774. RELATIONSHIP OF PHOTOSYNTHESIS TO RESPIRATION OF OCEANIC MICROALgae.J. S. BUNT, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124

In recent years, most measurements of primary productivity have been based on the carbon-14 technique introduced by Steemann Nielsen. In attempting to decide whether this method measures net or gross photosynthesis or something in between, comparisons have been made with net rates of oxygen evolution in photosynthesis. It has been conventional to calculate gross photosynthetic activity on the assumption that oxygen consumption continues in the light as it does in the dark. Data based on mass spectrometry have shown that this is not necessarily true. Increased oxygen consumption in the light has been attributed to processes leading to ATP formation. With this evidence at hand, studies have been initiated in these laboratories to learn whether changed rates of oxygen consumption are general among marine microalgae and to identify environmental factors influencing oxygen consumption in the light. While this work was in progress, reports appeared indicating that another process, photorespiration, may be significant in photosynthesizing tissue and that photosynthesis is influenced by oxygen concentration. This information forced a re-evaluation and extension of experiments in this laboratory. Progress has been hampered by technical difficulties not previously evident in the mass spectrometer technique and which raise doubt on interpretation of data. Notwithstanding these difficulties, it has been observed that photorespiration may be significant in photosynthesis and that oxygen concentration may affect the rate of photosynthesis. Further research is needed to determine the extent to which photorespiration is significant as a photosynthetic process and the factors which determine it.

5. LIVING SYSTEMS (NON-HUMAN)
5. LIVING SYSTEMS (NON-HUMAN)

has also been collected and will be published shortly. Further studies will be needed to understand the full significance of increased oxygen consumption in the light.

SUPPORTED BY U.S. National Science Foundation

**5.0775, BIOSYNTHETIC PROCESSES DURING DEVELOPMENT OF SEA URCHIN EGGS**

R.M. IVERSON, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124

The sea urchin egg is a suitable system for investigating the processes occurring during the division stages and early embryogenesis. Large quantities of synchronous cells for studying the biochemical and physiological events concerned with mitosis and development of the organism can be obtained and embryos can develop to the blastula stage in the absence of m-RNA synthesis, at which time new m-RNA must be synthesized for continued development.

This raises the question of how the oocyte stores cellular components, for example, the m-RNA during oogenesis, activates it upon fertilization, controls its function at the translational level during early embryogenesis, and initiates at the blastula gastrula stage new m-RNA synthesis and integrates its function with the m-RNA stored in the oocyte.

Our investigations are concerned with: (1) the appearance and characterization of the polysomes after fertilization and during early embryogenesis; (2) the activation and integration of function of the m-RNA stored in the oocyte with that synthesized at the blastula gastrula stage (do they have different 'classes' of ribosomes associated with them?), and whether they are encoded for similar proteins; (3) the characterization of selected proteins formed by the polysomes at selected developmental stages; and (4) the basis for the difference in the 105,000xg supernatants obtained from fertilized and unfertilized eggs to support in vitro protein synthesis.

SUPPORTED BY U.S. National Science Foundation

**5.0776, CHEMISTRY AND BIOLOGY OF SOME COELENTERATE NEMATOCYSTS**

H.M. LENHOFF, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124

The coelenterate nematocyst continues to intrigue biologists. The nematocyst, one of the most complex specialized intracellular structures known, is essentially a capsule containing an inverted thread retained by a closed operculum. When the nematocyst is stimulated to discharge, the operculum opens and the thread erupts. Depending upon the type of nematocyst, the erupted thread may either pierce the prey and inject a toxin, lasso the prey or adhere to adjacent surfaces. Investigations are planned to identify the chemical composition and physical properties of purified nematocyst capsules, and to purify the toxin and study the mechanism of its action. Information obtained from these studies will be used to investigate the synthesis to their eventual site of action, and their mechanism of discharge.

SUPPORTED BY U.S. National Science Foundation

**5.0777, EXPERIMENTAL STUDIES ON THE BIOLOGY AND FOOD CHAIN ECONOMICS OF THE CHAETOGNATHS**

M.R. REEVE, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124

The objective of this study is to advance our knowledge of the biology of this very important group of planktonic marine invertebrates, thereby working towards an understanding of their role in the food chain as plankton carnivores. Practical steps being taken to achieve these ends include the initiation of development of laboratory rearing techniques which will allow eggs hatched from mature adults to be reared through their immature stages and complete the cycle. Quantitative aspects of reproduction are being studied including gonad maturation sequence, egg production per brood and number of broods as a function of temperature. Energy budgets are being worked out using Artemia as food in experimental regimes by computing the gross growth efficiency of Sagitta hispida at various stages in its life history and at various temperatures. The budgets are balanced by making measurements also of oxygen consumption, dissolved nitrogenous excretion and faecal pellet production.

SUPPORTED BY U.S. National Science Foundation

**5.0778, ECOLOGY OF PHYTOPLANKTON IN SEMITROPICAL ENVIRONMENTS**

E.J. WOOD, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124

Vertical and horizontal distribution of phytoplankton was related to the hydrographic factors in the Straits of Florida, Northeast and Northwest Providence Channels and the Tongue of the Ocean. It was found possible to relate phytoplankton maxima to isopycnals, and to interpret the peaks in terms of seasonality and depth relationships. The species were found to relate directly to the North Equatorial Current. Papers published as a result of this grant include: E.J.F. Wood, Bull. Mar. Sci. 18, 1-14; 481-543, Vargo, G. Bull. Mar. Sci. 18, 5-60. In addition a further paper on the Autecology of Diatom Species in the Area is in press (Nova Hedwigia) and another on the dinoflagellates and their ecology is in MS.

SUPPORTED BY U.S. National Science Foundation

**5.0779, RELATIONSHIPS BETWEEN PHYTOPLANKTON AND ZOOPLANKTON IN THE CARIBBEAN SEA**

E.J. WOOD, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124

The phytoplankton of the Caribbean appears to be derived from the main from the North Equatorial Current, though contributions are made from the neritic communities along the coasts of Venezuela and Brazil, from the islands of the West Indies, and from the shallow banks in the Honduras region such as Gorda Bank and Arrowsmith Bank. The micro-algae from these areas, including many species of benthic and epibiotic diatoms, usually enter the water at depths of 50 to 100 meters. A further contribution comes from the Sargassum which forms a large part, possibly at times the major part of the plant biomass of the Caribbean Sea. This contribution includes benthic and epiphytic species of diatoms and flagellate, which may also form as great a biomass as the true phytoplankton. The effect of upwelling to the east of the West Indies has been shown in the phytoplankton populations. Work on the western end of the Caribbean was not completed at the conclusion of the grant.

SUPPORTED BY U.S. National Science Foundation

**5.0780, RED TIDE TOXICITY**

J.E. SYKES, U.S. Dept. of Interior, Biological Laboratory, St. Petersburg - St. Pt. Be., Florida 33706

This research is concerned with biochemical aspects of Gymnodinium breve, specifically the isolation and characterization of its toxin. Phase one includes development of growth of the organism; Phase two efforts to fractionate the toxin initially by analytical chromatography and later through use of preparative gas chromatography. Phase three will include a more detailed study of the chemical and physiological properties.

SUPPORTED BY U.S. National Science Foundation

**5.0781, THE OCCURRENCE AND EFFECTS OF PLANKTON IN THE SEA**

A.W. COLLIER, Florida State University, Graduate School, Tallahassee, Florida 32306 (NONR)

The investigator is analyzing the chemical and physical characteristics of the metabolites of planktonic organisms under natural conditions as well as in the laboratory under special environmental conditions in defined media. He is continuing his studies of the sub-planktonic organisms he discovered recently to determine their contribution to the physical and chemical properties of the air-sea interface and upper oceanic layers. Hydrobiological studies have been contributing a large amount of knowledge concerning the inhabitants of the sea and the effects
of the environment upon them. In the development of these studies, the more or less subtle ways in which the organisms effect the environment are coming under examination. The effects are particularly notable in the minute, but extremely abundant planktonic forms, many of which are being shown to be causative factors in many problems connected with the installation, maintenance, and performance of underwater equipment.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0782, MICROBIAL ACTIVITY IN NON-AQUEOUS SYSTEMS
C.H. OPPENHEIMER, Florida State University, Graduate School, Tallahassee, Florida 32306
A study of the growth and distribution of microorganisms that preferentially live in oil. Experiments will provide information on water availability in the non-aqueous oil environment. Growth rates of selected microbes will be measured.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

5.0783, RESEARCH ON THE ROLE OF BACTERIA IN THE OCEAN
W.J. PAYNE, Univ. of Georgia, Graduate School, Athens, Georgia 30602 (NONR)
Objective: Some marine bacteria are responsible for the process of denitrification whereby nitrogen is lost from the environment in the form of nitrogen and ammonia. This terminal year of research is to determine what specific bacteria and chemical events lead to this undesirable process and subsequent loss of valuable nitrogen for marine and animal use.

Approach: An effort will be made to characterize the specific bacteria, the enzyme system, and electron transport mechanisms involved in denitrification. A comparison of marine and terrestrial bacterial species will be made to determine fundamental differences in denitrification metabolism in the two types.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0784, PHYSIOLOGICAL CHARACTERIZATION OF CERTAIN MARINE BACTERIA
N.W. WALLS, Georgia Inst. of Technology, Engineering Experiment Station, Atlanta, Georgia 30332
The objectives of this research project were: (1) to isolate in pure culture the microorganisms contained in a mixed flora in certain ocean sediments material; (2) to lyophilize those and other bacteria collected in the field to preserve them for future study; and (3) to morphologically and biochemically characterize certain of the species.

SUPPORTED BY Georgia Institute of Technology

5.0785, DIVERSITY, COMMUNITY STRUCTURE AND TROPHIC RELATIONS OF TROPICAL ZOOPLANKTON
R.L. CUTTER, Univ. of Hawaii, Graduate School, Honolulu, Hawaii 96822
The research project involves sampling and analysis of plankton communities, in a tropical bay (Kaneohe Bay, Oahu) and in the open sea. Assessment of standing stocks and species diversity is being done in the bay as a whole. Two subregions have been chosen that are similar in general species composition but have different standing stocks and different indexes of diversity. In these subregions an attempt will be made to determine trophic relationships and energy pathways among the major species.

With the background experience gained in the bay, it is expected that future work will include vertical distribution and energy exchange problems in the open tropical Pacific. Field equipment is being readied for this purpose.

SUPPORTED BY U.S. National Science Foundation

5.0786, DEVELOPMENT AND EVALUATION OF A NEW TECHNIQUE FOR SAMPLING ZOOPLANKTON
G.I. MURPHY, Univ. of Hawaii, Hawaii Inst. of Marine Biology, Honolulu, Hawaii 96822

5. LIVING SYSTEMS (NON-HUMAN)

It is proposed to construct, test, and do preliminary experiments with a radical innovation in zooplankton sampling, a plankton purse seine. If successful, this technique should yield absolute calibration of conventional equipment, new insight into distribution, and a more meaningful approach to zooplankton community dynamics.

SUPPORTED BY U.S. National Science Foundation

5.0787, ISOLATION AND TAXONOMY OF YEASTS IN LAKES AND SEWAGE
L.R. HEDRICK, Illinois Institute of Technol., Graduate School, Chicago, Illinois 60616
To date, 13 different sites in the Calumet River area on the Illinois-Indiana border have been sampled, and yeast from two genera most often encountered were Candida and Rhodotorula. In an effort to determine just what aspects of pollution were affecting the yeast population, data on chemical and physical pollution indicators were fed along with the numbers of yeasts into an IBM 360 computer. At every station, it was found that two parameters which gave the highest regression values were the nitrite-nitrate nitrogen and dissolved oxygen content of the water.

Currently, a survey of changes in yeast populations with the seasons is being conducted. The following pathogenic yeasts have been isolated: Cryptococcus neoformans, Torulopsis glabrata, Candida tropicalis, Candida Parapsilosis, and Trichosporon cutaneum.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0788, ULTRASTRUCTURAL AND AUTORADIOGRAPHIC INVESTIGATION OF CALCIFICATION IN FORAMINIFERS
W.W. HAY, Univ. of Illinois, School of Engineering, Urbana, Illinois

This proposal is to extend a study of calcification in foraminifera already underway (NSF GB-4101). It has been possible to establish viable cultures of a wide variety of foraminifers, and to induce some species to reproduce and so become convenient subjects for the study of calcification, to perfect a technique for sectioning, coupling, and test work in order to start a survey of cell ultrastructure. A considerable amount of information on the biological ultrastructure of foraminifera is now being gathered, and study of specimens actively calcifying the test is being carried out. The project would extend the study from the species currently being investigated to representatives of other groups, correlate electron microscopic and light microscopic investigations of cytological structures, test a new working hypothesis of the calcification process, and study the pathway of calcium from uptake from the culture medium to implantation in the wall, using autoradiography.

SUPPORTED BY U.S. National Science Foundation

5.0789, ZOOPLANKTON OF THE GULF OF MAIN
K. SHERMAN, U.S. Dept. of Interior, Biological Laboratory, Boothbay Harbor, Maine 04538

This research will provide information regarding seasonal and annual changes in zooplankton distribution and abundance in relation to hydrographic conditions. Present effort is centered along the Gulf of Maine coast, from Cape Ann (Mass.) to Machias Bay (Me.), and from inshore to the 50 fathom isobath. Zooplankton collected from two series of seasonal cruises (winter, fall, summer) is examined: 1) underway cruises (20 stations) using a Gulf III sampler, on 30-minute oblique tows, taken from 20 meters to the surface, 2) inshore-offshore transect cruises from three areas (west, central and eastern gulf). Three stations, spaced at 7.5 mile intervals, are located on each transect. Collections are made with Clarke-Bumpus samplers towed in a series at 0-10 and 60 meters depending on bottom topography.

Environmental observations at each station include: 1) Nansen bottle casts at 0-10-20-30-60 meters and bottom, 2) bathymeterograph cast, 3) water transparency measurements using secchi disc and photometer, 4) meteorological observations recorded on NODC-BT log format, and 5) sea bed drifters and drift bottle releases.

203
5. LIVING SYSTEMS (NON-HUMAN)

The along-shore and inshore-offshore station collections are planned to extend over a two-year period. The 1963 along-shore zooplankton data has been analyzed for relative abundance, group and species (copepods only) composition and areal distribution.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0790, MICROBIOLOGY OF MARINE AND ESTUARINE INVERTEBRATES
R.R. COLWELL, U.S. Dept. of Interior, Biological Laboratory, Oxford, Maryland

A study of the natural bacterial flora of oysters and associated invertebrate animals has been initiated. Animals from specified areas of Chesapeake Bay and off the Atlantic Coast are being sampled, using specified aseptic techniques to determine the quantitative and qualitative bacteriological flora of the animals. The normal commensal flora of oysters is being determined by examination of the shell liquor, body flesh, and intestine.

Standard bacteriological procedures are being followed for sampling, testing, and analysis. However, newer techniques of diagnosis and taxonomy will be applied, including the high-speed computer methods and the nucleic acid analyses, techniques developed and/or adapted by the Principal Investigator in previous published research.

Ancillary studies of the environment of the animals, i.e., water and mud samples, are also being undertaken. Unique features of the bacterial populations which are observed will be studied in detail.

The work is being undertaken at Georgetown University with the active collaboration of personnel at the Biological Laboratory, Bureau of Commercial Fisheries, U. S. Fish and Wildlife Service, Oxford, Maryland.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0791, COMPARATIVE BIOCHEMICAL AND MORPHOLOGICAL CHARACTERISTICS OF MARINE FUNGI FROM SHELLFISH
S. GOLDSTEIN, U.S. Dept. of Interior, Biological Laboratory, Oxford, Maryland

Appropriate histological, histochemical, and cultural methods are used to determine the presence of fungal parasites in shellfish. With the use of conventional and laboratory prepared and modified media, isolations and clones are made of the fungi present in tissues. Physical and physiological parameters necessary for the growth and reproduction of the organisms isolated are established. Morphological properties and nutritional requirements of the isolates grown in vitro are described. Appropriate chemical and biochemical analyses are carried out on the isolates and supporting media so as to permit adequate characterization, possible identification, and to establish the taxonomic position of the isolates. The work is being undertaken at Brooklyn College.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0792, MORPHOGENESIS OF THE BACTERIOPHAGE
M.B. BAYLOR, Marine Biolog. Laboratory, Woods Hole, Massachusetts 02543

We are working on the interactions of genes that control the architectural proteins in the mature colipage. We believe we have markers for these genes and thereby will be able to locate genes controlling different proteins in the same structure and also genes, the products of which, modify the final functional structure.

We have established by four very different approaches that one group of genes in which our mutants occur, control tail structure not including tail fibres. Our methods included phage morphology as revealed by the electron microscope, in vitro assembly of T2-T4 hybrids, genetic homologies between T2 and T4 and examination of purified solubilized sheath by gel electrophoresis. However, we have found a mutant, not in this region, which also affects both sheath morphology and the pattern of the band on the gel. Our results led us to suggest that at least two, and probably more, proteins are contained in the sheath. More are concerned with sheath morphogenesis.

We intend to study the sheath components by several physical chemical techniques. We believe we have also a label, through our mutants, on other tail structures such as face plate and tube.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0793, A STUDY OF THE ECOLOGY OF THE MICROFAUNA LIVING BETWEEN INTERTIDAL MARINE SEDIMENTS
D.J. ZINN, Marine Biolog. Laboratory, Woods Hole, Massachusetts 02543

The work is directed toward studying ecologically and taxonomically the fauna belonging to the mesosymbiotic L. poter environment, naturally represented by the various kinds of intertidal substrata that make up the beaches of the New England Coast. The main effort is to collect and interpret information on the pisonam of the area. Representative beaches along the shores of Connecticut, Rhode Island, Massachusetts, New Hampshire and Maine will be sampled. In addition, to emphasize the colonial nature of the faunas comprising the biocoenose, attention will be paid to at the interstitial milieu and the lacunary spaces between the sand grains, in whose water films the mesosymbiotic organisms live, in terms of grain size, beach slope, temperature, salinity, oxygen, pH, tidal factors, meteorological and hydrological conditions, and so on. Faunal analysis will emphasize the relationships between the algae and the copepods. As time permits zoogeographical distribution patterns of the dominant forms will be considered by comparison with pisonamon collections made at convenient locations along southern atlantic coastal beaches of the United States.

SUPPORTED BY U.S. National Science Foundation

5.0794, LANGMUIR CIRCULATION AND PLANKTON ECOLOGY
E.R. BAYLOR, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543

The food chain in the ocean depends primarily upon the events occurring in the upper one hundred meters of water. Most of the production of phytoplankton takes place in this stratum. Also, it has been shown by the principal investigator and his associates that in the upper layer of this stratum the naturally occurring suspended and dissolved organic materials in sea water may be concentrated and converted into edible particles used by zooplankton by wave-induced foaming. The work of the principal investigator on patchiness of plankton abundance questions its relation strictly to the hydrodynamic variables of Langmuir circulation. Results have permitted modification of the original theory which needs testing. The predictions to be tested are: when the wind direction is steady for twenty-four hours the plankton abundance is well correlated with the wind direction; when a major shift in wind direction occurs, the plankton is patchy but poorly correlated with wind speed; when the wind is highly variable in direction for twenty-four hours the spatial distribution of plankton is virtually random.

The purpose of this research is to test a model of air-sea interaction developed by the principal investigator and his associates to explain the plankton distribution and its relation to wind pattern and surface circulation pattern. The model proposes that the horizontal roll vortices of Langmuir circulation in the water are coupled to and driven by larger (1KM) horizontal roll vortices in the wind. In effect, it is simply a large-scale Langmuir circulation in the air driving a smaller-scale Langmuir circulation in the water. A Hardy continuous plankton recorder will be towed to indicate what the Sperry reflectoscope (previous grant) recorded. Kites will be used to hold instruments directly over the plankton collection spots. All data will be subjected to computer analysis. The methods employed should settle many questions concerning plankton ecology, particularly the effect of Langmuir circulation on distribution.

SUPPORTED BY U.S. National Science Foundation

5.0795, RADIOELEMENT STUDIES IN THE OCEANS: PLANKTON DISTRIBUTION STUDIES
V.T. BOWEN, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543 (AT30-11)
On samples collected for fallout isotopes measurements, studies are made of the species distribution and relative abundances of Foraminifera, Radiolaria and Acantharia. With few systematic exceptions, the three groups show covariance rather than opposing abundances. Both Radiolaria and Acantharia prove to be major components of the plankton, and of evidently underestimated geochemical significance. In those water masses lacking one or another of these groups, this should show in form of aberrantly high surface concentrations of the appropriate element. Much of this work is now being prepared for publication.

SUPPORTED BY U.S. Atomic Energy Commission

5.0796, MICROBIAL TRANSFORMATIONS IN SEA WATER
H.W. JANNASCH, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543

Studies on the development of reproducible enrichment techniques in continuous culture for the isolation of characteristic marine bacteria were completed. Within a certain range of dilution rates and concentrations of the limiting substrate, chemostat enrichments were successful. Experimental attempts to separate single species from mixed cultures of known composition showed that successful or unsuccessful competition for the limiting substrate could be expressed by kinetic growth parameters of the individual species under given conditions. Species exhibiting low values of their growth parameters displaced species with relatively high values if the continuous culture was operated correspondingly at low dilution rates and/or low concentrations of the limiting substrates. This behavior is significant for the characterization of those microorganisms actually responsible for the degradation of organic materials in the sea under natural conditions.

Based on the determination of growth parameters, the studies on population dynamics were continued. Mixed pure cultures of marine and non-marine bacterial strains were grown in the chemostat at doubling times up to 100 hours and at various concentrations of limiting substrate. Predicted displacement times could be confirmed experimentally.

Techniques for studying sulfate reducing bacteria in steady state culture have been established. The kinetics of substrate (sulfate) and product (sulfide) limited growth were studied with the aim of detecting characteristic metabolic differences.

SUPPORTED BY U.S. National Science Foundation

5.0797, STUDIES ON MICROBIAL SULFATE REDUCTION AND SULFIDE OXIDATION IN MARINE ENVIRONMENTS
H.W. JANNASCH, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543

Forty-one strains of sulfate-reducing bacteria were isolated from various marine or saline environments including New England estuaries. Continental Shelves (U.S. East Coast and North Sea), the Peru trench, Lake Tibirias/Israel, the Red Sea, and Lake Parco (Italy). All strains were studied with respect to utilization of significant organic hydrogen donors, salinity requirements, optimum growth temperatures, growth temperature ranges, and resistance to hibitane. Based on these data the strains were classified according to Postgate and Campbell. Enzyme activities of carbohydrate metabolism in Desulfovibrio were studied under various growth conditions. Chemo- stat grown cells of various generation times were compared with batch culture grown cells.

SUPPORTED BY U.S. National Science Foundation

5.0798, BIOLOGY AND CHEMISTRY OF MARINE PLANKTON POPULATIONS
B.H. KETCHUM, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543

The short term changes which proceed during the growth of plankton populations are to be studied in the Gulf of Maine. A parachute drudge attached to a radio buoy is used to identify a particular patch of water and observations are made close to the buoy. The objectives of this program are to evaluate quantitatively the turnover rate of the nutrients and to study rates of decomposition in situ. It has been postulated that in situ recycling of elements maintains the level of productivity in parts of the world throughout much of the year, but no useful estimates of recycling rates have been available. Additional studies include the changes in the vertical distribution of chlorophyll and the rate of sinking of particles, the changes in the ratio of elements in particles as they sink and decompose in the water column, and diurnal variations in the rate of photosynthesis as a function of the chlorophyll content of the water. Studies of the vertical distribution of the zooplankton are included since a substantial part of the regeneration of elements may result from the phytoplankton respiration and zooplankton consumption and digestion of particulate matter in the sea.

SUPPORTED BY U.S. Atomic Energy Commission

5.0799, BIOLOGY AND PALEONTOLOGY OF MARINE DINOFLAGELLATES AND HYSTRICHOSPHERES
D. WALL, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543

The life histories of modern thecate dinoflagellates (Dinophyceae) are being investigated with special emphasis on those genera and species that produce resting spores. Such spores are abundant both on the surface sediments of present day seas and as microfossils (variously called fossil dinoflagellates and hystrichospheres) that are preserved in marine sediments of post-Paleozoic age in the main. We are attempting to correlate resting spores with their appropriate motile stage in the life histories of numerous marine and freshwater species by the germination of spores in vitro and unicellular cultures and also to study the biogeographic distribution of spores in surface sediments of the eastern coast of the United States and Caribbean area. Paleontological studies also will be made of the vertical distribution of dinoflagellates in some Late Tertiary and Quaternary marine epicontinental sequences and attempts will be made to relate this distribution to the observed lateral distribution of corresponding cysts in modern sediments.

SUPPORTED BY U.S. National Science Foundation

5.0800, NITRIFICATION BY MARINE MICROORGANISMS
S.W. WATSON, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543

This proposal is for the continuation and expansion of our studies on the role nitrifying bacteria play in the ocean and the molecular mechanisms by which these organisms convert, store and utilize energy derived from the oxidation of ammonia or nitrite. The specific objectives include: (1) the isolation and purification of new marine nitrifying bacteria; (2) the determination of the vertical and horizontal activity and distribution of nitrifying bacteria in the open ocean; (3) a morphological study of the fine structures of nitrifying bacteria; (4) a study of the metabolic pathway by which marine nitrifying bacteria oxidize ammonia to nitrite and nitrate to nitrate; (5) attempts to elucidate the reason or reasons why nitrifying bacteria are obligate autotrophs (6) a study of the role of the submicroscopic cymembrane systems and other submicroscopic structures observed in Nitrosocystis oceanus, Nitrosomonas europaea and Nitrobacter agilis; (7) a study of the kinetics of nitrification; (8) the development of new cultural techniques.

SUPPORTED BY U.S. Dept. of Hth. Ed. & Wel. - P.H.S.

5.0801, PLANKTON AND BENTHOS COMMUNITIES OF THE GREAT LAKES
J.F. CARR, U.S. Dept. of Interior, Biological Laboratory, Ann Arbor, Michigan

The objectives of this project are to determine the plankton and benthos species occurring in the Great Lakes and study their distribution, and seasonal and annual abundance. Plankton and benthos have been sampled on a routine seasonal basis in Lakes Erie and Superior, and during surveys of a Lakes Erie, Huron,
5. LIVING SYSTEMS (NON-HUMAN)

Michigan, and Superior. At present, we are concerned primarily with changes in the benthos of Lake Erie, seasonal fluctuations of diatoms in Lake Superior, and determining the sampling efficiencies of the orange-pool, Petersen, and Smith-McIntyre dredges in various sediments and at various depths. Smaller phases of the project involve a study of the Japanese snail Viviparous japonicus which has appeared in Sandusky Bay, Lake Erie, and a study of the polychaete Manayunkia species in Lake Erie.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0802, DISTRIBUTION AND ABUNDANCE OF ZOOPLANKTON IN LAKE ERIE

J. REYNOLDS, U.S. Dept. of Interior, Biological Laboratory, Ann Arbor, Michigan

This project is aimed at obtaining good estimates of relative abundance and standing crop of common species of zooplankton in Lake Erie. Such estimates require a knowledge of the dispersion and in catch contributed by factors causing other than real changes in biomass (i.e., apparent changes due to sampling). Initially, a restricted area in Lake Erie will be sampled to determine the extent of sampling error. Subsequent experiments will attempt to quantify those ecological relationships which significantly mask the real changes in zooplankton abundance. Considering present knowledge of zooplankton ecology, some of the factors studied will be light, oxygen, temperature, diurnal movement, and horizontal distribution. Proper treatment of the data will require multiple regression analysis and multiple analysis of variance using the high-speed computer. Inclusion of any significant ecological factors as an adjustment in estimation would increase the precision involved in detecting real changes in zooplankton abundance. Hopefully, these improved estimates may give additional meaning to the relation between density of zooplankton and survival of certain species of fishes in Lake Erie, particularly young-of-the-year. The project will begin during May 1967.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0803, PLANKTON ECOLOGY

D.C. CHANDLER, Univ. of Michigan, Graduate School, Ann Arbor, Michigan (NONR)

This research bears on three related studies. A planktological survey of Lake Michigan has been conducted with especial attention being given to the microcrustacea. Secondly, the aforementioned planktological survey cruise Research Ships of Opportunity was being used to obtain information and experience as to the utility and problem in setting up a continuing RSO program. This project is utilizing the specimens and data gathered in the lake survey sampling, in a study of the seasonal and geographical patterns in the abundance of the several stages in each of the four species of the copepod genus diaptomus. The gathering of data regarding physical, chemical, and biological parameters of ocean environments is a recognized necessity for the better understanding and prediction of effects of environmental factors on Naval operations. In order to collect adequate information, existing research equipment must be evaluated and new equipment developed. In addition, the technology of positioning the data gathering equipment in preselected geographical areas must be updated. Research Ships of Opportunity offer one means for synoptic oceanographic data collecting systems.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0804, PLANKTON REARING, ENVIRONMENTAL REQUIREMENTS AND SENSITIVITY STUDIES

C.M. TARZWELL, U.S. Dept. of Interior, Natl. Water Quality Lab., Duluth, Minnesota

This project is carried out by the Culturing, Production and Sensitivity Studies Unit of the Plankton-Microbiology Section. It has as its main objective the determination of the sensitivity of important planktonic organisms to selected materials or wastes. In accomplishing this objective, all planktonic organisms within the upper Great Lakes area will be collected and identified. Those representing a considerable portion of the total population will be cultured. It is anticipated that considerable time and effort will be devoted to this culturing activity. In connection with these activities, life history and requirements will be investigated and studied in some detail. Planktonic organisms of importance in the biota will be reared so that they may be used in short-term bioassay studies to determine the most sensitive species or life stages to a particular material or waste. This will involve the screening species or of wastes using a large number of different planktonic organisms. The species and life stage found to be most sensitive to the particular material or waste in question will then be used by another unit in studies to determine the long-term effects and the levels of a potential toxicant which are not harmful to the organism. This project was started in Fiscal Year 1967 and is a continuing activity.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0805, THE ROLE OF SULFUR BACTERIA IN CORROSION AND DETERIORATION

G.E. JONES, Univ. of New Hampshire, Graduate School, Durham, New Hampshire 03824

Objective: This task will assist the Navy in understanding the role of sulfur bacteria in the oceanic environment. Sulfur is relatively plentiful in the ocean, and its utilization by microorganisms contributes to corrosion and deterioration of structure materials. Approach: Marine sulfur oxidizing bacteria possess a membrane which appears to be the site at which sulfur oxidation takes place. The membrane will be harvested in quantity and examined for chemical composition and sulfur oxidizing activity.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0806, A STUDY OF THE ICHTHYOPLANKTON ASSOCIATED WITH TWO OF NEW JERSEY'S COASTAL INLETS

W.S. MURAWSKI, State Div. of Fish & Game, Trenton, New Jersey

A. Objectives: To determine the species of fish which are found in our lower estuaries as eggs and/or larvae. To further determine what time of year their occurrence takes place, for what duration of time, and under what salinity and temperature conditions. Information of this nature is very valuable in our biological appraisal of this area of the estuary, especially in regard to any proposed man-made changes in the environment.

B. Procedure: Weekly ichthyoplankton samples will be made year round at Manasquan and Corson Inlets. At the former station, the net will be fished from a bulkhead that runs parallel to the tide; and at the latter station, the net will be fished from the center of a low bridge that spans a branch of the inlet. In each case, the nets will be held stationary in a flooding tide. The nets used will be one-meter in diameter and will be fished in the surface waters for one hour during periods of darkness. Flowmeters will be used to determine the volume and velocity of the water sampled. Observations of the physical environment will include temperature and salinity.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish. New Jersey State Government

5.0807, BIOLOGICAL OCEANOGRAPHY & DETERIORATION - SHALLOW WATER MARINE SEDIMENTS & WATER COLUMN BACTERIA


Objective: To investigate biological problems associated with shallow continental shelf waters and to relate turbidity to microbiological content particularly directly over the sea floor. Approach: Develop instrumentation package for concomitant turbidity and bacteriological analysis of continental shelf waters from surface to sea floor. Conduct at-sea measurements within local waters. Perform bacteriological and gross particular analysis of samples.

SUPPORTED BY U.S. Dept. of Defense - Navy

206
5.0809, EXPERIMENTAL ECOLOGY OF LOWER MARINE FUNGI
S. GOLDSTEIN, City University of New York, Graduate School, Brooklyn - Brooklyn College, New York 11210

Comparative development and physiology of non-filamentous zoosporic phycomycetes isolated from polluted littoral habitats.

SUPPORTED BY City University of New York

5.0809, A NEW APPROACH TO NUTRITION, PHYSIOLOGY, AND MINERAL CYCLING OF FORAMINIFERA

We are continuing our studies of the foraminifers, a biologically poorly known group of microorganisms which is important in marine biogeochemical cycling. Priority has been given to the establishment of gnotobiotic dependable laboratory cultures for use in experiments. Tracer technique will be used to identify food organisms. Reduction of non-growth promoting organisms from autotrophic cultures and aseptic technique should lead to vigorous synxenic cultures with fewest associated food organisms.

We will study the microbial flora and fauna of natural littoral foraminiferal bloom areas and the physiological ecology of prominent members of the community that can be isolated in axenic culture. The results of the foregoing studies, correlated with energy-flow experiments and experimental manipulation of microcosms, should assist in the interpretation of the non-random distribution of foraminifera in nature and the conditions favorable to the bloom of certain species. This work will be of interdisciplinary value in marine productivity and paleoecology.

SUPPORTED BY U.S. Atomic Energy Commission

5.0810, MECHANISMS OF ATTACHMENT OF MARINE BACTERIA TO SURFACES
W.A. CORPE, Columbia University, Undergraduate School, New York, New York 10027 (N00014-68-A-0225 -0001)

Objective: This research concerns microorganisms which grow on marine surfaces and are involved in fouling and corrosion. This effort will assist the Navy in developing procedures and methods for producing surfaces which possess antifouling and anticorrosion properties.

Approach: The growth of microorganisms on marine surfaces may effect the subsequent growth and development of higher forms of plant and animal life. Deterioration of surfaces exposed to the marine environment by molluscs, crustaceans, and other life is usually preceded by microbial growth. This effort is being devoted to the examination of kinds and characteristics of film-forming bacteria.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0811, MICROBIOLOGICAL ASSAYS OF SEAWATER USING RADIOISOTOPES

Objectives: 1) To study the role of vitamins in the ecology of marine primary producers, with special emphasis on thiamine in sea water. 2) To isolate marine planktonic ciliates and other ecologically important phagotrophic and heterotrophic protozoa for studies of protozoan - phytoplankton relationships - a primary link in the marine food chain.

It was determined previously that thiamine was rapidly destroyed in sea water at temperatures greater than 30 degrees C and less rapidly at 20 degrees C. Thiamine destruction can be prevented, however, if various organic compounds are added to thiamine-enriched sea water before incubation at destructive temperatures. Among the compounds tested naturally occurring amino acids, nucleotides and citric acid were the most effective protectants. Since these or related compounds may also play the same role in nature, it is of interest to know the mechanism of protection, and, if, therefore, one objective of this program is to pursue this study further.

A representative of the ciliate order Tintinnopsis was isolated and has been maintained in vitro since June, 1966. Tintinnids are the most abundant and diverse ciliates found in the marine en-

vironment; they are the only ciliates found in the fossil record. Since they are voracious feeders, agglutinate particulate material to their loricae and have a rapid diversion rate, these protozoa appear to be important micro-consumers of primary producers. Their role will be evaluated in in vitro feddings studies.

SUPPORTED BY U.S. Atomic Energy Commission

5.0812, ECOLOGY OF PLANKTONIC FORAMINIFERA AND RELATED STUDIES
A.W. BE, Columbia University, Graduate School, Palisades, New York 10964

Geographic, vertical and seasonal distributions of shell-bearing plankton groups (Foraminifera, Coccolithophorides and Peridinidae), based on global plankton collection obtained on board R/V Vema and Robert Conrad.

The objective is to delineate the distributional patterns of individual species in the light of such environmental factors as temperature, salinity, depth, nutrients and food. This ecological information can be used for interpreting ancient environmental conditions during which fossil assemblages (now entombed in deep-sea sediments) had lived. Multivariate statistical analysis is used to determine coefficients of proportional similarity among the many species in order to discriminate natural species groupings.

The shell microstructures of planktonic Foraminifera and Peridinidae are being examined by transmitted and scanning electron microscopy and internal shell morphology is investigated by means of an X-ray projection microscope.

Research and development of plankton sampling gear is being continued to study sampling reliability.

SUPPORTED BY U.S. National Science Foundation

5.0813, C-14 UPTAKE, LIMITING FACTORS AND EXCRETION PRODUCTS OF ANTARCTIC PHYTOPLANKTON
P.R. BURKHOLDER, Columbia University, Graduate School, Palisades, New York 10964 (AT(30-1)3849)

With 14C techniques the assimilation and excretion of carbon by marine phytoplankton will be studied in relation to light, trace elements, phosphate, nitrate, and age of plankton blooms in waters adjacent to the Antarctic Peninsula. Effects of experimental enrichment of water samples upon the rate of carbon assimilation will be studied in the Gerlache Strait and the Drake Passage. It is hoped to obtain information that will help to explain variations in productivity in nortic and oceanic areas and the great differences that have been observed in assimilating numbers in different Antarctic areas and seasons.

SUPPORTED BY U.S. Atomic Energy Commission

5.0814, PHOTOSYNTHETIC BACTERIA
E.H. BALLANCE, State University of New York, Graduate School, Stony Brook, New York 11790

This investigation is concerned with the isolation and pure culture and characterization of representative types of photosynthetic marine sulfur bacteria. Special instruments for precision measurement of the temperature, pH, and osmotic optima for growth have been developed as valuable aids in the classification process.

This task represents an additional effort in the current program in marine microbiology. The proposed studies will be devoted to the development of stable and reliable criteria for the characterization of photosynthetic sulfur bacteria, a group of organisms commonly found in marine estuaries. These organisms occupy a unique position biologically. Comparatively little is known about them due to difficulties in isolation and cultivation in pure culture. The principal investigator has successfully isolated a large number of strains, however, and has successfully developed criteria for their characterization. The information gained from this task will add materially to our knowledge of the photosynthetic sulfur bacteria and their relationship to the marine environment.

SUPPORTED BY U.S. Dept. of Defense - Navy

5. LIVING SYSTEMS (NON-HUMAN)
5. LIVING SYSTEMS (NON-HUMAN)

5.0815, SYSTEMATICS OF ANTARCTIC HYMENOSTOMATIDA (PROTOZOA)
J.C. THOMPSON, Queens College, Undergraduate School, Charlotte, North Carolina 28207
Queens College will conduct a survey of the ciliate order of Hymenostomatida in Antarctica. The principle interest is in the freshwater and marine species of this order of Protozoa but, in addition to aquatic habitats, the principle investigator proposes surveys of available moss and lichen vegetation for obtaining collections of related groups. Living material will be studied in the field, using phase microscopy and recording observations on 16 mm phase movie film. Cultures prepared in the field will be used for selecting material for fixing and staining permanent mounts for the work at Queens College and for exchange material. Field observations will include information on life cycles, food, cysts, conjugation and characteristics of habitats. Special techniques developed by the principal investigator will be applied in the development of the systematic studies on nuclear and subpellicular bodies and fibrillar systems of hymenostome ciliates.

The work will be conducted by the principal investigator and a graduate assistant at Palmer Station.
SUPPORTED BY U.S. National Science Foundation

5.0816, PLANKTON ECOLOGY OF BAR-BUILT ESTUARIES
W.J. WOODS, Univ. of North Carolina, Institute of Marine Science, Morehead City, North Carolina 28557
Studies of plankton and phytoplankton populations have been conducted for several years in Bogue Sound and Pamlico Sound, North Carolina. In addition to periodic samples of the populations, water samples are analyzed for salinity, dissolved oxygen, nitrate, nitrite, ammonia, and total nitrogen, and phosphorus and total phosphorus. Primary production measurements (phytoplankton) are made routinely with nutrient enrichment.

A phase just starting will attempt to evaluate the contribution of the bentthic flora to the production of the sounds.
SUPPORTED BY U.S. National Science Foundation

5.0817, STUDIES OF THE AEROCCOCUS-PEDIOCOCCUS BACTERIA
J.B. EVANS, Univ. of North Carolina, School of Agriculture, Raleigh, North Carolina 27600
It is proposed to investigate the occurrence, general physiological activities, DNA base ratios and DNA homology of this group of bacteria. The organisms under primary consideration are Gram-positive cocci that tend to produce tetrads in suitable broth media, produce little or no catalase, generally produce greening on blood agar, and ferment glucose much less vigorously than do the lactic acid group of bacteria.

One of the initial phases of this study is concerned with the incidence of these organisms in the hospital environment and the means of differentiating them from the other Gram-positive cocci that are also found there. The physiological studies will be particularly interested in energy metabolism of these organisms. The DNA studies will seek to establish the basic genetic and taxonomic relationships within this group of bacteria.
SUPPORTED BY University of North Carolina

5.0818, DEGRADATION OF MARINE SURFACES BY SALT REQUIRING BACTERIA
L.E. DUNDAS, Univ. 1 Bergen, Bergen, Norway (F61052-67-C-0085)
The objectives of this research are to determine the biochemical, metabolic and genetic properties of some extreme, obligate halophilic (salt-requiring) microorganisms. This will include an investigation of the reality of their growth in halobacteria. Strains of microorganisms will be isolated from solar salt (salt produced from sea water by solar evaporation). These strains will be selected by treatment with penicillin. Strains of haloacidophilic bacteria have been shown to be sensitive to this drug. In this manner mutants will be produced auxotrophic for the various intermediates in the metabolic pathway, permitting a study of the regulatory mechanisms involved. The presence of two species of DNA in a single bacterial strain seems to be characteristic only of the halobacteria. Using standard techniques, the investigator will attempt to discover which fractions of DNA are able to hybridize with the two species of DNA.

The study of extreme halophiles will lead to a better understanding of marine microorganisms, which are important as geochemical catalysts, as links in the food chains leading to commercially important fish, and as fouling and corrosive agents on ships and structures in the water.
SUPPORTED BY U.S. Dept. of Defense - Navy

5.0819, THE ECOLOGIC IMPACT OF THE INTERACTIONS AMONG MICROORGANISMS AND AQUATIC CONTAMINANTS IN LAKE ERIE
R.M. PFISTER, Ohio State University, Graduate School, Columbus, Ohio 43210
Particulate matter in Lake Erie water will be examined on a physical, chemical, and biological basis, and this matter will be characterized using density gradient centrifugation, electron microscopy, and certain chemical analyses. Microbial portions of the Lake Erie ecosystem will be characterized on the basis of physiological types (not identification). Primary productivity, chlorophyll distribution and photosynthesis-pigment relationships will be examined to obtain information pertinent to particulate and bacterial interactions. Algae will be collected and treated to remove physically associated bacteria. Cultures of bacteria obtained from the algae will be examined in the same manner (e.g. determine physiological types) as the non-algal associated bacteria in water. Surface tension and water content of selected chemicals will be experimentally altered to study the effects on microbial populations (physiological types) and on types of particulates found in the water. Data from these experiments will be correlated in an attempt to establish cause-effect relationships.
SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rch Ohio State University

5.0820, MODERN FORAMINIFERA OFF OREGON
G.A. FOWLER, Oregon State University, Graduate School, Corvallis, Oregon 97331
The objective of the proposed study is to make a detailed examination of the foraminifera from the sea floor off the coast of Oregon. This is an almost unexplored area from the standpoint of foraminiferal ecology. Findings are expanding and augmenting existing knowledge from this and other parts of the world. Results of current investigations demonstrate considerable variation in data from three discrete samples at each station and between closely spaced profiles in the shelf. It is important to determine to what extent the variance of faunal trends occurs. Sufficient samples for this have been obtained already and are partially processed. One year is needed to complete the study.
SUPPORTED BY U.S. National Science Foundation

5.0821, HYDROSTATIC PRESSURE-TEMPERATURE, AS ENVIRONMENTAL PARAMETERS, ON GROWTH, BIOCHEMISTRY AND PHYSIOLOGY OF MICROORGANISMS
R.Y. MORITA, Oregon State University, Graduate School, Corvallis, Oregon 97331
Objective - a. Problem: The study of metabolic processes under the environmental extremes of temperatures near 0 degrees C and between 50 and 100 degrees C, and pressures near 1,100 atmospheres (17,600 psi.) and temperatures near 0 degrees C and 50 to 100

208
degrees C will be employed. In vitro studies concerned with the molecular volume and conformational changes of hot and cold marine microorganisms will furnish data concerned with the precise concept and mechanism of the pressure-temperature interrelationship that can happen in vivo.

Progress - a. 30 04 67 to 01 05 68 b. Research indicates generally that microorganisms (terrestrial and marine) coming from environments close to 1 atm. cannot tolerate pressures greater than 600 atm. Certain organisms have been isolated from deep sea environment but in the laboratory have not been shown to withstand elevated pressures from where they were isolated. Three types of organisms have been categorized according to their pressure sensitivity: 1) Cultures able to survive 4 weeks at 1,100 atmos. 2) Cultures able to survive 1 week at 1,100 atmos. 3) Cultures not able to survive 1 week at 1,100 atmos.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

5.0822, DISTRIBUTION OF CL. BOTULINUM E. IN FISH, SHELFISH AND THE AQUATIC ENVIRONMENT IN OREGON
K.S. PILCHER, Oregon State University, Agricultural Experiment Sta., Corvallis, Oregon 97331

Objectives are (1) to survey the distribution of this organism as indicated above by appropriate cultural methods; (2) investigate the non-toxic variant strains of the organism to determine whether reversion to toxicity may occur.

SUPPORTED BY Oregon State Government

5.0823, ENERGY AND ELEMENT TRANSFER IN LOWER MARINE TROPHIC LEVELS
L.F. SMALL, Oregon State University, Graduate School, Corvallis, Oregon 97331

We have been estimating energy and element transfer in marine phytoplankton and zooplankton. Energy flow in terms of organic matter assimilated by phytoplankton under different environmental conditions in the field, and the utilization of phytoplankton 'energy' by selected important grazers off the Oregon coast is being measured. Estimation of energy inputs and outputs, as well as standing stock of energy, is done in calories, carbon, and ash-free dry weight. We are initiating studies on nitrogen and major molecular constituents (proteins, carbohydrates, lipids) as other indices of energy (organic matter) transfer. We hope this year to get field measurements in an already selected marine environment characterized by single-species phytoplankton successional blooms and one period of intense grazing by a few copepod species. To our knowledge, this will be a first attempt to use essentially laboratory 'energy flow' approaches in a field situation pre-selected for its simplicity to test the approaches.

SUPPORTED BY No Formal Support Reported

5.0824, MARINE BACTERIAL ENZYMES
J.R. MERKEL, Lehigh University, Marine Science Center, Bethlehem, Pennsylvania 18015 (NONR)

This research is concerned with the isolation and characterization of marine bacteria in an effort to determine the influence of physical and chemical factors on their growth and enzyme production. Current emphasis is being placed on studies of their proteolytic enzyme production by these bacteria. A technique involving the separation of protein components by amonium sulfate is being employed for the identification of the enzymes in mixtures found in culture media. Another phase of this program deals with the distribution of proteolytic bacteria in various marine localities. This investigation is important to the Navy in yielding useful information concerning the role of bacteria and bacterial processes in the sea.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0825, DYNAMICS OF OCEANIC PLANKTON
W.H. SUTCLIFFE, Lehigh University, Graduate School, Bethlehem, Pennsylvania 18015

5. LIVING SYSTEMS (NON-HUMAN)

Preliminary experiments have shown that the concentration of ribonucel acid in some small marine animals may be used as a measure of growth or 'productivity'. Attempts are now being made to apply the method to marine zooplankton.

SUPPORTED BY U.S. National Science Foundation

5.0826, THE CHARACTERISTICS, MECHANISMS AND BIOGEOCHEMICAL CONSEQUENCES OF PHYTOPLANKTON FLOTATION
T.J. SMAYDA, Univ. of Rhode Island, Graduate School, Kingston, Rhode Island 02881

The characteristics, mechanisms and biogeochemical consequences of phytoplankton flotation will be determined experimentally. The influence of cell size, chain type and colony size, culture age, silicon and fat content on sinking rates will be investigated. The influence of organic substance liberation and the ensuring changes in viscosity, and the role of viscosity in flotation will be examined. The influence of nutrients and light on sinking rates, as well as the Gross and Zeuthen theory of flotation will also be examined. If time permits, the influence of sinking on the liberation of dissolved organic matter and on the formation of organic aggregates will also be determined.

SUPPORTED BY U.S. National Science Foundation

5.0827, MULTIVARIATE ANALYSIS OF MICROPALEONTOLOGICAL DATA FROM DEEP-SEA CORES
J. IMBIE, Brown University, Graduate School, Providence, Rhode Island 02912

Research initiated under NSF grant GP-4994 on fossilized microorganisms from deep-sea cores will be continued using multivariate analysis of paleontological data as a foundation for geological interpretation. Fossilized microorganisms provide an important basis for historical interpretation in geology and climatology and contribute to our knowledge of submarine processes of erosion, transport, and deposition; but to date few investigations involving mathematical treatment of micropaleontological data have been undertaken. In view of the complexity of distribution patterns, both in organism and sediments, which result from an interplay of geologic processes and ecological controls, it is especially desirable that mathematical bases for interpretation of the geologic record be improved. It is hoped that multivariate methods may prove helpful in extracting clear, reproducible patterns from complex data, and that these patterns will in turn be of maximum benefit in the interpretation of the geologic record.

Specific objectives of the continued research are: 1) to extend the analysis to depths where previously published analyses show conflicts between temperatures inferred from G. menardii and from oxygen isotope data; 2) to determine how many components are needed to describe foraminiferal communities in Atlantic cores, and if possible to interpret the components ecologically; 3) to attempt to derive a mathematical relationship between isotopic temperatures and quantitative data on planktonic foraminifera.

SUPPORTED BY U.S. National Science Foundation

5.0828, ELUCIDATION OF THE METABOLIC PATHWAYS OF MARINE PLANKTONIC ORGANISMS

This study is concerned with demonstrating the individual physiological processes concerned with the overall metabolism of marine planktonic organisms. This includes investigation of the various enzyme systems of these organisms and demonstrating the mechanisms of these systems with respect to enzyme concentration, substrate concentrations, pH, temperature, and coenzymes. Also included are investigations to determine the cell fractions or particulates with which the various enzyme systems are associated and the isolation and purification of the enzymes.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl
5. LIVING SYSTEMS (NON-HUMAN)

5.0829. EFFECT OF NITRilotRIACETIC ACID (NTA) UPON THE TOXICITY OF METALS TO SELECTED SPECIES OF ESTUARINE PHYTOPLANKTON


Laboratory studies will be conducted to determine the relationship of nitritolriacetic acid (NTA), a metal chelator, to the toxicity of metals to selected species of estuarine phytoplankton. The metals employed in this study will be those which are known metabolic toxins and are of importance from the standpoint of estuarine pollution.

The toxicity of the various metals to six species of phytoplankton will be determined in the presence of several concentrations of NTA. In addition to growth rate, C14 labeled carbon dioxide will also be employed as a parameter for determining levels of metal toxicity.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0830. EFFECTS OF PETROLEUM AND PETROLEUM WASTES UPON IMPORTANT SPECIES OF ESTUARINE PHYTOPLANKTON AND ZOOPLANKTON


The effects of petroleum and petroleum wastes upon important species of estuarine phytoplankton and zooplankton will be assessed. Assays on zooplankton will employ acute toxicity to various stages in the organisms' life history as the principal parameters. Assays on phytoplankton will involve the effects of pollutants on growth, photosynthesis, and respiration as well as mechanical effects such as cell lysis. Comparative toxicity of different types of petroleum products will be investigated.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0831. INTEGRATED FIELD AND LABORATORY SYSTEM FOR ASSAYING THE EFFECTS OF POLLUTANTS AND TOXICANTS UPON WATER QUALITY


The purpose of this project is to investigate the effects of pollutants and toxicants on natural populations of marine phytoplankton as well as on axenic cultures of selected species comprising these populations. Assays will be performed in natural and defined seawaters in such combinations as to obtain a continuum of responses. Laboratory cultures will be designed to simulate field conditions. Measurement of photosynthesis and respiration rates using radioactive carbon will be the principal technique employed and will be correlated with long-term growth studies.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0832. USE OF MARINE PLANKTONIC ORGANISMS FOR EVALUATING THE QUALITY OF MARINE AND ESTUARINE WATERS


This project is concerned with the development of bioassay methods and techniques, employing various species of marine phytoplankton and zooplankton, for determining the toxicity and identity of pollutants in the marine environment and for determining and predicting the short- and long-term effects of lethal and sublethal concentrations of pollutants upon planktonic organisms and other organisms in the marine environment.

The test species will include those which are ecologically important and, in the case of zooplankton, their various life stages.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0833. DETERMINATION OF SELECTED ENVIRONMENTAL REQUIREMENTS OF IMPORTANT MARINE PHYTOPLANKTON SPECIES


Studies have been initiated to determine minima, optima, and maxima of selected physical and chemical requirements of four ecologically and economically important species of unicellular marine algae. Requirements considered in this program are nitrogen, phosphorus, sulfur, and silicon; also temperature, light, major cations, and redox. Methods used on axenic cultures in synthetic seawater media are growth studies, radioisotopic tracer techniques, chemostatic culture and continuous culture techniques, and various physical methods of measuring environmental changes. Species studied are Skeletonema costatum, Olisthodiscus luteus, Nanochloris ocellata, and Dunaliella tertiolecta.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0834. DEVELOPMENT OF CULTURE METHODS FOR ECOCLOGICALLY IMPORTANT MARINE ZOOPLANKTON SPECIES


Methods to culture large numbers of individuals of Acartia tonsa, A. Clausi, Pseudodiaptomus coronatus, Tisbe furcata, Calanus sp., and Tigrigopus californicus are being devised and tested in conjunction with another project concerned with environmental requirements of these species. Desiderata are the production of large numbers of individuals in a minimal volume of medium, successful completion of life cycles through several generations, elimination of undefined chemical compounds from the medium, simplicity of apparatus, definition of food materials, and ability to operate on a continuous basis.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0835. DETERMINATION OF SELECTED ENVIRONMENTAL REQUIREMENTS OF IMPORTANT SPECIES OF MARINE ZOOPLANKTON


Acartia tonsa, A. clausi, Pseudodiaptomus coronatus, Calanus sp., Tisbe furcata, and Tigrigopus californicus are undergoing experimentation to determine optimal conditions of temperature, salinity, oxygen saturation, and food materials for successful completion of their life cycles. Organisms are cultured and subcultured in the laboratory under small volume, static conditions. End points and condition of cultures are determined by microscopic examination of life cycle progress, in some experiments using time-lapse photography.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0836. STUDIES ON THE DEVELOPMENT OF DERMOCYSTIDIUM MARINUM

J.G. MACKIN, Texas A & M University System, Graduate School, College Station, Texas 77843

Studies to date have showed that Dermocystidium marinum Mackin, Owen, and Collier, a parasite of oysters, is a member of the Labyrinthulales, and methods of culture have been developed. Extension of this work aims at study of the developmental cycle in culture, the relations beyond the Labyrinthulales, and application of increased knowledge of epizootiology toward control of the disease in Gulf Coastal estuaries.

SUPPORTED BY U.S. Dept. of Hith. Ed. & Wel. - P.H.S.

5.0837. LABORATORY STUDIES OF TOXIC DINOFAGELLATES

S.M. RAY, Texas A & M University System, Graduate School, College Station, Texas 77843

Shellfish oysters, clams, and mussels are being subjected to laboratory cultures of Gulf of Mexico dinoflagellates (Gymnodinium breve and Gonyaulax monilata) which are toxic to marine fishes, to determine if these shellfish will produce toxic symptoms when eaten by mammals and birds. We have induced shellfish poisoning in chicks by feeding them oysters which had been subjected to G. breve cultures. The influence of variable cul-
tured conditions and media on the relative toxicity of G. breve and G. manilata cultures, and the influence of such factors on the stability of the toxin(s) in shellfish will be investigated. Furthermore, factors that might influence the feeding activity of shellfish subjected to cultures of these dinoflagellates will be considered. Pharmacological and toxicological studies will be conducted to determine the nature and mode of action of the toxins produced by these two dinoflagellates. The purpose of the proposed work is to gather information that will permit the evaluation of the Gulf of Mexico dinoflagellates as potential etiological agents for paralytic shellfish poisoning. Basic information will be obtained on dinoflagellate-mollusc relationships, and thus contribute to our knowledge of ecology and physiology of these two groups of organisms. Other species of Gonyaulax: G. acutangula, G. catenella G. tamarenis, G. polyedra, G. polygramma, G. sphaeroidea, G. spinifera, and G. washingtonensis, will also be studied. The proposed studies are a part of this laboratory's long-range research program in molluscan biology.

SUPPORTED BY U.S. Dept. of Hith. Ed. & Wel.-P.H.S.

5.0838, BIOLOGICAL OCEANOGRAPHY (GULF OCEANOGRAPHY PROGRAM)
C.J. GUICE, U.S. Dept. of Interior, Biological Laboratory, Fort Crockett - Galveston, Texas
The ecological factors of the ocean environments must be known to make possible the predictions of shrimp productivity. The exact influence of an influx of oceanic water over the continental shelf is not known. To do this, some constant quality of the significant water mass must be measured, and this may be accomplished by a grouping of microplanktonic constituents.
Project objectives are to determine (1) the distribution and abundance of plankton species and their association with water masses in the Gulf, (2) which, if any, planktonic organisms are sources of food or predators, or both, for larval and postlarval stages of shrimp and (3) to correlate the distribution and abundance of plankton with physical and chemical properties of Gulf waters and evaluate the use plankton as indicators of significant water masses.
SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0839, ULTRASTRUCTURAL STUDIES OF PARASITIC AND SAPROPHYTIC FUNGI AND PROTOZOA ASSOCIATED WITH MARINE INVERTEBRATES
F.O. PERKINS, Virginia Inst. of Marine Sci., Gloucester Point, Virginia 23062
The research effort is being directed toward elucidating the fine structure of the following organisms in an attempt to better understand their life cycles and to better understand the host-parasite interactions: Minchinia Nelsoni, Minchinia costalis, "Pepper-crab" disease organism, Labyrinthula sp., Labyrinthomyxa marina.
The taxonomy and phylogenetic relationships of the above parasites will be re-evaluated upon completion of this study. Comparisons of the various organelle systems will be made with comparable systems in higher plants and animals.
SUPPORTED BY Virginia State Government

5.0840, A COMPARATIVE SYSTEMATIC INVESTIGATION OF MARINE CILIATES IN THE HOLLORICHIUS PROTOZOAN ORDER HYMENOSTOMATIDA
J.C. THOMPSON, Hampden Sydney College, Undergraduate School, Hampden Sydney, Virginia 23943
The proposed research will involve a comparative systematic study, especially of the somatic and bacular ciliature, of marine ciliates in the order Hymenostomatida. The primary objective of this investigation will be to collect marine ciliates in the order Hymenostomatida and to establish a system of taxonomy based on precise morphological data.
SUPPORTED BY U.S. National Science Foundation

5.0841, THE ECOLOGY OF COCCOLITHOPHORIDACEAE IN THE ATLANTIC COASTAL WATERS OF THE UNITED STATES
H.G. MARSHALL, Old Dominion College, Graduate School, Norfolk, Virginia 23508
The purpose of this research is to determine the spatial distribution of the coccolithophores in Atlantic coastal waters of the United States between Massachusetts and Florida. This represents a further study of the coccolithophores and other phytoplankters that are present at different seasons, over a four year time period. Collections have been made along transects over and beyond the continental shelf to depths of 300 meters. Emphasis has been placed on distribution and vertical stratification patterns of these algae and the classification of representative species.
The research project involves detailed studies on the characteristic phytoplankton of the continental shelf waters, the Gulf Stream, and the Sargasso Sea are included in this investigation. Specific physical and chemical data have also been collected at each hydrostation. The use of an electron microscope has been utilized in the identification of coccolithophore species.
SUPPORTED BY U.S. National Science Foundation

5.0842, NATURAL HISTORY OF SALMON POISONING RICKETTSIAE
R.L. OTT, Washington State University, School of Veterinary Medicine, Pullman, Washington 99163
The objectives of this project are to expand the knowledge available on the role of heminthetic endoparasites as vectors and reservoirs of viral and rickettsial diseases.
Work in this laboratory demonstrated that Neorickettsia helminthoeca the etiological agent of salmon disease of dogs, as well as another as yet unclassified rickettsial agent persist, remain viable and infectious for at least seven years in the metacecal stage of the fluke Nanophyetus salmincola, encysted in a salmonid fish. It has also been demonstrated here that the same fluke can transmit, at least mechanically, the virus of infectious canine hepatitis.
Experimental model systems are being developed to demonstrate the persistence and retention of virulence of the virus of infectious canine hepatitis in the canine dog around worm-Toxocara canis-and a dog tapeworm-Taenia taeniaformis. Additional model systems are being developed to show the persistence of the virus of feline panleucopenia in the cat roundworm Toxocara cati and the tapeworm Taenia taeniaformis.
These experimental model systems will simulate natural endoparasite-virus relationships and hopefully will demonstrate how many infectious agents persist from one host generation to the next.
SUPPORTED BY U.S. Dept. of Hith. Ed. & Wel.-P.H.S.

5.0843, INPEC BIOLOGICAL OCEANOGRAPHY - (PHYTOPLAGONK AND ZOOPLANKTON RESEARCH)
F. FAVORITE, U.S. Dept. of Interior, Biological Laboratory, Seattle, Washington 98102
Studies in progress in biological oceanography include phytoplankton productivity and zooplankton ecology.
Productivity and standing stock of phytoplankton and associated physical and chemical factors are measured seasonally in various water masses of the Pacific Subarctic region. The objectives are to assess the seasonal and annual primary production and determine its gross interrelationships with the environment. This work will continue with emphasis on the timing of changes in primary productivity during spring and associated changes of environmental conditions, especially zooplankton.
The zooplankton project is designed to study the seasonal and annual variations in abundance, distribution, and species composition of zooplankton populations with respect to known water regimes and environmental conditions in the central North Pacific Ocean. Current interest is directed toward study of the rapid spring increase of zooplankton organisms. Information from these investigations is necessary to understand the causes of variations in the migratory paths, growth and survival of salmon in the North Pacific Ocean and Bering Sea. Probable spin-off benefits...

211
5. LIVING SYSTEMS (NON-HUMAN)

specific zooplankton may serve as markers of matter masses and may be critical items in the food chain of other commercially important fishes.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0844, PREDICTION OF BIOLOGICAL POPULATIONS FROM THE PHYSICAL OCEANIC ENVIRONMENT
K. BANSE, Univ. of Washington, Graduate School, Seattle, Washington 98122 (NONR)

Objective: A precise and reliable modeling technique for the prediction of both temporal and geographic occurrence of marine organisms would provide the Navy with a major informational asset in the resolution of such biologically produced operational problems as the sonic scattering layers. One of the most sensitive factors available for distributional predictions of motile marine organisms is the cosmopolitan and fundamental link in the oceanic food-chain represented by the phytoplanktonic forms. Since the principal theoretical model of plankton abundance extends lacks comprehensive field data for verification and refinement, this task unit has been expressly designed to supply such data and advance the level of predictive competence in this area.

Approach: The principal investigator will utilize commercial 'Ships of Opportunity' plying the Seattle-Yokahama route, as well as deploying the R/V Thompson to gather the quantified data necessary to verify or modify the Sverdrup Model of planktonic abundance. Data will be obtained for: chlorophyll A, mixed oceanic layer depth, extinction coefficient of light in the sea, incident surface radiation, volume of plankton, and nutrient concentration. Cruises are being concentrated in the February-June period of rapid planktonic growth and the geographic areas of interest are the temperate and subarctic North Pacific.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0845, NUTRIENT LIMITATION AND SOURCES OF NITROGEN FOR MARINE PRIMARY PRODUCTIO
R.C. DUGDALE, Univ. of Washington, Graduate School, Seattle, Washington 98122

The program is in three main areas: Nutrient Limitation A mathematical model describing the behavior of nutrient-limited phytoplankton populations under steady-state has been constructed. The transient behavior of this model and solutions for more complicated models will be investigated through simulation techniques using digital computers. Observations at sea have indicated silicate limitation in Peru coastal waters and nitrate limitation in the Bering Sea. Using the model for experimental design, attempts will be made to extend and confirm these preliminary observations.

Uptake of New and Regenerated Nitrogen in Primary Production: Measurement of primary production with 15N has been proposed and some measurements already made. Nitrate uptake is called 'new production'. The total amount of new production as nitrate uptake and nitrogen fixation (or atmospheric precipitation in some cases) sets the maximum limit for losses from a steady-state phytoplankton population. Additional measurements using incubation techniques identical to those employed in some 14C measurements of primary production will be made. The technique may be useful in understanding food-chains in some areas.

Nitrogen Fixation A new technique, faster and more sensitive than the 15N method is to be calibrated and modified for use at sea. Acetylene is converted to ethylene by the nitrogen fixing enzyme system. The method of detection for ethylene is by gas chromatography. The low cost of the equipment and the simplicity and rapidity of the experimental procedure will make it possible to measure nitrogen fixation over broad areas of the ocean. The increased sensitivity makes it possible to look for low level nitrogen fixation.

SUPPORTED BY U.S. National Science Foundation

5.0846, ANAEROBIC BACTERIA IN THE MARINE ENVIRONMENT
J. LISTON, Univ. of Washington, Graduate School, Seattle, Washington 98122

Enumeration and isolation of anaerobic bacterial populations of water, sediments and animals in Puget Sound and adjacent waters will be continued. The presence of terrestrial pathogenic anaerobes in fish caught in polluted areas and the possible transfer of these organisms to the consuming public via the market chain will be investigated by selective sampling and laboratory experiments.

The identification of anaerobic bacteria isolated from the marine environment will continue by the use of appropriate media and techniques. The function of these organisms and their potential for survival and growth (particularly pathogenic) in the marine environment will be studied by growing isolates over a temperature range on a polythermostat to establish the minimum growth temperatures. In addition to this, the combined effects of temperature and pressure will be investigated.

SUPPORTED BY U.S. Dept. of Hith. Ed. & Wel. - P.H.S.

5.0847, MARINE PHYTOPLANKTON RESEARCH
R.E. NORRIS, Univ. of Washington, Graduate School, Seattle, Washington 98122

The primary phases of the research are 1) research on species of coccolithophorids and small dinoflagellates in preserved samples collected in the Indian Ocean; 2) isolation of northeastern Pacific and Indian Ocean species into unialgal culture, and using the isolated species for studies on life-histories, cytology, and nutrition; 3) investigation of species that seem to utilize the water's surface film at some phase of their life-history, with particular attention to the possible ways this adaptation has affected their morphology; 4) studies on consort and symbiosis in marine phytoplankton, especially with respect to culture of species from tropical and sub-tropical regions. Host and consort are cultured independently if possible, nutritional studies are being carried on, and compared, for the isolated species and the con-sorting pairs.

SUPPORTED BY U.S. National Science Foundation

5.0848, AQUATIC MYXOBACTERIA - CHONDROCOCUS COLUMNARIS
E.J. ORDAL, Univ. of Washington, School of Medicine, Seattle, Washington 98122

Comparative studies are being carried out on aquatic myxobacteria pathogenic to fish with special emphasis on C. columnaris which is of particular importance as an agent of disease in fishes in the Pacific Northwest. Comparison will be made with cultures isolated or obtained from fish in regions other than the Pacific Northwest. The myxobacteria associated with diseases of Atlantic salmon, reported to be a form of columnaris disease active at low water temperatures, are of particular interest. New an-tisera will be prepared for identification of specific strains of C. columnaris by antigenic analysis. Further studies will be made on the role of water temperatures in diseases of fishes including exploration of the possibility that high water temperature may induce increased virulence in strains of C. columnaris.

SUPPORTED BY U.S. Atomic Energy Commission

5.0849, MARINE-BACTERIA CULTURE
E.J. ORDAL, Univ. of Washington, Graduate School, Seattle, Washington 98122 (NONR)

This research involves: (1) the development of a steady state enrichment culture for selection of particular physiological types of aquatic or marine bacteria, and (2) the investigation of definitive groups of aquatic and marine bacteria. These bacteria include vibrios, stalked and budding bacteria, and myxobacteria.

This problem is significant to the Navy in improving the understanding of important food elements; possible mechanisms of corrosion, deterioration, and fouling, and other areas.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0850, ECOLOGY OF CLOSTRIDIUM BOTULINUM TYPE E IN GREEN BAY
H. SUGIYAMA, Univ. of Wisconsin, Graduate School, Madison, Wisconsin

Washington 98122 (NONR)
The presence of Clostridium botulinum type E in and on the fish of the Great Lakes constitutes a botulism hazard. The organism is particularly prevalent in Green Bay, not only in fish but also in environmental samples. The very low incidence of type E in the soil away from the aquatic environment suggests that passive accumulation of the organisms being carried down from the surrounding land mass is not the only explanation for this distribution. Attempts will be made to show the multiplication of type E in the bay itself. Other sources of the organism which contribute to the maintenance of the type E population in Green Bay will be studied. Effects of other microflora in limiting the growth of type E will be investigated. Shellfish Investigations of the Auke Bay Laboratory and the Institute of Marine Sciences, University of Alaska. The combined effort by the above groups resulted in detailed ‘ecosystem studies’ of selected areas.

5.0851, COASTAL AND INSHORE OCEANOGRAPHY
H.E. BRUCE, U.S. Dept. of Interior, Biological Laboratory, Auke Bay, Alaska

This project is a comprehensive study of the chemical, biological, and physical oceanography of selected estuarine environments in Southeast Alaska. The objectives are to describe the general physical, chemical, and biological oceanographic conditions of the inside waters of Southeast Alaska and the seasonal and annual variations in these conditions. The oceanographic work is done in conjunction with other investigations of the Auke Bay Laboratory (Biological Investigations and Shellfish Investigations) and with and Federal Water Pollution Control Administration and the University of Alaska. The combined effort by the above groups resulted in detailed ‘ecosystem studies’ of selected areas.

The oceanographic studies are broken down into physical and descriptive oceanography and chemical and biological oceanography which results in an over-all comprehensive program in oceanography. Biological oceanography includes studies in phytoplankton ecology, taxonomy, primary and secondary productivity, and energy transfer from the primary producers through the primary herbivores. Also included are studies on dissolved and particulate organic materials and their relations to primary and secondary trophic levels and to benthic organisms.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0852, ESTUARINE STUDIES OF SOUTHEASTERN ALASKA
J.B. KIRKWOOD, U.S. Dept. of Interior, Biological Laboratory, Auke Bay, Alaska

One of the aims of the Auke Bay Biological Laboratory is to accumulate detailed descriptive information on environmental characteristics of several estuarine environments within the inside waters of Southeastern Alaska, and to explain ecological reasons for some of the observed differences between environments. The ecological differences are undoubtedly responsible for the annual fluctuations and distributions and abundances of commercially valuable fish and shellfish species.

It is apparent that descriptive knowledge of local populations and their environments are not sufficient in themselves to provide a clear concept of basic ecological and biological principles controlling an ecosystem however, such knowledge is a prerequisite to planning and conducting more detailed and intensive studies of discrete ecological and biological problems. A cooperative study was initiated in April 1967 that will involve Oceanography Investigations, Marine Biological Investigations, Shellfish Investigations of the Auke Bay Biological Laboratory, and outside agencies such as Federal Water Pollution Control Administration and the Institute of Marine Sciences, University of Alaska.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0853, ARCTIC BIOLOGICAL OCEANOGRAPHY
M.B. ALLEN, Univ. of Alaska, Inst. of Marine Sciences, College, Alaska 99775

It is well known that the polar seas are among the most productive oceanic areas of the world, in spite of the low temperatures and the fact that the photosynthetic organisms responsible for primary production must spend several months of the year in total darkness and several more months with a notably limited amount of light, which may differ appreciably in spectral distribution from normal sunlight due to absorption and scattering of light by ice and materials trapped in it. The Arctic Ocean is especially rich in phytoplankton and grows fewer benthic plants, although an extensive benthic algal bed has been reported near Point Barrow, Alaska, and beds of eelgrass are found in several arctic and sub-arctic locations on the Alaskan coast. If there is active growth of any of these organisms during the winter months, it must imply both the possibility of heterotrophic metabolism of the organisms and the availability of sufficient organic materials to support growth in the waters. The organic material need not necessarily be dissolved; many phytoplanktons have the capacity for phagotrophy. The general objectives of this project are to determine (1) whether growth of photosynthetic organisms does occur during the arctic winter, (2) if so, what organic materials are used by the organisms involved, (3) whether these organic nutrients are present in the waters in which the organisms are found, (4) the yearly light and temperature regime to which the organisms are actually exposed, and (5) what are the mechanisms of adaptation which permit photosynthetic organisms to store sufficient reserves to help them through the months of total darkness in spite of much of a year spent at low light intensity. Both marine and freshwater environments will be investigated.

SUPPORTED BY U.S. National Science Foundation

5.0854, MARINE BIOLOGY IN ALASKA
K.M. RAE, Univ. of Alaska, Inst. of Marine Sciences, College, Alaska 99775 (NONR)

The object of this task is to increase scientific knowledge of the hydrobiology of Alaskan waters and to analyze peculiarly Arctic and sub-Arctic biological conditions. A group of scientists is chosen yearly by the Director of the Institute, with the Scientific Officer’s approval, to conduct short-term research in this area. Field work is emphasized. During the coming year, work will continue on cation exchange on particles and the availability of ‘sorbed’ metals to the benthos, and the biology and hydrobiology of the Aleutian Trench. New work will include the isolation of a new amino acid with an unusual chemical structure from marine coelenterates, and possibly from ciliates; the ecology and fine structure of Arctic sponges and the relationship to the silicon cycling in the sea.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0855, ECOLOGICAL STUDIES OF THE COPPER RIVER DELTA
B. HILLIKER, State Dept. of Fish & Game, Juneau, Alaska

Objectives: To determine the effect of land uplifting associated with the earthquake of March 27, 1964 on the production of waterfowl on the Copper River Delta.

Procedures: 1. Establish permanent vegetation sampling plots or transects within parts of the Copper River Delta used by ducks, geese, and swans during the breeding season. 2. Using this sampling system, collect data on the magnitude of the Delta (or a segment of it) showing the present distribution of vegetation types. 3. Obtain detailed descriptions on the plant communities now present, including species composition, the form or structure of each vegetation.
5. LIVING SYSTEMS (NON-HUMAN)

- Sonoran Coast. The International Marine Research Station at ranges along the typically hot, arid, desert climate of the Mexican area scientifically, but one of real interest due to Arizona 85721 (N00014-67-A-0209-0003)

- D.A. THOMSON, Univ. of Arizona, Graduate School, Tucson, 5.0856, GULF OF CALIFORNIA BIOLOGY

D.A. THOMSON, Univ. of Arizona, Graduate School, Tucson, Arizona 85721 (N00014-67-A-0209-0003)

This is a long-term program for the elucidation of the intertidal and oceanic biology of the Gulf of California, a little known area scientifically, but one of real interest due to its isolation linked with a high incidence of endemism and extreme tidal ranges along the typically hot, arid, desert climate of the Sonoran Coast. The International Marine Research Station at Puerto Penasco is jointly operated by the Universities of Arizona and Sonora (Mexico), and represents a unique research facility for studies in tropical biology by scientists from both cooperating countries.

This project which has as its goal a predictive level of ecological knowledge concerning those biological entities or systems which may affect Naval activities. In order to make such predictions, it is necessary to know as much as possible about the factors leading to such conditions as: alterations in bottom conditions due to density variations in biological populations, shorelines and emergent beach changes, bioluminescence, and emission absorption, or reverberation of acoustic transmissions.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0857, INTERRELATIONSHIPS OF MARINE ORGANISMS AND SEDIMENTS

R.N. GINSBURG, Bermuda Biol. Sta. For Res., St. George, Bermuda

The objective of the proposed program is to bring together exceptional graduate students and staff, from diverse fields of specialization, to observe, study, and to do research on the complex interactions between living organisms, bottom sediments, and rocks, and seawater.

The program consists of two parts: (1) For the first three weeks of the course, students are introduced to shallow-marine environments, their organisms, and sediments. They learn the common organisms, make maps of selected areas, and examine the bottom sediments. Half-day field exercises alternate with laboratories, and lectures. (2) The last three weeks of the seminar are spent on individual research projects of the students' own choosing. This past year each student prepared an illustrated report of his results. These brief papers will be published during the year.

SUPPORTED BY U.S. National Science Foundation

5.0858, ECOLOGICAL SURVEY OF EFFLUENT DISCHAGE AT TWO PULP MILLS IN HUMBOLDT COUNTY, CALIFORNIA

J.A. GAST, Humboldt State College, Graduate School, Arcata, California 95521

A continuing study is being carried out on benthic organisms, fish, commercial crabs, and water quality to see if there is any significant affect on the environment by the discharge of pulp mill effluent into the near shore waters of Humboldt County, California.

Sampling of bottom invertebrates with a Smith-McIntyre bottom grab is conducted monthly at specific locations. Sampling of water for chemical analysis and temperature measurements are made at regular periods.

Sampling of the neckton and commercial crabs by otter trawls. Otter trawl catches are examined on a quarterly basis.

SUPPORTED BY Georgia Pacific Corporation

Crown Simpson Pulp Company

5.0859, THE ECOLOGICAL ARCHITECTURES OF THE MARINE BIOSPHERE

J.W. VALENTINE, Univ. of California, Graduate School, Davis, California 95616

NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY John S. Guggenheim Memorial Foundation

5.0860, ENVIRONMENTAL BIOLOGY OF TOMALES BAY

E.H. SMITH, Univ. of Pacific, Graduate School, Dillon Beach, California 94929

The principal objective of the research is to learn how marine communities change in time under natural and artificial conditions. It must be stressed that the research now in progress has passed the faunal check list stage and moved into the investigation of individual organisms or groups of organisms and their relationship to the environment in which they are found. Such knowledge is required in order to evaluate and control the effect of man on the marine environment. Tomales Bay is one of the last unpolluted bays on the West Coast of the United States. The establishment of the Point Reyes National Seashore is expected to increase the artificial disturbance of the shallow water marine communities to an appreciable extent. It should be possible to observe the reciprocal effects between the increasing human population and the marine communities by maintaining a program monitoring the ecosystem. Data on physical and chemical parameters will be used to assess the relationship between the environment of individual organisms to the general environment of the region. This information can be used to reconstruct the pathways by which stress is applied to the community. Studies of functional morphology and environmental physiology will help to show how marine species react to changing conditions. The data acquired in these studies can be used to predict the impact of man on the marine environment elsewhere and to the ultimate feedback to human welfare.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0861, MARINE COMMUNITIES

E.W. FAGER, Univ. of California, Scripps Inst. of Oceanography, San Diego - La Jolla, California 92038 (NONR)

The objective is to understand the structure and dynamics of shallow bottom communities through observations of activities in the natural environment, and measurements of community and environmental parameters. A secondary objective is to extend the same or analogous methods to plankton communities. Measurements of the distribution and life histories of bottom organisms are made by diving. Plankton distributions are obtained from samples collected on cruises to critical areas. Critical points in life histories are checked by culturing organisms in the laboratory. The total approach is a combination of field observation and experimentation with laboratory studies and computer simulation and analysis. In the near future, it is planned to increase the amount of experimental manipulation of the environment, for example, by setting up replicated 'reefs' and moving or rearranging them from time to time. Improvements in the now widely used computer program for grouping will continue.

The key to methods of control, avoidance, or utilization of organisms is frequently found by observing the kind described here whereas without them, the development of a specific method is often expensive and of limited applicability.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0862, SIMULATION STUDIES OF ECOCOLOGICAL COMMUNITIES

E.W. FAGER, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

A simulation space program for ecological communities is being developed. It will now take up to 50 species. It uses biologically interpretable input data such as age-specific birth and death rates, growth rates, feeding rates, feeding preferences, etc. All population parameters are in terms of individuals; all growth and feeding relations are in terms of micrograms of carbon. The ef-
fects of changes in the input data, of changes in the interrelations between species and of perturbations involving sudden increases or decreases in some species can be investigated. It has been run on data for two species of copepods and two species of chaetognaths that are abundant in the nearshore waters. The results seem to constitute realistic predictions of what is seen in samples taken in the field. A few somewhat unexpected results have been obtained: cannibalism may be an effective way for a predator to maintain itself for a short time in the absence of prey; mortality associated with factors other than predation seems relatively unimportant in control of population size and persistence; in the presence of random variability in reproductive success, a pattern of births spread over several time periods is superior to one with the same intrinsic rate of increase but with the birth all at one time period. The model is being used to explore the consequences of different population parameters and patterns of birth and death and of different predator-prey and prey-predator interrelations.

SUPPORTED BY U.S. National Science Foundation

5.0863, RECENT AND ANCIENT FAUNAS OF A DROWNED ISLAND CHAIN (MID-PACIFIC MOUNTAINS)
W.A. WATSON, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

The fauna of guyots and deep seamounts remains virtually unknown. Intensive sampling should provide material with which to commence the analysis of several fundamental problems related to the fauna of guyots. Dredging of fossil deposits will provide information pertaining to the composition and affinities of past faunas, their relationship to present Pacific faunas, and the history of submerged islands.

The Mid-Pacific Mountains have been selected for such investigation. They are presently represented by an extensive chain of seamounts and guyots at 1,500 - 2,000 m, separated from one another by considerable depths. During the Cretaceous the guyots stood at the surface as oceanic islands. Fossil outcrops of shallow water origin are known to occur.

Major sampling tools to be employed are, free vehicle trap, set line and camera, pipe dredge, otter and bean trawl, and Isaac-Kidd Midwater Trawls.

Continuous Reflection Profiling with the Arcer will be used in order to reveal thickness and distribution of sediment overlying ancient land forms.

On an available-time basis, a recently charted seamount N.E. of Midway Island rising to within 35 fathoms of the surface, will be sampled by dredging and coring.

SUPPORTED BY U.S. National Science Foundation

5.0864, INTERACTIONS OF INTERTIDAL POPULATIONS
J.H. CONNELL, Univ. of California, Graduate School, Santa Barbara, California 93018 (NONR)

The investigator is analyzing the population dynamics of a selected group of organisms which inhabit the intertidal regions of rocky marine beaches. Particular emphasis is placed on the interrelationships involving the activities of predators and prey animals and the environmental factors which contribute to the equilibrium of the system.

Because the Navy conducts its operations in the oceans, it is necessary to understand as much as possible about their ecology and the factors influencing it. Marine biological communities pose many specific problems, the group under study contributing noteworthy insight into community deterioration, modification of bottom sediments or beach conditions, masking of acoustic signals. The phenomenon of community dynamics and balance, however, applies even more broadly and relates to all aspects of hydrobiology.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0865, ECOLOGICAL STUDIES OF ROCKY SUBTIDAL AREAS
C.H. TURNER, State Dept. of Fish & Game, Terminal Island, California

5. LIVING SYSTEMS (NON-HUMAN)

Objective: To study the plant and animal communities of rocky subtidal areas, including taxonomic classification and correlation between species and their relationships to sport fish populations.

Procedures: Studies will be devised to answer questions on the total ecological picture of these rocky subtidal areas, including interrelationship of species, relationship to substrate, and relationship of each to sport fishes.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish. California State Government

5.0866, ECOLOGY OF PANAMANIAN REEF COMMUNITIES
P. GLYNN, Smithsonian Institution, Balboa Heights, Canal Zone

This project is concerned with studies on the ecology of the shallow-water Porites furcata assemblage which occurs on the reef-flat habitat of coral reefs located along the southwestern coast of Puerto Rico and on the Atlantic seaboard of Panama. Initial, major emphasis has been given to a study of the meteorology, hydrography and plankton populations. Additionally, a systematic program involving the procurement of quadrant samples and other quantitative measurements needed to assess spatial and temporal variations of the biota has been executed on a long-term basis. The ultimate aim of the investigation is to obtain information on the following aspects of the coral community: a. composition and structure of the biological components; b. food interrelationships; c. movement of energy and materials through the assemblage.

SUPPORTED BY U.S. National Science Foundation

5.0867, ZONATION OF THE WEDDELL SEA BENTHOS
L.S. RANKIN, Univ. of Connecticut, Graduate School, Storrs, Connecticut 06268

The Weddell Sea, an area of essentially constant environmental characteristics, is an ideal 'laboratory' for the study of factors affecting the distribution of marine benthic organisms. The prevailing hypothesis, that these organisms are zonally present because of temperature regimes, will be tested through intensive collections at a few stations at representative depths. The waters in this sea should be at essentially the same temperature at the various depths. Similarity or differences in species distribution and abundance, therefore, may be ascertained, with temperature as a 'controlled' factor. Subsequent studies should evaluate other factors than temperature.

SUPPORTED BY U.S. National Science Foundation

5.0868, ZONATION OF THE WEDDELL SEA BENTHOS

Objective: An evaluation of the effects of various types of marshland management on the diurnal and seasonal concentration of phosphorus and nitrogen in tidal marshes.

Procedures: The water samples collected in the field will be processed in the following manner: 1. Inorganic phosphates - Reimold, R. J., 1965. An evaluation of inorganic phosphate concentrations of Canterbury Marsh. This procedure requires that inorganic phosphorus determination be made immediately after sample collection to avoid errors due to sample storage. The determination, a spectrophotometric technique, requires electrical power. 2. Total phosphorus - Water samples for total phosphorus concentrations are processed upon return to the Bayide Laboratory. The sample is oxidized in an ordinary au-
5. LIVING SYSTEMS (NON-HUMAN)


The results will be processed for computer evaluation of the various suspected relationships between the phosphorus and nitrogen concentrations and related physical parameters measured. The results will be processed for computer evaluation of the various suspected relationships between the phosphorus and nitrogen concentrations and related physical parameters measured. The results will be processed for computer evaluation of the various suspected relationships between the phosphorus and nitrogen concentrations and related physical parameters measured.

The results will be processed for computer evaluation of the various suspected relationships between the phosphorus and nitrogen concentrations and related physical parameters measured.
biology of the organisms will be considered in relation to temperature, salinity ranges, and some gross chemical characteristics. Also, the effect of potentially higher temperatures on the dominant and subdominant species will be studied in the field and later in the laboratory. Information presently available in relevant areas of study (i.e., publications and research logs of the Institute of Marine Sciences) will be further analyzed and utilized in this program.

Because the first power unit of the Florida Power & Light Company plant is now in operation, it will be necessary to choose several control sites in order to monitor the changes which are already in progress. Some rise in temperature and in the copper and iron content of the water near the effluent have already been observed during preliminary studies made by this Institution.

SUPPORTED BY U.S. Atomic Energy Commission

5.0878. WATER QUALITY AND FUNGI-NEMATODE-SEAGRASS RELATIONSHIPS
S.P. MEYERS, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124

The biological analyses of the fungal and nematode populations in Biscayne Bay, Florida, and their interrelationships within seagrass communities. Major attention is directed toward ecological and morphological analyses of foliculose and benthic nematodes, life cycle studies, and examination of animal succession patterns in specific habitats. Fungal studies concern physiological investigations of specific taxa and broad comparative investigations of cellulolytic activity especially that of the dominant representatives of the marine mycota. Levels of enzymatic production and related weight loss of cellulose, are compared with those of non-marine cellulolytic species. Projected lines of nematode study include analyses of the benthic nematode biota within other types of turtle grass communities, characterization of the oncholaimid population in the Bay to determine the extent and range of specific abundant taxa and their extant sex ratios, and further examination of factors affecting attraction and aggregation of marine nematodes to sites of organic deposition and decay.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0879. THE BIOLOGY OF THE INF ANA OF A TROPICAL SOFT BOTTOM AREA
H.B. MOORE, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124

A study is in progress on the biology and ecology of the infauna of the soft bottom of Biscayne Bay, Florida. This is considered typical of a tropical estuarine area. Papers have been published on the heart urchin, Moira atropos, and the lamellibranch, Tegelus divisus. Papers are in press on Chione cancellata on the fauna of intertidal muds, on subbital polychaetes and the biological effects on biogeochemistry in the bay. Studies are in progress on various molluscs, echinoids and brittle stars.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. C1

5.0880. EFFECTS OF PESTICIDES ON ESTUARINE PRODUCTIVITY
T.S. HOPKINS, Univ. of West Florida, Graduate School, Pensacola, Florida

The campus of The University of West Florida is located on the west side at the head of Escambia Bay, a commercially important estuary for the production of oysters, shrimp, and fish. Part of the drainage basin of this estuary, including an embayment or bayou and small stream lies on University property that has been dedicated as a natural conservation area and will remain undeveloped.

The Faculty of the Department of Biology and Marine Sciences plans to initiate a continuing study of this habitat to determine the ecological relationship. Concurrently, studies of the effects of pesticides on the benthic infauna of the bay that is not protected from man's encroachment will be included for comparative studies in determining the effects of pollution. It is anticipated that the program will serve as a training program for graduate students in the field of marine biology.

5.0881. PESTICIDES
P.A. BUTLER, U.S. Dept. of Interior, Biological Laboratory, Sabine Island - Gulf Breeze, Florida

Although commercial formulations of synthetic pest control chemicals are screened for mammalian and target-animal toxicity levels, little is usually known of their possible effect on marine animals. Theoretically, there is the possibility of any and all of these chemicals draining into estuarine areas important to fish and shellfish.

This project determines acute and chronic toxicity levels of potential and commercial pesticides to representative marine fauna including but not limited to oysters, shrimp, and mullet. Tests are conducted in a flowing sea water system or in the field. Special studies are underway to determine most suitable testing techniques and bioassay animals.

Studies of the kinetics of persistent pesticides following pilot-scale applications in the field are being expanded. Residue analyses of sub-strata and food-chain organisms are made to determine ultimate fate of chemicals and possible danger sites.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0882. LABORATORY BIOASSAYS
J.I. LOWE, U.S. Dept. of Interior, Biological Laboratory, Sabine Island - Gulf Breeze, Florida

The primary objectives of the subject project are: (1) determination of the acute toxic levels of pesticides to representative marine species, and (2) investigation of possible adverse effects of prolonged exposure of marine animals to sublethal concentrations of the common pesticides.

Short-term (96-hour or less) toxicity tests are conducted in the laboratory under controlled conditions. Most of the tests are conducted in constant-flow seawater systems using oysters, shrimp, and marine fish as bioassay animals. These acute toxicity tests will be a continuing function of the project as new chemicals are received for evaluation.

Long-term experiments (3 to 6 months duration) involving the chronic exposure of marine animals to sublethal concentrations of selected pesticides will be conducted when the efforts and results seem justified.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0883. ESTUARINE ECOSYSTEMS
G.E. WALSH, U.S. Dept. of Interior, Biological Laboratory, Sabine Island - Gulf Breeze, Florida

The purpose of this research is to determine effects of sublethal concentrations of pesticides upon estuarine ecosystems. At present, physical, chemical, and biological characteristics of four very similar coastal ponds are being analyzed to learn normal seasonal variations. When these are known, three of the ponds will be treated with pesticide and one with be utilized as a control. Effects of pesticide upon population dynamics and community structure will be studied after contamination.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0884. ECOLOGICAL STUDY OF CHARLOTTE HARBOR ESTUARY AND SHARK PROGRAM OF MOTE MARINE LAB
P.W. GILBERT, Mote Marine Laboratory, Sarasota, Florida 33577

A long-term ecological study of the Charlotte Harbor-Pine Island Sound estuary. This study of a relatively uncontaminated

217
5. LIVING SYSTEMS (NON-HUMAN)

250,000-acre body of water over a period of years will yield invaluable information to assist in the evaluation of the impact man makes as he continues to invade the area and modify the environment.

Projects involving the behavior, physiology, anatomy, endocrinology and biochemistry of sharks are continuously in progress. Use of this vessel in the collection of sharks has greatly facilitated this program.

SUPPORTED BY U.S. National Science Foundation

5.0885, DISTRIBUTION OF LIFE WITH DEPTH
R.J. MENZIES, Florida State University, Graduate School, Tallahassee, Florida 32306

The objective of this proposal is to improve our knowledge of the distribution of animal life in the sea directly off the coast of North Carolina through a detailed photographic study on selected biological properties of the sea floor from shelf depth (180 meters plus or minus 20 meters) to the abyssal plain (6000 meters).

As a mechanism of significant improvement of the use of underwater photographs in biological studies, each photographic series will be coupled with sampling of animal life. Thus, this project involves the use of a grab camera, a multi-shot camera coordinated with large trawls, identification of species photographed, correlation of observed distribution with sediment type and hydrographic information. The aim will be to associate gross and reproducible features in the distribution of animal life with topography, hydrography (water characteristics, T, S, O2) and sediment type.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ct

5.0886, ECOLOGY OF KRAFT PAPER MILL EFFLUENT IN SAPELO & ST. CATHERINES SOUNDS, GA
M.D. DAHLBERG, Univ. of Georgia, Marine Institute, Sapelo Island, Georgia 31327

This study will survey the ecological effects of kraft mill effluent from the Intestate Paper Co. in Riceboro, Ga. This study will determine changes, if any, in the chemistry, flora and fauna of the study area including Riceboro Creek, North Newport River, Sapelo Sound and St. Catherine's Sound.

SUPPORTED BY Georgia State Government

5.0887, AEGEAN SEA BIOLOGY
V. KJORTSIS, Athinain Eth Kai Kap Pambima, Athens, Greece (N62555-3693)

This research is an ecological study of northern areas of the Aegean Sea. Emphasis is on the determination of the environmental factors which influence the distribution of bottom organisms of that area. Qualitative and quantitative analyses are made of daily and other cyclic fluctuations of environmental factors in an attempt to discover the mechanisms by which they affect the biological populations.

Biologically, the Aegean Sea is virtually unknown and hydrographic data of the area are sparse and sporadic. It is, however, especially interesting because of the extensive shoreline and the intricate currents around the islands. The exchange of water with the Sea of Marmara and the Black Sea adds to the variety of ecological conditions and makes the area a valuable base of research operations.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0888, INVESTIGATE FACTORS DETERMINING DISTRIBUTION OF PHYSICAL AND CHEMICAL PROPERTIES OF THE PACIFIC OCEAN

Studies of Pacific-wide oceanographic conditions already under way reveal certain classes of deviations from average conditions which are being investigated in a variety of ways. For example, the effects of mid-ocean island groups on the distribution of properties as well as on currents, are evident, and are being studied by means of field investigations including direct current measurements; theoretical analysis including mathematical modeling with a computer; and physical modeling using a scale hydrodynamic model of the Hawaiian Islands. Winter-summer changes in properties are associated with water-mass formation and dissipation, which will be studied using field data and mathematical models. Long-term changes are also evident in synoptic sea-surface data obtained at nine monitoring stations maintained on islands throughout the central Pacific; these changes are being studied by means of Fourier analyses, which yield information on amplitudes and phase angles of periodic changes.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0889, BIOLOGICAL RESEARCH ON THE VOLCANIC ISLAND SURTSEY AND ENVIRON
S. FRIDRIKKSSON, Sursey Research Society, Reykjavik, Iceland (A730-11)

Research on the terrestrial biota of the new volcanic island, Sursey, was continued during the year 1967, using the unique opportunity for studying dispersal, colonization and succession of plants and animals. Plant parts continued to disperse by ocean to the previously sterile islands. These were classified and recorded and when growth started, the locations of the plants were mapped. Already four species of coastal plants have colonized the island. Cakile edentula, Honkenya peploides, Elymus arenarius and Mentinea maritima as well as two mosses, Funaria hygrometrica and Bryum argenteum. Birds were also found to take part in the dispersal. Of the 14 species of migratory birds caught on the island during the spring, snow buntings were found carrying seed in their gizzards. As these birds had apparently migrated from the British Islands on their way to Greenland this must be regarded as a case of long distance dispersal of seed. As the immigration, however, most likely takes place from the close neighborhood, the vegetation of other islands in the group was studied. For comparison an ecological study of vegetation on a nunatak in the glacial Vatnajökull was continued. Regarding terrestrial invertebrates already 63 species have been recorded on Sursey of which 37 species were discovered in 1967, the majority of these being casual visitors whereas only certain flies as Leria modesta, breeding in carcasses on the shore are permanent inhabitants. A meteorological station was established for climatic observations and a small field laboratory has been built on the island.

SUPPORTED BY U.S. Atomic Energy Commission

5.0890, ECOLOGICAL SUCCESSION ON SURTSEY
S. HEMAMNNSSON, Sursey Research Society, Reykjavik, Iceland (F61052-67-C-0087)

A comprehensive coordinated study of the biological development of the new volcanic island 'Surtsey' will be continued with emphasis on geological and meteorological contributions to the total ecology. Especially considered is the succession of biological communities which establish themselves on the newly emerged areas of new land and the factors which determine or influence the sequences.

The solution to the Navy's problem of fouling and deterioration of underwater equipment will depend on an ability to predict the sequence of biological events. The land mass formed as a result of the volcano provides a unique opportunity to observe one set of these sequences under natural conditions.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0891, MARINE BIOLOGY OF RED SEA AND EASTERN MEDITERRANEAN
L. FISHELSON, Tel Aviv University, Tel Aviv, Israel (F61052-67-C-0043)

The investigator and his staff are conducting a comprehensive series of ecological studies in the Red Sea and Mediterranean Coast of Israel. Distribution of the dominant forms of plant and animal life, especially the benthic forms, is being mapped and related to environmental conditions and bottom sediments at mid-depth and in abyssal regions. The study is underway of the impact of man on the population dynamics, life histories, and physiology of the organisms present in the Red Sea with emphasis on the many forms which are newly discovered.
Because these waters are virtually unknown with regard to their ecological and biological regimes, it is essential that more information be collected on all environmental characteristics of this area. These studies are particularly important since they involve an area in which the effects of engineering operations on the environment can be studied. The effects of the Suez Canal on the oceanography and biology of the Red Sea are dramatically observable, and it is expected that great changes in the Eastern Mediterranean will follow the completion of the Aswan Dam. Information collected relates to sound transmission effects, abundance and distribution of marine fouling and boring organisms, and ambient noise levels.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0892, MARINE LABORATORY
J.G. BROOME, State Wildlife & Fish Comm., New Orleans, Louisiana

This project area incorporates all six of the previous described phase areas, namely coastal Louisiana. Here, the project leader will compile, analyze and interpret the data.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish. Louisiana State Government

5.0893, HYDROGRAPHIC AND BIOLOGICAL SURVEY OF MONTWSWEAG BAY AND VICINITY
D. DEAN, Univ. of Maine, Ira C. Darling Ctr. For Res., Walpole, Maine 04573

This project will investigate the quantitative distribution of benthos (by Ponar grab sampling), the types and distribution of zooplankton (010 net plankton), and the distribution of temperature and salinity in space and time in Montsweg Bay and vicinity. This study is a short-term (June to August 1968) pilot project for a long-range research program anticipated to begin in 1969 and extend through 1973. The latter project will monitor before-and-after changes accompanying the operation of a nuclear-powered electric generating plant scheduled to commence operation early in 1972.

SUPPORTED BY Maine Yankee Atomic Power Company

5.0894, WATER QUALITY - BENTHIC INVERTEBRATE RELATIONSHIPS IN ESTUARIES
D. DEAN, Univ. of Maine, Ira C. Darling Ctr. For Res., Walpole, Maine 04573

This project proposes to investigate the relationships between water quality and benthic invertebrates in Maine estuaries. Studies will be conducted in three estuaries, the Penobscot, the upper part of the Damariscotta and the Sheepscot, representing heavily polluted, moderately polluted and unpolluted conditions, respectively. Comparable portions of each estuary will be studied to determine the benthic communities present, the settlement of benthic invertebrate larvae, larval metamorphosis, and the growth and survival of juvenile forms. Hydrographic, chemical and geological parameters of the waters and sediments will be measured and used as guidelines for controlled laboratory experiments on larval settlement. The results of this project should aid 1) in the interpretation of fish distribution patterns in estuaries subject to different levels of pollution and 2) in predicting biotic changes that would occur in an estuary subjected to increased or decreased pollution loads.


5.0895, AN ENVIRONMENTAL SURVEY OF THE DAMARISCOTTA RIVER ESTUARY, LINCOLN COUNTY, MAINE
B.J. MCALELCE, Univ. of Maine, Ira C. Darling Ctr. For Res., Walpole, Maine 04573

The present environmental characteristics of the Damariscotta River are little known, and may be significantly altered by the construction of a sewage treatment plant in the upper estuary.

SUPPORTED BY Maine State Government

5.0896, ECOLOGICAL STUDIES OF ATLANTIC AND GULF COASTAL ESTUARIES OF IMPORTANCE TO WATERFOUL
H.D. IRBY, U.S. Dept. of Interior, Patuxent Wildlife Res. Ctr., Laurel, Maryland

The estuaries, sounds, and bays of the Atlantic and Gulf Coasts are of primary importance to the bulk of migrating and wintering waterfowl of the Atlantic, Mississippi, and Central Flyways. These habitats are of particular importance to diving ducks, for which we have few good habitat management techniques.

These areas are among the most susceptible to destruction from channelization, industrial development, real estate development, hurricanes, regulation of river flows, marsh drainage for mosquito control, and pollution from many sources. Because of the difficulty of making accurate observations of the productivity of estuaries, the distribution, abundance, quality, and quantity of the biota of these areas are more poorly known than most other waterfowl habitats.

This broad-scale study will provide much-needed information on the value and quantity of the estuarine habitat still of importance to waterfowl and establish a historical record of those values. The broad scope of this study makes it imperative that adequate planning and preliminary reconnaissance be conducted prior to finalizing specific work units. Initially, one biologist will conduct the needed reconnaissance to organize the program and formulate the specific plans.

This project will be started in fiscal year 1966 and will include a period of at least 5 years to determine major patterns of trends and fluctuations in estuarine vegetation and waterfowl use.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish

5.0897, OCEAN WATER INTRUSION INTO BACK BAY, VIRGINIA, & CURRITUCK SOUND, NORTH CAROLINA, ON THE WATERFOWL & FRESHWATER FISH HABITAT
J.L. SINCOCK, U.S. Dept. of Interior, Patuxent Wildlife Res. Ctr., Laurel, Maryland

The initial investigation into the ecology of Back Bay, Virginia, and Currituck Sound, North Carolina, was terminated on March 7, 1962, when an Atlantic Coastal storm introduced ocean water into the fresh to slightly brackish water of the area. The second phase of the investigation is now in progress and its objectives are to determine the effects of the increased water salinity on the waterfowl and fresh water fish habitat. The methods employed are identical to the first phase of the investigation.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish

5.0898, ECOLOGICAL STUDY OF DUXBURY BAY
C.A. WILLINGHAM, William F. Clapp Laboratories, Duxbury, Massachusetts 02323

The purpose of this study is to survey the flora and fauna of Duxbury Bay and establish the pattern of interactions between these organisms and the various environmental parameters found in Duxbury Bay. The Bay itself is a relatively high salinity area with a fifteen foot tidal amplitude. Twice each day the bay bottom is left exposed by the outgoing tide. Data are collected on the
5. LIVING SYSTEMS (NON-HUMAN)

various organisms from twelve stations along transects which cross the Bay.

SUPPORTED BY Battelle Memorial Institute

5.0899, YEAR-ROUND PROGRAM OF RESEARCH IN MARINE ECOLOGY

M.R. CARRIKER, Marine Biolog. Laboratory, Woods Hole, Massachusetts 02543

A year-round, long-term program for basic research and training in the systematics and ecology of the marine biota of the area was initiated in 1962 with the assistance of funds from the Ford Foundation and grant NSF GB-561. The present request is for continued support for research and advanced training in the coherent area of marine ecology of the Cape Cod region. The research will stress ecological life histories and population ecology with reference to the complex of environmental parameters. the commonest dominant marine and estuarine species along the coast, and even less of organisms off the coast. Especially lacking is information on the ecology of larval and early post-set stages. Research associates participating in the program will select specific problems on some aspect of the marine ecology of the region. These concerted studies should add important information to our knowledge of the ecology of marine organisms of the northeast coast of the United States. A second benefit of the program is the increased training of individuals in marine ecology. The results of these investigations will enhance the work of other biologists who participate in the Laboratory's summer programs.

SUPPORTED BY U.S. National Science Foundation

5.0900, BENTHONIC BIOLOGY

M.R. CARRIKER, Marine Biolog. Laboratory, Woods Hole, Massachusetts 02543 (NONR)

This is a long-term, year-round comprehensive study of the biota of Cape Cod region using standardized collection and analysis methods. Pelagic, as well as bottom organisms to a minimum size of 1 mm are included. The major purpose is to understand the spatial and temporal distribution and density of organisms relative to temperature, salinity, bottom substrate and biological neighbors. Taxonomic studies are also included. Scuba divers make direct observations and the most up-to-date equipment available is being used from shipboard. New equipment designs are also being developed. Attention is focussed on the composition and ecology of organisms living in, on, or near, the sea bottom. Not only do these organisms most often contribute to the fouling mass, but they directly affect the characteristics of the sediments. They may consolidate the bottom, or prevent its consolidation, and lead to shifting and instability.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0901, THE OCEANOGRAPHY OF NEW ENGLAND FISHING BANKS

D. BUMPUS, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543

The purpose of the research is to determine the relationships between meteorological conditions, hydrographic conditions, and the distribution and abundance of groundfish in the ocean between Nova Scotia and New Jersey. Methods include standard hydrographic cruises, release of drift bottles, and sea bed drifters and the collection routinely of meteorological and hydrographic information from lightships and Texas Towers along the entire Atlantic Continental Shelf.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0902, BIOLOGY OF THE DEEP-SEA BENTHOS

H.L. SANDERS, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543

Diversity, zonation and density were the major research interests of our deep-sea benthic program during the period of July 1, 1967 to June 30, 1968. Our findings on the Guyhead-Bermuda Transect of low animal density, pronounced faunal zonation, and very high diversity were verified in our sampling of bathyal and abyssal depths in the tropical Atlantic. We therefore conclude that these features are universal attributes of the deep-sea benthos. The diversity of our deep-sea samples is about the same order of magnitude as that present in tropical shallow seas and considerably greater than equivalent shallow boreal marine and tropical and boreal estuarine environments. We are also able to measure the horizontal as well as the vertical component of deep-water benthic zonation using a modification of the rarefaction methodology. At least for the groups examined, a change of a few hundred meters vertically is equivalent to thousands of kilometers horizontally.

SUPPORTED BY U.S. National Science Foundation

5.0903, ENVIRONMENTAL CHANGES IN LAKE ERIE

J.F. CARR, U.S. Dept. of Interior, Biological Laboratory, Ann Arbor, Michigan

Lake Erie has experienced major changes in the benthos and fish populations. Analyses of physicochemical data show that concentrations of most major ions have increased significantly, very low dissolved oxygen concentrations occur during the summer, and mean annual water temperatures have increased. Present studies are directed toward documenting the extent of change in the benthos and studying the factors which result in the oxygen depletion of the hypolimnetic waters. Laboratory and field studies are being made of the exchange of nutrients and the oxygen demand at the mud-water interface.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0904, PHYSIOLOGY AND BEHAVIOR

T.A. EDSALL, U.S. Dept. of Interior, Biological Laboratory, Ann Arbor, Michigan

Laboratory and field studies are underway to determine the potential productivity of Lake Michigan for intermediate and top carnivores. Recent biological changes in Lake Michigan that have altered the lake's trophic structure are under investigation. Analysis of food chains and energy flow within and between trophic levels will include studies of food preference, food competition, and the efficiency of utilization. The effects of the chemical and physical factors of the environment on the physiology and behavior of native and exotic species are being investigated. Special emphasis will be placed on determining the role of these factors as controlling mechanisms in energy flow and productivity in the ecosystem.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0905, EXPLORATORY COLLECTION AND CARE OF AQUATIC INVERTEBRATES FOR TESTING AT TIBURON

T. LANE, U.S. Dept. of Interior, Fish Pesticide Res. Lab., Columbia, Missouri 65201

It is necessary to explore sources of brackish-water and marine invertebrates for pesticide bioassay work at Tiburon, and to determine the most feasible procedures for collecting and holding the test animals. Areas in San Francisco Bay and the delta of the Sacramento- San Joaquin will be searched, and culture of animals will be studied at Tiburon, and holding facilities will be tested under various space, time, feeding, and water flow conditions.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0906, TOXICANT TOLERANCE STUDIES - SCREENING OF PESTICIDES AND AQUATIC INVERTEBRATES AT TIBURON

T. LANE, U.S. Dept. of Interior, Fish Pesticide Res. Lab., Columbia, Missouri 65201

The work will be performed to obtain acute toxicity information on marine and estuarine aquatic invertebrates with insecticides, herbicides, and other pesticides at Tiburon, California. Invertebrates and toxicants will be tested in continuous-flow systems in the laboratory, according to a standard test method, and the data will be treated by probit analysis to obtain LC50 values under various time schedules.

220
5. LIVING SYSTEMS (NON-HUMAN)

The ultimate purpose of laboratory experiments on the uptake, accumulation, and retention of radionuclides from sea water by marine organisms is to collect sufficient data to be able to anticipate the dangers from any intentional or accidental pollution of an estuary or the oceans. To have some assurance that predictions concluded from results of laboratory experiments will be valid, it is necessary that laboratory data be compared with data collected as nearly as possible under field conditions. This is believed, can be accomplished by comparing laboratory findings with results obtained on the accumulation of radionuclides by communities of organisms held in large raceway ponds.

Research activities include experimentation in the laboratory and in the field. Laboratory experiments are being conducted with communities of marine organisms maintained in large tanks (1000-liter capacity) exposed to flowing sea water containing various radionuclides including zinc-65, iron-59, iodine-131 and cesium-137. Also, a marine community composed of oysters, clams, fish, snails, crabs, algae, and marsh grass was placed in a shallow salt water pond and exposed to zinc-65 and chromium-51. Organisms, sediments, and water are being removed periodically, their radioactive content measured, and then returned to the pond. Upon completion, samples will be analyzed for total element so that the specific activity of the components in the pond can be determined. Data obtained in such experiments also will be useful in determining the trace metal requirements of various marine organisms.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0913. OPTIMUM ECOLOGICAL DESIGNS FOR ESTUARINE SYSTEMS OF NORTH CAROLINA
H.T. ODUM, Univ. of North Carolina, Inst. of Marine Science, Chapel Hill, North Carolina 27514

This project will provide information on the feasibility of establishing associations of organisms in estuaries which can produce man's wastes, metabolize inflow, develop the missing loops of the mineral cycles, and channel the fertility into one or more populations with food potential. Nine marine ponds will be constructed in a high marsh area along the coast of North Carolina. Three of the ponds will be continually seeded with mixtures of marine organisms (larvae, adults, plankton, microorganisms, etc.) and will receive a steady flow of urban waste mixed with sea water. Three ponds will be seeded, but will be supplied only with sea water, i.e., no wastes. The remaining three ponds will receive the wastes mixed with sea water, but will not be seeded artificially.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
5. LIVING SYSTEMS (NON-HUMAN)

Principal populations, some principal nutrient cycles and the total photosynthetic production and system respiration will be measured. Those populations of larger organisms which develop in large mass will be studied for growth rate and not production per area of meat potential.

SUPPORTED BY U.S. National Science Foundation

5.0914. EVALUATION OF HABITAT ALTERATION, CURRITUCK SOUND
T.E. CROWELL, State Wildlife Resources Comm., Raleigh, North Carolina

The objective of this job is to record the extent of habitat alteration that results from the influx of salt water and/or turbidity to Currituck Sound during the Fiscal Year and to evaluate the resulting effects upon the game-fish resources.

Particular emphasis will be placed upon the drainage of artificially maintained salinities out of Back Bay and upon such salt-water intrusion as may result from natural, storm initiated, breaks through the Outer Banks.

The work outlined under the preceding Jobs 1-A to 1-G, inclusive, was recognition of habitat changes and estimating their effects upon separate facets of the Currituck Sound flora and fauna.

The subject job represents, in essence, an integration of all of the individual considerations into one comprehensive analysis of the combined direct and indirect effects of habitat alteration upon the game fish.

The procedures employed will involve an integrated consideration of the net effects upon the game-fish resources resulting from the interaction of the various individual effects of habitat alteration after the latter have been estimated.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0915. CHANGES DURING EUPTROPHICATION OF AN ESTUARY
D.B. HORTON, Univ. of North Carolina, School of Agriculture, Raleigh, North Carolina 27600

To measure quantitatively the effects of the pollutants and the ensuing eutrophication on the communities of the plankton, rooted aquatic plants, and the macrobenthos, and to determine the factors that influence the distribution and abundance of the various species. 2. To predict the effects of even greater pollution of this estuary and, if possible, to make suggestions to alleviate the eutrophication. 3. To demonstrate the value of field plot design for understanding the biology of an estuary and for predicting effects of a pollutant. 4. To determine if a measurement of the heterotrophic activity of the planktonic bacteria with radioisotopes is a useful method of indicating the degree of eutrophication and pollution.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rch
North Carolina State University
North Carolina State Government

5.0916. RESEARCH IN MARINE BENTHIC ECOLOGY OFF OREGON
A.G. CAREY, Oregon State University, Graduate School, Corvallis, Oregon 97331

The influence, abundance, and ecology of the large and small marine benthic macrofauna off Oregon are being studied to define interrelationships of the benthic fauna with their environment. A line of stations across the continental shelf, continental slope, and Cascadia Abyssal Plain has been sampled repeatedly with trawl, dredge, and grab to a depth of 3000 meters and a distance of 322 kilometers offshore. The fauna shows a layered distribution, many species being limited to a narrow depth range. Six depth zones exhibit transitions from one animal assemblage to another. These transitional areas are generally associated with changes in sediment type, one of the complex of environmental factors affecting distributions. The benthic invertebrates are most abundant beyond the edge of the shelf at 225 meters; a slightly smaller peak in abundance occurs inshore at 25 meters.

SUPPORTED BY U.S. National Science Foundation

5.0917. MARINE ECOLOGICAL STUDIES
J.W. HEDGEPETH, Oregon State University, Graduate School, Corvallis, Oregon 97331 (N00014-67-A-0369-0001)

This is a program of long-term observations on populations of intertidal and shallow water marine invertebrates of the Oregon Coast. Investigations are being made into the effects of environmental fluctuations on these populations. The continuous recording of intertidal water and air temperatures on a rocky shore, never previously attempted, are made to provide essential data for understanding environmental stresses that influence distribution, abundance and reproduction of marine organisms. Studies of organisms at the recording stations and at standard plot sites are to coincide with the continuous record.

Hydrobiological data such as these can lead to better understanding of the interrelationships among the biological, physical, chemical, and geological components of marine environments. This understanding is essential for the development of more efficient and effective techniques for the control of and/or protection against marine life whose presence or absence are of operational significance to the Navy. Biological fouling and deterioration, modification of beach conditions, and bottom sediments are examples.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0918. EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS
R.E. MILLEIMANN, Oregon State University, Agricultural Experiment Sta., Corvallis, Oregon 97331

1. To evaluate, through short-term bioassays, the acute toxicity to certain estuarine organisms of the insecticide Sevin. 2. To determine the effects of Sevin on a community of organisms in artificial mud flats. 3. To follow the residual life and metabolism of Sevin in estuarine organisms and in their environment. 4. To study compounds related to Sevin, as well as other pesticides, in the above manner.

SUPPORTED BY Oregon State Government

5.0919. EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS
R.E. MILLENAMANN, Oregon State University, School of Agriculture, Corvallis, Oregon 97331

Studies are continuing on the establishment of a well-balanced community of organisms in laboratory models of an estuary. The chronic effects of Sevin and other pesticides on members of such communities will be studied. Studies are in progress on the effects of the insecticide Sevin and Dursban on the survival, growth, and reproduction of the Dungeness crab, the viviparous shiner perch, and the oxicarpus chum salmon. Biochemical studies on the modes of action of Sevin and its metabolites on estuarine organisms are continuing.

SUPPORTED BY U.S. Dept. of Hith. Ed. & Wel. - P.H.S.

5.0920. BIONOMICS OF FISHES AND SHELLFISHES
C.E. WARREN, Oregon State University, Agricultural Experiment Sta., Corvallis, Oregon 97331

To obtain bionomic information of important fishes and shellfish species of Oregon bays in relation to ecological factors (water temperatures, salinity, turbidity, etc.); pH, dissolved oxygen, carbon dioxide, turbidity, edaphic conditions, folds, industrial and domestic sewage wastes, etc.); continue development of aqua-culture procedures for oysters, clams and other species of importance, particularly rearing of free-swimming larval stages of oysters and clams to seed stage; and, obtain reliable biological information as to resistance and susceptibilities of marine organisms to various pollutational conditions occurring in marine waters and provide methods and scientific data for predicting effects on marine organisms and for establishments of water quality criteria for marine areas.

Description of Work: Perform bioassays with various toxic effluents commonly discharged into marine waters using fishes and the several life stages of oysters and other marine organisms as test animals; and perfect the mussel embryo-larval bioassay techniques for quickly assessing the toxic components of effluents discharged by wood-processing industries into bays and estuaries.
Continue oyster culture studies, particularly the rearing of pelagic larvae of the Kumanoto oyster to 'seed' stage under controlled laboratory conditions; and begin preliminary studies on the damages and control of mud-shrimps to oysters.

SUPPORTED BY U.S. Dept. of Agriculture
Oregon State Government

5.0921, THE ENVIRONMENTAL REQUIREMENTS OF MARINE PLANKTONIC ORGANISMS

This study is concerned with obtaining marine planktonic organisms in culture and the developing of methods for the mass culturing of these organisms. Also included are studies to determine the environmental requirements of marine planktonic organisms in relation to nutrients, temperature, pH, salinity, and light quantity and the physiological responses of lower marine forms to environmental changes.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0922, ENVIRONMENTAL CONDITIONS AND POPULATION DYNAMICS IN SELECTED UNEPOLUTED ESTUARIAL AND COASTAL AREAS

When the full research program is under way, laboratory studies will be made for the determination of the environmental requirements of marine organisms and levels of potential toxicants which are acutely toxic and those which are not harmful under conditions of continuous exposure. These laboratory findings are to be field tested. It is proposed to make these tests in pilot areas or in areas which are controlled but resemble the natural environment or in areas where the environment is essentially natural. It is planned to introduce these toxicants at the selected levels in such areas and to keep their concentrations at a constant level in order to determine their effects on the biota under conditions of continuous exposure. In order to evaluate these effects, the environmental conditions and the populations and the relative abundance of the different organisms under natural conditions must be known. It is proposed to begin a study in the immediate future to serve as such a baseline, so that changes due to potential toxicants or changes in environmental conditions may be evaluated.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0923, HISTOLOGICAL, HISTOCHEMICAL AND HISTOPATHOLOGICAL EFFECTS OF WATER POLLUTANTS ON MARINE ORGANISMS

The National Marine Water Quality Laboratory has as its function, the collection of data essential for the development of water quality criteria for the protection of aquatic life and other uses. To secure this data, research must be carried out to determine (1) the levels of potential toxicants which are acutely toxic and those which are not harmful under conditions of continuous exposure. Several disciplines will be utilized in this work, including histology, pathology, toxicology, exzymology, biochemistry, etc. In this project, it is planned to determine the effects of sublethal and very low levels of toxicants on important marine organisms through histological, histochemical and histopathological studies. In order to do this effectively and efficiently, the normal histology of these organisms must be known. Therefore, before the completion of the main laboratory, studies of the histology of so-called normal organisms in unpolluted areas are being initiated to serve as a baseline of comparison for evaluating the effects of sublethal levels of potential toxicants. A library of slides will be built up using the normal or normal condition for all important marine organisms in the shore and estuarial areas. It is expected that this project will get underway in Fiscal Year 1967 and will continue for a number of years.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0924, EFFECTS OF CRUDE OILS AND THEIR EMULSIONS TO MARINE ORGANISMS

Oil discharges at sea, especially accidental discharges by super-tankers, represent a potential threat to aquatic life. Laboratory bioassays on the acute toxicity of different grades of crude to various species of marine fishes and crustaceans are now in progress. The effect on toxicity of emulsifying or complexing the oil with various chemical agents is being investigated.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0925, BIOLOGICAL COLONIZATION OF A RECENTLY FORMED ISLAND
B. MAGUIRE, Univ. of Texas, Graduate School, Austin, Texas 78712

Analysis of rate and pattern of colonization of fresh waters on the recently formed volcanic island, Surtsey, will give new insight into some of the processes and interactions which determine the biogeography of islands. Information gained by the analysis of the communities as they develop should permit increase of our understanding of: 1. The process and pattern of community development when its greatest limit is the arrival of potential participants, 2. Some aspects of the ecology of colonizing species which relate to their successful transport to and invasion of the water in the tubs, 3. The inter-relation between dispersal rates to island communities and the rate at which previously successful colonizers are eliminated, 4. The nature and relative stability of the communities which occur at equilibrium or near equilibrium conditions in this kind of small, isolated habitat, and 5. The mechanisms of passive dispersal of small aquatic organisms. Dilution and enrichment experiments should give information concerning the number of resting stages of various species which are present but not taking part in the active community at the time of collection. Interpretation of the seral stages which follow both dilution and enrichment should provide information concerning the importance of the process of succession in production of community structure observed and hopefully also will permit increased insight into the nature of the successional process itself.

SUPPORTED BY U.S. National Science Foundation

5.0926, A STUDY OF SELECTED CHEMICAL AND BIOLOGICAL CONDITIONS OF THE LOWER TRINITY RIVER AND THE UPPER TRINITY BAY
D.R. BALDWIN, Texas A & M University System, School of Agriculture, College Station, Texas 77843

The Galveston Bay System of Texas serves as an essential nursery area for commercial shrimp and certain fishes. The System serves in this capacity because of the discharge of fresh water from the Trinity River and the subsequent mixing of this fresh water with the saline waters of the Gulf of Mexico. Available data suggest that a reduction in the flow of water will cause the System to become more saline and thus unable to serve as a nursery area. The Texas Basins Project, the proposed dredging of the Trinity River for navigation, and the current construction of the Wallisville Dam just above the Trinity River Delta will influence the chemical, physical, and biological conditions of the System. The purpose of this project is to determine the nature of this influence. Samples of fishes, crustaceans, and water will be collected from above and below the proposed site of the Wallisville Dam to determine (1) the chemistry of the water, (2) the fish and crustacean fauna, (3) the salinity tolerances of the animal species collected, (4) the role of a dam on the flow of nutrients into a major bay system, and (5) the population dynamics of the fauna.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rch Texas A & M University System

5.0927, THE EFFECT OF CONTROLLING SALT-MARSH MOSQUITOES ON BEEF CATTLE PRODUCTION, PLANT
5. LIVING SYSTEMS (NON-HUMAN)

ECOLOGY, SOIL PRODUCTIVITY, AND ESTUARINE ANIMALS

J.C. SMITH, Texas A & M University System, Agricultural Experiment Sta., College Station, Texas 77843

Objectives: (1) To determine the nature and extent of loss in beef production of Hereford, Brahman and Brador cattle from high infestations of salt-marsh mosquitoes (Aedes sollicitans and Aedes taeniorhynius), (2) Ascertain the feasibility of chemical control of mosquitoes in salt marsh areas, (3) Determine the effectiveness of physical methods of mosquito abatement (water management) in salt marsh pastures, (4) Determine the effect of physical control practices on soil structure and productivity, on plant species, and on estuarine animals.

Supported by: Obj. in the salt-marsh and each pasture stocked with three breeds of cows. Chemical mosquito control will be maintained on two pastures with the other two pastures left as a control. The animals will be individually sprayed in one treated pasture and one control pasture. Periodic weights, calving percentage, and milk production records will be maintained on the cows. Periodic and weaning weight and carcass quality will be recorded on the calves. Mosquito counts will be made on both light trap collections and selected animals from each group to measure mosquito population. Obj. bay will be surveyed for elevation and a main lateral ditch cut from the lowest depression into the bay. Feeder laterals will be cut from the minor depressions to the main lateral ditch to permit free water movement by tidal action. Mosquito population, plant and soil studies, estuarine animal studies, pasture fertilizer, weed 028, control and pasture management will be evaluated in this phase of the program.

Supported by: Texas State Government

5.0928, ECOLOGY OF WESTERN GULF ESTUARIES (ESTUARINE PINES FOR BEEF CATTLE PRODUCTION) W.L. TREN'T, U.S. Dept. of Interior, Biological Laboratory, Fort Crockett - Galveston, Texas

Demands upon water resources along the coast of Gulf of Mexico are rapidly altering the estuarine environment. These combined alterations disturb the integrity of large estuaries to the extent that entire biological systems may be significantly affected. Basic to an evaluation of the effects of estuarine alteration is knowledge of the inter-relations of factors, such as nutrients, bottom types, marine organisms, and vegetation.

Project objectives are to (1) compare the productivity of natural estuarine habitats with areas altered by dredging, spoiling, bulking and filling; (2) determine practical methods for rehabilitating altered habitats so that productivity can be reestablished; and (3) determine management procedures for maintaining or increasing the productivity of estuarine areas.


5.0929, BIOLOGY-MIDDLE EAST ESTATWATERS J.S. PEARCE, Amer. University At Cairo, Cairo, United Arab Republic (N6255-5022)

The proposed research is designed to delineate life cycles and reproductive periodicities of selected marine organisms of the Red Sea, Gulf of Suez, and the Suez Canal. These waters, even though relatively small in volume, span from tropical to moderate temperate latitudes; and consequently, the common widespread tropical Indo-Pacific species native to this area are subjected to varying degrees of seasonal temperature change. The investigator will compare breeding frequencies of tropical area versus north temperate area populations of the same species in an attempt to determine what environmental factor(s) are responsible for the synchronization of reproductive development within a population or possibly within a particular species.

The Middle East Indo-Pacific waters are areas where there are pronounced deficiencies in biological and environmental data. It is essential that information on normal fluctuations in population composition and abundance be obtained, in order to predict the effect of the biological and environmental parameters.

Supported by: U.S. Dept. of Defense - Navy


A continuing cooperative investigation between the AEC and the Bureau of Commercial Fisheries has been carried out in the marine area adjacent to the Columbia River mouth since 1961. The objectives of the investigation are to (1) determine on a seasonal basis the composition, distribution, and relative abundance of marine resources inhabiting these waters, and (2) assist in the evaluation of the role that the bottom animal community plays in the biological transport of radionuclides by providing samples of various bottom dwelling animals for radiological analysis by the Radiation Ecology Laboratory at the University of Washington.

The relative abundance of fish in this area ranged from a high of about 5,000 pounds per hour of trawling at depths of 50 fathoms to 100-300 pounds per hour of trawling at depths greater than 50 fathoms. Invertebrate catch rates were lower, being greatest at depths from 100-375 fathoms where they averaged 100-250 pounds per hour of trawling. The investigation has also shown that commercially utilized forms of fishes, such as sablefish, inhabit depths at least to 600 fathoms, and that several forms such as Tanner crabs, Pacific ocean perch, and sablefish undergo seasonal bathymetric movements. In addition, other commercially utilized species, such as Pacific hake and Dover sole, carry out north and south seasonal migrations in the study area. A study of the feeding habits of the Pacific hake, the dominant higher level forage species in the outfall area, has established that this species feeds primarily on euphausiad shrimp, a form important in the uptake of 65Zn. The above results represent steps leading toward an eventual understanding of the radionuclide budget in the marine area adjacent to the Columbia River mouth with an assessment of the magnitude of the total radionuclide load imposed on the system by the atomic reactors at Richland, Washington. Knowledge gained as to size and composition of the deep-water fish and invertebrate populations will also be helpful in appraising deep-water dumping sites.

Supported by: U.S. Atomic Energy Commission

5.0931, ANNUAL PHYTOPLANKTON PRODUCTION IN PUGET SOUND WATERS G.C. ANDERSON, Univ. of Washington, Graduate School, Seattle, Washington 98122

Studies of phytoplankton production are being continued in Puget Sound. The investigation, since 1964, has provided quantitative information on annual phytoplankton production and mean standing crop as well as annual productivity of the entire area.

The research proposed herein is to elucidate the reasons for the very large blooms off Seattle when maximum values of 6-7 g C/square meter are photosynthesized per day. Weekly, daily and diurnal sampling will be carried out during periods of high phytoplankton production along with measurements of hydrographic conditions, light and nutrients. Particular attention will be given to the effect of stability, as affected by tides and winds, on the timing of phytoplankton blooms. Measurements will be made of the chemical composition of the crop as well as growth rates of dominant species.

Experimental work involving studies of phytoplankton blooms in enclosed columns of water in situ will be carried out. In this manner, the effects of advection will be eliminated. Culture studies will be conducted with some of the herbivoros copepods.

Supported by: U.S. Dept. of Interior - F. Water Pol. Ctl

51. PRODUCTIVITY - BIOCHEMISTRY

(Food Chains, Primary Productivity, Laboratory Studies of Reproduction, Cytology, Physiology, and Behavior.)

5.0932, PHOTOBIOLOGICAL STUDIES ON MARINE CHRYSONOMADS M.B. ALLEN, Univ. of Alaska, Graduate School, College, Alaska 99773

224
This research is to continue studies on the phosphorylation and electron transport system of Hymenomonas chloroplasts. These have previously been shown to carry out active cyclic photophosphorylation with phenazine methosulfate (PMS), but not to possess appreciable activity when FMN or vitamin K compounds are used as cofactors, nor to be capable of non-cyclic photophosphorylation with NADP or ferricyanide. Since the chloroplasts retain a high degree of overall photosynthetic activity, it seems unlikely that these results are due to a deficiency in the oxygen evolving system. The reasons for this difference from green plant chloroplasts will be investigated and the ability of the chloroplasts to carry out various other light driven electron transport reactions will be explored.

An attempt to isolate the organelle with the finely coiled lamellar structure and determine its composition and metabolic activity, if any, will be made. The marine chloroplasts are generally considered to be a group of organisms in which many evolutionary experiments have taken place, and the possibility exists that this organelle represents a vestige of some experiment with chloroplast structure. On the other hand, structures appearing somewhat similar in the electron microscope have been observed in photosynthetic cells. In these cells, it has been proposed that the structures are digestive organelles. Possible relations with the coccolith forming system must also be considered, since such a function has previously been suggested.

SUPPORTED BY U.S. National Science Foundation

5.0933, DYNAMICS OF THE NITROGEN CYCLE IN THE SEA J.J. GOERING, Univ. of Alaska, Graduate School, College, Alaska 99775
This is an investigation into several aspects of the marine nitrogen cycle using 15N tracer techniques. The major emphasis is on measurement of in situ rates of nitrogen fixation, nitrate, ammonia, and amino acid assimilation, nitrification, and denitrification.

SUPPORTED BY U.S. National Science Foundation

1. To study the movements and possible migrations of the four recreationally important species in Yaquina Bay, Oregon, in relation to environmental factors. 2. Estimate the abundance by tagging and recapturing procedures. Species to be studied are the white sea perch (Phanerodon furcatus), pile perch (Rhacochilus vacca), striped sea perch (Ephibotreus lateralis) and the starry flounder (Platichthys stellatus). Intra-estuarine and coastal movements of these fishes will be determined by analysis of tag recoveries. Yaquina Bay will be divided into nine geographical areas for sampling purposes. Environmental data (tide, temperature, salinity) will be taken at each trawl sampling station. Estimates of population will use the capture-mark-and-recapture technique.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0935, STRUCTURE AND FUNCTION OF CELL ORGANELLES DURING GROWTH AND DEVELOPMENT M. ALFERT, Univ. of California, Graduate School, Berkeley, California 94720
The structure of the nucleus and nucleolar-like bodies, and their role in ribosome formation in Urechis are being studied; attempts will be made to hybridize ribosomal RNA to DNA of the nucleolar organizer of fixed plant cells in situ. The structure of the Urechis acrosome and the formation, characterization and function of acrosomal basic protein are being studied. The onset and termination of nuclear basic protein synthesis in relation to DNA synthesis in unfertilized eggs of Urechis and its effect on early development will also be studied--cytochemical, biochemical and electron microscopic techniques will be used in these investigations.

SUPPORTED BY U.S. National Science Foundation

5.0936, STRUCTURE AND FUNCTION OF CELL ORGANELLES DURING GROWTH AND DEVELOPMENT M. ALFERT, Univ. of California, Graduate School, Berkeley, California 94720
The structure of the nucleus and nucleolar-like bodies, and their role in ribosome formation in Urechis are being studied; attempts will be made to hybridize ribosomal RNA to DNA of the nucleolar organizer of fixed plant cells in situ. The structure of the Urechis acrosome and the formation, characterization and function of acrosomal basic protein are being studied. The onset and termination of nuclear basic protein synthesis in relation to DNA synthesis in unfertilized eggs of Urechis and its effect on early development will also be studied--cytochemical, biochemical and electron microscopic techniques will be used in these investigations.

SUPPORTED BY U.S. National Science Foundation

5.0937, UPTAKE AND ASSIMILATION OF ORGANIC COMPOUNDS IN MARINE ORGANISMS G.C. STEPHENS, Univ. of California, Graduate School, Irvine, California 92664 (N00014-67-A-0320-0001)
The investigator is attempting to determine the role of dissolved organic matter in the nutrition of organisms and in the total economy of the sea. Results of studies by others have not been definitive on this important subject, although the investigator's laboratory has established the ability of soft-bodied invertebrates to remove amino acids and other small organic molecules from dilute solutions characteristic of natural waters. He is conducting laboratory and field studies to determine the mechanism of uptake and assimilation of the organic matter, the metabolic fate of the compounds, and to assess the potential contribution of this process to the total nutrition in the sea.

Since it is unlikely that any areas of the sea are completely sterile for long, and since many Navy problems are caused by biological agents, it is important to determine the basic factors which influence the distribution and abundance of organisms.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0938, UPTAKE OF ORGANIC COMPOUNDS BY MARINE INVERTEBRATES G.C. STEPHENS, Univ. of California, Graduate School, Irvine, California 92664
A number of soft-bodied marine invertebrates are capable of removing small organic compounds from solution in the ambient medium. This has been established for almost 100 genera in 11 phyla. The present project is designated to explore the potential significance of the process as a source of nutrition, b. as a source of specific required dietary constituents, and c. as a source of information for the organisms.

The project is also designed to exploit the capability of pulse labeling the free amino acid pools of the organisms studied in order to study their metabolism. Finally, we propose to study the mechanism of uptake of small organic compounds.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0939, PHYSIOLOGY OF MARINE ORGANISMS R. LAZER, U.S. Dept. of Interior, Fishery Oceanography Ctr., La Jolla, California
This project deals with the study of energy budgets of important food fishes and of the organisms on which they depend for their food. Primary attention has been directed both to the utilization of food during assimilation and to the measurement of quantities required for growth, maintenance activities, and reproduction from the egg to the adult. Important physiological aspects such as osmoregulation and salinity tolerance, digestion, chemoreception, and rates of development are also studied under different environmental variables such as light, salinity, and temperature.

It is further planned to study the requirements of larval fish after the critical period of yolk resorption and to carry through other studies to sea in the Center's new research vessel, David
5. LIVING SYSTEMS (NON-HUMAN)

Starr Jordan, where it will be possible to measure these requirements under the most realistic experimental situations.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0940, PRODUCTIVITY MEASURES

P.E. SMITH, U.S. Dept. of Interior, Fishery Oceanography Ctr., La Jolla, California

In order to assess the abundance and availability of commercial fish stocks, it is necessary to understand the food chain in the sea which begins with the primary production of phytoplankton and proceeds through many complex steps to the production of fish. Comprehensive data on physical oceanography and primary biological production, accumulated over many years of survey cruises, are available from the California Current area but better information is needed on the composition and distribution of the zooplankton and nekton, higher in the food chain.

Present studies on zooplankton abundance in the California Current will be continued to include the development of more precise sampling techniques and methodology. Computer analysis of past zooplankton data is nearly complete and the results will be used to improve the efficiency of future surveys. Nekton distribution and abundance will be assessed by two independent methods; one will be a limited number of tows with standard trawl gear and the other, more extensive method, will be standard transects with small-scale sonar apparatus.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0941, STUDIES OF PROTEINS UNDER EXTREME ENvironments

J.K. LANFY, U.S. Natl. Aero. & Space Adm., Ames Research Center, Moffett Field, California 94035

OBJECTIVE a. Problem - To study the biological, physical-chemical and structural properties of proteins, enzymes and membranes which function at concentrations of salt so high as to be normally incompatible with life. b. Application - To provide a basis for understanding life processes possibly present in extraterrestrial situations. c. Identification of the components of the membrane-bound respiratory chain, study the effects of the presence and absence of salt on substrate-protein and protein-protein interactions. Exploration of the unique features of proteins in halophiles which require salt.

APPROACH: Spectrophotometric and polarographic study of the oxidation and reduction of cellular components. Use of inhibitors and redox dyes in identifying pathways of electron transfer. Fractionation and individual study of some of the enzymes involved.

PROGRESS: Reporting period 04 67 to 04 68. The cytochromes of H. cutibrium have been identified by their pyridine hemochromogen spectra and by their functional relationship to various reduced substrates. It was found that at neutral pH all electron flow passes through cytochromes b559, c555 and a592. At higher pH, however, an alternate pathway operates as well which consists of cytochromes b563 and c560. The alternate pathway shows different salt dependence than the main pathway and is inactivated on overnight incubation. Two publications on this work are being submitted to Archives of Biochemistry and Biophysics. "Studies of the Electron Transport System of Extremely Halophilic Bacteria. I. Spectrophotometric Identification of the Cytochromes in H. cutibrium, and II. Salt Dependence of Cytochrome b563.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

5.0942, POLYPEPTIDE INTERACTIONS ON A STEERLE SEASHORE

H.H. PATTEE, Stanford University, Graduate School, Palo Alto - Stanford, California 94035

This work is one approach to the general origin of life problem. We assume two working hypotheses: (1) On the primitive earth there was established a sterel, reversible, multi-phase cycle which provided the primary materials and reaction processes to condense and degrade copolymers, and (2) in this complex environment, one necessary condition for the origin of life is the occurrence of specific catalytic control of monomer sequence in copolymer synthesis. One set of experiments is designed to demonstrate a possible geochemical cycle for carbon and nitrogen passing through copolymer synthesis and degradation. Synthesis of many biological monomers such as amino acids has already been demonstrated. We have studied the degradation of the large amounts of nearly intractable melamine-like material which probably requires continuous deposition on silica beaches, exposure to ultraviolet radiation from 1800-2000 angstroms and return of soluble products to the sea. A second set of experiments is designed to find reasonable condensation reactions for amino acids in the sea, and catalytic monomer ordering constraints resulting from heterogeneous reactions at interphase boundaries on foams, emulsions or particles. Theoretical studies on the ordering of copolymer sequences and the origin of hereditary codes is being simulated by computer programs.

SUPPORTED BY U.S. National Science Foundation

5.0943, PRESSURE EFFECTS ON MARINE ORGANISMS

H.A. LOWENSTAM, Calif. Inst. of Technology, Graduate School, Pasadena, California 91109 (10/35)

Studied will continue on the biochemistry and physiology of organisms collected from deep ocean waters. Organisms will be collected from various depths in the ocean and maintained in open flow, high pressure vessels at preselected pressures and studied with regard to such factors as viability, growth rates, and nutritional requirements. During these studies, research will be continued on the design and development of more advanced culture equipment and techniques pertinent to maintaining living deep sea organisms under high pressures.

It is becoming more apparent that deep ocean environments represent areas of vital importance to Naval operations. Little knowledge of any aspect of these waters has been obtained by direct observation. Present concepts are based largely on predictions and extrapolation from shallower waters and from very few actual samplings. Although historically thought to be a biological desert, the deep oceans are now known to be populated by a moderate number of organisms, but representing a relatively large number of species and displaying many bizarre characteristics.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0944, CAROTENOIDS, CAROTENOID CHROMOPROTEINS, AND ASSOCIATED LIPIDS IN ANIMALS

D.L. FOX, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

Comparative biochemical studies of the metabolic fractionation of carotenoids and associated pigments in marine and other aquatic animal phyla (e.g. sponges, coelenterates, worms, crustaceans, mollusks, echinoderms, fishes and birds), with special reference to (1) selective assimilation of unchanged food-carotenoids; (2) complete destruction or partial oxidation of some of these, e.g. into alcohol or ketone derivatives; (3) relative quantifies of various carotenoid fractions stored; (4) disposition as carotenoid chromoproteins, e.g. in certain nudibranch mollusks and asteroid echinoderm, and the possible physiological bearing of carotenoids, e.g. in photokinesis of animals.

Melanins, naphthoquinones and tetrapyrrolys (porphyrins and bilins) are of common incidence, and may call for some special attention in certain animals. Studies such as these are sometimes found to be significant in supporting certain morphological differences between species or subspecies of a common genus. In other instances, a single species within a lower evolutionary group, such as the plumose anemone, Metridium, may involve considerable flexibility in its metabolism of colored molecules.

SUPPORTED BY U.S. National Science Foundation
Two separate but related projects are underway designed to answer the question: How does a population of embryonic cells maintain its quality of being embryonic? One project is a study of the cellular basis of asexual reproduction in Tunicates, and the other a study of the developmental potential of cell cultures of unincubated chick blastoderm cells.

The ascidians (sea squirts) can reproduce asexually in a variety of ways. There are at least two other embryonic populations in addition to the embryonic cell population of the blood that can provide a cellular basis for asexual reproduction. The histological studies which have been done on asexual reproduction and regeneration in this genus indicate that during asexual reproduction only one embryonic cell population, the lymphocyte cell class, provides the cellular basis for new bud formation. During regeneration of the zooid, the other embryonic cell population, the epicardium, provides the cellular basis for new tissue formation. The epicardium is only found within the zooid proper while the lymphocyte cell class is found both in the stolon and in the zooid. The relationship between these two embryonic cell populations will be studied by making chimeras between closely related species of Clavelina such that only the lymphocyte population of one species is present and only the epicardial cell population of the other species is present.

SUPPORTED BY U.S. National Science Foundation

5.0946. BIOCHEMICAL BASIS OF SPECIFIC CELL ASSOCIATION
T.D. HUMPHREYS, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

The arrangement of individual cells into a variety of specific groupings and architectural patterns characteristic of adult tissue is being investigated. Explanations of this cell order usually center around some ideas of cell surface reactions; such as specific cell adhesion which guides cells during morphogenesis. However, there has been little information on the mechanism by which the surfaces of cells interact with one another and the ideas invoking adhesive reactions in guiding cells during development have necessarily been speculative.

A system for isolation and analysis of the aggregation factor on the sponges available in the Pacific Ocean is being worked out. The information gained by the isolation of the cellular components involved in species specific aggregation of marine sponge cells suggests many experiments on the cells of higher organisms. To work out the problems of tissue dissociation and to demonstrate and characterize an aggregation factor, cells of early chick embryos will be used.

SUPPORTED BY U.S. National Science Foundation

5.0947. MARINE PHYSIOLOGY
P.F. SCHOLANDER, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

SUPPORTED BY U.S. Dept. of Hth, Ed. & Wel. - P.H.S.

5.0948. STUDIES OF THE EFFECTS OF NUTRIENTS ON THE GROWTH OF PHYTOPLANKTON IN THE TROPICAL PACIFIC OCEAN
W.H. THOMAS, Univ. of California, Inst. of Marine Resources, San Diego - La Jolla, California 92038

5. LIVING SYSTEMS (NON-HUMAN)

Algal cultures from the tropical Pacific Ocean have been established and their growth has been measured in various media and at several light intensities and temperatures. At optimum light and temperature levels, nutritional requirements are defined in terms of the effects of nutrient concentration on growth rates and final yields of both cultures and natural populations. To describe the relative fertility of various areas of the tropical Pacific, these nutrient requirements are compared with nutrient concentrations in sea water samples. To determine which nutrients are limiting, sea water samples have been enriched with various nutrients and the effects of enrichment on photosynthesis or chlorophyll synthesis have been measured. The degree of deficiency of natural populations will be defined by comparing various intracellular ratios and photosynthetic parameters - especially assimilation ratio - in populations from poor water with the same ratios and parameters in populations from rich water. These will be compared with the same ratios and parameters in cells grown in the laboratory at varying degrees of nutrient deficiency.

SUPPORTED BY U.S. National Science Foundation

5.0949. NUTRIENT STORES IN REPRODUCTION IN SEA INVERTEBRATES
M.A. NIMITZ, Dominican Coll. of San Rafael, Graduate School, San Rafael, California 94901

The aims of this investigation are fourfold: 1) to trace the reproductive cycle of two species of starfish (Pistilia miniatina and Pisaster ochraceus) and two crustaceans (Pachycrapsus crassipes and Emerita analoga) through monthly gonad index determinations of samples of 10 animals. 2) to determine the sites of lipid and carbohydrate nutrient stores in the tissues of each species by histochemical procedures, and to trace changes in the location (and quantity, insofar as possible histochemically) of the reserves during the course of the reproductive cycle; 3) to determine the effects of a period of starvation commensurate with the normal period of gametogenesis on the quantity and quality of the gametes produced; 4) to gain as much information as possible on the distribution of acid and neutral mucopolysaccharides and proteins in the tissues of these animals.

SUPPORTED BY U.S. Dept. of Hth, Ed. & Wel. - P.H.S.

5.0950. PHYSIOLOGY OF LUMINESCENT SIGNAL SYSTEMS
J.F. CASE, Univ. of California, Graduate School, Santa Barbara, California 93108 (NONR 50014-67-A-0120-0002)

It is proposed to study, physiologically and behaviorally, the visual receptors of light producing marine and terrestrial animals to consider the development of their function as receptors of photic and other stimuli and their response mechanisms. The investigation will attempt to determine the biological significance of the luminescent systems and to examine the role of the environment in the operation of the systems.

The light producing behavior of many organisms serves as a means for quantitative detection of certain trace elements required for luminescence in some forms. Controlled production of light, when and where desirable, is possible and the proposed study will permit more effective control.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0951. BEHAVIOR AND SPECIFICITY IN MARINE SYMBIOSIS
D. DAVENPORT, Univ. of California, Graduate School, Santa Barbara, California 93108 (NONR 50014-67-A-0120-0002)

Objective: The understanding of the responses of marine organisms to the physical environment and to one another is of direct importance to a wide range of problems encountered by the Navy in the marine environment. The presence or absence of organisms which are responsible for biodeterioration, bioluminescence, or bioacoustical problems as determined by a host of environmental factors about which little is known.

Approach: Intereelationships between symbiotic marine organisms are being investigated by researchers to determine what biochemical attractants may be produced by the animals, and
5. LIVING SYSTEMS (NON-HUMAN)

what means are employed for sensing these chemicals. Attempts are being made to isolate the active principles.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.0952, PALEOBOTANICAL RESEARCH AT YALE UNIVERSITY
T. DELEFORYAS, Yale University, Graduate School, New Haven, Connecticut 06520

Studies on the development of reproducible enrichment techniques in continuous culture for the isolation of characteristic marine bacteria were completed. With a certain range of dilution rates and concentrations of the limiting substrate, chemostat enrichments were successful. Experimental attempts to separate single species from mixed cultures of known composition showed that successful or unsuccessful competition for the limiting substrate could be expressed by kinetic growth parameters of the individual species under given conditions. Species exhibiting low values of their growth parameters displaced species with relatively high values if the continuous culture was operated correspondingly at low dilution rates and/or low concentrations of the limiting substrates. This behavior is significant for the characterization of those microorganisms actually responsible for the degradation of organic materials in the sea under natural conditions.

Based on the determination of growth parameters, the studies on population dynamics were continued. Mixed pure cultures of marine and non-marine bacterial strains were grown in the chemostat at doubling times up to 100 hours and at various concentrations of limiting substrate. Predicted displacement times could be confirmed experimentally.

Techniques for studying sulfate reducing bacteria in steady state culture have been established. The kinetics of substrate (sulfate) and product-sulfide limited growth were studied with the aim of detecting characteristic metabolic differences.

SUPPORTED BY U.S. National Science Foundation

5.0953, AN ANALYSIS OF PHOSPHORUS AND NITROGEN COMPOUNDS IN TIDAL MARSH DRAINAGE
F.C. Daiber, State Board of Game & Fish, Dover, Delaware

Objective: An evaluation of the effects of various types of marshland management on the diurnal and seasonal concentrations of phosphorus and nitrogen in tidal marshes.

Procedure: Water samples will be collected from managed marishes representing ditched, high-level impounded, low-level impounded, and old and new Tavemage pools. Collections from natural marshland will serve as the control. The ditched marsh will be represented by Canary Creek Marsh. All the other types of marsh mentioned will be located on the Murderkill Marsh.

Collections will be made every six hours for one 24-hour period at each area once a month. The collection dates will be at 3 or 5 week intervals to allow sampling of spring and neap tides. Water samples will be collected in 250 ml amber glass bottles with rubber stoppers. Salinities will be collected in translucent plastic bottles for later determination. Water temperature will be measured with a centigrade thermometer. A battery-operated field pH meter will be used to determine pH and redox potential. Time, weather condition and air temperature will also be recorded.

The distance from the laboratory to the Murderkill Marsh area and the time involved in travel requires that the investigators remain in the field during the 24-hour collection period.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish. Delaware State Government

5.0954, PRIMARY PRODUCTION AND DECOMPOSITION IN ESTUARINE WATER
H.D. Putnam, Univ. of Florida, School of Engineering, Gainesville, Florida 32601

The objective of the proposed research is to contribute to an understanding of the synthesis and decomposition of organic matter by primary producers in an estuarine environment. Studies will be conducted to estimate the productivity of certain red and brown algae which are part of the benthic community in the Waccasassa Estuary. Appropriate methods for measuring fixation of isotopic carbon by attached plants were worked out under grant No. WP-00678-03 which will be completed by this investigator August 31, 1967.

In addition an attempt will be made to define more clearly the limiting factors for primary production in the Waccasassa Estuary. Emphasis will be directed toward the interaction of chemical and biological factors.

Efforts also will be made to follow the decomposition of organic matter under anoxic conditions in estuarine sediments. These studies will be directed mainly toward the characterization of substrates which are involved in methanogenesis. The pool size of volatile fatty acids resulting from the breakdown of algae will be determined and efforts made to establish metabolic turnover rates of these components.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0955, PRIMARY PRODUCTIVITY

Objectives: 1. To understand the biology of the primary producers in the sea and to predict times and places of high organic production. 2. To develop valid techniques for measuring the standing crop and production rates of the primary producers in the sea, in order to meet the objective stated above.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0956, INTERACTIONS OF MARINE NUTRIENT COMPLEXES

Objective: To clarify the nutritional roles of iron and phosphorus compounds within the framework outlined in the proposal.

A laboratory study of possible chemical and physical interaction of iron and phosphate compounds within the marine nutrient cycle. a. Study of the mechanism of such interaction, if found, using labelled compounds of 32P and 59Fe as chemical tracers. b. Study the relationship of such interactions upon ingestion and assimilation in phytoplankton using 32P and 59Fe as chemical tracers.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0957, FORMATION AND UTILIZATION OF TERPENES
D.G. Anderson, Univ. of Miami, School of Medicine, Miami - Coral Gables, Florida 33124

Isolated and purified zooxanthellae, intracellular symbionts of gorgonians and other marine invertebrates, are used as a source for enzyme systems capable of converting isopenoid intermediates into a series of sesquiterpene hydrocarbons, a macrocyclic diterpene (polyprenyl acetate), and other isopenoid products. Formation of these compounds is followed radiochemically from a series of labeled substrates, including specific and non-specific isomers of farnesy1 pyrophosphate.

The gorgonian - zooxanthellae symbiotic complex as studied from the viewpoint of terpene synthesis and terpene utilization. Gorgonian species utilized include P. americana, P. porosa, and E. mammosa.

SUPPORTED BY U.S. Dept. of Hith. Ed. & Wel. - P.H.S.

5.0958, DEVELOPMENTAL STUDIES OF SELECTED INVERTEBRATES
H.B. Owre, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124

Descriptive studies of the development of locally abundant, littoral invertebrates which are either potentially useful to man as experimental forms or as food, or are deleterious, are underway. The subjects are members of the phyla Coelenterata, Platyhelminthes, Annelida, Mollusca, Echinodermata and Hemichordata. Information is being accumulated on size at reproductive maturi-
5. LIVING SYSTEMS (NON-HUMAN)

This is a renewal of GB-3156. Studies on the sequence of chemical events leading up to light emission in several luminous systems will be continued (i.e., the sea snail, Renilla reniformis, a model peroxidase type luminous system, luminous bacteria, and luminous earthworms (Diplocardia)). A detailed study of the enzymology of these processes and of the nature of the intermediates involved in these reactions will be made. Renilla luciferase has been purified about 100 fold and a partial separation of the 3 ', 5' -diphosphoadenosine (DPA) - linked activating enzyme from that of luciferase has been achieved, utiliser the hope to completely separate these activities and study the mechanisms of a recently discovered, DPA-dependent, sulfite-luciferin) sulfite exchange reaction. In addition, more Renilla luciferin will be isolated in order to continue the structural studies. Isolation of a luciferase from a strain of bacteria that emits at a different wavelength than luciferase isolated from Ph. fischeri will be attempted and a comparison of the properties of the two enzymes will be made. Studies on the mechanism of the peroxidase-luminal-H2O2 luminous system will be continued. It is hoped to correlate light production with one of the many enzyme complexes found in this reaction and the nature of the reactions which will be studied used large specimens of Diplocardia. A H2O2 requirement for this reaction has been demonstrated. Isolation of the luciferase and luciferin from Diplocardia is in progress.

SUPPORTED BY U.S. National Science Foundation

5.0963, THE ROLE OF COPROPHAGY IN MARINE FOOD CHAINS
D. FRANKENBERG, Univ. of Georgia, Graduate School, Athens, Georgia 30602

This study will evaluate the hypothesis that fecal material plays a significant trophic role in marine food chains. The proposed research will seek answers to the following questions: 1. What kinds of marine animals, under what conditions, utilize fecal pellets as food; 2. How much organic matter is made available in fecal pellets of various marine organisms; and 3. What physical, chemical and microbiological changes occur in fecal pellets after excretion. Information pertinent to these questions will be sought for a variety of marine organisms representing a diverse spectrum of feeding and taxonomic types.

SUPPORTED BY U.S. National Science Foundation

5.0964, THE ROLE OF FECAL PELLETS IN MARINE FOOD CHAINS
D. FRANKENBERG, Univ. of Georgia, Graduate School, Athens, Georgia 30602

The proposed study will evaluate the hypothesis that fecal material plays a significant trophic role in marine food chains. The study will be conducted utilizing field and laboratory facilities of the Department of Zoology and the Marine Institute of the University of Georgia. This proposal summarizes the evidence leading to the hypothesis, and outlines studies designed to test it.

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SUPPORTED BY U.S. National Science Foundation

5.0962, CHEMISTRY AND ENZYMATOLOGY OF BIOLUMINESCENCE
M. J. CORMIER, Univ. of Georgia, Graduate School, Athens, Georgia 30602

This proposal seeks to determine the mechanism of the peroxides-luminal-H2O2 luminescent system in processes involving bacterial photoproduction. The synthesis of the many enzyme complexes involved in these reactions will be studied. Isolation of the luciferase and luciferin from Diplocardia is in progress.

SUPPORTED BY U.S. National Science Foundation

5.0959, RELATION OF ENVIRONMENTAL FACTORS TO THE PRODUCTIVITY OF ESTUARINE SEDENTARY FAUNA
P.A. BUTLER, U.S. Dept. of Interior, Biological Laboratory, Sabine Island - Gulf Breeze, Florida

The incidence of setting per square centimeter per seven days on asbestos-cement plates at one station in Santa Rosa Sound near Pensacola, Florida has been measured since 1949. Predominant fauna counted include barnacles, oysters, echinoids, and holothurian echinoderms.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wei.

5.0960, SONIC SENSITIVITY OF FISHES AND AMPHIBIA
B.A. WEISS, Univ. of South Florida, Graduate School, Tampa, Florida 33620

In this project, the relative roles of auditory and lateral line sensitivity will be investigated in selected fishes and amphibians through a shock avoidance technique in response to a stimulus of closely controlled characteristics. Additionally, the evolution of auditory receptors will be studied by use of late stage tadpoles and fully developed frogs. An attempt will be made to differentiate between the near and far fields in sonic reception by fishes.

Sound production and reception by aquatic organisms gains in importance as acoustic instruments become more discriminate through technical refinements.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0961, BIOSYNTHESIS OF BROMOPHENOLS IN MARINE INVERTEBRATES
R.B. ASHWORTH, Univ. of Georgia, Graduate School, Athens, Georgia 30602

During attempts to isolate luciferin from the marine hemichordate Balanoglossus biminiensis an interesting brominated compound was isolated and its structure identified by UV, IR, NMR, mass analysis and melting point data. The isolated brominated Balanoglossus biminiensis (10-15 mg. per organism) and is responsible for its peculiar odor which has been described as 'iodoform-like.' These worms, belonging to the family, echinoderms, are distributed all over the world and comprise some twelve genera and fifty species, at least three of which are luminescent. Although dibromophenol has been identified only in one species, all apparently synthesize the compound since all possess the same pungent odor. There is no evidence to suggest any connection between luminescence and production of the compound.

It might be surmised that bromophenol production is simply a defense mechanism, but this does not explain the prodigious synthesis of the compound. It is also possible that dibromphenol serves as an intermediate in thyroxine production in invertebrates.

It is hoped that by setting up a large-scale collection program of Balanoglossus biminiensis and other related invertebrates that sufficient material can be collected to resolve the question as to whether bromophenol is produced in other families of marine invertebrates and if so, whether there is a relationship to thyroxine biosynthesis.

SUPPORTED BY U.S. National Science Foundation

5.0962, CHEMISTRY AND ENZYMATOLOGY OF BIOLUMINESCENCE
M. J. CORMIER, Univ. of Georgia, Graduate School, Athens, Georgia 30602

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5.0963, THE ROLE OF COPROPHAGY IN MARINE FOOD CHAINS
D. FRANKENBERG, Univ. of Georgia, Graduate School, Athens, Georgia 30602

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SUPPORTED BY U.S. National Science Foundation

5.0964, THE ROLE OF FECAL PELLETS IN MARINE FOOD CHAINS
D. FRANKENBERG, Univ. of Georgia, Graduate School, Athens, Georgia 30602

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SUPPORTED BY U.S. National Science Foundation
5. LIVING SYSTEMS (NON-HUMAN)

5.0965, FIELD EXPERIMENTS ON THE FLUX OF RADIONUCLIDES THROUGH A SALT MARSH ECOSYSTEM
L.R. POMEROY, Univ. of Georgia, Graduate School, Athens, Georgia 30602 (AT(40-1)-3238)

After some 12 years of work on the salt marshes of Georgia by a number of investigators, it is now possible to begin building models of the flux of materials through the system. A compartmental-diagram model, showing standing stock and flux of phosphorus, is being developed. This is now being transformed into a mathematical model suitable for computer simulation of events in the salt-marsh ecosystem. The model will be tested and refined by computer techniques. Deficiencies in our data shown by computer analysis will be remedied by additional, small-scale field and laboratory work. Manipulation of the model simulating changes in flux and storage of phosphorus by various populations (compartments) will help us predict the effect of various natural and man-made changes on the ecology of salt marshes.

In its present primitive state our model tells us that the marsh grass, Spartina alterniflora, is the dominant primary producer, and that the microbial community is unusually important in the biogeochemistry of phosphorus in marshy estuaries. Spartina appears to be taking all its phosphorus requirements from subsurface, reduced sediments that would otherwise be a sink. This phosphorus is released into the water when the Spartina dies and decays, as most of it does. This process undoubtedly has great significance in maintaining high productivity in the estuary.

SUPPORTED BY U.S. Atomic Energy Commission

5.0966, METABOLISM OF MARINE ECOSYSTEMS
L.R. POMEROY, Univ. of Georgia, Graduate School, Athens, Georgia 30602

This research is concerned with secondary and tertiary stages in the food web of natural waters. The results of work on the metabolism of microorganisms are in part a result of the energy available to all organisms in the sea is consumed by microorganisms. These microorganisms are in part bacteria and in part flagellates and other heterotrophic protists. The latter appear to be of major importance in the regeneration of PO₄ (and probably NH₃ as well). The microorganisms of the open sea are to a considerable extent associated with the so-called organic aggregates, which are the detritus material thought to originate through some physico-chemical process of aggregation from dissolved organic materials. The research now proposed is concerned with such aspects of the metabolism of ultraplankton as diurnal cycles of respiration, respective roles of bacteria and flagellates, energy content of the entire water column, descriptive aspects of the organic-aggregate community, and further development of methods appropriate to the research. Some of the developmental and exploratory parts may be done in fresh water and inshore marine environments.

SUPPORTED BY U.S. National Science Foundation

5.0967, METABOLISM OF COMPLETE WATER COLUMNS
W.J. WIEBE, Univ. of Georgia, Graduate School, Athens, Georgia 30602

The University of Georgia proposes to make estimates of total metabolism of both photosynthesis and respiration for a series of water columns in the Southern Ocean between Antarctica and approximately 50 degrees S latitude. In this investigation, metabolism of all populations from bacteria in the sediments to phytoplankton will be considered. Metabolism rates for respiration, photosynthesis and assimilation will be made under in situ conditions of light, temperature, salinity and pressure. The incorporation of pressure represents a new approach. Data on the metabolic rates and flow of energy through the water columns are essential to the analysis of the integrated biological system (ecosystem). For data on photosynthesis it is proposed to use El Sayed’s method as well as a C14 method. Respiration of marine mammals and birds will be taken from available data on abundance and metabolism. Quantitative sampling of bathypelagic and benthic fishes can be estimated from the work of Wolfschlag. Crustacea estimates will utilize work by McWhinney. Ultraplankton estimates will involve a method developed by Pomeroy.

The investigation is proposed for Eltanin cruise 37. It requires six stations: (1) shallow water off the Antarctic continent, (2) Antarctic continental shelf, (3) Antarctic continental slope, (4) deep (5,000 m) station in the Southern Ocean, (5) Antarctic Convergence, (6) Divergence. Stations will require at least four 48 hours; the cruise party will consist of seven persons.

SUPPORTED BY U.S. National Science Foundation

5.0968, IMPROVEMENT AND APPLICATION OF BENTHIC ALGAL ISO TOPE PRODUCTIVITY MEASURING METHODS
M. DOTY, Univ. of Hawaii, Graduate School, Honolulu, Hawaii 96822 (AT(04-3)235-4)

Benthic algal genera and community productivity methods, measurement and interpretation are being studied in seeking an understanding of the changes in algal populations as they vary with longitude in the Central and Western Pacific. The principal algal genera are those conspicuous in the communities where coraline algae, Caulerpa and Eucheuma are abundant. Studies of physio-ecological phenomena such as response of algae to dissolved organic material, current and their periodicities are specific approaches.

SUPPORTED BY U.S. Atomic Energy Commission

5.0969, SENSORY PROCESSES, MARINE AND HUMAN
G. VONBEKESY, Univ. of Hawaii, Laboratory of Sensory Sciences, Honolulu, Hawaii 96822

The investigators propose to conduct research on the sense organs and transmission pathways of man and other animals, particularly the marine animals. Different sense modalities will be studied and compared for general sensory principles as well as for principles specific to particular senses.

Initial investigations will study the amplifying mechanism in sensory transducers, the role of inhibition in localization and sensory magnitude, inhibition between point sources in the eye, nerve membrane permeability, the role of free radicals in the nerve impulse conduction and sensory changes with neurological disease. A variety of experimental techniques will be employed, such as electrophysiological recording, electron spin resonance, psychophysical average error matching, and psychophysical location.

SUPPORTED BY U.S. National Science Foundation

5.0970, REGULATION OF IONIC CONSTITUENTS OF PROTOSLAM
H.B. STEINBACH, Univ. of Chicago, Graduate School, Chicago, Illinois 60637

The work in general, consists of a series of studies to determine how living cells manage their inorganic ion content. More specifically, the projects include: A. Studies on regulation of water and salts by frog skins. Empty sacs of skin can manufacture a fluid, nearly isotonic to normal blood and of concentration and composition nearly independent of the external bathing media. This system is being studied as a convenient device for solving problems of secretion. B. Studies on the relationship of K ion to amino acid contents of marine invertebrate muscle and nerve. As an example, crab nerve and crab muscle have about the same intracellular concentration of amino acids but nerve extract contains a high proportion of dicarboxylic acids and double the K concentration as compared to muscle. C. Comparative studies on fresh water invertebrates and their ability to manage osmotic problems. D. Intracellular distribution of ions, studied by re-distribution of muscle fiber components during high speed centrifugation in isosmotic media.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.
5. LIVING SYSTEMS (NON-HUMAN)

'mitochondrial pump.' A similar 'pump' is found in the Blue Crab gill and is responsible for absorbing salts when the animal is adopted from sea water drowning. An unusual method of pinocytosis is seen in the basal folds of the cells, involving out-pocketings of the folds. This may be the mechanism for the first step in Diamonds' theory of salt and water movement.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.0975, THE BIOLOGY AND CHEMISTRY OF TRACE ELEMENTS IN MARINE AND ESTUARINE WATERS

W.R. TAYLOR, Johns Hopkins University, Graduate School, Annapolis, Maryland (AT(30-1)-3497)

The objective of the project is to clarify the biogeochemical cycles of trace elements through the initial trophic levels of the Chesapeake Bay. Both biological and chemical samples have been collected in the major river entering the upper Chesapeake Bay and a series of stations in the Bay. Chemical analyses are done by atomic absorption spectrophotometry. Both phytoplankton and zooplankton organisms are being surveyed quantitatively for spatial and time distribution patterns.

The chemical sampling program is nearly complete. Analyses for iron, manganese, copper, nickel, zinc and cobalt have been partially completed. The trace metal requirements of representative phytoplankton organisms are being investigated. An iron requirement has been found for five algae. Cladocerans appear to be a major component of the zooplankton.

SUPPORTED BY U.S. Atomic Energy Commission

5.0976, PHYSICAL AND BIOLOGICAL OCEANOGRAPHY OF A LUMINOUS BAY

W.D. MCELROY, Johns Hopkins University, Graduate School, Baltimore, Maryland 21218 (AT(30-1)-3480)

The present study will be concerned with a detailed physical and biological study of one well protected bioluminescent bay in Jamaica. However, the equipment constructed for this study will be used for additional studies at other sites, such as the luminescent bay on the south shore of Puerto Rico and our own Chesapeake Bay in Maryland. There are several biological parameters that will be studied but two that are very useful and can be measured quantitatively are photosynthesis and luminescence of the phytoplankton.

The Jamaican 'Phosphorescent Bay' is ideal for our proposed studies and is located near the town of Falmouth on the north shore abouaMontego Milo. The density of the organisms in this bay is most unusual and forms essentially a constant bloom. The average depth of the bay is about four feet with a surface area of about one square kilometer. The bay is bordered on the north, east and south by dense strands of mangrove trees. The entire Falmouth Harbor lies behind extensive offshore coral reefs and the bay is therefore protected from extreme wave action. The tidal variations are very small - seldom more than 12 cm. Thus this is a well protected bay that supports heavy growth of dinoflagellates - an ideal place for study since it is not, as yet, affected by tourists in contrast to other such bays. From our previous investigations we feel that the bay is an ideal natural oceanographic model p.c., using many characteristics of larger estuaries. Continuous monitoring of temperature, salinity, tide, climate, fresh water influence, flushing rates, etc. will produce a series of records that are essential for the interpretation of the biological data. As an oceanographic model the waters of the bay may, at some future date, be manipulated physically and/or chemically to study the relative effects of such change upon both oceanographic and biological aspects.

SUPPORTED BY U.S. Atomic Energy Commission

5.0977, IMMUNOLOGY AND SEROLOGY OF MARINE ANIMALS

G.E. KRANTZ, U.S. Dept. of Interior, Biological Laboratory, Oxford, Maryland

Serological and biochemical techniques are employed to describe differences among genera, species, and subpopulations of marine animals (fishes, mollusks, Crustacea). Preliminary stu-
5. LIVING SYSTEMS (NON-HUMAN)
dies of the cellular and humoral responses of invertebrates to injected foreign proteins and particulate antigens have been initiated. Clinical diagnostic tests and comparative serology of paramyxovirus infections in marine animals are being developed to enhance analyses of variation in healthy and diseased marine animals.

Serological techniques include the development of rabbit antisera for use in immuno-electrophoresis, agglutination, precipitation, complement fixation, and fluorescent antibody tests. Biochemical studies utilize agar, starch, and polyacrylamide gels, and cellulose acetate in electrophoretic studies of proteins and enzymes from invertebrate tissues (body fluids, serum, hemocytes, muscles, and style). Biochemical studies utilize agar, starch, and polyacrylamide gels, and cellulose acetate in electrophoretic studies of proteins and enzymes from invertebrate tissues (body fluids, serum, hemocytes, muscles, and style).

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5.0978, TISSUE CULTURE - VIROLOGY
A. ROSENFIELD, U.S. Dept. of Interior, Biological Laboratory, Oxford, Maryland

Attempts are being made to establish in vitro monolayer cell cultures of various invertebrate tissues (particulary Crassostrea virginica) for the purpose of using cultured cells to study the life cycles and physiology of certain infectious agents (such as certain viruses, bacteria, fungi, and protozoans) as well as to study the cytopathogenic manifestations, biochemistry, morphology, and cytology of the cultured cells themselves.

Tissue explants and dispersed cells taken from a variety of oyster tissues are planted in commercial and laboratory prepared media with and without supplements under a variety of environmental conditions. Addition to media of mitotic initiators such as colchicine and phytohemagglutinin are also being attempted.

Maintenance for periods up to three weeks of isolated oyster cells and up to 10 months for heart tissues has been accomplished. However, cell division and concomitant increases in cell number have not been observed, nor have cell lines as yet been established.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0979, IONIC PERMEABILITIES OF THE SQUID GIANT AXON. - EFFECTS OF CHEMICAL AGENTS

The ionic current flow across the membrane of the squid giant axon and the central nerve cord of a marine worm has been measured, without the complications of excitation and propagation, after a sudden change of the membrane potential. The currents have been analyzed in terms of the membrane permeability to sodium and potassium ions. Much of classical nerve physiology is explained by these permeabilities which are themselves not understood. The original instrumentation of the squid giant axon has been extensively modified and expanded in continuing work with the squid axon. The membrane potential is measured between micropipette internal and nearby external reversible electrodes and is maintained and changed as required by an electronic control system. This system computes, produces, and measures the necessary flow of membrane current between axial and external axon electrodes to follow command rapid changes of the membrane potential. Considerable progress has been made in improving the reliability, speed and simplicity of the system.

The voltage clamp technique allows measurements of ionic current flow across nerve membrane as a function of voltage and time. These parameters have been combined into a set of empirical equations capable of expressing nerve membrane activity, but the physical meaning of the equations is unknown. It is hoped that use of these equations will contribute to understanding the physical mechanisms of the membrane. Irrespective of the chemical properties of the substances, this may permit dissection of the lumped parameters of the equations as well as a correlation of known chemical properties with the observed effects.

SUPPORTED BY U.S. Dept. of Hith. Ed. & Wel. - P.H.S.

5.0980, FORMATION AND METABOLISM OF NEUROHUMORAL TRANSMITTER SUBSTANCES IN MARINE ANIMALS

Studies of the metabolism of appropriate compounds in more primitive animals can offer clues to the evolutionary development of those enzyme systems which break down both foreign compounds and naturally occurring substances in the body. Levels of the classically studied drug metabolizing enzymes have therefore been determined in several tissues of pelagic animals. The observation that shark interrenal body contained surprisingly high levels of an endogenous substrate for transmethylating enzymes led to the discovery that conversion of norepinephrine to epinephrine takes place in this organ. The clamsbarnbranch interrenal body is analogous to the cortex of the mammalian adrenal gland. The presence of what is usually a medullary function in such a tissue suggests that this organ can be utilized to study the interrelationship between corticosteroids and catcholamines.

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5.0981, METABOLISM OF NEUROHUMORAL TRANSMITTER SUBSTANCES IN MARINE ANIMALS

This study represents an attempt to follow development of neurohumor transmitter substances and their metabolism in animals lower on the evolutionary scale. Pelagic organisms have developed not only variants of transmitter substances (such as octopamine) but also a variety of potent blocking agents (neurotoxins) and it is hoped that a better understanding of their structure and metabolism may aid in elucidating the function of neurohumoral transmitters.

SUPPORTED BY U.S. Dept. of Hith. Ed. & Wel. - P.H.S.

5.0982, MORPHOLOGIC REGULATORY MECHANISMS IN TERRESTRIAL AND MARINE ORGANISMS
J.W. HASTINGS, Harvard University, Graduate School, Cambridge, Massachusetts 02138

The mechanisms of formation, organization and removal of structural elements of animal tissues during development are under investigation. To understand the way these processes are regulated and synchronized with each other, work has been directed to the fibrous protein, collagen, since this structural element is involved in practically all tissue remodeling processes from embryogenesis through senescence.

Five areas are under investigation: (1) morphogenesis of collagen in reaggregating sponges and the germination of gemmules, (2) collagen biosynthesis in reaggregating sponges, (3) hormonal regulation of protein synthesis and comparative studies in fish and amphibia, (4) formation and properties of yolk protein in teleosts, and (5) autonomy, regeneration and collagenases in invertebrates.

SUPPORTED BY U.S. National Science Foundation

5.0983, MOLECULAR MECHANISMS IN BIOLOGICAL CLOCKS
J.W. HASTINGS, Harvard University, Graduate School, Cambridge, Massachusetts 02138

Studied in the area of biological rhythmicity - endogenous persistent rhythms, which continue to occur even when the organism is kept under constant conditions - are being carried out. A unicellular photo-synthetic organism, the marine dinoflagellate Gonyaulas is being used. It exhibits several rhythms (photosynthesis, luminescence, cell division) and has been shown to exhibit rhythmicity in the isolated single cell.

This research is concerned explicitly with the molecular nature of the rhythm mechanism and how it controls the 'target' systems.

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232
5.0984, MOLECULAR STUDIES OF DIFFERENTIATING CELLS
E. BELL, Mass. Inst. of Technology, Graduate School, Cambridge, Massachusetts 02139

Although a number of reports have concluded that the mature, unfertilized sea-urchin egg is quiescent, recent experiments have made it clear that this view is not longer tenable. It is true nonetheless that fertilization results in an increase in the rate of protein synthesis. The less active, or previously thought 'inactive' state, of the unfertilized egg has been attributed to defects of one kind or another in the egg's protein synthesizing apparatus. Much recent work has focused on 'masked' m-RNA.

The research is concerned with regulation of micro-molecular synthesis in mature clam and sea urchin eggs before and after fertilization, in developing and differentiating pollen grain cells and in cells of the chick lens and feather which pass through distinct phases of proliferation, morphological differentiation and senescence.

SUPPORTED BY U.S. National Science Foundation

5.0985, MOLECULAR ASPECTS OF CELLULAR DIFFERENTIATION AND DIVISION
P.R. GROSS, Mass. Inst. of Technology, Graduate School, Cambridge, Massachusetts 02139

Work is primarily on early stages in the embryogenesis of the sea urchin is underway, making use of concepts and methods developed in molecular biology, in relation to the transcription of genetic information and its translation into new proteins.

Identification underway on the intracellular location and ultrastructural features of stored mRNA, the fraction of the genome represented by stored messengers, and such architectural details of the stored particles as may influence their utilization in protein synthesis. Further evidence will be obtained on the translation-level control of protein synthesis during early development of the sea urchin, with respect to the whole pattern of protein biosynthesis and to the assembly of certain differentiated organelles, including microtubules, cilia, mitotic proteins, and membrane derivatives. Certain features of the metabolism of early embryos, related to cell division and differentiation without growth, will be studied. Among them is the initial absence of ribosomal RNA synthesis accompanied by a rapid increase in the number of chromonemes.

SUPPORTED BY U.S. National Science Foundation

5.0986, FILAMENTOS, MORPHOGENESIS AND CONTRACTION OF MUSCLE
B. KAMINER, Marine Biolog. Laboratory, Woods Hole, Massachusetts 02543

The main objectives of the proposed study are to gain a better understanding of the molecular structure of muscle filaments and of the factors which influence their pattern of organization, size and stability. Comparative studies of myosin filaments, for example, suggest that the intrinsic structure of the myosin molecule determines the size of the natural filaments under given environmental conditions.

The in vitro findings will be applied to living muscle and also to problems in muscular dystrophy.

SUPPORTED BY Marine Biological Laboratory

5.0987, CELL DIVISION, BIOENERGETICS, CHEMISTRY OF MUSCLE
A. SZENTGYORGYI, Marine Biolog. Laboratory, Woods Hole, Massachusetts 02543

Our research has made it probable that cells are kept in the quiescent state by glycolytic derivatives which are present. Though these are contained in animal cells in surprisingly high concentration, they were not discovered until the present because they are masked. It is the object of the proposed research to collect more data about their distribution and function, prepare them in pure condition, establish their chemical configuration and synthesize them.

5.0989, UTILIZATION OF FRESHWATER FISH FOR ANIMAL FOODS
R.A. GNAEDINGER, U.S. Dept. of Interior, Technological Laboratory, Ann Arbor, Michigan

Detailed studies on the time/temperature relationships for inactivating enzyme thiaminase were completed. The purpose of the study was to examine the potential usefulness and energy requirements for related heat processing approaches for rendering white, thiaminase-containing fish safe for animal foods, particularly mink.

Subsequently, an experimental fish reduction process, under study for making fish press-cake from thiaminase-containing fish, was modified to convert the approach to a continuous pressure cooker type. The initial bench-scale model was scaled up to a pilot plant or working model and is presently undergoing testing. In addition to developing engineering and economic-related specifications for production-size models, press-cake and meals will be prepared for extensive 2-year mink feeding studies that are planned for initiation this year under a separate project.

Studies are underway or are planned to examine several experimental FPC products made from whole fresh fish, press cake, and fish meal, utilizing several freshwater industrial species. Solvent extraction procedures will be employed; resulting products will be examined for yield and general composition data, their content of elemental residues, and biological response by feeding studies.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.0990, NUTRIENT ASSIMILATION - ATES - FIELD STUDIES
W. ABBOTT, Gulf Coast Research Laboratory, Ocean Springs, Mississippi

5. LIVING SYSTEMS (NON-HUMAN)

It is also our object to draw closer the relation of these glyceral derivatives to incidence and the development of cancer, and to establish the optimal conditions for their possible therapeutic use.

SUPPORTED BY Marine Biological Laboratory
5. LIVING SYSTEMS (NON-HUMAN)

A series of estuarine ponds have been formed by capturing a bayou channel between levees. The ponds are utilized for factorial experimentation on effects of various nutrients in multiple dose combinations.

Phosphorus studies have shown that the ultimate fate of an added tracer spike is conditioned by the recent fertilization history of the pond. Ability of the whole pond ecosystem to function as a sort of "phosphorus buffer" is indicated by the results. Repetition of phosphorus studies and studies on the nitrogen cycle are planned for the near future.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

5.0991, STUDIES ON INORGANIC NUTRIENT ASSIMILATION RATES IN ESTUARINE PONDS

W. ABBOTT, Gulf Coast Research Laboratory, Ocean Springs, Mississippi

The captioned research grant has provided funds for construction of 18 estuarine ponds. These ponds are being utilized for field scale testing of hypotheses developed during a series of microcosm studies (Abbott, J. Water Poll. Control Fed., 38:258-270 (1966); 39:113-122 (1967)).

Studies are oriented toward evaluation of phosphorus and nitrogen turnover rates, kinetics of uptake of these elements, and validity of their roles as limiting nutrients in hyperfertilized estuarine situations.

SUPPORTED BY Rockefeller Foundation

5.0992, MECHANICAL PROPERTIES OF MAMMALIAN CELLS

R. W. CORELL, Univ. of New Hampshire, School of Engineering, Durham, New Hampshire 03824

Cells are the basic building elements of living organisms. The gross or macroscopic mechanical behavior of tissues is dependent upon the rheologic properties of the cells themselves. Research in this field, in recent years, indicates that considerable effort will be required at the cellular level before more complete understanding is obtained for the gross rheologic properties of groups of cells or tissues. Therefore, a student-faculty team is studying the viscoelastic properties of individual cells. To accomplish this, stationary cultured cells are grown in the laboratory. Diluted suspensions containing the cells whose rheologic characteristics are sought, are studied by injecting living cells into a nutrient filled microscope chamber. The cells are viewed through a horizontally mounted research microscope. The cells, in time, settle down through the nutrient solution. Some of the cells settle on an optical viewing platform. The data on the flow and deformation characteristics of the cells on this platform are obtained by time-lapse photomicrographs. These photomicrographs provide the experimental data from which a number of characteristics are determined as a function of time, including: 1. Cell Shape. 2. Rate of Change of Membrane Stress. 3. Strain in Cell Membrane.

SUPPORTED BY University of New Hampshire

5.0993, STUDIES ON THE STRUCTURE OF HEMERYTHRIN

G. L. KLIPPENSTEIN, Univ. of New Hampshire, School of Agriculture, Durham, New Hampshire 03824

Hemerythrin, the oxygen-carrying protein of certain marine invertebrates, including the sipunculoids, is being studied from a structural point of view. There are three general aspects to this project: 1) A study of the primary structure of the hemerythrin of the sipunculoid Golfingia gouldii and analysis of the structures of several molecular variants of hemerythrin which occur in this species. 2) An examination of the primary structure of the hemerythrin from another sipunculoid species, Dendrostomum pyrroldes, and evaluation of similarities and differences between this and G. gouldii hemerythrin. 3) An investigation into the structure of the active or iron-binding site in hemerythrin. This latter project involves chemical modification studies on the protein of G. gouldii and studies comparing the structures of hemerythrins of several species.

The goals of this research are: 1) to gain insight into structure-function relationships in this protein system, particularly with regard to the structure and chemistry of the iron-protein linkages; 2) to provide information on the evolution of this protein and the evolutionary relationships between invertebrates containing hemerythrin.

SUPPORTED BY University of New Hampshire

5.0994, BIOCHEMISTRY OF DEVELOPMENT

M. SPIEGEL, Dartmouth College, Graduate School, Hanover, New Hampshire 03755

Brief Description of Research Project: Isolated blastomeres of the sea urchin embryo, if taken at early cleavage stages, are able to regulate almost perfectly to form a normal larve of reduced size. Methods have been devised to isolate pure cell suspensions of the three sizes of later blastomeres: micromeres, mesomeres, and macromeres. These cells, when recombined in sea water, are capable of regenerating to form normal embryos.

Using this technique, investigations are underway on the effects of poly-U on unfertilized and fertilized sea urchin eggs and to continue investigations on the identification of the protein synthesized during early development with particular emphasis on the basic proteins. Other projects underway include (1) an investigation of the "appearance," localization and chemical composition of a basic protein found during amphibian gastrulation, and (2) investigations on the factors regulating tryptophan pyrrolase activity in development.

SUPPORTED BY U.S. National Science Foundation

5.0995, PHYSIOLOGICAL AND BIOCHEMICAL REQUIREMENTS OF PHYTOPLANKTON SPECIES

J. MAHONEY, U.S. Dept. of Interior, Sandy Hook Marine Lab., Highlands, New Jersey

Description of Work: Grow pure cultures of each species in various salinities, light intensities, photoperiods, and temperatures to determine their gross physiological tolerances. By varying the composition of chemically defined artificial sea water media, 1) determine nutritional requirements of species 2) determine which of those non-essential nutrients available in the sea the species is capable of utilizing. Determine carbon, nitrogen and phosphate sources, vitamins, and trace metals utilized by each species.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.0996, CELL CONTACT IN RELATION TO GROWTH AND MORPHOGENESIS

M. STEINBERG, Princeton University, Graduate School, Princeton, New Jersey 08540

A research program to study cellular properties of adhesion, aggregation, sorting out and migration is underway. Fundamentally, it is hoped to explain how the arrangement of diverse types of cells into tissues is brought about; how this arrangement is maintained; and how it is re-established following disturbance to it. The proposed studies will be 1) determine nutritional requirements of species 2) determine the associations and spatial arrangements adopted by cells and tissues in mutual contact; 2) the degrees of selectivity exercised by cells in adopting these associations; and 3) the origins and magnitudes of the physical forces under the influences of which cells and tissues rearrange themselves.

One area of investigation, the selectivity of cell adhesion will employ an examination of chick embryonic cells to determine whether adhesions between cells of different histotypes are initiated randomly or discriminately, and of whether homologous cells 1) of fore and hindlimb and 2) of mouse and chick make adhesions between one another. Spongocell aggregation of this will be studied in a similar manner by use of the electron microscopy together with specific stains which reveal cell surface

234
constituents as a means for quantifying cell aggregation and the effects of agents upon it; and the use of microscopic electrophoretic analysis as a means for determining certain physical chemical properties of the sponge cell surfaces.

SUPPORTED BY U.S. National Science Foundation

5.0997, ECOLOGY OF SKELETAL PLANKTON
A.W. BE, Columbia University, Graduate School, New York, New York 10027

Grant NSF GB-155 assisted in the investigation of living plankton Fcraminifera. Dr. Be now wishes to extend his studies to include two other calcareous shell bearing groups of plankton, Pteropoda and Coccolithophoridae. Regional planktonic surveys in the Pacific, Atlantic and Indian Ocean are to be continued in order to obtain data on the geographic, bathymetric, and seasonal distributions of plankton populations. Collected material is to be sorted, identified and enumerated. All data will be processed and subjected to multivariate statistical analysis using computers. The knowledge of spatial and time distributions of contemporary species belonging to these three groups should lead to a coherent analysis of their environmental significance. This in turn is a prerequisite for extending the degree of accuracy and reliability of interpreting fossil assemblages and paleoenvironments in deep sea sediments.

SUPPORTED BY U.S. National Science Foundation

5.0998, GRANT FOR RESEARCH IN ISOLATION OF MARINE PROTEINS
O. ROELS, Columbia University, Graduate School, New York, New York 10027

NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY John J. Ryan & Sons Incorporated

5.0999, INTERACTION OF PROTEINS WITH METAL AND HYDROGEN IONS
E.M. BRESLOW, Cornell University, School of Medicine, New York, New York

Studies of cupric and zinc ion - binding to ribonuclease will be continued to elucidate the mechanism by which ribonuclease is inhibited by these ions. Particular emphasis will be given to the application of gel-filtration chromatography to determine binding constants and to study of the interactions of nucleotides and metal ions upon binding to ribonuclease. Studies of the protein neurophysin will continue with the aim of developing new purification procedures and of characterizing in greater detail the interactions of neurophysin with oxytocin and vasopressin.

Myoglobin investigations will emphasize further studies of the conformational relationships between myoglobin and apomyoglobin, and the mechanism of propotophylin-sensitized apomyoglobin photooxidation.

SUPPORTED BY U.S. Dept. of Hth. Ed. & Wel. - P.H.S.

5.1000, A HISTOCHEMICAL STUDY OF THE CENTRAL NERVOUS SYSTEM OF LIMULUS POLYPHEMUS
R. VONBURG, Fordham University, Graduate School, New York, New York 10458

Acetylcholine has been implicated as a transmitter in the neural ganglion and the use of new purification procedures and of characterizing in greater detail the interactions of neurophysin with oxytocin and Vasopressin. It has also been demonstrated that it enalances the firing rate of the abdominal ganglion (Von Burg, and Corning, 1968), after ectopic application. Histochcmical studies are underway that will attempt to localize themainesterase activity in the central nervous system of adult organisms.

SUPPORTED BY Fordham University

5.1001, NUTRITIONAL STUDIES ON MARINE ORGANISMS
L. PROVASONI, Haskins Laboratories Inc., New York, New York

5. LIVING SYSTEMS (NON-HUMAN)

This grant continues support of a long-range examination of the fundamental nutritional aspects of marine ecology, such as the nutritional relationships between the organisms and the chemical environment, and the relationships between organisms. The results of these studies have revolutionized our thinking on the trophic relationships of phytoplankton.

The project will now be extended into three new phases which, nevertheless, represent a continuation and development of this program. Each is an attempt to apply new technological thought and methods to outstanding problems in marine ecology. The specific goals are concerned with neglected ecological and practical problems. The role of light in the production of nutrients other than carbohydrates is to be investigated.

The second phase will involve the examination of metabolites as morphogenetic factors for seaweeds in order to obtain information which will lead to successful cultivation of these marine plants. Finally, the nutrition of marine crustaceans is to receive attention.

The search for methods to create micron-sized particles as nutrients as the microorganism comprising the normal food of the filter feeders will be continued. Since phagotrophy is common in invertebrates, such a technical advance would be widely useful in the laboratory culture of marine invertebrates.

SUPPORTED BY U.S. National Science Foundation

5.1002, EXPERIMENTAL MANIPULATION OF MECHANICAL AND PHYSIOLOGICAL RHYTHMS - A DUAL APPROACH TO THE BIOLOGICAL CLOCK PROBLEM
J.D. PALMER, New York University, Graduate School, New York, New York 10003

The circadian activity rhythms of several species of passerine birds and the tidal activity rhythm of the fiddler crab (Uca) will be studied under a variety of photo- and thermoperiods, under constant conditions, and under thermal stress in an attempt to discover new properties of these rhythms. Secondly, the photosynthetic rhythm of the very large, single-celled algae, Acetabularia, will be studied (polarographically) in a variety of experimental conditions. These cells can be easily enucleated so that the various roles of the nucleus and the cytoplasm in biological rhythms can be ascertained.

SUPPORTED BY U.S. National Science Foundation

5.1003, CHEMISTRY AND FUNCTION OF BRAIN PLASMALOGENS
M.M. RAPPORT, Yeshiva University, School of Medicine, New York, New York 10033

The chemistry and biochemistry of plasmalogenes are under study. Thu organic chemistry of alpha, beta-unsaturated ethers is being examined in relation to possible functions of this type of lipid in mammalian and marine animal tissues. Enzymic as well as chemical characterizations of the phospholipid species (plasmalogenes) serve to distinguish them from the structurally analogous phosphatidyl species (diacyl phosphatides), and further studies of the difference are in progress.

Phosphatidial ethanolamine appears to be a major constituent of the myelin membrane that may have metabolic as well as structural significance. The biochemical relevance of a number of systems is being investigated.

SUPPORTED BY U.S. Dept. of Hth. Ed. & Wel. - P.H.S.

5.1004, CHANGES IN THE LIMITING NUTRIENT DUE TO TEMPORAL, GEOGRAPHIC, AND DEPTH VARIATIONS
G.S. POSNER, City University of New York, Graduate School, New York - City College, New York 10031

Laboratory and field studies of nutrient enrichment are being used to explore the effect of geography, depth in the water column, time and factors associated with time of a non-cyclical nature on nutritional factors controlling phytoplankton abundance in New York and semi-tropical waters.

SUPPORTED BY City University of New York
5. LIVING SYSTEMS (NON-HUMAN)

5.1005, BIOLOGICAL PRODUCTIVITY IN THE SARGASSO SEA, THE GULF STREAM AND IN THE ATLANTIC COASTAL WATERS OFF CAPE HATTERAS
P.R. BURKHOLDER, Columbia University, Graduate School, Palisades, New York 10964

Studies will be conducted to determine seasonal variations in the biological productivity in the U.S. Atlantic Coastal Waters, the Sargasso Sea, the Gulf Stream and the continental slope and shelf between Montauk Point and the Chesapeake Bay. The influence of effluents entering the ocean via the Hudson River and Chesapeake Bay estuaries, on the plankton in the shelf area and in adjacent water masses will be determined. Consideration will be given to possible radionuclide accumulation in plankton and other indicator organisms. Integrated biological studies will include measurements of primary productivity and of the standing crop of plankton and nekton and their chemical composition. Supporting data will be obtained for inorganic and organic nutrients in the water and for light energy available for photosynthesis in the water columns at all stations. By using different types of collecting apparatus and suitable screens for sorting various particle sizes of organisms in the food chain, an attempt will be made to evaluate the biomass of different size classes of organisms which contribute to the total biomass. These materials will also serve for the biochemical study of protein metabolism at different trophic levels in the sea, with particular reference to the sequences leading from phytoplankton to crustaceans to important species of fish. The data will be compared to that obtained during 1966-1967 in the coastal area off Cape Hatteras, Gulf Stream and Sargasso Sea.


SUPPORTED BY U.S. Atomic Energy Commission

5.1006, VITAMIN A AND PROTEIN METABOLISM
O.A. ROELS, Columbia University, Graduate School, Palisades, New York 10964

It is the purpose of the present investigation to determine the metabolic function of vitamin A outside the visual cycle. Vitamin A is essential for growth and growth is specifically related to protein synthesis. Previous studies in our laboratory have indicated a close relationship between peptide synthesis and vitamin A status. Increasing the level of intracellular retinol appears to be governed by the vitamin A status of the animal. The size of the intracellular amino acid pools may be governed by protein synthesis or catabolism or by the transport mechanisms of amino acids or peptides across the cell membrane. Effect of retinol and its derivatives, of alpha tocopherol and of the coenzyme Q group of compounds on the structure and function of biological membranes is therefore under intensive investigation. Various model systems are being utilized in this study: lipid monolayers - lipid bilayers - cells and subcellular organelles of protozoan (Ochromonas muhalisensis)

SUPPORTED BY U.S. Dept. of Hith. Ed. & Wel. - P.H.S.

5.1007, EFFECT OF LIPIDS ON STABILITY OF BIOLOGICAL MEMBRANES
O.A. ROELS, Columbia University, Graduate School, Palisades, New York 10964

It is the purpose of the present study to determine the effect of retinol, alpha-tocopherol, coenzyme Q and their analogs and metabolites on the stability, the structure and the function of biological membranes. Lysosomes, microsomes and plasma membranes will be isolated by density gradient centrifugation and will be used for further study concerning the effect of certain lipids on membrane stability and function. The relative purity of the centrifuged fractions and the fine structure of the particles and membranes will be investigated by electron microscopy (with zymosan removed by filtration) and biochemical studies of the same preparations. These combined biochemical and electron microscopic studies should clarify the influence of certain lipid factors on the structure and function of biological membranes.

SUPPORTED BY U.S. Dept. of Hith. Ed. & Wel. - P.H.S.

5.1008, MECHANISMS OF CYTOKINESIS IN ANIMAL CELLS
R. RAPPAORT, Union College & University, Graduate School, Schenectady, New York 12308

Division of animal cells is a physical event which can best be analyzed by physical experimentation. Despite early recognition of the importance of cytokinesis in the lives of cells and organisms, available information has been fragmentary and derived from study of a very few forms. In this investigation experimentation will be extended to cell-types not usually used and new experiments will be devised. Several areas of investigation will be pursued. A better understanding of the events which determine where division will take place will help in analysis of the nature of the division process as well as revealing more about the preparatory phase. Once division has begun, it will be possible to subject the source of the required force to biophysical analysis and thus learn more of its constitution.

As circumstances permit, three different cell types will be used for experiments - vertebrate cells in tissue culture, dividing marine invertebrate eggs and dividing amphibian eggs. Investigations will be carried out at the Union College campus and the Mount Desert Island Biological Laboratory.

SUPPORTED BY U.S. National Science Foundation

5.1009, ZOOPHYSIOLOGY OF OCEANIC BENTHIC ANIMALS OFF THE NORTH CAROLINA COAST
F.J. VERNBERG, Duke University, Graduate School, Beaufort, North Carolina 28516

There has been considerable speculation about the factors which influence the zoogeography and speciation of oceanic animals. However, there is limited documentation with observational and experimental data. The oceanic waters off the North Carolina coast are not only rich in fauna as shown by recent ecological studies but also offer markedly different biogeographic regions. In the present study it is proposed to try to characterize the physiological parameters which are operative in two of these biogeographic areas. One of these areas in a submerged reef in the warm waters of the Florida current, the other a cold-water area just north of Cape Hatteras and Diamond Shoals. These physiological studies would include both resistance and capacity adaptations of various stages in the life cycle of the dominant species of both areas. The physiological indications of adaptive responses to the environment to be studied would include reproductive cycles, feeding behavior as influenced by temperature, measurement of various overt function responses and metabolic-temperature curves using animals acclimated to different thermal levels, and osmoregulatory ability at different temperatures.

SUPPORTED BY U.S. National Science Foundation

5.1010, PRODUCITIVITY OF ESTUARINE AND MARINE ECOSYSTEMS (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION)
H.B. WILLIAMS, U.S. Dept. of Interior, Radiobiological Lab., Beaufort, North Carolina 28516

All life ultimately depends on autotrophic organisms. Therefore, knowledge of primary production in estuaries is required for evaluation of their potential to produce commercially important fish and shellfish, and for elucidation of the movement of radionuclides through estuarine food chains into edible species. The primary production of phytoplankton and benthic algae, two groups of autotrophs important in the characteristically shallow southeastern estuaries, is being measured at regular intervals in inshore waters near Beaufort, N. C. Phytoplankton production is estimated by the light and dark bottle technique. Bottles of sea water (with zooplankton removed by filtration) are incubated for 24 hours at several fractions of surface illumination, and changes
in dissolved oxygen are determined by titration. To estimate benthic production, areas of bottom are enclosed (in situ) for 24 hours beneath clear and opaque plastic bell jars, and changes in dissolved oxygen within the jars are obtained by titration of water samples withdrawn from them. In addition, measurements of standing crop accompany the measurements of production.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.1014. SUBCELLULAR REACTION TO INJURY IN THE KIDNEY
B.F. TRUMP, Duke University, School of Medicine, Durham, North Carolina 27706

The principal research objective is the delineation, at the subcellular, supramolecular, and molecular levels, of the response of kidney cells to lethal and sub-lethal injury. The principal emphasis is on the structural and functional modulation of cellular membranes as they relate to modification of energy transduction by these systems. Complementary objectives include an understanding of the ultrastructural characteristics of human renal disease, methods of ultrastructural and cytochemical analysis, and the ultrastructural basis of active transport. Particular attention has been given to the study of systems such as isolated, perfused flounder tubules and to bladder in Ussing chambers, where correlations between alterations of structure and function can be made.

SUPPORTED BY U.S. Dept. of Hith. Ed. & Wel. - P.H.S.

5.1015. MECHANISMS OF CALCIUM CARBONATE DEPOSITION
K.M. WILBUR, Duke University, Graduate School, Durham, North Carolina 27706 (NONR)

The investigator will continue his analysis of physiological and biochemical and crystallographic mechanisms of calcium carbonate deposition in shells and other structures in marine organisms. In particular, during this renewal period, the principal investigator will concentrate on the ultrastructure of the barnacle shell and its relations with the substratum. The calcium deposition process will be studied, in part, radiographically after exposure of the animals to Ca45 in sea water.

One of the goals of the research in this programmatic area of interest is the discovery of vulnerable stages in the life cycles of fouling organisms. Physical or chemical intercession at these stages could provide the means for the prevention of attachment to submerged structures and equipment. Data resulting from this research will help prepare Navy planners for combating fouling, and will furnish information that can be used to reduce the yearly multimillion dollar cost, maintenance, delay, etc., caused by this fouling.

SUPPORTED BY U.S. Dept. of Defense - Navy

5.1016. CALCIFICATION MECHANISMS IN MARINE ORGANISMS
K.M. WILBUR, Duke University, Graduate School, Durham, North Carolina 27706 (NONR)

The general objective of our program is a comparative study of calcification systems in certain marine organisms. It has two major phases. The first is a study of the ultrastructure of each system with particular attention to the relationship of crystal formation to cell components and the organic matrix. The second phase concerns physiological aspects of calcification with emphasis on conditions which favor and inhibit calcification.

The studies are being carried out on the following: 1. Amino acid analysis of organic matrix in mollusc shells 2. Analysis of extrapallial fluid of molluscs 3. Intracellular localization and transport of calcium by marine algae 4. Experimental studies of nucleation and crystal growth in the organic matrix of marine algae.

SUPPORTED BY U.S. Dept. of Hith. Ed. & Wel. - P.H.S.

5.1017. PRODUCTIVITY STUDIES IN NORTH CAROLINA SALT MARSHES
A.W. COOPER, Univ. of North Carolina, School of Agriculture, Raleigh, North Carolina 27600

This research will study primary productivity in North Carolina salt marshes. Studies in other areas have shown that salt marshes are among our most productive natural communities. Salt marshes fix large quantities of solar energy and perhaps as much as half is washed out by the tide into estuarine waters and forms a major source of food for commercial and sport fisheries which inhabit estuaries during some point in their life cycle. Despite their obvious importance, salt marshes are sub-

237
5. LIVING SYSTEMS (NON-HUMAN)

ject to great destructive pressures by man. There have been no studies of productivity in North Carolina and such studies are needed to enable the State to develop better policies with respect to its management of these lands and associated waters.

Initial field work will obtain data needed for a final classification of community types in North Carolina salt marshes. The distribution of these types will then be mapped from aerial photographs and the total acreage of each type determined. Detailed studies will then be made of primary productivity within each type. Clip-samples will be used first, but it is hoped that these will be supplemented by refined data using techniques such as gas analysis so that estimates can be made not only of net productivity but also of gross productivity. From these data and the distribution data estimates of total productivity of each type on the entire coast will be made.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rch
North Carolina: State University

5.1018, CONDUCTION AND INTEGRATION
R.K. JOSEPHSON, Case Western Reserve Univ., Graduate School, Cleveland, Ohio 44106

Work in this laboratory is directed toward an understanding of physiological mechanisms controlling behavior in lower animals. Specific projects planned include (1) a comparative study of pacemaker systems and conducting systems in hydrozoan polyps, (2) a study of the properties of electrically active epithelia in Hydra, and (3) an investigation of the neural control of sound production and of rapidly contracting muscles used in singing by the katydid Neoconocephalus robustus.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.1019, PRODUCTIVITY OF OCEANIC POPULATIONS OF VERTICALLY MIGRATING ANIMALS
W.G. PEARCY, Oregon State University, Graduate School, Corvallis, Oregon 97331

Project Description: Collections obtained with meter plankton nets and midwater trawls will provide data on the number and biomass of common species of vertically migrating animals off Oregon. Changes in size frequency distributions of species will be used to estimate growth rates. With periodic estimates of growth and population size, net production will be calculated. Seasonal and inshore-offshore variations in numbers and population size structures will also be studied, particularly in regions influenced by upwelling.

SUPPORTED BY U.S. National Science Foundation

5.1020, ENERGY TRANSFER IN LOWER MARINE TROPICL LEVELS
L.F. SMALL, Oregon State University, Graduate School, Corvallis, Oregon 97331

We are obtaining estimates of energy flow in significant second trophic level grazing organisms in the pelagic marine environment. Currently we are employing respiration and growth measurements, and ingestion-ejection measurements, and propose to compute carbon budgets. Effects of temperature, light, pressure, food types and concentrations, and grazer concentrations are being investigated. Extrapolations of physiological data in the laboratory to conditions in the sea are to be attempted, to assess relative importance of various organisms in the energetics of the pelagic biota.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.1021, POPULATION STUDIES ON INTERTIDAL INVERTEBRATES
P.W. FRANK, Univ. of Oregon, Graduate School, Eugene, Oregon 97403

Using recently developed techniques of marking, the investigator is determining longevity and growth rate of a number of gastropod mollusks, and of several species of echinoderms (Asturoidea). Growth of all sizes is observed for at least a 1-year period. Work is being done at the Great Barrier Reef Committee Research Station at Heron Island, Queensland, Australia, and along the Oregon coast.

The main information to be gained concerns 1) whether longevity on a tropical reef is relatively high--as is to be expected from arguments about stability of the fauna; 2) the extent to which data gathered on size distributions may be of value in making predictions about longevity. Comparisons will be made between different species, and between different populations of the same species. Specific organisms concerned, for the Barrier Reef: Nerita albicilla, Trochus pyramidalis, Conomurex luhuanus, Monetaria annulus, Conus flavus and Conus spp.; For the Oregon coast: Tegula funebralis, Searlesia dira.

SUPPORTED BY U.S. National Science Foundation

5.1022, COMPARATIVE STUDY OF NITROGEN SECRETION IN FISHES
R.W. MORRIS, Univ. of Oregon, Graduate School, Eugene, Oregon 97403

The investigator plans to investigate some aspects of nitrogen secretion in fishes, specifically the possibility of metabolic origins of at least some of the nitrogen found in the gas bladders of certain bony fishes.

Comparative studies will be run on anadromous species, freshwater fishes from freshwater ancestry, marine fishes of recent freshwater ancestry, freshwater fishes of marine ancestry, and marine fishes of marine ancestry. Gas will be removed from the gas bladders of the fishes, fishes will be denied access to molecular nitrogen during regeneration of its contents by being kept in an atmosphere of commercial oxygen (less than 1.0% N2). These will be run with suitable controls for varying periods of time.

SUPPORTED BY U.S. National Science Foundation

5.1023, NEUROSECRETION AND ENDOCRINE PHYSIOLOGY
L.H. KLEINHOLZ, Reed College, Graduate School, Portland, Oregon 97202

The proposed work continues studies with the physiological and chemical characterization of four neurosecretory hormones of the crustacean eyestalk: the retinal pigment hormone, a family of chromatophorotropins, and the diabetogenic hormone. The basic physiological and bioassay methods have already been established. The major portion of current and future work deals with purification of the separate hormones, determination of their physiological specificities. It is expected that amino acid compositions of these will be determined, and hopefully, that sequence studies will be made on the purified peptide hormones.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

5.1024, NUCLEIC ACID AND PROTEIN SYNTHESIS DURING OOGENESIS
M.J. ALLEN, BAY, MINDORO, PHILIPPINES

The transcription and translation of genetic information during oogenesis and early development in spiralin eggs, specifically those of the polychaetous annelids (Antolytus and Chactopterus) and those of the gastropod mollusc Byammana, are being studied. This study involves exposure of developing eggs and embryonic stages to the radioactive precursors of nucleic acids and proteins in conjunction with actinomycin D and puromycin. The chief aims (besides continuing the radioautographic studies of Antolytus eggs) are: 1) to extend to annelid eggs biochemical studies similar to those on Ilyanassa and sea urchin eggs, and 2) to detect differential gene activity in spiralin eggs (specifically those of the gastropod Ilyanassa) by radioautography; in effect, to make a biochemical cell lineage study on these eggs.

SUPPORTED BY U.S. National Science Foundation

5.1025, PRIMARY PRODUCTIVITY IN PUERTO GALERA BAY, MINDORO, PHILIPPINES
A.A. DELACRUZ, Univ. of The Philippines, Manila, Philippines

NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE
SUPPORTED BY Society of The Sigma Xi

5.1026, CHEMICAL RESPONSES BY MARINE ORGANISMS TO STRESS
H.P. JEFFRIES, Univ. of Rhode Island, Graduate School, Kingston, Rhode Island 02881

The ocean is physically stable compared with land and freshwater environments, and the medium has intimate association with the life it bathes. Consequently marine organisms have developed less complex regulatory systems than their terrestrial and aquatic counterparts. But when the ocean does change—by natural processes or as the result of pollution—it follows that the biotic community will also change, along with the ecosystem's ability to process waste materials. Homeostatic control at the community level is, therefore, an essential element in understanding the sea's populations, especially in coastal waters where environmental oscillations are large.

The major goal of this investigation is to identify and measure quantitatively the ways marine communities respond to ecological stress. The internal responses are measured in terms of homeostasis; the external stresses result from temperature, salinity, competition, food and pollution.

The first phase of this investigation showed that the balances of free amino acids, fatty acids and blood constituents are sensitive indicators of environmental conditions. Relationships observed in nature between external stress and internal composition are now being analyzed in the laboratory. In addition, the genetic determinants of chemical specificity will be separated from environmental influences in copepods, mollusks and fishes.

When we know the minimum stress intensities and corresponding maximum internal tolerances within which normal community composition and function are maintained, we should be able to predict the fate of populations living under various conditions of water quality.

SUPPORTED BY U.S. Dept. of I - prior - F. Water Pol. Ctl

5.1027, TROPHIC RELATIONSHIPS IN SHOAL BENTHIC ENVIRONMENTS
N. MARSHALL, Univ. of Rhode Island, Graduate School, Kingston, Rhode Island 02881

Shoal benthic environments in the estuaries of the southern New England coast are very productive in the natural state. Trophic relationships in these habitats are being pieced together through studies of producer and consumer groups. Since little is known of the organic matter contribution by the benthic microflora and fauna populations of the Antarctic Ocean to determine: A. The effect of temperature on the lipid composition of phytoplankton, zooplankton and fish. B. The influence of temperature on polyunsaturated fatty acid metabolism of marine organisms. C. The changes in the triglyceride and phospholipid (Polar lipid) structure and fatty acid composition of marine oils as they pass through the entire food chain, including whales. D. The relation of kinds and amounts of marine water lipids with plankton production in Antarctic and Gulf of Mexico waters.

SUPPORTED BY U.S. National Science Foundation

5.1028, AGE DETERMINATION OF LARGE ATLANTIC SHARKS
J.G. CASEY, U.S. Dept. of Interior, Marine Game Fish Research Lab., Narragansett, Rhode Island 02882

Sample sharks from southern New England to North Carolina. Collect vertebrae that represent full ranges of sizes, section vertebrae to treat for microscopic examination; interpret year marks using standard techniques of age determination; prepare growth curves for Careharhinus milberti, C. obscurus, Carcharias taurus, Carcharodon carcharias, Prionace glauca, and Spymena zygaena.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

5.1029, LIPASE RESISTANT GLYCERIDES
N.R. BOTTINO, Texas A & M University System, School of Agriculture, College Station, Texas 77843

The long-chain highly unsaturated fatty acids typical of aquatic animal lipids, (eicosapentaenoic, docosapentaenoic, and docosahexaenoic acids) are known to be located preferentially in the 2-position of the glycerides of marine crustacea and fish. On the other hand, these acids are located in the extrem e positions of whale oil triglycerides. The reasons and mechanism for the change in position are being investigated by feeding whale oil, fish oil, and shrimp to pigs. It is expected that the pig, whose triglycerides, like those of the whale, possess higher unsaturation in the extreme than in the middle positions, will distribute the long-chained highly unsaturated fatty acids in a manner similar to that of the whale. As a control, groups of rats which have the 'normal' predominance of unsaturation in the middle position of their triglycerides will also be fed whale oil and fish oil, separately.

SUPPORTED BY U.S. Dept. of Hith. Ed. & Wel. - P.H.S.

5.1030, BIOLOGICAL PRODUCTIVITY INVESTIGATIONS OF THE WATERS SURROUNDING ANTARCTICA
S.Z. ELSAYED, Texas A & M University System, Graduate School, College Station, Texas 77843

This amendment to Texas A&M Research Foundation proposes participation in the Weddell Sea Expedition during autumn 1967-68 to investigate the biological productivity of the Weddell Sea with emphasis on factors governing organic production for comparison with other Antarctic regions. The objectives are: (1) to estimate standing crop of phytoplankton in euphotic zone; (2) to measure primary productivity by C14 uptake method (3) measure light transmission and solar radiation; (4) study concentration of nutrient elements; (5) study condensation of soluble and particulate organic carbon; and (6) obtain plankton samples. This participation represents an extension of shipboard work on USNS Eltanin in South Pacific under GA-915 and will utilize existing supplies and equipment essential for the additional work, with the personnel accommodation provided by this amendment.

Equipment and supplies for the work aboard USCGC Glacier will be provided by USARP. The principal investigator will be assisted on shipboard by two assistants from Texas A&M Research Foundation and one technician from the USCGC Glacier.

SUPPORTED BY U.S. National Science Foundation

5.1031, LIPID COMPOSITION OF ANTARCTIC MARINE ORGANISMS AND SEA WATER
L.M. JEFFREY, Texas A & M University System, Graduate School, College Station, Texas 77843

The objectives of the research are to utilize the low temperature flora and fauna populations of the Antarctic Ocean to determine: A. The effect of temperature on the lipid composition of phytoplankton, zooplankton and fish. B. The influence of temperature on polyunsaturated fatty acid metabolism of marine organisms. C. The changes in the triglyceride and phospholipid (Polar lipids) structure and fatty acid composition of marine oils as they pass through the entire food chain, including whales. D. The relation of kinds and amounts of marine water lipids with plankton production in Antarctic and Gulf of Mexico waters.

SUPPORTED BY U.S. National Science Foundation

5.1032, ORGANIC PRODUCTION OF EPIFAUNAL ORGANISMS
W.E. PEQUEGNAT, Texas A & M University System, Graduate Scho +, College Station, Texas 77843

Research will be continued on the energy budget of the biomass of rock-reefs of the sublittoral zone. Growth rates of the living population will be studied, primary production of the area will be determined, the concentrations of soluble and particulate organic carbon in the ambient water will be measured; from these and supplemental data, on local currents and associated hydrographic information, calculations will be made with regard to the amount of energy required to support an incomplete ecosystem of this kind.

Possibilities in control of, protection against, and utilization of biological material and activity are also considered in this program. Information resulting from this research will be particularly useful in the prediction of the type and distribution of organisms which cause or affect fouling and deterioration of submerged equipment and structure.

SUPPORTED BY U.S. Dept. of Defense - Navy

239
5. LIVING SYSTEMS (NON-HUMAN)

5.1033, CARBON DIOXIDE FIXATION IN HETEROTROPHIC ORGANISMS. III THE BREAKDOWN OF GLYCOGEN IN MARINE INVERTEBRATES

J. AWAPARA, Rice University, Graduate School, Houston, Texas 77001

Our previous work has established that a large number of marine invertebrates degrade glycogen to yield products not commonly observed in other animals. Of these products, succinic acid appears in abundance. In order to account for the formation of one molecule of succinic acid from one molecule of glucose carbon; three of the six glucose carbons flow into succinic acid, a process which requires two reductive steps. The two reductions are balanced by the oxidation of two molecules of glyceraldehyde phosphate during glycolysis. The other three carbons undergo reactions to produce alanine. None of the reactions involve oxidoreductions.

All the above expectations have been realized and proven by a series of experiments. The ratio of alanine to succinic acid formed from glucose was found to be one in every instance.

In sum: many marine invertebrates degrade glycose as follows: (Step 1) Glucose reacts to form 2 phosphoenolpyruvic acid (PEP). (Step 2) PEP reacts to form pyruvic acid, which reacts (Step 3) to form alanine (Step 4) PEP reacts to form oxaloacetic acid which reacts (Step 5) to form malic acid which, in turn, reduces (Step 6) to form fumaric acid, forming (Step 7) succinic acid. Two molecules of coenzyme are reduced in (1); the two molecules of reduced coenzyme serve as the reducing agent in steps (5) and (7). Although the pathway of glucose breakdown has been elucidated in general terms, there remain some difficult questions to be answered. For example, how is fumaric acid reduced to succinic acid when oxygen is present. Under these conditions it is unlikely that the reaction is the reverse reaction of the oxidation of succinic acid by the mitochondrial succinic dehydrogenase.

We are now studying the reduction of fumaric acid in marine organisms in the presence of oxygen.

SUPPORTED BY Robert A. Welch Foundation

5.1034, PRESENCE OF ENZYMES RELATED TO DNA SYNTHESIS IN EGGS OF ECHINODERMS

R.E. BLACK, Coll. of William & Mary, Graduate School, Williamsburg, Virginia 23185

BRIEF DESCRIPTION OF RESEARCH PROJECT:
Research on protein synthesis during sea urchin development is underway to determine which enzymes related to DNA synthesis are present in the cytoplasm and which enzymes must be synthesized. The enzymes concerned in the experiments are the deoxyribonucleotide kinases and DNA polymerase.

The enzymes will be studied in preparations of nucleate and enucleate sea urchin eggs. Preparations of unfertilized eggs of various species will be evaluated under exposure to puromycin to determine whether the enzymes are stored in the nucleus or cytoplasm or both, are found in sperm nuclei, and/or are synthesized during each cleavage division.

SUPPORTED BY U.S. National Science Foundation

5.1035, BIOCHEMISTRY OF FISH MUSCLE AND QUALITY CHANGES

H.S. GRONINGER, U.S. Dept. of Interior, Technology Laboratory, Seattle, Washington

Many of the biochemical reactions that occur in post-mortem fish muscle affect the flavor and textural quality of the muscle. Some of the enzyme catalyzed degradations of nucleotides and nucleosides appear to be important quality changes.

The objectives of this work are (1) to study some of the nucleotide and nucleoside degradations in fish muscle, and (2) to study potential methods of controlling these reactions.

Results: The dephosphorylation rate of inosinic acid (IMP) was found to vary over a fairly wide range in the muscle from different species of fish. There was some difference in the stability of the enzymes from different species. It was found that the dephosphorylation of IMP could be inhibited in certain species by treatment of the muscle with ethylendiamine tetraacetic acid. In substrate specificity studies it was shown that the dephosphorylation activity can be attributed mainly to the nucleotidase enzyme. The nucleotidase activity is found mainly in the micromolar fraction after centrifugation of muscle extracts.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

5.1036, MEASUREMENTS OF OXYGEN CONSUMPTION BY THE SEA BED IN DEEP WATER OF PUGET SOUND

K. BANSE, Univ. of Washington, Graduate School, Seattle, Washington 98122

Instrumentation to push light and dark bell-jars into the sediment under TV control will be used to measure the in situ oxygen consumption of the level sea bed in Puget Sound to 200 m depth. Oxygen electrodes and telemetry will be employed. Eight stations on which the infauna is well known will be visited quarterly for one year. The oxygen consumption in cores will be studied at the same time. The fraction, due to the macrofauna of the total oxygen consumption of the bottom will be estimated. In shallow water, oxygen production from microscopic benthic algae will also be measured.

SUPPORTED BY U.S. National Science Foundation

5.1037, CYTOPLASMIC FILAMENTS AND CELL MOVEMENT IN DEVELOPMENT

R.A. CLONEY, Univ. of Washington, Graduate School, Seattle, Washington 98122

Brief Description of Research Project: The development of any metazoan is characterized by a complex series of cellular movements leading to increased cellular interaction, functional specialization and structural complexity. A theory of development depends, in part, on an understanding of cellular kinetic mechanisms and their regulation and control in ontogeny.

Ultrastructural studies revealed oriented filaments and microtubules in cytoplasm fixed in a phase of movement. Experiments are performed with ascidians (tunicates) where contraction of the caudal epidermis during metamorphosis is accompanied by extensive and rapid alignment of filaments in the axis of shortening. The epidermis contracts to 1/20 of rest length in only six minutes. Data obtained from time lapse cinematography, electron microscopy and a variety of experimental methods support the hypothesis that the filaments are contractile elements.

Work is continuing to determine to what extent the contractile mechanism in the caudal epidermal cells of the ascidians is related to contractile mechanisms in other cells (such as muscle and fibroblasts) in terms of structural and physiological properties. The development of birefringence in the epidermal cells of the ascidians is related to the organization of filaments observed in ultrastructural studies of fixed tissues will be correlated.

SUPPORTED BY U.S. National Science Foundation

5.1038, BIOLOGICAL OCEANOGRAPHY

T.S. ENGLISH, Univ. of Washington, Graduate School, Seattle, Washington 98122

The broad objective is to determine the daily and seasonal distribution of phytoplankton, zooplankton and organic detritus in a typical water column beneath the ice and to measure the annual biological productivity. Aspects of the community are placed upon quantity of light at various depths and to the transfer of radiant to chemical energy by phytoplankton populations whose abundance is measured by analysis of the concentration of chlorophyll a. Production is measured by carbon-14 techniques and energy transfer is followed through the food chain from producers through the several trophic levels of consumer populations.

Distribution, kinds, numbers and behavior of planktonic organisms and detritus contribute to knowledge of the total environment of Arctic.

SUPPORTED BY U.S. Dept. of Defense - Navy

240
5.1039, THE EFFECTS OF SEAL AND FISH PREDATION ON CERTAIN ANANTARCTIC BENTHIC COMMUNITIES R.T. Paine, Univ. of Washington, Graduate School, Seattle, Washington 98122

The additional funds for GA-1187 will permit complementary work on the research of trophic stratification within shallow water communities. This will consist of (1) collection of sediment samples with a piston corer adjacent to the established experimental, exclusion cages and (2) quantitative enumeration of bacteria present. A second addition to the original proposal is measuring the respiratory (maintenance) cost of the dominant benthos to permit ecologically more dynamic standing crop measures for information on decomposers active in the Antarctic marine communities. This will be conducted by the principal investigator. For the purposes of the additional field objectives and to provide necessary assistance in the planned scuba work, two more graduate assistants are included under the supplement.

The field work will be conducted at McMurdo Station, principally during the austral summer by four scuba graduate assistants. The principal investigator will be at the Bio Lab one month. Plans for early winter participation are under consideration.

SUPPORTED BY U.S. National Science Foundation

5.1040, STUDIES ON GAMETOGENESIS IN HYDROMEDUSAE E.C. Roosenrunge, Univ. of Washington, School of Medicine, Seattle, Washington 98122

A detailed and, as far as possible, a quantitative exploration of the sequence of events in the regeneration of gonads after castration is to be carried out in Philadelphia by means of observations on the living, histology, and electron microscopy. The source and mode of proliferation of germ cells is to be investigated by labelling with thymidine-H3. External factors which stimulate or inhibit regeneration of ovaries or testes are to be explored. Steroidal hormones are of most immediate interest. In addition, the role of the gastrodermis and the influence of gonadal tissues on gonadal regeneration will be studied.

SUPPORTED BY U.S. National Science Foundation

6. PUBLIC HEALTH AND SAFETY

6A. FOOD AND FOOD SANITATION

(FLSH Protein Concentrate; Seafood Processing and Marketing; Irradiation.)

6.0001. BOTTOM FISH, FISH WASTE, SCRAP FISH & OTHER SEA PRODUCTS FOR FUR ANIMAL DIETS J.R. Leekley, Univ. of Alaska, Agricultural Experiment Sta., College, Alaska 99701

Object: To determine the relative feeding value to fur-bearing animals of ocean and fresh water fish, fish products now being discarded by canneries and cold storage plants, sea mammals that are harmful to commercial fisheries in Alaska, scrap fish available in the Great Lakes region, and other products which have no market for human consumption.

Plan of work: Feeding tests at Petersburg will be made on various types of fish, fish waste products and sea mammals singly and in combination. Special consideration will be given to compounded satisfactory feed mixtures and to nutritional characteristics of diets made of readily available Alaska feed ingredients. Chemical analyses will be run as necessary. Rates of growth and complete breeding and reproduction records will be kept on animals receiving test diets. Various vitamins, antibiotics, antioxidants, and other supplements and preservatives will be tested as to desirability and level of feeding, with emphasis on further comparison of the relative value of phenolic antioxidants and to tocopherols in control of yellow fat disease, and on the value of certain dietary iron compounds in prevention of cotton-pelt disease. Work at Juneau will be continued on the use of trawler chubs and alewives (Great Lakes fish species) in diets for mink.

SUPPORTED BY U.S. Dept. of Agriculture

6.0002. PROCESSING ALASKA SHRIMP J. Collins, U.S. Dept. of Interior, Technological Laboratory, Ketchikan, Alaska

This research involves a general study of the processing of pink shrimp. Specifically, we plan to modify existing methods or develop new ones to improve quality and develop new products.

Immediate improvements in quality can be made by developing an alternate method to the ice-holding method currently used to prepare shrimp for mechanical peeling. A pre-cooking technique that is being developed as an alternate to ice-holding results in much better quality and suggests end products other than canned. Accordingly, methods are being studied to produce a machine-peeled frozen cocktail style pack to replace the scarce and costly hand-peeled product.

Since the red color of the shrimp is an important factor of quality, current studies are concerned with the stability of the carotenoid pigments during peeling and other operations in the canning process. Conditions of retorting (time and temperature) are being studied. The use of the various additives to stabilize the carotenoids during frozen storage of machine-peeled, blanked, frozen shrimp are being studied.

The program is a continuing one and future projected work will include vessel unit handling and delivering systems, and demonstrations of the need for developing heading and sorting equipment.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0003. PROCESSING KING CRAB R.D. Tenney, U.S. Dept. of Interior, Technological Laboratory, Ketchikan, Alaska

This project is designed to improve quality and increase value of king crab seafood products by improving canning methods by increasing natural moisture retention, by adopting new freezing methods, and by combing raw freezing with satisfactory thawing and shocking variables. Additionally, to fabricate by-products of king crab waste to provide a useful product from large amounts of costly material which is presently discarded to form a pollution problem.

Work is being done on the use of polyphosphates as additives for control of moisture retention and reduction of canning defects such as sulfide blackening and struvite. This approach is now nearing completion.

There is a need for freezing methods that are more efficient and more amenable to use aboard vessels and ashore. Studies on brine freezing of cooked crab have been initiated and will be followed by storage studies with chemical and organoleptical testing of brine frozen product over a time temperature cycle.

In combination with the brine-freezing studies on cooked crab, studies on both brine-freezing and blast-freezing of raw crab will be made. Experimentation of thawing, cooking and extraction of meats through manipulation of these variables will follow to determine an efficient method of processing raw frozen crab.

Additional studies on preserved crab meat processed from crab waste are in progress in conjunction with other laboratories. These studies include mink and chick-feeding experiments using crab meal as a source of protein.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0004. CONSUMER EVALUATION OF FISH PRODUCTS W.R. Morrison, Univ. of Arkansas, Agricultural Experiment Sta., Fayetteville, Arkansas 72701

The objectives are (1) to investigate the influence of socio-economic characteristics of the population on consumer evaluation of smoked buffalo fish ribs, breaded scored fillets; and other products prepared from farm produced fish, (2) to evaluate consumer conceptual image of the products, reaction to product characteristics such as appearance, flavor, aroma, texture, etc., and reasons for these reactions, (3) to estimate market potentials and competitive position of these products.

Description of work - The first phase of the study will be conducted in Memphis, Tenn., with Census Tracts comprising the sampling unit. City blocks will be randomly selected from the census tracts with the number of blocks selected in each tract depending upon the population characteristics within the tract. Households will be randomly selected within city blocks. For
6. PUBLIC HEALTH AND SAFETY

cooperating households an enumerator will fill out a family 
questionnaire and will give the homemaker the test item along 
with special instructions and an evaluation schedule on which the 
adult members of the household will list their separate evaluations 
of the test product.

If acceptance of the test items by consumers appears likely, 
further market testing may be desirable. Experimental procedure 
for this phase of the study would depend upon the kind of 
economic information needed. Appropriate analytical techniques 
for studying consumer acceptance would be used in any further 
testing.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - F.D.A.

6.0005. PROGRAM PROJECT - FOOD MICROBIOLOGY 

G.F. STEWART, Univ. of California, School of Agriculture, 
Davis, California 95616

Research on food-borne infections and intoxications, espe-
cially those caused by the Salmonella and Clostridia.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

6.0006. THERMAL DESTRUCTION OF TYPE E CLO-
STRIDIUM BOTULINUM 

C.W. BOHRER, Natl. Canners Association, Washington, District of 
Columbia

The characterization and definition of the heat resistance of 
Clostridium botulinum type E is foods forms the foundation of 
this project. The interlocking effects of spore production medi-
um, recovery medium for heat injured cells, and heating substrate 
on resulting resistance found in the initial years of this grant will 
be expanded. The effects of water activity on outgrowth of spores 
will be studied both as to optimum growth and limits for out-
growth. In addition, the heat inactivation of the type E toxin will 
be defined. Knowledge on all of these factors are of extreme im-
portance to food processors, food handlers, and public health of-

cials for use in preventing outbreaks of type E botulism.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

6.0007. DIMETHYLNITROSAMINE IN CURED, SMOKE-
D WHITE FISH AND FLOUR BLEACHED WITH OXIDES OF 
NITROGEN 

C.J. BARNES, U.S. Dept. of Hlth. Ed. & Wel. , F.D.A. Div. of Food 
Chem., Washington, District of Columbia 20204

To determine the amount of dimethylnitrosamine in cured, 
smoked whitefish following treatment with sodium nitrate, and in 
flour following treatment with oxides of nitrogen.

To determine ethylene dichloride at 5 ppm in whole fish 
protein concentrate.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - F.D.A.

6.0008. RADIOCHEMICAL TECHNIQUES 

M.K. ELLIS, U.S. Dept. of Hlth. Ed. & Wel. , F.D.A. Div. of Food 
Chem., Washington, District of Columbia 20204

Purpose: To improve, develop, and/or apply radio-chemical 
techniques for the determination of radionuclides in foods and to 
promote and/or assist in the utilization of such techniques and 
Drug Administration research projects and regulatory problems.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - F.D.A.

6.0009. TOXIC IMPURITIES IN MARINE PROTEIN 
CONCENTRATE 

T. FAZIO, U.S. Dept. of Hlth. Ed. & Wel. , F.D.A. Div. of Food 
Chem., Washington, District of Columbia 20204

To develop qualitative and quantitative methods for the 
isoaltion and determination of toxic impurities and their altera-
tion products in marine protein concentrates.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - F.D.A.

6.0010. BACTERIOLOGICAL SURVEYS FOR MICROBI-
AL STANDARDS FOR FOOD 

F.A. PHILLIPS, U.S. Dept. of Hlth. Ed. & Wel. , F.D.A. Div. of 
Microbiol., Washington, District of Columbia 20204

To compare inspectional and analytical results of good and 
poor manufacturing operations in order to develop microbiologi-
ical standards for coliforms, E. coli, coagular-positive Staphylococcus and aerobic plate counts for several classes of 
food products.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - F.D.A.

6.0011. INVESTIGATION OF DECOMPOSITION IN 
SHRIMP 

B.S. RICHARDS, U.S. Dept. of Hlth. Ed. & Wel. , F.D.A. Div. of 
Food Chem., Washington, District of Columbia 20204

Purpose: To find a substance or substances indicative of 

decomposition in shrimp and to devise a method for its deter-
mination.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - F.D.A.

6.0012. INVESTIGATION OF THE PRESERVATION OF 
FOODS BY FREEZE DRYING 

B.S. RICHARDS, U.S. Dept. of Hlth. Ed. & Wel. , F.D.A. Div. of 
Food Chem., Washington, District of Columbia 20204

To determine the effects of freeze drying on sensory, chemi-
cal, and physical measurements of decay. Develop chemical in-
dices of decomposition applicable to freeze-dried foods.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - F.D.A.

6.0013. CHARACTERISTICS OF CANNED SALMON 

G. THOMPSON, U.S. Dept. of Hlth. Ed. & Wel. , F.D.A. Div. of 
Food Chem., Washington, District of Columbia 20204

To accumulate information on the characteristics and fill of 
container of canned salmon involving the five species of Pacific 
salmon for use in proposing standards for canned salmon.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - F.D.A.

6.0014. ELECTROPHORETIC PROFILES FOR THE 
IDENTIFICATION OF FISH SPECIES 

R.R. THOMPSON, U.S. Dept. of Hlth. Ed. & Wel. , F.D.A. Div. of 
Food Chem., Washington, District of Columbia 20204

To develop a catalog of electrophoretic protein band pat-
tterns for various fish species for use in determining when a 
cheaper fish species has been substituted for a more expensive 
one.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - F.D.A.

6.0015. COMPOSITION OF BREADED FISH PRODUCTS 

J.C. WERREN, U.S. Dept. of Hlth. Ed. & Wel. , F.D.A. Div. of 
Food Chem., Washington, District of Columbia 20204

To accumulate information regarding good manufacturing 
practices on which to base a requirement for fish flesh content 
and the amount of breading material in proposing standards for 
breaded fish products.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - F.D.A.

6.0016. INVESTIGATION OF FOOD PRESERVATION 
METHODS 

G.E. WOOD, U.S. Dept. of Hlth. Ed. & Wel. , F.D.A. Div. of Food 
Chem., Washington, District of Columbia 20204

To develop information regarding the mechanisms of decom-
position and preservation processes. Relate organoleptic, chemi-
cal, physical, and microbiological data on food spoilage.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - F.D.A.

242
6.0017. INOCULATED PACK STUDIES ON LOW-DOSE IRRADIATED MARINE PRODUCTS - SHRIMP  
B.Q. WARD, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124  
The Contractor will conduct research involving irradiation with ionizing radiation at low-dose on marine products, principally inoculated packs of shrimp. This program will investigate outgrowth and toxin production by the organism Clostridium botulinum, Type E, in the low-dose irradiated shrimp following, as a minimum, the protocol established by an AEC Ad Hoc Committee for this type of study. On completion of the studies on shrimp, the program will proceed with similar studies on oysters.  
SUPPORTED BY U.S. Atomic Energy Commission

6.0018. MARKET RESEARCH STUDIES ON THE EFFECTS OF THE FLORIDA MARKETING PROGRAM ON THE SALE OF FLORIDA SEAFOODS  
H.W. SHIELDS, State Board of Conservation, Tallahassee, Florida  
Objective: To determine the degree of effectiveness of the Florida marketing program in increasing the demand for Florida seafoods in retail and institutional markets.  
Procedure: The Florida Board of Conservation has contracted with the University of Florida for a study of the effectiveness of the marketing program. The University of Florida has completed the studies and a report will be submitted during 2-11-1969. Funds will be provided the University of Florida to publish this report.  
SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.  
Florida State Government

6.0019. ANALYSIS OF THE DEMAND FOR RED MEAT, POULTRY, EGGS, SEAFOOD, AND MEAT MIXTURES  
R. RAUNIKAR, Univ. of Georgia, Agricultural Experiment Sta., Athens, Georgia 30602  
(1) To estimate levels and patterns of consumption and expenditures for red meat, poultry, eggs, seafood, and meat mixtures by socio-economic groups of the Atlanta urban population.  
(2) To analyze the effect of income, prices, price relationships, race, occupation, education, household composition, and other socio-economic factors on the consumption of various red meats, poultry, eggs, seafood, and meat mixtures, and to determine the substitution relationships among red meats, poultry, eggs, seafood, and meat mixtures, and between these products and their substitutes.  
Description of Work: Detailed data on quantity, price, expenditure and price of red meat, poultry, eggs, seafood, and meat mixtures will be analyzed for a panel of approximately 300 households in the Atlanta, Georgia, Cross-sectional and time series analyses will be used. The time series analysis will reveal seasonal and cyclic variations in the several food items. Weekly and quarterly summary data will be used to measure the effect on quantity purchases of red meats, poultry, eggs, seafood and meat mixtures resulting from changes over time in prices, income, and price relationships. Substitution relationships will also be analyzed. Work will consist primarily of an analysis of data previously accumulated.  
SUPPORTED BY U.S. Dept. of Agriculture  
Georgia State Government

6.0020. ESTIMATING THE VALUE ADDED TO SEAFOOD PRODUCTS LANDED IN GEORGIA AT THE VARIOUS STAGES OF THE MARKETING CHANNEL  
D.H. CARLEY, State Game & Fish Commission, Atlanta, Georgia  
Objective: To estimate the value added to seafood products landed in Georgia at the various stages of the marketing channel from the primary producer (fishermen) to the consumer.  
Procedure: Prices and/or charges and the amount of each form of seafood product at each stage of the marketing process will be obtained from personal interviews, mail questionnaires, and secondary sources. Quantitative techniques will be used to determine the proportion of the total value of seafood products going to each segment of the industry.  
SUPPORTED BY U.S. Dept. of Agriculture  
Georgia State Government

6.0021. ANALYZING THE FACTORS AFFECTING THE DEMAND FOR SEAFOOD AND TO PROJECT THIS DEMAND TO FUTURE TIME PERIODS  
C.M. FRISBIE, State Game & Fish Commission, Atlanta, Georgia  
Objective: To estimate the demand for seafood and to project these demands to the year 1970.  
Procedures: Secondary data from a consumers panel in Atlanta, Georgia, operated from 1958 through 1962 will be utilized to estimate demand for seafood products. The cross sectional analysis will be used to determine the effects of income, race, household, and composition on purchases of seafood.  
SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.  
Georgia State Government

6.0022. GROWTH CHARACTERISTICS OF TYPE E CLOSTRIDIUM BOTULINUM IN THE TEMPERATURE RANGE 34 TO 50 F.  
A marked extension of the refrigerated storage life of low-dose irradiated fresh marine food products might create a health hazard due to Clo. botulinum Type E, because of its ability to grow at low temperature, the radiation resistance of its spores, and the ubiquity of the organism in marine environments. Studies are in progress to assess the importance of this problem. It is proposed for the contractual year January 15, 1968 through January 14, 1969 that inoculated pack studies be conducted on selected marine products; namely, pickled blue crab, clams, and scallops. The protocol recommended by the Ad Hoc Committee to the AEC on botulism will be followed. The relationship between the earliest time for toxin production and the time for unacceptable recognition of spoilage by the potential consumer will be determined.  
Inoculated pack experiments were conducted on fresh haddock and cod. The results at 46 F and below are quite encouraging. The results at 50 F are somewhat less favorable than at lower temperatures. However, the 50 F results must be considered in view of the rigorous test criterion used in establishing the maximum product storage life estimates, that being unanimous rejection of a sample based solely on odor as judged by an untrained consumer type panel.  
SUPPORTED BY U.S. Atomic Energy Commission

6.0023. ANTIOXIDANT AND NUTRITIONAL POTENTIAL OF FERMENTED AND UNFERMENTED SOYBEANS IN COMBINATION WITH FISH  
L.V. PACKETT, Univ. of Kentucky, Agricultural Experiment Sta., Lexington, Kentucky 40506  
Objective: To determine the changes in nutrient composition that occur in the fermentation process of making temeph from soybeans. To preserve whole raw fish by mixing with temeph and determine the feasibility of this method for preserving fish as a protein source in technologically underdeveloped countries. To evaluate the potential of the antioxidant of temeph in preventing autolysis of proteins and deterioration of protein in both raw and freeze-dried whole fish. To determine physiological and tissue effects resulting from consumption of fish, soybeans, temeph, and fish-temeph mixtures as the only protein source in rat and chick diets.  
Description of work: Compositional differences in soybeans and fermented soysteps will be determined. High oil and low oil raw dehydrated and freeze-dried fish will be mixed with temeph or soybeans and stored without refrigeration. Lipid autooxidation organoleptic and protein deterioration test (trimethylamine ox-
6. PUBLIC HEALTH AND SAFETY

ide, trimethylamine, dimethylamine, free tyrosine, volatile fatty acids and decarboxylated amino acids) will be made to assess product quality. Fish and temeph or soybean combinations will be tested at protein sources. PER and tissue antioxidant capacity (liver homogenate thiobarbituric acid assay, B-glucuronidase activity (tissue respiration) will be determined on rate receiving the fish-soybean and fish-temeph as a sole source of protein.

SUPPORTED BY U.S. Dept. of Agriculture
University of Kentucky

6.0024, RADIATION PASTEURIZATION OF SHRIMP AND OYSTERS
A.F. NOVAK, Louisiana State University, School of Agriculture, Baton Rouge, Louisiana 70803

Radiation pasteurization of shrimp and oysters has proven to be a highly successful procedure for increasing their iced storage life.

Physical, chemical, microbiological, and organoleptic studies have been completed in evidence that this process is safe, and that irradiated shellfish are preferred over the non-irradiated products when subjected to consumer appraisal.

The scope of proposed research will include investigations into the value of reduced temperature during radiation (cryogenics), the required condition of shellfish prior to irradiation, mechanisms by which texture seems to be improved during irradiation, the developments of a simple procedure for determining the extent of radiation, the effect of radiation on traces of insecticidal residues which may be found in shellfish, and the isolation and identification of compounds and their changes during irradiation.

Microbiological techniques, chemical analyses, gas chromatography, infra-red spectrum analysis, organoleptic tests and nutritional evaluations will be included in making these studies.

This progress should enable the consumer to purchase a higher quality product, while increasing production and income for the producer.

SUPPORTED BY U.S. Atomic Energy Commission

6.0025, COMMERCIAL IRRADIATION OF SHELLFISH WITH A PORTABLE SHIPBOARD IRRADIATOR
A.F. NOVAK, Louisiana State University, School of Agriculture, Baton Rouge, Louisiana 70803

The portable shipboard irradiator will be used for making commercial feasibility studies at a dockside shrimp unloading site on the Gulf coast.

Washed, headed, and iced stored shrimp will be obtained from several trawlers to uncover problems caused by variations in ship construction, and handling by different crews. When arriving dockside, the shrimp will be packaged and irradiated at 0.22 plus or minus 0.05 Megarad, and iced stored for appraising shelf life extension. Products showing evidence of decompnent will not be irradiated.

The samples will be analyzed chemically for indole and ammonia, and microbiologically for total counts and several pathogens. Organoleptic evaluations will include general appearance, odor, texture, sweetness, flavor and blackspot.

Results will be reviewed for possible application to commercial practices, and for solving unforeseen problems which could serve to aid in the preparation of a petition to the F.D.A. for approving low dose radiation preservation of shrimp.

SUPPORTED BY U.S. Atomic Energy Commission

6.0026, CAUSES AND PREVENTION OF UNDESIRABLE CHANGES IN THE QUALITY OF FRESH AND FROZEN GULF SHRIMP IN REFRIGERATED STORAGE
A.F. NOVAK, Louisiana State University, Agricultural Experiment Sta., Baton Rouge, Louisiana 70803

Cause and prevention of undesirable changes in the quality of fresh and frozen Gulf Shrimp in refrigerated storage. Subproject: Radiation Pasteurization of Shrimp.

Objectives: 1. To extend the refrigerated storage life of peeled deveined shrimp. 2. To extend the refrigerated storage life of peeled deveined shrimp.

Proposed Work: Shrimp samples will be irradiated at 50,000 to 750,000 rads and stored in ice at 36-40 degrees Fahrenheit. At periodic intervals samples will be removed from storage, unirradiated controls also, for chemical, microbiological and organoleptic evaluation.

SUPPORTED BY Louisiana State Government

6.0027, EVALUATION OF PRESENT AND PROPOSED LAWS REGULATING THE PROCESSING AND PACKING OF OYSTERS
A.F. NOVAK, Louisiana State University, Agricultural Experiment Sta., Baton Rouge, Louisiana 70803

1. To reappraise the total solids range of Louisiana oysters. 2. To measure the amount of drained liquid obtained with various grades of oysters throughout the year. 3. To study and evaluate improved procedures for processing and packing. 4. To propose regulatory changes to the F.D.A. for the establishment of rational standards favorable to both the packer and consumer.

Proposed Work: Oysters will be processed and packed at several packing houses monthly using present F.D.A. methods. Drained liquid content and total solids will be determined after various time intervals of draining after washing.

SUPPORTED BY Louisiana State Government

6.0028, REGIONAL DEMAND IN THE U.S. AND TRENDS IN THE FISHING AND SEAFOOD PROCESSING INDUSTRIES OF THE CHESAPEAKE BAY AREA
R.E. SUTTOR, State Dept. of Ches. Bay Afrs., Annapolis, Maryland

Objectives: (1) To determine product classification and regions for demand analysis, determine availability of data, and make preliminary consumption estimates; (2) to determine trends in the Chesapeake Bay catch and resources employed in fishing; (3) to determine trends in the seafood processing industries and their relationship to consumption and the Bay catch.

Procedures: (1) The classification of seafood products which is most relevant to studying regional differences in consumption will be determined. The regions to be used in the demand analysis will be delineated. The available data on the consumption of seafood and the relevant demand theory will be reviewed. Preliminary estimates of regional consumption will be made. (2) Detailed data on the Bay catch, will be assembled and analyzed. Labor and capital quantities and wages and prices will be used to estimate the value of economic resources employed in the Bay fishing industry. Changes in these resources will be compared with changes in the catch. (3) Trends in the seafood processing industry of the Chesapeake Bay area will be analyzed and the current structural characteristics of the industry will be described. Changes in the industry will be related to changes in consumption and the Bay catch.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish. Maryland State Government

6.0029, STABILITY OF FOOD LIPIDS TO IONIZING RADIATION
W.W. NAWAR, Univ. of Massachusetts, School of Agriculture, Amherst, Massachusetts 01003 (AT(30-1)3499)

The objective of this project is to gain detailed information on the nature and magnitude of radiation effects on the lipids of foods. A combination gas chromatograph-fast scan mass spectrometer system will be used in the continuing identification of the volatile components produced in the lipid fractions of irradiated fish. Various other micro-chemical techniques will be used to determine radiation-induced changes in the nonvolatile fraction. The organoleptic implications of the various compounds characteristic as irradiation-induced will be established.

SUPPORTED BY U.S. Atomic Energy Commission
6.0030, EFFECTS OF IONIZING RADIATION ON FOOD LIPIDS
W.W. NAVAR, Univ. of Massachusetts, School of Agriculture, Amherst, Massachusetts 01003

Pork fat, beef fat, fish oil and a number of model systems were irradiated under controlled conditions and the volatile components analyzed qualitatively and quantitatively. Dosages from 0.3 to 7.0 megarads were studied. Approximately 50 compounds formed by radiation of fats were identified. The flavor implications of such compounds is being investigated. The effect of the physical state of the fat on the volatiles formed by radiation is under study.

SUPPORTED BY U.S. Dept. of Hith. Ed. & Wel. - P.H.S.

6.0031, THE EVALUATION OF WHOLESONESENS OF RADIATION SUB-STERILIZED FOOD PRODUCTS USING RATS
E.F. REBER, Univ. of Massachusetts, Graduate School, Amherst, Massachusetts

The phase of the work to evaluate the wholesomeness of irradiation pasteurized clams fed to rats for a two-year period has been completed. The irradiation of clams did not impair the growth, feed efficiency, reproduction of male and female rats. There were indications of significant treatment effects in serum glutamic pyruvic transaminase, lactic acid dehydrogenase and white blood cell counts at various time intervals. There was no significant effect on the sizes of the organs weighed at the time of necropsy which could be correlated with an effect of feeding irradiated clams. Work is planned to investigate the protein quality of clams which appears to be complicated by the presence of thiaminase. Additional work will also be done to investigate the presence and effect of thiaminase as it occurs in clams.

SUPPORTED BY U.S. Atomic Energy Commission

6.0032, CONSUMER EDUCATION AND MARKET DEVELOPMENT
F.C. WILBOUR, State Div. of Marine Fisheries, Boston, Massachusetts

Objective: To promote greater utilization of northwest Atlantic seafoods on a national basis.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish. Massachusetts State Government

6.0033, RADIOPASTEURIZATION OF FISHERY PRODUCTS-OPERATION AND DEVELOPMENTAL INVESTIGATIONS
J.A. HOLSTON, U.S. Dept. of Interior, Technological Laboratory, Gloucester, Massachusetts

This contract deals with the investigation of radiopasteurization of fishery products of commercial significance and the establishment of handling and processing methods necessary for commercial application of irradiation in the seafood industry. The work is broken down into two divisions: laboratory research; developmental studies involving the Marine Products Development Irradiator (MPDI).

The major objectives of the research are (1) to establish the maximum edible shelf life of radiopasteurized and nonirradiated haddock and codfish fillets (based solely on odor of raw sample); (2) to determine the optimum dose for radiopasteurizing scallops and blue crab meat; (3) to continue the study of the feasibility of using radiopasteurizing to extend the shelf life of slacked-out products (products stored and handled frozen until they reach the retail counter such that they are thawed and held refrigerated until sold and consumed); (4) to complete the study of the effect of preirradiation quality on post irradiation quality and shelf life of clam meats and cod fillets, and to look into the preirradiation quality of ocean perch as it affects the postirradiation shelf life of the fillets; (5) to continue to relate organoleptic changes in radiopasteurized, nonirradiated, and sterile, nonirradiated fish with changes which occur in the composition of the volatile chemical components in the product; and (6) to monitor bacteriological quality of test samples in order to observe relationship between quality of irradiated and nonirradiated fish with total plate counts (e.g., of specific organisms such as Clostridium botulinum, E. coli).

SUPPORTED BY U.S. Atomic Energy Commission

6.0034, RADIATION PRESERVATION OF FISHERY PRODUCTS
J.A. HOLSTON, U.S. Dept. of Interior, Bureau of Comm. Fisheries, Gloucester, Massachusetts

The objectives of this contract are: Task I. 1. To conduct quality studies on mackeral, whiting, blue crab, scallops, lobsters, and oysters. 2. To conduct applied flavor and odor studies to relate changes in composition of the volatiles of irradiated products to changes in product quality. 3. To expand the studies to determine the effect of pre-irradiation quality level on post-irradiation shelf life of clam meats, ocean perch, and other species. 4. To ascertain the bacteriological quality of samples initially and periodically following irradiation, and to determine the bactericidal effects of different low dose levels of irradiation. 5. To determine the maximum edible shelf life of fish fillets packed in commercial 20-30 lb. fillet tins. 6. To conduct large scale shipping, storage, and distribution tests of marine products in conjunction with the operation of the Marine Product Development Irradiator and in cooperation with the fishing industry. 7. To conduct studies of irradiated and non irradiated commercial size shipments of fresh fish and shellfish with industry to determine efficacy of the radiation treatment. 8. To determine if present commercial distribution and storage conditions are suitable for handling irradiated fresh fillets, and if present market and distribution of these products can be broadened. 9. To perform irradiation services for AEC-sponsored projects and other approved federal, state, or industry requests. Task II. 10. To operate an on-ship irradiator to establish possible advantages of irradiating seafoods at sea. Task III. 11. Determine the advantage of irradiating in inert or reducing gases. 12. Develop analytical methods to expedite analyses of volatile components in fish in cases where suitable methods do not exist. 13. Determine the absorption characteristics of known bacteriostatic salts in whole fish fillets.

SUPPORTED BY U.S. Atomic Energy Commission

6.0035, LABORATORY SCALE INVESTIGATION INTO THE FEASIBILITY OF RADIOPASTEURIZING FISH PRODUCTS
J.A. HOLSTON, U.S. Dept. of Interior, Technological Laboratory, Gloucester, Massachusetts

This research is concerned with many related aspects of determining the feasibility of pasteurizing fish products by irradiation. Storage studies are conducted in which we measure the benefits of radiation at 50 to 200 kilorads for fillets and up to 450 kilorads for shellfish by comparing the organoleptic quality, the total plate count, and the shelf life of irradiated samples with those characteristics of the nonirradiated samples. The effects of storage temperature, packaging materials, and initial quality of the fish are determined concurrently. The samples are also studied to determine the composition of their volatile chemical compounds using gas chromatography and mass spectrometry. Significant changes in the concentration of the volatile chemical compounds can thus be related to organoleptic changes, and attempts to control the production of critical compounds can then be made.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0036, IRRADIATION SERVICES AND STUDIES
J.A. HOLSTON, U.S. Dept. of Interior, Technological Laboratory, Gloucester, Massachusetts

The Marine Products Development Irradiator operates under contact to the U.S. Atomic Energy Commission for preservation of fresh marine food products. Preservation of foods by ionizing radiation is the newest and least known method of preservation. All foods do not react in the same manner to identical doses of irradiation. The reasons for this phenomenon can only be determined by performing the necessary experimental irradiation experiments in cooperation with industry and research units. We
6. PUBLIC HEALTH AND SAFETY

service all industry requests for experimental irradiation services and all similar requests that arise from university, state or other federal agencies. We supply information and technical services other than irradiation services in joint industry-government studies on specific food irradiation problems. Irradiation services are available at no cost provided such services are not available from private industry.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0037, COMMERCIAL BENEFIT STUDIES

J.A. HOLSTON, U.S. Dept. of Interior, Technological Laboratory, Gloucester, Massachusetts

The objective of this study is to determine the magnitude of the shelf life extension conferred by ionizing radiation over non-irradiated control samples of fishery products when both are subjected to the stresses normally encountered by commercial size shipments in regular channels of distribution from fish pier to inland consumer. This research is also aimed at adding proof that the radiation doses proposed for fresh marine food products accomplish the intended technical effect and do not exceed the amount reasonably required to achieve the purpose of irradiation. The help of qualified industry experts will be solicited to determine the commercial benefits to be derived from radiation treatment of fresh seafoods for extension of shelf life.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0038, INCIDENCE OF BACTERIA OF PUBLIC HEALTH SIGNIFICANCE IN FRESH COMMERCIAL SHELLFISH

J.A. HOLSTON, U.S. Dept. of Interior, Technological Laboratory, Gloucester, Massachusetts

Some seafoods such as crabmeat and oysters are commonly eaten with no further cooking. Thus, there exists a greater possibility of transmission of pathogenic organisms by means of these two seafoods than by those shellfish which are always cooked before consumption. The accepted public health indices of bacterial contamination of shellfish (coliforms and fecal coliforms) are liable to pasteurizing dose levels. Therefore, we propose to determine the minimum efficacious radiation dose level of these and other bacteria of public health significance in shellfish. Irradiation treated packs will be subjected to commercial shipping and handling to determine whether or to what extent the usual bacterial indices of sanitation are reduced and held at acceptable levels. Such tests will include total plate counts, coliforms, fecal coliforms, coagulase positive staphylococcus and salmonellia.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0039, SHIPBOARD IRRADIATION STUDIES

J.A. HOLSTON, U.S. Dept. of Interior, Technological Laboratory, Gloucester, Massachusetts

In work conducted under a Task I project, it was established that the length of the postirradiation shelf life of fish is a function of its preirradiation quality. The main object of this research, scheduled to terminate August 1967, is to determine the extent of the benefit which might be gained by irradiating fish at sea just after catching them. The fresh caught fish are packaged and irradiated at different levels aboard the vessel using a portable irradiator. A storage study of these samples will indicate to us the extent of savings in radiation energy we can expect if we irradiate fish before they undergo bacterial contamination under normal handling. We can also obtain more information regarding the benefits reasonably required to achieve a stopgap which preliminary experiments seemed to indicate, and we can determine the effect of double dose applications (a fractional dose applied at sea followed by a fractional dose applied on land when the vessel docks).

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0040, FUNDAMENTAL RADIATION CHEMISTRY RESEARCH

J.A. HOLSTON, U.S. Dept. of Interior, Technological Laboratory, Gloucester, Massachusetts

This project, which is scheduled to terminate September 30, 1967, is concerned with investigating fundamental aspects of Radiation Chemistry. The primary objective is to develop or to modify existing analytical methods. Methodology is required for studying changes in the concentrations of volatile and nonvolatile chemical compounds in fish flesh, and for measuring the penetration of bacteriostatic salts in fish flesh. Practical techniques for conducting applied chemistry research in areas described above have been successfully developed as has a technique for controlling the composition of headspace gases in packaged fish products. The latter technique has enabled us to study the possible synergistic effects of radiation and inert or reducing gases for controlling spoilage in fish.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0041, INVESTIGATION OF FEASIBILITY OF STERILIZING FISH BY RADIATION

L.J. RONSIVALLI, U.S. Dept. of Interior, Technological Laboratory, Gloucester, Massachusetts

This research conducted under contract to the U.S. Army Quartermaster is concerned with determining the feasibility of producing shelf stable sterilized fish products. This involves the solution to difficult problems associated with high level radiation (about 4.5 msrads). The problems are to minimize induced radiation effects on flavors and odors to prevent color changes, and inactivate flesh enzymes by some method other than the use of radiation which is considered inadequate for enzyme inactivation. Practical methods which can be used to solve these problems are often introduce one or more new problems. Thus, heat, which can be satisfactorily used to inactivate enzymes, unfortunately causes gross, undesirable physical changes in the product.

Under the terms of the contract, research is directed to unprocessed fish products such as fillets, but can be directed towards processed items such as fish cakes, fish rolls, etc. should it be found that it is not feasible to radiosterilize the unprocessed items.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0042, FUNDAMENTAL STUDIES IN THE FLAVOR AND ODOR CHEMISTRY OF FISH PRODUCTS

J.W. SLAVIN, U.S. Dept. of Interior, Technological Laboratory, Gloucester, Massachusetts (AT(49-7 )2443)

Many published data indicate the feasibility of preserving fish as well as other heat labile food products with ionizing radiation. However, some detrimental organoleptic changes occur as a result of irradiation, extended storage, environmental factors, and combinations of these.

The objective of this research program is to define the development of detrimental organoleptic changes in irradiated fishery products in terms of related chemical and biochemical reactions. The information gained in this research will be used to derive maximum benefit from radiopreservation methods and to otherwise exert control measures over spoilage processes.

The approach employed in this continuing research is to study by instrumental methods, the volatile fractions in fish products since quality is largely reflected by the chemical compounds in their flavors and odors. Techniques to collect volatile compounds have been developed, and recently we modified and combined two analytical methods which enabled us to establish the effect of irradiation, extended storage, available oxygen, temperature, and bacteria on the development of carbonyl compounds in clam meats. We are presently evaluating methods for studying the development of sulfides and mercaptans in spoiling fish, and this will be followed by an investigation of methods to study amines and possibly other compounds. The capability to follow the development of these important compounds is the key to controlling detrimental changes in fish products.

SUPPORTED BY U.S. Atomic Energy Commission
6.0043, GROWTH AND TOXICOCGENESIS OF C. BOTULINUM IN FISHERY PRODUCTS
J.T. GRAIKOSKI, U.S. Dept. of Interior, Technological Laboratory, Ann Arbor, Michigan

The objective of this project is a study of the growth of C. botulinum type E, in reference to all spore forming organisms (those organisms important in the design of processing parameters). Growth involves the germination of the spore, proliferation of the vegetative cell with toxin synthesis, subsequent sporulation, and a period of spore dormancy. Dormancy also involves the unique characteristic of spore resistance. The development and evaluation of agents which inhibit and/or kill the organism is an integral part of growth studies, i.e., antimetabolites. This aspect is of importance in the development of proper sanitation procedures.

Basic to this study is the development of methodology for measuring growth requirements and the end products of metabolism, including the toxin.

Portions of the research are carried out under contract.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0044, EFFECTS OF HANDLING AND PROCESSING PROCEDURES IN POTENTIAL PATHOGENUS ON FISH
J.T. GRAIKOSKI, U.S. Dept. of Interior, Technological Laboratory, Ann Arbor, Michigan

Research in this project is directed toward a determination of the effects of processing and handling procedures on the survival, growth, and toxicogenicity of C. botulinum and other potentially pathogenic or toxicogenic microorganisms which may be found in fishery products. The next step in this research sequence is to develop and recommend processing techniques which will produce fishery products of acceptable quality that are safe for human consumption. The most immediate problems under this project are to assess the current degree of risk to the public from smoked fish consumption caused by the presence of C. botulinum (particularly type E) and to develop smoked fish processing guidelines that allow a margin of safety to the consumer.

In reference to smoked fish processing, the establishment of methodology for the standardized production of a quality smoked fish is being developed, since knowledge in this area is completely lacking even within industry itself. In the present phase of the project, the primary emphasis is being placed on the processing parameters for the production of smoked whitefish chub of uniform quality. Concurrently, the effect of know inhibitors of C. botulinum outgrowth is being evaluated for type E strains (NaCl, NaNO₂, organic acids, etc.).

In respect to control of botulism in smoked fishery products, the heat resistance of C. botulinum type E spores is being studied in phosphate buffer and in fish flesh. The influence of hydrogen ions, sodium chloride, nitrite, nitrate, and other inhibitors on the heat resistance of the spores in fish flesh is being compared. The outgrowth potential of botulinum type E spores at various incubation temperatures and in the presence of sodium chloride, nitrite, antioxidants, and various hydrogen ion concentration is being determined. Portions of the research are carried out by contract.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0045, CONTROL OF OXIDATIVE CHANGES IN FRESHWATER FISH
R.A. GREIG, U.S. Dept. of Interior, Technological Laboratory, Ann Arbor, Michigan

The primary objective of this project is to determine methods for significantly improving the frozen storage capabilities of freshwater fish products. Investigations to fulfill this objective have been centered on controlling the onset of oxidative rancidity during frozen storage of these products. Investigations on controlling other quality deterioration factors—such as off-color development—will also be examined.

A secondary objective is to evaluate possible chemical methods for objectively following the above mentioned quality deterioration factors in frozen freshwater fish products.

Preliminary studies on various freshwater species were broadened to include basic investigations to determine the mechanisms of lipid oxidation in freshwater fish, a limiting problem in extending the frozen storage of many species. Particular attention is being paid to the catalytic factors involved and methods to block these.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0046, COMPOSITION STUDIES OF FISH AND SHELLFISH AS RELATED TO STORAGE AND PROCESSING PROBLEMS
R.N. FARRAGUT, U.S. Dept. of Interior, Technological Laboratory, Pascagoula, Mississippi

Work undertaken under this project will attempt to relate differences in composition of various fish and shellfish to problems encountered in the handling, processing, and storage of the product. Differences in composition from species to species can be related to the appearance of particular problems in the handling of the species. An attempt will be made to utilize specialized knowledge of compositional factors in solving technical problems in order to increase the consumption of that particular product. Specific problems on hand include, but are not limited to: browning discoloration of cut surfaces and skin of snapper and grouper steaks and fillets during frozen storage; development of rancidity in frozen Spanish mackerel; discoloration of processed crab meat; and skin shrinkage upon cooking of certain species of snapper. The effects of various antioxidant, chelating agents, packaging atmospheres, and packaging materials will be investigated.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0047, PROCESSING AND PRODUCT DEVELOPMENT OF EDIBLE FISH AND SHELLFISH
R.N. FARRAGUT, U.S. Dept. of Interior, Technological Laboratory, Pascagoula, Mississippi

The first phase of this work will be concerned with the development of new products and processing methods for the several additional red snapper species—a new resource delineated by Exploratory Fishing and Gear Research.

The second phase, to be carried out concurrently with the first and to be financed by Army Research Laboratories contract, will be to develop a product(s) suitable for irradiation sterilization processing. Others to be included are, but not limited to, the mackerel, oyster, clam, blue crab, mullet, and grouper fisheries.

a. In cooperation with Exploratory Fishing and Gear Research, Pascagoula Fisheries Station, fisheries with large potential will be delineated. b. Suitable products, processes, and packages will be investigated. c. The product, process, and package most suitable for particular markets (institutional vs. retail) will be selected and produced in cooperation with retail industry. d. Through the cooperative effort of the Branch of Marketing, suitability and marketability of the product will be tested. e. Information gathered will be made known to industry through oral, audio-visual, and written communications.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0048, CHEMICAL REACTIONS IN PROCESSED SEAFOODS
H.C. THOMPSON, U.S. Dept. of Interior, Technological Laboratory, Pascagoula, Mississippi

Changes, occurring during the storage and processing of seafoods, in the basic biochemical and physiological make-up of seafood products contribute both evident and non-evident changes in quality of the product as it reaches the consumer. The objective of this project is to define the changes and the mechanisms underlying these changes. Possession of the basic facts concerning changes in quality will thus enable logical and scientific correction of storage and processing procedures to ensure a better quality product.

Work is underway in defining the basic mechanism(s) concerned in the iron sulfide discoloration of canned shrimp. Although this problem appears to be related to pH of the raw and processed material, research has indicated that this is a superficial answer and that changes in the basic structure of a protein or
6. PUBLIC HEALTH AND SAFETY

other biochemical constituent during iced storage allows the
binding and loss from tin plate.

Further work is being done presently on changes occurring
during iced storage of shrimp which result in altered texture of the
finished product. In this connection, the possibility of alteration in
the chemical and physiological structure of the connective tissue
proteins is being investigated.

Other problems to be considered in the future are: The loss
of protein-bound water and its effect on texture, the connection
of protein denaturation with toughness in texture, the effect of
bacterial enzymes on quality deterioration in seafoods.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0049, CONTAINERIZATION OF FISHERY PRODUCTS
M.E. WATERS, U.S. Dept. of Interior, Technological Laboratory,
Pascagoula, Mississippi

The containerization of shrimp, on shore and at sea, will form
the first phase of this work. Subsequent investigations will in-
clude, but are not limited to, the menhaden and industrial fish
industries.

a. Efficient containers will be selected and evaluated first in
the laboratory and then in the field. b. Demonstrations of efficien-
cy and consequent economic gain will be made to the industry via
audio-visual techniques.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0050, CHEMICAL AND MICROBIOLOGICAL APPLI-
ICATIONS TO PRODUCT ENGINEERING
B.J. WOOD, U.S. Dept. of Interior, Technological Laboratory,
Pascagoula, Mississippi

Work undertaken in this project will attempt to relate scienti-
ific principles to the solving of technical industrial problems.
Better methods of preparing, handling, and transporting fishery
products will be devised. Adaptation of advances made by other
segments of the food industry will be made for use with fishery
products as the starting medium. New products, processes, and
concepts in handling will be experimented with. Specific points
include, but are not limited to: containerization of iced stored
shrimp; development of a satisfactory method of freezing raw
oysters; development of means of reducing bacteria present in
fishery products; development of an on-board shrimp heading
machine; development of methods to increase iced storage life of
shrimp; and development of techniques for processing industrial
fish at sea.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0051, DEVELOPMENT OF MECHANIZATION DEVICE
PROTOTYPES
B.J. WOOD, U.S. Dept. of Interior, Technological Laboratory,
Pascagoula, Mississippi

The first phase of this project will deal with the development of
an onboard fish press that will reduce the moisture content of
certain species of fish by as much as 50 percent. The resulting
product will be suitable for processing into pet food, fish meal, or
fish protein concentrate. Other devices to mechanize the handling
of fish and shellfish will constitute subsequent phases and will in-
clude, but not limited to, a shrimp deheading device, fish filleting
and handling devices, etc.

a. Develop prototype mechanization devices. b. Test proto-
type and product therefrom. c. Contract with reputable engineer-
ning firm to design final version of the device.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0052, ENTERIC BACTERIA AND VIRUSES IN
SEWAGE, WATER, AND SHELLFISH
L.W. SLANETZ, Univ. of New Hampshire, Graduate School,
Durham, New Hampshire 03824

Studies will be continued on the correlation of numbers of
coliforms, fecal coliforms, and fecal streptococci with the
presence of salmonellosis and enteroviruses in seawater and oyster
samples collected from stations in our bay and estuarine areas.

Particular attention will be given to the detection of salmonellae
and viruses in oysters harvested from shellfish growing waters
considered to be of approved sanitary quality based on recom-
manded coliform standards. Hydrographic conditions in the study
areas will be determined to establish the possible impact of such
conditions on the microbiological data obtained. Studies will also
be continued to assess the efficiency of newly installed sewage
treatment plants in eliminating enteric bacteria and enteroviruses
in seawater and shellfish at sampling stations in several estuarine
and bay areas. The effectiveness of depuration procedures for
providing shellfish of acceptable microbiological quality will be
determined using shellfish harboring indicator bacteria, salmonel-
lae, and enteroviruses.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

6.0053, BIOCHEMISTRY OF FISH AS RELATED TO
HUMAN NUTRITION
A.E. TERRI, Univ. of New Hampshire, Agricultural Experiment
Sta., Durham, New Hampshire 03824

Objectives: 1. To investigate release of hypoxanthine from
the breakdown of muscle ATP, with a view to expanding use of
this reaction for estimating freshness and potential storage life of
fish as food for humans. 2. To investigate fish as a source of
amino acids and their use as protein supplements for humans.

Work Proposed: 1. Species of fish commonly consumed in
the New England area will be analyzed for hypoxanthine which
results from the breakdown of muscle ATP. The relationship
between free hypoxanthine and storage time will be studied, and
an attempt made to use the procedure for estimating future
storage life of various specimens. 2. In the studies with amino acid
amides, standard synthetic organic (ammonolysis of amino acid
esters), and chromatographic methods will be employed. The
chromatographic work will involve investigation of numerous sol-
vent systems in an attempt to define one which is efficient for
chromatographic separation and identification of amides. If
development of an analytical method is successful it will be used
for investigation of these compounds in various marine species.

SUPPORTED BY U.S. Dept. of Agriculture
New Hampshire State Government

6.0054, NUTRITIVE VALUE OF FISH AND OTHER
MARINE PRODUCTS
A.E. TERRI, Univ. of New Hampshire, Agricultural Experiment
Sta., Durham, New Hampshire 03824

The objective of the project is to determine the nutritive
value with respect to water soluble vitamins, and amino acids, of
fish and other marine products such as lobsters, clams and
oysters. Various species have been analyzed quantitatively for
several of the B-vitamins. This work is continuing with respect to
thiamine and ascorbic acid. Various species have been analyzed
quantitatively, by means of paper chromatography, for their free
amino acids, and proteins. Present, and future work involves
development and improvement of quantitative chromatographic
amino acid analyses, and their application to various fish species.

SUPPORTED BY New Hampshire State Government

6.0055, FERMENTED PROTEIN-RICH FOODS
A.G. VANVEEN, Cornell University, Graduate School, Ithaca,
New York

A need exists for cheap, digestible, nutritious and acceptable
protein-rich foods to combat protein malnutrition which is
prevalent in many areas in the world.

So-called 'fermented foods' from soybeans, peanuts, grain
legumes, fish, spices, and milk fall in this category (and a similar
microbiological treatment might be applied to some other com-
modities such as sources of leaf protein). There is no acceptability
problem with these fermented foods in areas where they are
known, but this acceptability is usually a serious problem with
'new' and unknown protein-rich foods.

Microbiological, biochemical and nutritional research of
these products has been very incomplete and the presence of
mycotoxins will have to be investigated. There is a great need for
6. PUBLIC HEALTH AND SAFETY

Individual variation and past history will also be evaluated as to source, level, and nature of original contamination, and the time lag between harvesting and processing. Plankton, Phosphorous and Nitrogen content and distribution of the process water will be measured also to determine the effect of variations in these factors on the process. Seasonal variations exhibited by the clams will also be evaluated.

Experiments will be run concurrently to determine the effect of each variable. These tests will be repeated periodically throughout the year to test for seasonal variations.

Procedures and techniques will follow those given in ‘Standard Methods for the Examination of Shellfish and Sea Water’ for bacteriological work and ‘Standard Methods for Water and Waste Water’ for chemical examinations.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish. New York State Government

6.0059, EFFECT OF PROCESS ON SHELLFISH
G. STROBEL, State Div. of Fish & Game, Oakdale - Long Island, New York 11769

Some concern has been raised about the effects of the process on the value of the clam with particular emphasis on shelf-life. Local dealers claim that clams harvested during the time of year when they are emerging from hibernation have a shorter shelf-life than those taken during the rest of the year. Since plants will have to operate during the winter months, and since economics will play a major role in determining the feasibility of such a process, it is necessary to determine any effects of depuration on market value.

Work on this phase will start immediately and continue for one year to determine any seasonal variations.

Work will be performed at the plant in West Sayville, N.Y. with laboratory tests performed in the State laboratory at Oakdale, L.I., using established techniques.

Part 5 of 5.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish. New York State Government

6.0060, RESEARCH AND GRADUATE TRAINING IN FOOD AND DRUGS FROM THE SEA, AND MARINE POLLUTION
O.A. ROELS, Columbia University, Graduate School, Palisades, New York 10964

Applied biological research will be expanded in three main areas: Food from the Sea; Drugs from the Sea; and Detection of Marine Pollution.

Under the Food from the Sea category, work will be expanded on the fermentation of trash fish for the development of foods suitable for human use, and the isolation of marine proteins to produce hydrolysates and protein isolates suitable for human consumption. In the Drugs from the Sea studies, new antibiotics and potential anticancer agents will be isolated, and their structure and synthetic defined. The Pollution Studies are intended to devise novel systems of detecting marine pollution and ways of monitoring and relieving its undesirable effects on the environment. The initial effort will be to determine the influence of effluents from the land upon the water masses between Montauk Point and the Chesapeake Bay with particular emphasis on the influence of Long Island Sound, the Hudson River, the Delaware and the Chesapeake.

SUPPORTED BY U.S. National Science Foundation
6. PUBLIC HEALTH AND SAFETY

6.0062, EFFECT OF STORAGE ON FISH MUSCLE PROTEINS
N.B. WEBB, Univ. of North Carolina, Agricultural Experiment Sta., Raleigh, North Carolina 27600

The objectives of this project are to evaluate the methods of analysis and determine the effect of changes in emulsifying capacity, viscosity, water-binding capacity, texture and rheological properties and protein solubility of fish and/or shell fish muscle proteins during post-mortem storage. Furthermore, the characteristics of these basic properties of muscle proteins are to be used in developing the functional aspects of seafood products. The experimental work is to entail the evaluation of muscle protein changes in relation to microbiological level, time of storage and temperature of storage. Subsequently, these findings are to be used as a basis to manufacture comminuted prefabricated seafood products.

SUPPORTED BY North Carolina State Government

6.0063, SURVIVAL OF FOOD PATHOGENS IN RADIATION PASTEURIZATION SEAFOOD
A.W. ANDERSON, Oregon State University, Graduate School, Corvallis, Oregon 97331

Studies were conducted under controlled conditions in order to observe the resultant survival patterns in solid crabmeat and in Hartsell's broth of Salmonella enteritidis, S. paratyphi A, S. choleraesuis, S. pullorum, streptococcus pyogenes, and Staphylococcus aureus after individual exposure to Co 60 irradiation. A 'tailing off' was found in the survival patterns of S. paratyphi A, S. pullorum, S. enteritidis, and S. aureus when irradiated in crabmeat, but was not found upon exposure in Hartsell's broth. However, S. choleraesuis and S. pyogenes showed a definite 'tailing off' in the broth while only weakly, if any, in the crabmeat. Thus this 'tailing off' phenomenon cannot be explained as a mere effect of the medium, but rather indicates a much more complex situation. The results indicate that predictable pasteurization doses usually based on D values would be quite inaccurate, since the projection is based on sigmoidal and linear inactivation curves.


6.0064, DEVELOPMENT OF THE SHAD INDUSTRY
D.L. CRAWFORD, Oregon State University, Agricultural Experiment Sta., Corvallis, Oregon 97331

Objectives: (1) Develop new products consistent with the unique characteristics of shad. (2) Improve the quality of shad processed by usual methods. (3) Investigate the utilization of shad by-products. (4) Determine the potential United States market for fresh Pacific shad in areas not presently supplied. New products utilizing shad such as precooked frozen products and such items as fish sausage of various kinds will be developed. Procedures used in canning, freezing, sardines and anchovies will be adapted to shad. Processed variables such as time and temperature and factors such as sex, moisture and fat content on the final texture and acceptability will be investigated. The effect of pre-processing procedures such as brining and application of polyphosphates as firming agents will be determined. Conventional means of processing shad such as mild curing, smoking, kippering, pickling and freezing will be investigated. The effect and value of certain additives including antemidants will be investigated for possible use in processing shad. The potential of expansion and extension of the marketing of fresh Pacific shad into areas not presently supplied will be investigated. The suitability of the by-products of the shad industry for animal, fish and pet food will be determined.

SUPPORTED BY Oregon State Government

6.0065, DEVELOPMENT OF NEW HUMAN FOOD PRODUCTS FROM SHAD
E.W. HARVEY, Oregon State University, School of Agriculture, Corvallis, Oregon 97331

Objectives: Develop new products consistent with the unique characteristics of shad: examples: fish sausage, fish loaf of the luncheon type, pepperoni, etc.

Procedures: A fish sausage using shad as the major component will be developed using condiments which are commonly associated with pork sausage, frankfurters, salamis, etc. Fish of the Sebastodes grouping, which are in abundant supply off our coastal waters will be the complimentary fish used with shad to formulate the fish sausage. Incorporation of cereals and other fish items will be used to improve textural characteristics and to comminution of objectionable bone particles will be investigated. Casings of various types including both artificial and natural will be tried. Fish loaf samples using artificial as well as natural smoke will be prepared. Partial economics of the operation will be determined through records of ingredient cost and yields. A close monitoring to determine keeping quality and bacterial load will be conducted. Samples will be submitted to taste panel for consumer acceptance tests.


6.0066, PREPARATION OF FISH PROTEIN HYDROLYSATES
D.K. LAW, Oregon State University, School of Agriculture, Corvallis, Oregon 97331

Objectives: To develop a method of preparing protein hydrolysates from fish scraps and by-products including hake and dogfish.

Procedures: A procedure used to pasteurize salmon viscera will be adapted to digest hake, dogfish and other fish. Time and temperature relationships will be studied to determine optimums. Methods for bone and oil separation will be studied. A high degree of protein solubility may occur with particular increase in free amino groups. Formal titration and other appropriate chemical methods will be used to determine the degree of proteolysis. Proximate analysis of the protein hydrolysates will be determined. Their nutritive value will be determined in preliminary studies with suitable test animals including fish.

Work Schedule: For the remainder of the fiscal year (approximately from Feb. salmon viscera will be digested to hake, dogfish and other fish scrap. Optimum time and temperature relationships for this process will be determined.


6.0067, UTILIZATION OF HAKE, DOGFISH, AND BY-PRODUCTS OF THE FILLET INDUSTRY FOR PROTEIN SUPPLEMENTS
D.K. LAW, Oregon State University, Agricultural Experiment St., Corvallis, Oregon 97331

Objectives: (1) Develop fish protein hydrolysates from fish scraps and by-products including hake and dogfish. (2) Prepare and evaluate high quality fish meals made from hake, dogfish, and by-products of the fillet industry. (3) Investigate procedures for heat pasteurization and acidification of hake which will yield a stable protein product.

Hake, dogfish, and other fish scrap will be digested utilizing the natural autolytic and digestive enzymes in fish and possibly certain vegetable proteolytic enzymes. Time and temperature relationships will be studied to determine optimums. Methods of bone and oil separation will be investigated. Uses for these hydrolysate products will be investigated and evaluated. Fish meal of hake, dogfish, and other fish scraps will be prepared and evaluated both chemically and nutritionally. The use of antioxidants will be investigated. Procedures will be developed for pasteurization of hake and dogfish. The addition of various acids to this pasteurized product to achieve a stable product which can be stored at room temperature will be investigated. The storage stability of these products and the antioxidants for prevention of fat oxidation will be determined.

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250
6.0068. UTILIZATION OF LATENT MARINE RESOURCES AND WASTE PRODUCTS
D.K. LAW, Oregon State University, Agricultural Experiment Sta., Corvallis, Oregon 97331

Objective: To investigate the latent marine resources and available waste products as sources of protein and other nutrients for use in animal and human nutrition. A method for production of a low-fat marine protein concentrate from hake and other latent species will be developed. The marine protein concentrate will then be used as a source of protein for use in human nutrition. Procedures will be developed for processing and storing shrimp and crab scrap. Its nutritive value as a supplement in trout rations will be evaluated as a source of protein for use in human nutrition.

6.0069. SURVIVAL MECHANISM OF IRRADIATED BACTERIA IN FOODS
J.S. LEE, Oregon State University, Agricultural Experiment Sta., Corvallis, Oregon 97331

Objectives - (1) Examine and describe the nature of the changes that occur in microorganisms that have received sub-lethal doses of radiation. (2) Investigate the action of certain food additives and bacteriostatic agents on radiation injured microorganisms. (3) Investigate the effect of radiation on microorganisms according to the physiological or genetic parameters, e.g., permeability changes, DNA degradation, capability to produce exotoxins, antibiotics sensitivity and morphological or taxonomic variations.

Select group of microorganisms will be studied in order to demonstrate the nature and extent of sub-lethal radiation damage. We have already demonstrated this in Escherichia coli B. (1) This will be extended into other bacteria that survive irradiated foods in a significant number. We will initiate our investigation with Achromobacter species that survive in irradiated Dover sole, Dunneens crabmeat, and in Pacific system. (2) The sub-lethally damaged cells can be isolated from the non-injured cells by the penicillin technique. A threshold concentration of penicillin may be incorporated in the basal media for the initial recovery of radiation survivors. After incubation to permit the growth of healthy cells which then are inactivated by penicillin the plates will be overlaid with complete media. This will dilute the penicillin and also permit the growth of cells that did not grow on the basal media. These colonies will be investigated for their physiological and genetic variations.

6.0070, SURVIVAL MECHANISM OF IRRADIATED MICROORGANISMS IN FOOD
J.S. LEE, Oregon State University, School of Agriculture, Corvallis, Oregon 97331

Irradiation of food is being accepted as an extended method of preserving man's food supply. A further understanding of the action of radiation on food-borne microorganisms, at the cellular level, is the subject area of this proposal. This proposal intends to investigate the nature of change that occurs in sub-lethally injured microorganisms due to irradiation. Several food preservatives such as sodium benzoate, potassium sorbate and sodium chloride have been shown to exert different effects on radiation injured bacteria than to the unirradiated cells. In irradiated sea-foods, for example, the recovery rates of survivors at 7 degrees C were further reduced by 0.1% sodium benzoate. The irradiated Salmonella typhimurium and S. enteritides on the other hand, remained viable for longer periods of time at 7 degrees C when 0.1% sodium benzoate was present.

The mode of action of such food additives and other bacteriostatic agents on the radiation injured bacteria will be determined by investigating the cellular function following irradiation. Respiration, catalytic incorporation of nutrients and the specific effects of the preservatives can be determined by manometric methods. The suspected change in permeability, degrees of macromolecules or inhibition of their synthesis can be determined by the use of radioisotopes. Other changes that will be examined will include capability to produce toxins, sensitivity to antimicrobial agents and morphological and taxonomic variations.

6.0071. LIPID OXIDATION AND ASSOCIATED BIOCHEMICAL CHANGES OCCURRING DURING THE PROCESSING AND STORAGE OF FISHERY PRODUCTS
R.O. SINNHuber, Oregon State University, Agricultural Experiment Sta., Corvallis, Oregon 97331

1. Investigation of objective methods for the determination of quality of fishery products. 2. Determination of oxidative rancidity by chemical or physical means. 3. Investigation of changes which occur in lipids during processing and storage. 4. Investigation of antioxidants and their role in the prevention of oxidative rancidity.

Changes in the lipid portion of seafoods will be followed by applying or developing certain chemical tests and correlating these results with sensory evaluation. Techniques to be used are the iodine and picric acid methods and the 2-thiobarbituric (TBA) acid, peroxide and carbonyl determinations will be modified to permit their application for a greater variety of processed seafood products. The Sanger technique will be used to follow reactions between the protein and carbonyl groups of lipid oxidation as related to browning of stored fishery products. The effect of antioxidants in stabilizing the lipid portions of seafood products will be determined by application of the above techniques and by the cellie method for accelerated tests.

6.0072. INVESTIGATE THE EFFECT OF IRRADIATION ON THE MICROBIAL FLORA SURVIVING IRRADIATION PASTEURIZATION OF SEAFOODS
R.O. SINNHuber, Oregon State University, Agricultural Experiment Sta., Corvallis, Oregon 97331

1. Study the shift in the natural microbial flora (including yeasts and molds) due to the variation in irradiation resistance and determine a) the spoilage by these microorganisms, b) their pathogenicity. 2. Determine whether a significant number of those microorganisms which survive are mutants, and their role if any in spoilage. 3. Investigate the complimentary effects of approved food additives such as nitrates, nitrates, sodium chloride, and possibly other radiolabile agents.

By taste panel methods the maximum allowable radiation dose will be determined. The kinds, types, antimicrobial effects of the surviving microorganisms will be ascertained by conventional methods. The normal microbial flora and spoilage pattern as well as that which results after radiation and storage will be followed by chemical and microbiological techniques.

6.0073. DEVELOPMENT OF RADIATION STERILIZED FISH ITEMS FOR ARMED FORCES FEEDING
R.O. SINNHuber, Oregon State University, Agricultural Experiment Sta., Corvallis, Oregon 97331

1. Conduct studies to determine optimum conditions for producing acceptable irradiation sterilized seafood products that will remain stable at ambient temperature. 2. The species shall include but not be limited to cod and halibut. 3. The influence of the following processing variables will be studied: a) selected additives, b) antioxidants, c) odor scavengers, d) Oxygen scavengers, e) packaging environment, f) Cooking procedures and use of condiments at time of serving for evaluation. 4. Sufficient samples shall be prepared to permit periodic examination of the over a period of 9 months. The storage temperature will be 72 degrees F. Large consumer type acceptance panel evaluation will be made of the various treatments using proven psychological methods with adequate controls and statistical evaluation of the results. Appropriate chemical tests will be made to determine the changes that occur during storage and to correlate these findings with panel evaluation.

6. PUBLIC HEALTH AND SAFETY

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251
6. PUBLIC HEALTH AND SAFETY

6.0074, STORAGE STABILITY STUDIES ON RADIATION STERILIZED FISH ITEMS
UNKNOWN, Oregon State University, Agricultural Experiment Sta., Corvallis, Oregon 97331

1. To determine cause of 'browning' and other changes that occur during storage of irradiated fish items. 2. To develop methods for controlling these changes that adversely affect the products.

3. The various treatments will be evaluated by subjective panel evaluations after storage at 22 degrees Centigrade over a period of 12 months.

SUPPORTED BY Oregon State Government

6.0075, VITAMIN K5 AS A FOOD PRESERVATIVE
H.Y. YANG, Oregon State University, Agricultural Experiment Sta., Corvallis, Oregon 97331

1. To study the inhibiting action of Vitamin K5 against various food spoilage microorganisms.

The effectiveness of vitamin K5 on the microorganisms isolated from meats, seafoods, fruits and vegetables will be studied. Two or three foods from each group will be used as representative samples. Vitamin K5 in the concentrations ranging from 10 to 1000 ppm will be added to these organisms and their survival will be observed. The combined effect of vitamin K5 and other food preservation methods on microorganisms will be studied using various concentrations of vitamin K5 in combination with canning, freezing, dehydration, and irradiation techniques and determining the effect of the combined process on the survival of the microorganisms.

SUPPORTED BY Oregon State Government

6.0076, THE COMPOSITION, NUTRITIVE VALUE AND QUALITY OF FISHERY PRODUCTS WITH SPECIAL EMPHASIS ON LIPID AND ITS INTERACTION
T.C. YU, Oregon State University, Agricultural Experiment Sta., Corvallis, Oregon 97331

Objectives: 1. Extend the storage life of frozen seafood products. 2. Improve nutritive value and to prolong the storage life of fish meal and fish flour. 3. Stabilize lipids in irradiated fishery products.

Methods and Procedures: The plant operations will be divided into operations; general production study will be conducted on the freezing storage and shipment aspect of the plant. Partial budgeting and/or linear programming will be used to evaluate the potential of various alternative approaches to resolving production problems where inefficiencies are discovered.

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6.0077, THE STORAGE LIFE OF ICED DEEP SEA RED CRABS - GERYON QUINQUEDENS
A. HOLMSEN, Univ. of Rhode Island, Agricultural Experiment Sta., Kingston, Rhode Island 02881

Justification: The red crab is caught in large quantities by the deep sea lobster trawlers. It has a delicate flavor and a good dressing percentage, but since it can not be stored in lobster tanks it is thrown overboard.

Objective: To determine the keeping quality of iced crabs and the effect of icing on the texture of the meat.

Procedure: On board a trawler various ways of icing crabs will be tried (iced in the hull, iced in burlap bags, vegetable bags etc.). The crabs will be stored for various lengths of time from one to ten days, and bacteriological test will be carried out to determine the effect on quality of handling, temperature, and length of storage.

SUPPORTED BY Rhode Island State Government

6.0078, THE STRUCTURE OF DECISION MAKING IN MAJOR MARKETING AGENCIES OF FOOD FISH IN THE N.E. UNITED STATES
H.C. LAMPE, Univ. of Rhode Island, Agricultural Experiment Sta., Kingston, Rhode Island 02881

Objectives: (1) To determine the variables controlling decisions in the purchase, processing, and distribution of fish in the existing market system; including: short run factors regarding volume, variety, source, and prices; effect of existing market restraints on the scope of decisions; evaluation of the information leading to decisions; and examining the effect of firm policy on the scope of decisions by those responsible for the purchase, sale, and distribution of fish. (2) To determine changes necessary in the structure in order to effect changes in the market process for food fish; with particular attention to the importance of reducing costs as an inducement to change, and the possibility of changes in decision making structure as regards marketing.

Work Proposed: (1) From secondary and primary sources develop a complete description of the channels of trade to determine: the volumes of fish of various species moving through; to evaluate the relations between imports, cold storage holdings and catch volume; to examine the price-quantity relations among relations among various species. (2) To survey industry representatives (wholesalers, manufacturers and chain store buyers regarding the importance of species, prices, quality, and quantity of fish purchases.

SUPPORTED BY Rhode Island State Government

6.0079, MARKETING EFFICIENCY IN A COOPERATIVE FOOD-FISH PROCESSING PLANT, A CASE STUDY
II. C. LAMPE, Univ. of Rhode Island, Agricultural Experiment Sta., Kingston, Rhode Island 02881

Objectives: To discover and identify inefficient product handling and processing in a cooperative multiple product, fish food processing plant; to develop and recommend alternative methods of processing and product handling as a means of reducing marketing costs; to analyze and recommend changes in plant and equipment that will improve the operating efficiency of a given plant.

Methods and Procedures: The plant operations will be divided into definite job series, and the jobs will be further subdivided into operations; general production study will be conducted for each operation and for each job; a detailed production study will be conducted on the freezing storage and shipment aspect of the plant; partial budgeting and/or linear programming will be used to evaluate the potential of various alternative approaches to resolving production problems where inefficiencies are discovered.

SUPPORTED BY Rhode Island State Government

6.0080, PROCESS ENGINEERING
J.A. DYER, U.S. Dept. of Interior, Technology Laboratory, Seattle, Washington

This project is designed to study the application of chemical engineering processes to the production and utilization of fish oils. The current project is the production of high-grade fish oil from the solvent processes used to produce fish protein concentrate.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

252
6.0081, OUTGROWTH OF CLOSTRIDIUM BOTULINUM TYPE E IN NONIRRADIATED AND IRRADIATED FISHERY PRODUCTS

M.W. EKLUND, U.S. Dept. of Interior, Technology Laboratory, Seattle, Washington (AT(49-7)2442)

Objective: During a study of the incidence and concentration of Clostridium botulinum type E cells in the marine environment, strains of nonproteolytic types B and F were isolated from the Pacific Coast of the United States. Both of these types are uncommon to the North American continent and only a few pure cultures of this type exist in the world. Since these cultures were isolated from the marine environment, it is very important that the physiological and biochemical characteristics of these strains be studied to determine whether they are of any greater public health significance than type E in irradiated fish products held at refrigerated temperatures.

Results to date: The physiological and biochemical characteristics of strains of nonproteolytic Clostridium botulinum types B and F are indistinguishable from those of type E. Nonproteolytic types B, E, and F all: 1) produce a protease activated by trypsin; 2) produce spores of low thermal resistance; 3) grow and produce toxin at 35 degrees F.; and 4) possess the same cultural, biochemical, and colonial characteristics. The data collected thus far, however, do not indicate that the outgrowth time of types B and F at refrigerated temperatures are any greater public health significance than that of type E. Antitoxin sera prepared by immunizing rabbits with the toxoid of the nonproteolytic type F isolate do not show any cross-neutralization with the toxins of other known types of C. botulinum. However, approximately 2 to 3 MLD of type F toxin is cross-neutralized by 1,000 anti-MLD of type E antitoxin. More detailed experiments are currently in progress to evaluate the degree of safety that exists in irradiated fish products with respect to Clostridium botulinum. The factors responsible for the differences in the outgrowth of type E in petrale sole and haddock fillets are also being investigated.

SUPPORTED BY U.S. Atomic Energy Commission

6.0082, CHEMISTRY OF FISH OILS AND THEIR UTILIZATION

E.J. GAULITZ, U.S. Dept. of Interior, Technology Laboratory, Seattle, Washington

This project is phased to study the chemical and physical changes that occur during processing, handling, and storage of fish oils and fish oil derivatives to edible usage.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0083, APPLICATION OF RADIATION PASTEURIZATION PROCESSES TO PACIFIC CRAB AND FLounder


The objective of this work is to develop a practical procedure for the radiation pasteurization of Pacific crab meat, flounder fillets, and related products. The specific tasks are: 1. The determination of the optimum pre- and post-irradiation conditions (sample treatments, radiation dose, storage-life tests, etc.) directed towards defining commercial process parameters. 2. The development of methods for assessing quality for maintaining quality control, and for establishing the safety of the radiation-pasteurized seafoods by sensory microbiological, chemical, and physical tests. 3. The determination of maximum time (R-value) for an untrained panel to unanimously reject irradiated fillets and relate to the toxin-production time of corresponding irradiated fillets inoculated with spores of Clostridium botulinum type E at various storage temperatures to establish the safety of the irradiation process. 4. The determination of the commercial value of the radiation-pasteurization process by shipping commercial quantities of irradiated fillets through regular commercial channels for evaluation by industry.

SUPPORTED BY U.S. Atomic Energy Commission

6.0084, PRESERVATION AND DEVELOPMENT OF FOOD PRODUCTS

R.W. NELSON, U.S. Dept. of Interior, Technology Laboratory, Seattle, Washington

This project involves a continuing study of methods (sensory, chemical, and physical) for determination of the quality of fishery products, the changes due to processing, and the effects of various techniques of preservation. Current subprojects are:

Quality Criteria Development: In connection with other projects and phases of the program research will be conducted on methods of evaluating and assessing the quality of fishery products. The criteria developed will be used in evaluating the effectiveness of preservation and processing variables and treatments for the entire program. Adaptation of color measurement techniques to fishery products evaluation, improved procedures for measuring texture, and rapid methods for measuring salt content are examples of analytical procedures which may be investigated.

New Products from Underutilized Species: Underutilized species will be used in preparing new types of products and in modifying conventional products which will accommodate some of the unusual properties previously considered undesirable. Fish blocks prepared from ground fish tissue of various species will be investigated. Products such as fish catfish, canned smoked products, fish blocks with flavor additives, and canned products with altered flavor and texture will be prepared as a means of utilizing species of rockfish, sole, herring, mussels, squid, and others which are not readily acceptable in their present form.

Shellfish Preservation Studies: Research is being conducted on methods of holding and shipping live shellfish in order to extend market areas farther from the fishing grounds. Procedures for packaging live crabs and maintaining them alive after reaching the destination are being developed. The relationship between time and temperature of holding and crab condition are being studied. The feasibility of air-shipping live crabs from the Pacific Coast to the East Coast is being investigated.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0085, STUDY OF THE BASIC MICROBIOLOGICAL AND BIOCHEMICAL FACTORS IN THE IRRADIATION PRESERVATION OF MARINE PRODUCTS

J. LISTON, Univ. of Washington, Graduate School, Seattle, Washington 98122

This project represents a continuation of a general investigation of the effects of low dose gamma radiation on the microflora of fish and shellfish and the changes which occur in this flora during refrigerated storage of the irradiated food. The results achieved previously have confirmed that sequential double irradiation treatments are highly effective in retarding bacterial spoilage of fish fillets. Studies of the nature of radiation damage in S. aureus cells suggest that this effect may be due in part to a sensitizing effect of the primary irradiation exposure. The proposed work is designed to determine optimum conditions for effective double irradiation processes and to relate the procedure to shipment of fresh seafood. Radiation studies will be made of the effectiveness of low dose irradiation in eliminating enteric organisms from West Coast shellfish.

SUPPORTED BY U.S. Atomic Energy Commission

6.0086, LOW TEMPERATURE GROWTH OF BACTERIA ON FOODS

J. LISTON, Univ. of Washington, Graduate School, Seattle, Washington 98122

This investigation is concerned with the low temperature growth of bacteria on foods. The organisms to be used in these studies will be gram-negative rod-shaped bacteria. Objective: During a study of the low temperature growth of bacteria on foods. The organisms to be used in these studies will be gram-negative rod-shaped bacteria. Objective: During a study of the low temperature growth of bacteria on foods. The organisms to be used in these studies will be gram-negative rod-shaped bacteria. Objective:
active at low temperatures. Enzyme systems which show activity shifts with lowered temperature will be investigated to determine their temperature optima and confirm or refute the hypothesis that psychrophilic growth in bacteria is mediated by the cell's ability to produce both mesophiles and psychrophilic enzymes.

SUPPORTED BY U.S. Dep. of Hith. Ed. & Wel. - P.H.S.

6.0087, BOTULINUM FOOD POISONING IN RELATION TO FIS. EY PRODUCTS
E.M. FOSTER, Univ. of Wisconsin, Agricultural Experimental Sta., Madison, Wisconsin

Objectives: To study (1) ecology of C. botulinum type E in the Great Lakes; (2) conditions affecting spore formation by C. botulinum type E; (3) the heat resistance of C. botulinum type E spores with the view of establishing minimum times and temperatures that will destroy the majority of spores without damaging marketability of the product; and (4) to establish conditions necessary to prevent growth of C. botulinum type E fishery products.

Procedure: Samples of fish, water and mud from the Great Lakes will be tested for C. botulinum type E to see if its occurrence can be related to specific environmental conditions. Study cultural conditions of spore formation of C. botulinum, observing effects of nutrients, pH, incubation temperature, and time on sporogenesis. Establish minimum temperature and time which will destroy all heat sensitive spores. Determine efficacy of various food additives for purpose of preventing growth of spores which survive the heat process. Salt, benzoate, nitrite and polyphosphate hold promise. Whether an effective control procedure is found in the laboratory it will be tried on a pilot scale basis with full size equipment operated under normal commercial conditions.

SUPPORTED BY U.S. Dept. of Agriculture
Wisconsin State Government

6.0088, DISTRIBUTION OF C. BOTULINUM IN COMMERCIAL SMOKED FISH
E.M. FOSTER, Univ. of Wisconsin, Agricultural Experimental Sta., Madison, Wisconsin

Outbreaks of type E botulism in 1960 and 1963 have been traced to smoked fish processed in the Great Lakes area. The purpose of this study is to determine the source of C botulinum type E in this fish.

Samples of water, mud and fish from various places in the Great Lakes will be tested for the presence of the type E organism to see if it occurs commonly and, if so, where it exists on or in the fish. Various species of fish will be tested to see if there is a difference in incidence between species. Efforts will be made to determine the natural habitat of the organism if it is found commonly. Concurrently, experiments will be run to evaluate methods of detecting C botulinum type E in natural materials.

SUPPORTED BY Wisconsin State Government

6B. HYPERBARIC MEDICINE AND ADAPTATION
(affects of Deep Oceans on Divers and Habitation)

6.0089, MAN IN THE SEA - VISUAL ACUITY RESEARCH
R.A. CHRISTIANSON, North Amer. Rockwell Corp., Long Beach, California 90803

Experiments at North American Rockwell's Ocean Systems Operations conducted the initial phases of a research program for testing and measuring the visual responses of divers underwater. Using specially developed techniques and instrumentation, it was found that divers require between 63 and 72 percent more time to perceive and respond to the details of an object when viewed underwater. According to test conclusions, this is partially due to the slight jarring of a diver's head caused by his rising exhalation bubbles, as well as other probable contributing factors. This work was undertaken because divers are being called upon to perform complex underwater-tasks, read instruments in flooded submersibles, and perform a variety of visual search and identification missions where visual perception of objects underwater is of major importance. The project manager, R. A. Christianson, concluded that the technique and instrumentation developed for the visual acuity research was highly successful and will be standardized as a basis for future company experimentation in this area.

The experimental work was conducted at the Dr.ing Research Facility of the University of California at Los Angeles. A technical report, 'A Study of Visual Acuity Underwater Using an Automatic Landolt Ring Presentation Technique', X8-128.020, February 1968, was prepared by Raymond A Christianson.

SUPPORTED BY North American Rockwell Corporation

6.0090, SHARK ATTACKS
L.P. SCHULTZ, Smithsonian Institution, Washington, District of Columbia 20560 (NONR)

This work unit provides for the compilation of information on factors relating to shark attacks on humans. These data include geographic distributions of certain shark species and the environmental conditions attending shark attacks. These data are now being analyzed in an effort to form a basis for the prediction of attacks. A central reference file is maintained for the use of investigators in this field. In addition, the Museum's reference collection of sharks and other elasmobranch fishes has been made accessible to researchers by the establishment of special new tanks and hoists which allow easier observation and handling of the large specimens. The shark file is now being prepared for incorporation into a data retrieval system.

It has become evident that the Navy's increasing use of relatively unprotected swimmers and divers in such operational activities as beach reconnaissance, UDT work, and amphibious landings has increased the hazard of encounter by sharks and other noxious animals. Damage to morale and the interference with psychological readiness are often equally detrimental to an operation. It is important, therefore, that the extent of the problem in specific geographic areas be evaluated and that as much as possible be learned about the conditions which affect the behavior of sharks. Such information will also serve to guide the chemists and engineers in the development of shark repellents, as well as those who must judge the value of recommended methods.

SUPPORTED BY U.S. Dept. of Defense - Navy

6.0091, SEALAB III PARTICIPATION

The U.S. Navy is exploring the possibilities of having men do useful work from an ambient pressure habitat 620 feet beneath the surface of the ocean off San Clemente Island, California (Sealab III). As an integral part of this experiment two aquanauts from the Bureau of Commercial Fisheries will, for the first time at this depth, do extended work in marine biology and ecology. The major purpose of BCF participation is to create a cadre of personnel trained in saturation diving techniques and familiar with engineering, design, support, and operations of seafloor habitations. In so doing, the Bureau will be assisting the Navy by providing know-how in marine biology. The participation of the Eucal's diving scientists will also enable them to make a preliminary assessment of the value to research programs of in situ observations and work.

A number of short-term experiments will be undertaken. These include: lobster transplant studies, light attraction studies of fish and invertebrates, observations of fish behavior, species interaction, and light production by biological organisms.

The development of this underwater capability will reveal new avenues of bureau knowledge and radically different methods of ocean harvesting.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0092, METABOLIC ADAPTATION TO COLD
S.K. HONG, Yonsei University, Seoul, Korea

254
Objective: Prof. Hong will continue his studies on cold adaptation of the diving women of Korea which he has been working on for several years in collaboration with Prof. Herman Rahn and Dr. D. W. Rennie of the University of Buffalo. Emphasis in the first phase of this grant will be on regional heat loss during cold water immersion in order to describe more precisely the role of blood flow and deep muscle temperature.

6.0093, ENVIRONMENTAL PHYSIOLOGY
L. FARHI, State University of New York, School of Medicine, Buffalo, New York 14214

Objective: The objective of this program is to increase our knowledge and understanding of the effects of various environmental stresses on Naval and Marine Corps personnel. This research will elucidate and solve some of the biomedical problems of deep submergence associated with the adverse conditions of free swimming and SeaLab type environments.

Approach: The contractor is conducting research, using basic and novel techniques and high pressure physiology to study submergence, deep submergence, increased 'G' forces, and gas exchange in SeaLab type environments. Each of these operational conditions, which is characterized by specific change in one or more of a relatively small number of environmental factors such as gravity, pressure, temperature, breathing atmosphere, or surrounding medium, is being studied. This program will not only investigate how man is affected by these various environmental conditions but also how the steps that can be taken to improve performance, extend the limits of exposure, and promote acclimatization.

SUPPORTED BY U.S. Dept. of Defense - Navy

6.0094, HUMAN TEMPERATURE REGULATION IN WATER
D. W. RENNIE, State University of New York, School of Medicine, Buffalo, New York 14214

It is our broad purpose to study temperature regulation of human beings in a water environment. Emphasis will be upon the effects that exercise in water has upon body heat loss, overall cardiac output and the vascular distribution of blood. Specifically, we propose to measure heart rate, VO2, cardiac output and regional heats of man at rest and exercising in water of different temperatures and in different underwater postures. The ventilatory response to exercise in water will be compared to that in air as will the local distribution of blood to exercising limbs.

Basic instrumentation and techniques have been and will continue to be developed on ourselves in the Department of Physiology at Buffalo. These methods will then be applied to a study of cold-acclimatized human beings, the Korean diving woman, who have been studied extensively by us in the past in the excellent field laboratory in Pusan, Korea.

SUPPORTED BY U.S. Dept. of Defense - Air Force

6.0095, THERMAL REGULATION DURING WATER IMMERSION OF MAN
A.B. CRAIG, Univ. of Rochester, School of Medicine, Rochester, New York 14627

Water immersion is a physiological stress which affects respiratory, cardiovascular, and thermal regulatory mechanisms. Past and present studies in this laboratory have indicated that in man an understanding of the heat exchanges during immersion is fundamental to many other responses. Indirect calculations by methods used for man in air are not applicable to the subject in water.

It is proposed that thermal exchanges and their regulation will be studied using methods of direct calorimetry. A bath calorimeter will be constructed and operated. Heat loss from the bath will be controlled and measurable. Heat input will be from the immersed subject and from electrical heating elements.

SUPPORTED BY U.S. Dept. of Defense - Air Force

6.0096, MANNED DIVING RESEARCH
H.R. SCHREINER, Ocean Systems Incorporated, Tonawanda, New York 14150

Exposure of the deepsea diver to air or synthetic breathing gas mixtures under increased pressure leads to the uptake of inert gases by his tissues. These dissolved gases must be removed by his circulatory and respiratory system during his ascent to the surface in a manner which precludes the formation of a clinically significant gas phase. This program evaluates in human decompression experiments the theoretical ascent profiles that have been developed for this purpose by proprietary computer methods. A five-lock, 700-cu.ft. pressure chamber is being utilized for this investigation. This manned diving research facility is extensively instrumented for physiological research, its individual components provide working pressure equivalent to seawater depths ranging from 600 to 1000 feet.

Proprietary decompression schedules for helium-oxygen dives to up to 450 feet of seawater developed by this program have been extensively field-tested by Ocean Systems Operations, yielding a current level of incidence of decompression sickness of 2%. The current objective of this program is to extend this decompression capability to manned working dives to depths of 1000 feet.

SUPPORTED BY Ocean Systems Incorporated

6.0097, HUMAN PERFORMANCE
H.R. SCHREINER, Ocean Systems Incorporated, Tonawanda, New York 14150

The limits of human performance under conditions of submergence and exposure to high gaseous pressures is being investigated under this program. Particular attention is being directed to measuring the ability of the deep sea diver to perform manual and mental tasks and to determine the degree of deterioration of his performance under the influence of environmental factors.

SUPPORTED BY Ocean Systems Incorporated

6.0098, DECOMPRESSION TABLE DEVELOPMENT
H.R. SCHREINER, Ocean Systems Incorporated, Tonawanda, New York 14150

Using advanced mathematical models of inert gaseous transport in the human body this proprietary project is devoted to (1) computer analysis of past diving experience, (2) establishment by statistical methods of the probable risk of decompression sickness associated with any given dive profile, (3) development, by digital computer methods, of decompression tables for dives to depths of up to 1500 feet of seawater.

SUPPORTED BY Ocean Systems Incorporated

6.0099, NITROGEN-OXYGEN DECOMPRESSION TABLES FOR ALTITUDE FLIGHT
H.R. SCHREINER, Ocean Systems Incorporated, Tonawanda, New York 14150

The objective of this program is to complete the development of nitrogen-oxygen decompression tables for the safe ascent of aerospace personnel from ground level to altitude which was initiated during the first year of this contract. This will be done by (1) analyzing a total of 1338 altitude decompression histories accumulated under controlled laboratory conditions, (2) extracting from these computer analyzed decompression histories statisti-
6. PUBLIC HEALTH AND SAFETY

function of macromolecules by virtue of specific interactions? (2) to the following two questions: (1) Do gases having important

6.0100, RESEARCH STUDIES IN MOLECULAR PHARMACOLOGY

Research under this program is designed to produce answers to the following two questions: (1) Do gases having important roles in pharmacology, anesthesia, and diving physiology alter the function of macromolecules by virtue of specific interactions? (2) What effects do these gases have on the permeability of cell membranes to amino acids, sugars and ions?

Approaches to be utilized in the execution of this program include the measurement of (1) solution and solid state binding equilibria of inert gases with biopolymers, (2) electronic absorption spectra of inert gas-modified compound systems to determine possible charge-transfer interactions, (3) 'inhibitor' binding energies from thermodynamic analysis of enzyme inhibition kinetic data, and (4) membrane transport in cultured mammalian cells.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

6.0102, CHARACTERIZATION AND MODE OF ACTION OF PROTEIN VENOMS OF MARINE ANIMALS
G.A. FEIGEN, Stanford University, School of Medicine, Palo Alto - Stanford, California 94305

During the past year Dr. Feigen has undertaken a preliminary investigation of the chemistry and mode of action of the venom produced by the Hawaiian sea urchin. The results of these studies show that the venom is a protein having a Svedberg coefficient of 2.6, that it is relatively stable at room temperature at a neutral pH, and that it precipitates from aqueous solution in the presence of 65%-saturated ammonium sulfate. It is lethal in intravenously and intraperitoneal injection in mice. It contracts the isolated guinea pig heart. Concomitantly, it liberates histamine from these tissues together with other physiologically active materials which have not yet been identified. Preliminary studies of its mode of action suggest it may be a lecithinase.

The aim of the present research is to complete the chemical and pharmacological characterization of this venom and to initiate certain immunological, physiological, and biochemical studies to contribute to the understanding of its chemistry and mode of action. At the same time, it is intended to compare the chemical, pharmacological, and immunological characteristics of the venom of the Hawaiian species with that found on the Pacific coast, particularly in the vicinity of the Hopkins Marine Station at Pacific Grove.

SUPPORTED BY U.S. National Science Foundation

6.0103, MODE OF ACTION OF MARINE TOXINS
G.A. FEIGEN, Stanford University, School of Medicine, Palo Alto - Stanford, California 94305

Studies during the current grant period have shown that crude sea urchin toxin contains a variety of enzymes which can react with serum proteins to form dialyzable physiologically active products that have striking pharmacological similarities to plasma kinins. Partially purified fractions have shown a high degree of substrate specificity, particularly with respect to attack on 1) purified a2-macroglobulin and 2) B-globulin. They also possess the property of inactivating the product as well as synthetic bradykinin. These fractions are immunogenic and the rabbit antibodies have been shown to 1) fix complement; 2) precipitate; 3) protect against, and 4) neutralize the toxin. This year our aims will be: 1) to continue purification by column chromatography; 2) to study the mode of enzymatic action on natural and synthetic substrates; 3) to determine the antigenic components; 4) and to attempt a characterization of the product formed by pharmacological and chemical methods, which will require the preparation of large quantities of material by the attack of the various enzymes on human plasma proteins.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

6.0104, PHARMACOLOGY AND CHEMISTRY OF TOXIC MARINE ANIMALS
F.A. FUHRMAN, Stanford University, School of Medicine, Palo Alto - Stanford, California 94305 (N00014-67-C-0319)

Objective: Understanding the sources as well as the effects of toxins found in certain marine organisms is germane to successful survival techniques. Hence, it is important to have a background of pharmacological information regarding such toxins as those found in the eggs of certain fish.

Approach: The investigator will study the effects of cabezon (Scopaneichthys marmoratus) toxin on lymphocytes in the blood, muscle contraction, and upon other organs. Preliminary studies of the chemical structure of the toxin and its purification have been necessary to provide material for the pharmacological studies.

SUPPORTED BY U.S. Dept. of Defense - Navy

6.0105, CHEMISTRY AND PHARMACOLOGY OF TETRODOTOXIN
H.S. MOSHER, Stanford University, Graduate School, Palo Alto - Stanford, California 94305

The distribution of tetrodotoxin in nature is being explored and a search is being made for other animal toxins.

Chemical studies aimed at the synthesis of tetrodotoxin-like structures are under investigation. The ultimate aim is to prepare related derivatives or analogs for further investigation of their pharmacological activity.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

6.0106, USEFUL BIOMEDICAL MATERIALS DERIVED FROM THE SEA - AN INTERDISCIPLINARY APPROACH

Recent work identified the presence of a substance extracted from the liver of the lemon shark which acts as a stimulant to the body's host defense system and also suggested that other fractions of this same extract could inhibit this same system. At the present time physical and chemical analyses are being made to determine the structure of the active agents. Work under this project will include the determination of the scope and level of effectiveness of the materials in various disease states and the tolerance level and toxicity, if any. Also, efforts to understand the biochemical mechanism by which these materials activate the host defense system will be made.

256
6.0107, PHYSALIA TOXIN AND THE ACTIVITY OF BIOLOGICAL MEMBRANES
A.H. BANNER, Univ. of Hawaii, Hawaii Inst. of Marine Biology, Honolulu, Hawaii 96822

The investigator is examining the properties of the toxin of Physalia, the ‘Portuguese Man O’ War’ which accounts for its activity on specialized conduction systems as those in the mammalian heart, on ionic regulation in crustaceans and on the sodium, potassium and ATP enzymes of gills, nerves and gut membranes of crustaceans. He is utilizing his knowledge of this toxin as a means to study the mechanisms of active transport in a variety of biological membranes.

Physalia, as well as most other pelagic coelenterates, produce a potent toxin. While some forms are mainly a nuisance, others are fatal and have been known to cause death in seconds. Its mode of action is not known and the proposed research may provide information useful in the development of antidotes for slower acting forms or perhaps preventative to be administered to personnel liable to encounter jellyfish. Knowledge about active transport through biological membranes is applicable to an enormous number of biological and medical problems.

SUPPORTED BY U.S. Dept. of Defense - Navy

6.0108, EFFECTS OF INGESTION OF RADIOACTIVE FISH AND THE NATURE AND BIOLOGY OF TOXINS IN CERTAIN FISHES
A.H. BANNER, Univ. of Hawaii, Hawaii Inst. of Marine Biology, Honolulu, Hawaii 96822

This is part of a comprehensive investigation of the toxin causing ciguatera, a disease resulting from the ingestion of coral reef fish of the Pacific. Studies included in the project are: 1. An investigation of the biological origin and transmission of the toxin; it is suspected that the toxin originates in some alga at the base of the food pyramid and is transmitted through the food chain to the large carnivores where it is stored. 2. An investigation of the chemical nature of the toxin; the empirical and structural formula of the toxin, previously isolated at the ratio of approximately one part per million of raw fish, are currently being studied. 3. An investigation of the pharmacological action of the toxin; during the previous year it was established that this toxin is an irreversible anticholinesterase, and presently this knowledge is being utilized to develop a new in vitro assay, while other species of fish are being considered to have the same toxin, are being investigated to determine the presence of a toxin with this specific action.

SUPPORTED BY U.S. Atomic Energy Commission

6.0109, EXPLORATION FOR TOXIC MARINE ANIMALS IN THE TROPICAL PACIFIC
A.H. BANNER, Univ. of Hawaii, Hawaii Inst. of Marine Biology, Honolulu, Hawaii 96822

The investigator and his team are searching the waters off of the tropical Pacific Islands for organisms in the food chain which may be the source or one of the sources of the toxins found in marine life, capable of causing severe poisoning in humans. Special attention is being accorded those organisms or toxins which have not previously been extensively studied.

The importance of understanding the geographical distribution and physiological action of toxins relates to protection of personnel which may consume toxic foods under survival or recreational conditions. The utilization of these toxic substances for medical purposes may provide new investigative techniques in human pathology.

SUPPORTED BY U.S. Dept. of Defense - Navy

6.0110, EXPLORATION FOR TOXIC MARINE ANIMALS IN THE TROPICAL PACIFIC
A.H. BANNER, Univ. of Hawaii, Hawaii Inst. of Marine Biology, Honolulu, Hawaii 96822 (N00014-67-C-0127)

The investigator and his team are searching the waters off of the tropical Pacific Islands for organisms in the food chain which may be the source or one of the sources of the toxins found in marine life, capable of causing severe poisoning in humans. Special attention is being accorded those organisms or toxins which have not previously been extensively studied.

The importance of understanding the geographical distribution and physiological action of toxins relates to protection of personnel which may consume toxic foods under survival or recreational conditions. The utilization of these toxic substances for medical purposes may provide new investigative techniques in human pathology.

SUPPORTED BY U.S. Dept. of Defense - Navy

6.0111, PHYTOCHEMISTRY OF NARCOTIC PRINCIPLES IN CAULERPA
M.D. DOTY, Univ. of Hawaii, Graduate School, Honolulu, Hawaii 96822

Three kinds of substances have been obtained in pure form: sterols, red crystalline caulerpin and a physiologically active compound, caulerpin. Significant progress has been made toward processing 76 kilos of Caulerpa lamourouxi for major and pharmacologically active constituents. Techniques were developed and modified. Three papers were presented at the International Congress of Marine Phycolology symposia, one was published and two are in the manuscript stage.

Taxonomic studies preliminary to phytochemistry work have been done on the genera Caulerpa and Laurencia.

Using special gas chromatographic columns, a mixture of about 50 aromatic substances has been obtained from Dictyopteris plagiogramma and D. australis and these are awaiting mass spectrometric determination.

At present the chemical work involves developing thin-layer chromatographic and other microsats methods for use in following the active substances in the food chain and in ecological work.

A marine laboratory has been refurbished and air conditioning for experimental culture of Caulerpa, and general culture methodology is being developed for future chemical biogenetic work.

SUPPORTED BY U.S. Dept. of Hth. Ed. & Wel. - P.H.S.

6.0112, PACIFIC BIOMEDICAL RESEARCH
T.A. ROGERS, Univ. of Hawaii, Pacific Biomedical Res. Center, Honolulu, Hawaii 96822

Planning in the Pacific Biomedical Research Center will be continued with particular emphasis on development of: a) A Marine Experimental Laboratory for the exploitation of marine organisms for basic biomedical research. b) A research program in the pharmacology of natural products of the Pacific. c) A research program in regeneration of nerve structure and function. d) A program in Tropical Medicine, with initial emphasis on Hansen’s Disease. e) A program in experimental psychology. f) Planning for the orderly development of rapidly expanding animal facilities in several physical locations.

SUPPORTED BY U.S. Dept. of Hth. Ed. & Wel. - P.H.S.

6.0113, MARINE TOXINS OF THE TROPICAL PACIFIC
A.H. BANNER, Univ. of Hawaii, Hawaii Inst. of Marine Biology, Kaneohe, Hawaii 96744

The importance of understanding the geographical distribution and physiological action of toxins relates to protection of personnel which may consume toxic food under survival or recreational conditions and to the utilization of the substances for medical purposes may provide new investigation techniques in human pathology.
6. PUBLIC HEALTH AND SAFETY

In the investigation all marine toxins arising from the tropical biota of the reef and shore fauna of the Central Pacific that may be passed on to man, directly or indirectly, will be studied. The studies are divided into three major phases: the biological origin, the chemical isolation and identification, and the pharmacological action of the toxins. Correlated with the major aspects of the investigation is the accumulation of local island knowledge of toxic marine animals, native remedies, and the epidemiology of fish poisoning in the Pacific.

For the present year of investigation, as in the previous years, the main emphasis will be upon those fish which are regionally toxic and cause the loosely defined disease known as ciguatera. Biological field studies will be conducted in French Polynesia; chemical studies will attempt to further elucidate the structure of the toxic molecule, now isolated; and pharmacological studies will be concerned both with the development of assay methods adaptable for field conditions and with investigations of the mode and site of action of the drug.

SUPPORTED BY U.S. Dept. of Hth. Ed. & Wel. - P.H.S.

6.0114, STUDIES ON VIBRIO FOOD POISONING
K. FUJIWARA, Chiba University, Chiba City, Japan

The purpose of this work is elucidation of manifestation mechanism in vibrio food poisoning. The project consists of two parts mainly.

The first one is feeding experiments with monkeys to examine synergic activities of toxic metabolites produced by the pathogenic bacteria in provoking symptoms. The materials given will be mixtures of endotoxin fractions and haemolytic agents extracted from cells and culture supernatants of Vibrio parahaemolyticus. The materials of torquacity will be examined histologically and microbiologically.

The second part is study on host side factors in developing of food poisoning symptoms. In order to investigate the influences of substances in pharmacological activities similar to histamine i.e. serotonin will be given to experimental animals with living cells of Vibrio parahaemolyticus. And besides, the relationship between animal conditions and situations of living, i.e. fatigue and other factors which might have influences on vegetative nervous systems, in human beings, will be investigated epidemiologically in many outbreaks of this type of food poisoning.

SUPPORTED BY U.S. Dept. of Hth. Ed. & Wel. - P.H.S.

6.0115, ORGANIC CHEMICAL STUDIES ON ANIMAL AND PLANT TOXIN
Y. HIRATA, Nagoya University, Nagoya, Japan

Organic chemical studies are currently in progress on the following toxic components of plant and animal origins.

1) Alkaloids of Daphniphyllum macropodum M.: Synthetic work is in progress. Structural investigations of newly isolated alkaloids is being conducted. Transformation of yuzurimine to daphniphylline is being attempted. Physiological action of each alkaloid is being tested.
2) Alkaloids of Orchidaceae: Synthetic work is in progress. Transformation of certain alkaloids is being conducted. Transformation of yuzurimine to daphniphylline is being attempted. Physiological action of each alkaloid is being tested.
3) Alkaloids of Anodendron affine D. and of Trochelospermum asiaticum N. (Apocynaceae): The alkaloidal components have not as yet been obtained in a pure form. The latter one was reported to have anti-cancer properties. 4) Toxic plankton (Gonyaulax polyedra): We have collected a large amount of the plankton and are currently attempting purification of the toxic component(s).

SUPPORTED BY U.S. Dept. of Hth. Ed. & Wel. - P.H.S.

6.0116, MARINE ANIMAL TOXINS
S.L. FRIESS, U.S. Navy, Medical Research Inst. , Washington - Bethesda, Maryland

This effort is comprised of two closely related parts. The pharmacology and physiological pathways of biologically active substances from marine organisms and the modes of action of some of these substances when used in the field to repel or deter sharks. Holothurin, an extremely toxic substance produced by certain echinoderms is the primary subject of these studies. Other substances are also being sought which will have similar characteristics and action.

The need to become knowledgeable about biologically active substances from the sea is serious from several points of view. Very little is known about these substances, many of which are very different from terrestrial toxins. Personnel in survival, operational, or recreational situations must be warned of the presence and behavior of dangerous local animals, antidotes, and treatment techniques must be developed. Since the producers of the toxins appear to use them against enemies, they serve as a likely source of information about protective chemicals and repellents, especially against sharks.

SUPPORTED BY U.S. Dept. of Defense - Navy

6.0117, ACTIVE CHEMICAL PRINCIPLES DERIVED FROM ECINODERMS
S.L. PRIESS, U.S. Navy, Medical Research Inst. , Washington - Bethesda, Maryland (PO)

This work unit involves the study of the neuropharmacologic, enzymic and toxicologic properties of biologically active principle elaborated by marine animals and plants. Primary emphasis is directed to those natural products and their derivatives which exert blocking actions in mammalian neuromuscular tissues, or which appear to exert specific actions at chemoreceptor systems controlling behavioral responses to stimuli. Holothurin A, an extremely toxic substance extracted from the Balsamian Sea cucumber is the primary subject of these studies, while other toxins extracted from related Echinoderms are being compared pharmacologically.

Operational difficulties created by noxious marine animals point to the need to become knowledgeable about biologically active substances from the sea. Very little is known about the substances, many of which are very different from terrestrial toxins. Personnel in survival, operational, or recreational situations must be warned of the presence and behavior of dangerous local animals, antidotes, and treatment techniques must be developed. Since the producers of the toxins appear to use them against enemies they serve as a likely source of information about protective chemicals and repellents, especially against sharks.

SUPPORTED BY U.S. Dept. of Defense - Navy

6.0118, ELASMOBRANCH PHARMACOLOGY
S.L. SCHWARTZ, U.S. Navy, Medical Research Inst. , Washington - Bethesda, Maryland (PO)

This research program is a pharmacological survey of the elasmobranches. Primary emphasis is on the actions of drugs and the consequences of their various means of administration on sharks. A comprehensive array of drug depressants and stimulants is being evaluated for their effects on the central nervous system and cardiovascular systems of sharks, as well as on the chemical nerve system of sharks, as well as on the central nervous systems of sharks, as well as on the cardiovascular system. Concurrently, the drug and stress-induced reactions of the study animals will be described as a function of the variation in their biochemical profile.

There exists a continuing need for knowledge of the many noxious marine animals encountered in Naval operations. Particularly important in this regard is the requirement for wide ranging studies on shark biology. Protection of Naval personnel from predacious shark activities and the related search for an improved shark repellent necessitate comprehensive data on the reactions of these animals to chemical and physical stimuli. Additionally, the increasing numbers of scientists who are utilizing sharks as study animals in Naval medical research relating to normal and abnormal human physiology and biochemistry point up the need for foundation studies such as this one.

SUPPORTED BY U.S. Dept. of Defense - Navy

6.0119, ELASMOBRANCH PHARMACOLOGY
S.L. SCHWARTZ, U.S. Navy, Medical Research Inst. , Washington - Bethesda, Maryland

258
This research program is a pharmacological survey of the elasmobranchs. Primary emphases will be on the actions of drugs and the consequences of their various means of administration on sharks. A comprehensive array of drug depressants and stimulants will be evaluated for their effects on the central, autonomic, and peripheral somatic nervous systems in sharks, as well as the cardio-vascular complex. Concurrently, the drug and stress-induced reactions of the study animal will be described as a function of the variation in their biochemical profile.

There exists a continuing need for knowledge of the many obnoxious animals encountered in Naval operations. Particularly important in this regard is the requirement for wide ranging studies on shark biology. Protection of personnel from predacious shark activities and the related search for an improved shark repellent necessitate comprehensive data on the reactions of the animals in medical research relating to normal and abnormal human physiology and biochemistry point up the need for foundation studies such as this one.

SUPPORTED BY U.S. Dept. of Defense - Navy

6.0120, MONITORING OF PESTICIDE LEVELS IN THE GREAT LAKES

R. REINERT, U.S. Dept. of Interior, Biological Laboratory, Ann Arbor, Michigan

A monitoring program to measure levels of insecticides in various species of fishes and water from each of the five Great Lakes.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0121, COMPARATIVE STUDIES OF DINOFLAGELLATE TOXINS

J.J. SASNER, Univ. of New Hampshire, Graduate School, Durham, New Hampshire 03824

The proposed research program will attempt to elucidate the physiological and pharmacological effects of several naturally occurring marine dinoflagellate biotoxins. Primary objectives are: 1) to culture several dinoflagellate species in the laboratory; 2) to concentrate these cells, extract and accumulate the harmful materials; and 3) to test, in a comparative manner, their effects on living systems, particularly nervous and muscle tissues. The primary goal is to study the deleterious effects of these microorganism products on the electrogenic properties of excitable systems; including resting and action potential in nerve and muscle and parameters of contraction and tension development in muscle. Both vertebrate and invertebrate nerve-muscle systems will be tested. Similar experiments, comparing neurogenic and myogenic cardiac systems, are planned. In general, comparative studies will include the testing of toxins on invertebrate organisms, particularly molluscs and crustaceans which, in nature, are subject to the effects of dinoflagellate 'blooms'.

The association of paralytic shellfish poisoning and ciguatera-like poisoning with substances produced by marine dinoflagellates has closely linked commercial fisheries research with that of public health. Relatively recent chemical and biological findings concerning this association will now permit studies of the comparative effects of these naturally occurring biotoxins, as well as their specific site(s) and mode(s) of action. It is toward this understanding that this research proposal is intended.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

6.0122, STUDIES ON PHARMACOLOGICALLY ACTIVE COMPOUNDS DERIVED FROM MARINE ORGANISMS


The proposed work is subdivided into 3 parts:

(1) To develop nutritional fish protein concentrates suitable for use in human diets,
(2) To nutritionally evaluate fish protein concentrate,
(3) To investigate the basic chemistry of fish protein concentrates.

SUPPORTED BY Oregon State Government

6.0123, NEW DRUGS FROM THE SEA, ESPECIALLY ANTIBIOTICS

P.R. BURKHOLDER, Columbia University, Graduate School, Palisades, New York 10964

Numerous kinds of marine plants and animals are being screened for antimicrobial properties and other kinds of biological activity. Crystalline compounds and oils have been isolated from marine algae and sponges and the chemical structures determined for some of them.

Research will continue mainly on the isolation and characterization of antimicrobial substances produced by marine flora and fauna in the Caribbean Sea and the Pacific Ocean.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

6.0124, STUDY OF TOXIN SYNTHESIS IN PRYMNESSUM PARVUM

G.M. FADILLA, Duke University, School of Medicine, Durham, North Carolina 27706

To establish axenic cultures of marine and fresh water algae that yield toxins of potential health hazard in order to study the factors which govern the growth and toxigenesis of such organisms. To continue investigations on the cellular localization of toxin synthesis in the euryhaline flagellate Prymnesium parvum by density gradient ultracentrifugation and extend such studies to representatives of dinoflagellates, such as Gonyaulax and Gymnodinium. Lastly, to develop physiological and chemical assays of such toxins to determine their mode of action, chemical identity, and potential use as pharmacological agents.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

6.0125, UTILIZATION AND PREPARATION OF FISH PROTEIN CONCENTRATE

J.E. LANGER, Oregon State University, Agricultural Experiment Sta., Corvallis, Oregon 97331

Objectives: (1) To develop nutritive fish protein concentrates suitable for use in human diets, (2) To nutritionally evaluate fish protein concentrate, (3) To investigate the basic chemistry of fish protein concentrates. (4) To investigate, develop and/or improve products utilizing fish protein concentrate that are aesthetically consistent and of acceptable flavor to the ethnic and national groups intending to use fish protein concentrate in their diets. A fish protein concentrate (FPC) will be developed that is suitable for use in human diets. Experiments will be conducted to evaluate and expand basic knowledge concerning the chemistry and nutritive value of FPC. New and/or existing products will be investigated utilizing FPC as a source of protein. Especially efforts will be directed toward the development of food products that will be acceptable to those in the developing nations who are desperately in need of nutritive proteins in their diets.

SUPPORTED BY Oregon State Government

6.0126, MARINE ANIMAL USE IN THE STUDY OF HEALTH PROBLEMS

I. PRATT, Oregon State University, Graduate School, Corvallis, Oregon 97331

The proposed work is subdivided into 3 parts:

Ivan Pratt will work on the life cycle of a hemiurid trematode, Tubulovesicula lindbergi and start or continue several other trematode and acanthocephalan ecology studies.

Austin Pritchard will study the metabolism of intertidal molluscs and crustaceans by varying oxygen tension, temperature and other ecological factors.

Frederick Hisaw, Jr. will work on the isolation and effects of various hormones or hormone-like substances found in fish, tunicates and echinoderms.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

6.0127, CONTROL OF PLANT PATHOGENS USING ACTIVE ANTIMICROBIAL SUBSTANCES ISOLATED FROM MARINE ALGAE

N.G. NADAL, Univ. of Puerto Rico, Agricultural Experiment Sta., San Juan - Rio Piedras, Puerto Rico 00931

The proposed work is subdivided into two parts:

(1) To isolate and purify substances that are active against the disease-causing organisms, and (2) To achieve control of these disease-causing organisms using these isolated substances.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.
6. PUBLIC HEALTH AND SAFETY

Description of Work: Sargassum complex purified from crude extracts of Sargassum natans, Chondria litoralis, Cymopolia barbata will be separated in A and B fractions by paper chromatography. Their effect (using bioautographs) will be studied on such plant pathogens as Fusarium of tobacco and coffee, Cerocspora cf. tobacco, coffee and banana, Alternaria of tobacco and Pseudomonas on tomatoes. Dose response curves will be drawn. Synthetic and natural medias (plant tissue extracts) will be evaluated as well as the effect of nutrition on pathogenicity of the organisms. Evaluation will be made using antibiotics (cyclohumice, antymycin and streptomycin) as control standards.

SUPPORTED BY Puerto Rico Government

6.0128, ACTIONS OF BIO-TOXINS ON CELL MEMBRANES
M.H. EVANS, Agric. Research Council, Cambridge, United Kingdom

It is proposed to determine, as a first stage, how many so-called 'neurotoxins' of animal origin (snake and other venoms, tissues of poisonous animals and toxins produced by marine organisms) have specific actions upon the nervous and muscular systems of higher vertebrates. If modern neurophysiological research techniques confirm that a poison has a specific neurotoxic action, that poison will be subjected to a more detailed analysis to try and determine the site and mode of action, in the hope that some of these poisons may prove to be useful tools for the physiological research, or may have valuable therapeutic applications.

Some progress in this direction has already been made in the case of some relatively simple stable substances such as Tetrodotoxin and Saxitoxon. As these poisons are now available in pure form it is proposed to subject their actions on nerve and muscle cell membranes to further detailed electrophysical analysis.

Concurrently, the more complex protein types of toxin, especially the venoms of some snakes (Crotalus, Naja and Notechis species) scorpions (Androctonus, Buthus and Centruroides spp.) and spiders (Atrax and Latrodecus spp.) will be studied with the intention of determining whether their reported neurotoxic actions are due primarily to some specific toxic constituent or are more general consequences of their enzymatic activity.

SUPPORTED BY U.S. Dept. of Hith. Ed. & Wel. - P.H.S.

6D. SAFETY AT SEA
(navigation Safety; Shark Attacks.)

6.0129, SURVIVAL CRAFT DRIFT AND LEEWAY
R.C. CLASBY, U.S. Dept. of Transportation, Oceanographic Unit, Washington, District of Columbia

This project is an attempt to determine the effects of wind and sea surface currents on various types of survival craft. The data will be used to update the drift and leeway tables presented in the National Search and Rescue Manual (CG-308).

The project was initiated in FY-68 and will be a continuing project at this Unit.

During the studies buoy-surface current meter systems, with a wind recorder, will be implanted. An 'over-the-side' deck recording current meter will be used, and surface drogues tracked. Various types of life rafts will be used. No oceanographic casts will be made during any of the cruises.

This project is designed to provide a controlled experiment from which data concerning the direct effects of surface currents and wind on various types of survival and small craft can be obtained. This data can then be used to up-date the drift and leeway tables in the Coast Guard Search and Rescue Manual resulting in an increase in search accuracy. The tables now used were prepared during the late 1940's and are very general in scope, having been based on observations with small life rafts at low wind velocities.

Surface currents will be determined from a stationary buoyed current meter and surface drogues. Surface winds will be determined from a wind recording system also mounted on the buoy. The test craft will be equipped with radar transponders and radar reflectors to facilitate tracking. Positions of underway targets will be referenced to two stationary radar targets, i.e. Nantucket Light Vessel and the instrumentation buoy.

SUPPORTED BY U.S. Dept. of Transportation - Coast Guard

6.0130, SEARCH AND RESCUE - U.S. COAST GUARD
A.E. KARP, U.S. Dept. of Transportation, Coast Guard, Washington, District of Columbia 20591

The objective of this project is to provide consultants to assist with problems concerned with locating and rescuing victims of marine accidents. These services will include definition of Operations Research Studies and aid in monitoring such studies.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

6.0131, DIVER NAVIGATION DEVICE

Objective: Provide an accurate means of navigation for the individual diver. Swimmer missions require precise navigation. insure location of the objective in restricted visibility water.

Equipment fulfilling this need must be extremely compact, neutrally buoyant and easily handled by a swimmer and yet provide reliable navigation data regardless of adverse conditions. The system or systems must withstand the environmental conditions imposed.

Approach: Through industry or Navy labs a model of an active self-contained navigation device will be constructed to demonstrate feasibility applied to individual swimmer navigation. This system will include a total depth recorder for bottom profile mapping, and thus provide a complete device specially suited for the navigation problem in the inshore area. The device will present and record course, drift angle and distance traveled information to the swimmer plus providing a permanent record of total water depth.

SUPPORTED BY U.S. Dept. of Defense - Navy

6.0132, STUDIES OF SHARK REPELLENTS AND OTHER ANTI-SHARK MEASURES
H.D. BALDRIDGE, U.S. Navy, Aerospace Medical Center, Pensacola, Florida 32512

The purpose of this project is the development of reliable assay procedures for determining shark repellent activity with a low dependency on subjective observations. Supportive field and laboratory research is being carried out in the areas of buoyancy, maneuverability and drug exposure dynamics as physical and chemical factors affecting shark behavior.

One section of the Noxious Marine Animal Program is concerned with the biology of sharks. Sharks pose a physical, as well as psychological, hazard to personnel in the sea for operational or recreational purposes. They may also cause the loss of moored and floating equipment because they are capable of biting through cable and puncturing flotation gear. In order to develop effective shark repellents and survival techniques, therefore, it is necessary to determine the dynamics, mode, and limits of action of physico-chemical factors in the natural or induced field environment which influence these animals.

SUPPORTED BY U.S. Dept. of Defense - Navy

6E. WATER QUALITY AND POLLUTION

(waste Disposal Effects; Pollution Identification, Monitoring, and Movement. See Chapter 5 For Effects on Non-humans and Chapter 6m For Engineering Aspects.)

6.0133, FATE OF INLAND DERIVED CONTAMINANTS IN AN ESTUARY
P.B. MEDZ, Univ. of Alaska, U.S.D.L Alaska Water Lab. College, Alaska 99735

Orgams and inorganics in an estuary have both marine and ground and surface water resources. The changes occurring to inland originating organic and inorganic pollutants as they enter the estuarine environment and the determination of their impact on
the biota of the estuary will be investigated. The overall objective is to isolate sources of pollutants that have an unfavorable effect upon the marine environment and through a systems analysis to determine how these pollutants can most effectively be removed from the water system.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

6.0134. RELATIONSHIP BETWEEN GLACIAL FLOUR POLLUTION AND POLLUTANTS FROM OTHER SOURCES

In the heavily glaciated areas of Southeast Alaska glacial silt is washed into the estuaries in large amounts. Industrial wastes from the paper pulp and canning industries and domestic and marine sewage could interact as floation agents with this finely divided silt. The nature of this interaction, the susceptibility of the adsorbed organic pollutants to stabilization by with this finely divided silt. The nature of this interaction, the susceptibility of the adsorbed organic pollutants to stabilization by

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

6.0135. HISTORICAL STUDY ON EFFECT OF HARBOR DREDGING ON THE ENVIRONMENT (ENVIRONMENTAL FACTORS PERTINENT TO EFFECTS ON MARINE ENVIRONMENTS)

The methods used in mining a marine mineral deposit will have an effect on the efficiency of mining and also on the surrounding environment. The nature of the excavation, the disposal of the barren material, and the general disturbance of the area, will each present its own problems.

Such problems must be studied from the point of view of the exploiter and of the conservativist.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

6.0136. SAN PABLO BAY STUDY
F.A. NUDI, U.S. Dept. of Interior, Tiburon Marine Lab., Belvedere - Tiburon, California 94920

Objectives: To determine the effects on marine life caused by increased dredging and spoil disposal by the Army Corps of Engineers at pre-selected areas in San Pablo Bay in cooperation with U.S.B.S.F.W. River Basins.

Procedure: Monthly sampling will be made for the collection of water samples and marine organisms at five separate areas involving twelve stations from Tiburon Peninsula to Carquinez Strait. Sampling areas include past, present and future dredged and spoilt areas as well as areas yet to be dredged or spoilt.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

6.0137. EDDY DIFFUSION AND BACTERIAL REDUCTION IN WASTE FIELDS
J.E. FOXWORTHY, Univ. of Southern California, Graduate School, Los Angeles, California 90007

The principal objectives of the proposed work are: 1. To further demonstrate the applicability of previously proposed continuous volume source diffusion models to the dispersion of conservative tracer dye and bacteria within surface waste fields in the sea. 2. To ascertain the effect of the type of submarine outfall on the rate of dispersion of tracer dye and bacteria. 3. To determine, under field conditions, the rates of disappearance of coliform and fecal Streptococcal Group bacteria. 4. To investigate the effect of vertical mixing combined with radiant energy (sunlight) on bacterial disappearance in surface waste fields.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

6.0138. ULTRAVIOLET ABSORPTION IN COASTAL WATERS
R.B. TIBBY, Univ. of Southern California, Graduate School, Los Angeles, California 90007

The proposed work revolves around the basic hypothesis that UV absorbance is a quantitative measure of the extent and dilution of organic marine sewage and that it is directly related to organic load and may be a better index to organic load than BOD.

Improved methods developed during the past year for determining dissolved, particulate and total carbon, and for separating the contributions of organic and inorganic constituents of the waste field and of the background waters, now will be applied in situ and in conjunction with the routine monitoring programs of selected waste disposal agencies in Southern California whose discharge is subject to primary, secondary, or tertiary treatment.

The procedures also may provide information on the rates of biodegradation in the marine environment.

Present studies on the productivity of phytoplankton and benthic algae by oxygen evolution and isotopic carbon uptake will be continued, and will be correlated with the release of extracellular metabolites as determined by UV absorbance.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

6.0139. WATER QUALITY AND NUTRIENTS, SACRAMENTO-SAN JOAQUIN RIVER SYSTEM
W.D. SILVEY, U.S. Dept. of Interior, Water Resources Division, Menlo Park, California

This research is part of the program of water resources investigations conducted by the U.S. Geological Survey in cooperation with the State of California. The total project is to provide the knowledge needed to avoid excess blooms of tidal plankton and undesirable concentrations of dissolved oxygen by determining the relationships between nutrients, tidal plankton, dissolved oxygen, and fish in this estuarine environment. The water quality aspects of the study includes source and concentration of both organic and inorganic constituents in waters in the delta system together with pertinent physical characteristics.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

6.0140. EFFECTS OF WATER POLLUTION IN SAN FRANCISCO BAY
R.K. LINSLEY, Stanford University, School of Engineering, Palo Alto - Stanford, California 94305

1. To determine how people are affected by water pollution in San Francisco Bay. 2. To estimate the number of people affected in various ways by water pollution in the bay. 3. To measure attitudes toward water pollution in the Bay. 4. To determine where people acquire information about pollution in the Bay. 5. To determine what actions of adjustment (substitution, curtailment of activity, reduction in frequency of participation, etc.) are taken by people as a result of water pollution in the Bay. 6. To obtain data that could be used in an assessment of the economic value of water pollution control measures, especially the value of recreational activities and esthetics.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

6.0141. POLLUTION STUDY OF THE VENICE DISTRICT CANAL
W.A. ANIKOUCHINE, Oceanographic Services Inc., Santa Barbara, California 93105

Study conducted in a 90-foot scaled hydraulic model of the canal.

SUPPORTED BY Los Angeles City Government - California Koebig & Koebig, Inc.
6.0144,  EFFECTS OF HEATED WATER DISCHARGE ON THE MARINE ENVIRONMENT
D.D. POLLARD, Oceanographic Services Inc., Santa Barbara, California 93105

SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY Redondo Beach City Government - California

6.0143,  ORGANIC DEBRIS ON CONNECTICUT BEACHES AND SHORES
R. BENOT, General Dynamics Corporation, Gorton, Connecticut

General field surveys of selected sites are made. The quantity and identity of beach debris present in significant amounts is determined. Water characteristics (temperature, dissolved oxygen, salinity, turbidity) are determined. The origin of the debris is determined if possible. The microbial flora of water, sand, mud, and debris are determined in relation to the mode of decomposition of the debris.

SUPPORTED BY Connecticut State Government

6.0144,  STUDY OF EFFECTS OF OFFSHORE DUMPING

Study will be made of the effects on the local environment of the offshore dumping (under Corps of Engineers permit) of such things as sewage sludge, cinder, and acid wastes. Study will include circulation and dispersion patterns, and changes in bottom characteristics, and collection of bottom organisms. Data are planned for eventual interpretation in terms of effects on biota. Initial work will be done in the New York Bight.

SUPPORTED BY U.S. Dept. of Defense - Army

6.0145,  EFFECTS OF HEATED WATER IN A TIDAL ESTUARY

The Patuxent River is one of the few rivers entering Chesapeake Bay that presently is more or less free from cultural influences. In the near future rapid change is expected to result from urbanization in the upper basin and operation of a large generating plant at Chalk Point, which will significantly alter the temperature of the water in that vicinity. At times the heated water released into the estuary will be equal to or greater than the fresh water inflow.

The objective of this project is to understand the effects of such release in the physical, chemical, and biological character of a tidal river by studying the yearly and seasonal attachment, rates of growth and mortality of attached organisms, and associated physical factors, including salinity. Interrelations between the environment and aquatic biota will be determined for the normal hydrologic condition and the heated condition over a period of about two years for each.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

6.0146,  DEMONSTRATION OF THE LIMITATIONS AND EFFECTS OF WASTE DISPOSAL ON AN OCEAN SHELF
R.F. MCALLISTER, Florida Atlantic University, Graduate School, Boca Raton, Florida

The purpose of this project is to learn the existing ecological regimen of an area subject to waste injection, and the effect of waste injection on an ocean shelf through a combined oceanographic and biological survey. It is further intended to learn how, by knowledge of local currents, to optimize the location of sewage outfalls. Studies will include the analysis of water and bottom samples and classification of the fauna and flora.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctr Boca Raton City Government - Florida

6.0147,  PESTICIDE MONITORING PROGRAM
P.A. BUTLER, U.S. Dept. of Interior, Biological Laboratory, Sabine Island - Gulf Breeze, Florida

Cooperative program involving 15 private, state and federal laboratories who collect duplicate samples of mollusks from approximately 175 estuarine stations on Atlantic, Gulf and Pacific coasts at monthly intervals. Program initiated 1965, proposed to continue until 1969; 1500 analyses completed September 1965. Samples are sent to the Gulf Breeze Laboratory for pesticide residue analysis. Eastern oyster is chief bioassay animal, also used Mya arenaria, Mercenaria mercenaria, Ostrea luria, Crassostrea gigas and some fish species. Each sample is screened for Aldrin, DBC, Dieldrin, DDD, DDE, DDT, Endrin, Heptachlor, Hexpachlor epoxide, Lindane and Methoxycholor. Analyses are made with electron capture gas-liquid chromatography techniques.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0148,  PESTICIDE KINETICS
C.W. MILLER, U.S. Dept. of Interior, Biological Laboratory, Sabine Island - Gulf Breeze, Florida

Investigate, under field conditions, the occurrence and distribution of insectoricides in tidal areas associated with an estuary. Samples of water, soil and selected biota will be collected immediately prior to application of the test material to establish a baseline indicitative of previous commercial treatments. The persistence, localization and possible degradation of the test chemicals will be followed.


6.0149,  CHEMICAL ANALYSES
A.J. WILSON, U.S. Dept. of Interior, Biological Laboratory, Sabine Island - Gulf Breeze, Florida

In order to evaluate data now being obtained by a nationwide surveillance of organochlorine pesticide pollution in estuaries, studies are in progress to determine rates of uptake and the metabolism of these pollutants in marine species.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0150,  BACTERIOLOGICAL STUDY OF THE POLLUTION OF KANEHOE BAY, OAHU
K.R. GUNDERSEN, Univ. of Hawaii, Water Resources Research Ctr., Honolulu, Hawaii 96822

A comprehensive study of coliform distribution and other indicator bacteria of sewage origin will be made of the water in Kanehoe Bay, Oahu, Hawaii including hydrological and meteorological observations. Six sites near sewage outfalls and in the Bay will be sampled at two water depths and of the bottom deposit. Sewage just prior to disposal will also be sampled. All liquid samples will be collected at least weekly and with aseptic technique. Liquid bottom samples will be analyzed for coliforms 35 degrees C; thermostable 45 degrees C, enterococci, 35 degrees C and total count 25 degrees C. Prior to sampling, air and water temperatures, wind direction and speed, cloudiness, rainfall, water turbidity will be measured.

This study is expected to provide the much needed data for determining the degree of sewage treatment required and for a planned study of the bacterial involvement in the transformations of inorganic nitrogen and sulfur compounds in the Bay.

6. PUBLIC HEALTH AND SAFETY

6.0147,  PESTICIDE MONITORING PROGRAM
P.A. BUTLER, U.S. Dept. of Interior, Biological Laboratory, Sabine Island - Gulf Breeze, Florida

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SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
6.0151, ECONOMIC ANALYSIS OF THE MARKET STRUCTURE OF THE COMMERCIAL FISHING INDUSTRY IN THE NORTHEAST  
C. YEH, Univ. of Maine, Agricultural Experiment Sta., Orono, Maine 04473  
Objectives: 1) To determine the product flow and existing characteristics of the commercial fishing industry and its relative importance in the Northeast, 2) To analyze the dynamic aspects of the supply and demand situation for the major species of finned fish and shellfish of the Northeast, and 3) To assess implications of potential changes in the market structure and its performance on the fishing industry, poultry and livestock producers and consumers.  
Description: The Delaware station will concentrate primarily on studying menhaden and other fish used in animal feeds. The first procedural step will require the compilation of data related to the distribution of menhaden fish including the primary markets, marketing channels and product use by poultry and livestock. 
Estimates of supply and demand parameters for menhaden fish will be obtained. Statistical procedures including linear programming and single equation regression models will be used to evaluate the relationship of fish meal to poultry and livestock production.  
SUPPORTED BY U.S. Dept. of Agriculture  
Delaware State Government

6.0152, EFFECTS OF THERMAL POLLUTION ON PRODUCTIVITY AND STABILITY OF ESTUARINE COMMUNITIES  
J.A. MIHURSKY, Univ. of Maryland, Natural Resources Institute, College Park, Maryland  
A multidisciplinary investigation is proposed to study thermal pollution of an estuarine community. Laboratory studies of behavioral, metabolic and growth responses to heat stress will be integrated with field experiments to evaluate the overall impact of thermal pollution on an estuarine ecosystm. Specificaly, the laboratory phase will study representative species from the phytoplankton and planktonic herbivores. Growth of algae and intrinsic rates of increase of copepod populations will be used to evaluate thermal stress separately and when other environmental components are varied. At the same time, survival, behavior and metabolism of vertebrates and macro-invertebrates will be measured in gradients of temperature and salinity. 
Field experiments will determine the influence of heat pollution on several trophic levels. Rates of mortality, biomass turnover or production and energy flow will be used to evaluate the impact of pollution. An ideal field situation has been provided by the newly constructed electrical generating plant at Chalk Point on the Patuxent river estuary. 
The field experiments may be divided into those which test the direct effect of the passage of a part of the estuary through the power plant. The indirect effect of effluent water on the plankton community adjacent to the power plant may be determined by correlation and comparison with pre-existing patterns of biomass, production and species structure of the plankton. Similarly, pre-pollution-phase measurements of vertebrate and macro-invertebrate standing stocks may be correlated and compared with those existing under thermal pollution.  
SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rch  
University of Maryland

6.0153, IMPACT AND FATE OF POLLUTION IN ESTUARIAL WATERS  
C.F. COLE, Univ. of Massachusetts, School of Agriculture, Amherst, Massachusetts 01003  
The project is a comprehensive, long-range study of Massachusetts estuaries to determine the origin, character, distribution, influence and fate of ionic, molecular, colloidal and suspended pollutants reaching the estuary and to examine ways in which natural tidal flushing action may be improved. The initial phase of this broad program involves the effects and ultimate fate of pesticides used for cranberry culture on land draining into the Weweantic estuary on the southern shore of Cape Cod. These studies are directed to the following: 1) Bio-degradability of selected pesticides. 2. Influence of pesticides and other environmental variables on the fish population of Weweantic estuary. 3. Adsorption of pesticides on representative soils and the ultimate fate of these adsorbed pesticides reaching the water resource on salt particles.  
SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rch  
University of Massachusetts

6.0154, RATES OF PESTICIDE BUILDUP IN SALMONIDS RECENTLY INTRODUCED IN THE GREAT LAKES  
R. REINERT, U.S. Dept. of Interior, Biological Laboratory, Ann Arbor, Michigan  
A program to follow the buildup of insecticides in lake trout and coho salmon that have recently been introduced into Lakes Michigan and Superior. The eggs and fry will be studied before the fishes are introduced into the lakes and then as these populations develop they will be sampled periodically. When the fishes reach maturity their eggs and progeny will be examined for pesticide levels.  
SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0155, MECHANISMS OF PESTICIDE ACCUMULATION IN AQUATIC ORGANISMS  
R. REINERT, U.S. Dept. of Interior, Biological Laboratory, Ann Arbor, Michigan  
A laboratory program designed to compare the relative importance which direct uptake of insecticides from water and biological magnification via the food chain have on the buildup of chlorinated hydrocarbon insecticides in aquatic communities.  
SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0156, COMPOSITION OF LEAD HALIDE POLLUTION AEROSOL  
J.W. WINCHESTER, Univ. of Michigan, School of Engineering, Ann Arbor, Michigan  
It is proposed to determine the relative composition of aerosol particles over the range of radius 0.2 to 10 microns with respect to lead, chlorine, bromine, and iodine. In urban areas pollution sources are probably significant for all these elements, but in the natural atmosphere substantial amounts of chlorine, bromine, and iodine come from the sea. Sampling of atmospheric particles is done by means of a cascade impactor, and analysis for these elements is carried out using anodic stripping voltammetry for lead and neutron activation for the halogens. Initial results have indicated distinctive particle size distribution patterns for each of the four elements, and these patterns are interpreted in terms of the source of the particles and chemical reactions in the atmosphere involving oxidation, volatilization, and condensation. Sampling and analysis are planned to reveal the details of the interrelationships among these processes.  
SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

6.0157, GREAT LAKES RESEARCH - SPOIL DISPOSAL EFFECTS  
A.P. PINSAK, U.S. Army, Lake Survey, Detroit, Michigan 48226  
Physical, chemical and biological factors within the water mass and associated solid material which can be related to dredging and disposal of spoil material are being investigated in
6. PUBLIC HEALTH AND SAFETY

order to determine effects of this material on characteristics of the lakes. The study will examine changes in water characteristics, dispersion rates, and areal extent; changes in nature of bottom sediments from dumping and dredging and degree to which characteristics of these sediments are improved; and different effects of various dredging techniques on pollution.

Field investigations during 1967 centered on eleven selected rivers, harbors, and open water and diked disposal areas of different basic types in Lakes Erie, Huron, and Michigan. Inasmuch as data on actual levels of pollution which can be traced to various kinds of dredging is lacking, each area was studied before, during, and for a significant period after dredging and disposal of spoil material.

Interim reports for each study area are being prepared and a comprehensive report is scheduled for completion in 1968.

SUPPORTED BY U.S. Dept. of Defense - Army

6.0158. MARQUETTE, MICHIGAN CHEMICAL CONTROL OF SEA LAMPREY

Marquette, Michigan

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

analyze the effectiveness of individual treatments.

rate bioassays and chemical analyses of the water; precise meter-

physical characteristics and flow data of infected streams, accu-

presence and distribution of ammocete populations in tributaries;

streams with chemical, and to determine if such action will con-

in the streams tributary to the lake by treatment of these

Huron. The study is designed to eliminate all generations

control effectively the parasitism on lake trout and other fish.

The control method requires a thorough knowledge of:

the prevalence and distribution of ammocete populations in tributaries;

physical characteristics and flow data of infected streams, accu-

rate bioassays and chemical analyses of the water; precise meter-

ing of the chemicals; and posttreatment surveys to measure and

analyze the effectiveness of individual treatments.

A total of 99 Lake Michigan streams contain sea lampreys.

All streams were treated by July 1966. Treatments since then have been repeated at approximately 4-year intervals or at intervals determined from observations on the rate of reestablishment and growth of sea lampreys.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0159. LAKE HURON CHEMICAL CONTROL

B.R. SMITH, U.S. Dept. of Interior, Biological Station, Marquette, Michigan

The Bureau of Commercial Fisheries, under the direction of the Great Lakes Fishery Commission, is using selective larvicides as an experimental method of control for sea lampreys in Lake Michigan. The study is designed to eliminate all generations present in the streams tributary to the lake by treatment of these streams with chemical, and to determine if such action will control effectively the parasitism on lake trout and other fish.

The control method requires a thorough knowledge of:

the presence and distribution of ammocete populations in tributaries;

physical characteristics and flow data of infected streams, accu-

rate bioassays and chemical analyses of the water; precise meter-

ing of the chemicals; and posttreatment surveys to measure and

analyze the effectiveness of individual treatments.

There are 48 tributaries along the U.S. shore of Lake Huron known to contain sea lampreys. Three of these were treated in 1962. Treatments in this area were resumed in 1966 and 18 streams were treated.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

6.0160. A STUDY OF THE OPEN WATER DISTRIBUTION AND ABUNDANCE OF NET-PLANKTON AS AN INDEX OF EUPTROPHICATION IN LAKE SUPERIOR

T.A. OLSON, Univ. of Minnesota, School of Public Health, Minneapolis, Minnesota 55455

The research is aimed at applying the Continuous Plankton Recorder Techniques of Pardy to non-oceanic situation, namely Lake Superior. Hardy recorders were designed for marine work and can be towed behind merchant vessels and other commercial

craft proceeding at their normal cruising speeds. During these
tows, a band of silk bolting cloth is automatically fed across a tun-

el-opening to collect organisms from the water. Under highly ef-
ficient filtering conditions, three cubic meters or 3000 liters of
clear water are strained over each ten-mile section of the course and organisms in the catch are deposited in a chronological order on the moving band. After exposure the band is covered by another layer of silk to hold the organisms in place and the two bands are then tightly rolled up in a small tank of formalin preservative. At the end of each 500-mile run the roll is removed from its chamber and shipped to the laboratory where a count is made of the organisms.

The zooplankters (herbivores) which make up the second trophic level of the ecological pyramid can be accepted as a reflection of the primary production and therefore as an expres-
sion of the state of fertility or quality of the water being studied.

Because such large areas can be covered and each mile traversed can be associated with a definite point on the bolting cloth band one can detect variations which occur over the entire lake and can readily locate such areas of variance accurately on a geographical basis. The method is envisioned as a practical parameter of water quality which will be of distinct value in studies of any of the Great Lakes.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Reh University of Minnesota

6.0161. BRACKISH WATER PURIFICATION BY BIOLOGICAL FUEL CELL POWERED ELECTRODIALYSIS

W.A. SCHELLER, Univ. of Nebraska, School of Engineering, Lincoln, Nebraska 68508

Purification of brackish water containing 1000-5000 ppm of salts by electrodialysis appears to be more economical than any of the present day distillation techniques, but it is still expensive. A reduction in the water costs might be realized if a useful byproduct were produced in the water purification process.

The primary objective of the proposed research is to in-
vestigate the possibility of using an electrodialysis cell for brackish water purification in conjunction with a biological fuel cell powered by microorganisms capable of living in the brine effluent from the electrodialysis unit, feeding on cellulose contain-
ing materials such as hay, corn stalks, etc. and suitable for pro-
cessing into cattle feed or feed supplement. Furthermore it is planned to investigate the effect of operating variables on the perfor-
ance of the electrodialysis unit within the range of voltage-
current-power capabilities of a battery of biological fuel cells.

Finally, using the experimental results as a basis, economic evaluations will be made in order to determine the economic op-
timum arrangement of electrodialysis units and biological fuel cells.

This is a five year program from fiscal 1966 through fiscal 1970.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Reh University of Nebraska

6.0162. MICROBIOLOGY OF ESTUARINE AND SHELL-FISH POLLUTION

L.W. SLANETZ, Univ. of New Hampshire, Graduate School, Durham, New Hampshire 03824

The research objectives of this project are designed to (1) determine the reliability of current bacteriological criteria or standards for monitoring the sanitary quality of shellfish and shell-
fish growing waters, (2) determine whether fecal streptococci should replace coliforms as indicators of fecal contamination of estuarine water and shellfish, (3) determine whether bacteriophages will be useful indicators of enteric virus contamination of estuarine water and shellfish, (4) evaluate depuration procedures and factors which affect the decontamination of oysters and clams under laboratory and field conditions, (5) develop the efficiency of newly installed sewage treatment plants in reducing or eliminating contamination of estuarine waters via enteric bacteria and viruses.

SUPPORTED BY U.S. Dept. of Hith. Ed. & Wel. - P.H.S.
6.0165, DELAWARE ESTUARY AND BAY WATER QUALITY SAMPLING AND MATHEMATICAL MODELING PROJECT
J. F. WRIGHT, Delaware River Basin Comm., Trenton, New Jersey

The purpose of this project is to evaluate the accuracy and reliability of the research data, and information made available for use in a mathematical model of the Delaware Estuary by conducting a series of sampling runs in the estuary over a period of years. These samples will be analyzed and compared with mathematical model projections in an effort to validate the mathematical concept for use in an estuary pollution abatement program.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl
Delaware River Basin Commission

6.0166, QUALITY STANDARDS TO DETERMINE RELEASE OF SHELLFISH FOR MARKETING PURPOSES
G. STROBEL, State Div. of Fish & Game, Oakdale - Long Island, New York 11769

Initially it will be necessary to hold the clams pending the results of bacteriological tests before they can be released for distribution. The holding time required will depend on correlating process time required with certain specific groups that can be determined within the time period available. If these correlations do not prove feasible, it will necessitate the design of a holding system so that the shellfish will not be released until their sanitary quality can be determined. A wet-storage system seems a reasonable approach to this problem, but dry-storage will also be investigated. This work will be done concurrently with the other phases of this sub-project. Various storage conditions will be investigated from the start of the project and will continue until an optimum condition is reached or bacterial studies prove storage unnecessary. The work will be under the direction of G. Streubel, Assistant Sanitary Engineer and J. Redman, Bacteriologist. Additional personnel include: 1 Technician.

The work will be located at the plant site in West Sayville, N.Y. with bacteriological tests performed at the laboratory in Oakdale, N.Y. All testing procedures will follow Standard Methods. Part 4 of 5

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.
New York State Government

6.0167, THE ACCUMULATION OF FISSION PRODUCTS BY MARINE FISH AND SHELLFISH
T. R. RICE, U.S. Dept. of Interior, Radiobiological Lab., Beaufort, North Carolina 28516 (AT(49-7)-5)

The cycling of elements in the estuarine environment is being followed by observing the movement of radioisotopes in the water, biota, and sediments. Quantitative data on the cycling of radioactive elements are important since effluents containing radioactive elements often flow into estuarine waters. With such data, it should be possible to predict the pathways taken by the radioactive elements.

The potential importance of Cord grass, Spartina alterniflora, in conveying radioisotopes of zinc, manganese, and iron into estuarine food chains was evaluated on the basis of its annual production, its content of the elements, and its annual cycle of growth and decay. An environmental tracer experiment was carried out in which naturally-occurring fallout radioactivity in the estuary served as the tracer isotopes. In the laboratory, the influence of certain environmental factors on the concentrations of zinc 65 accumulated by an experimental community was tested. Finally, the interactions of radiation, salinity, and temperature on the physiology of the estuarine fish, the mummichog, was observed.

Spartina production was found to approach one-third the total phytoplankton net production of adjacent estuaries and is thus potentially important in estuarine food chains. The unusually high iron content of the dead material suggested that Spartina may be especially important in the movement of radioisotopes of iron from water and sediment into estuarine animal populations. Concentrations of gamma-emitting fallout radioisotopes were monitored in Rangia over a 30-mile stretch of river and a salinity range of less than 0.1 to greater than 15 parts/thousand. Ruthenium 106 and ruthenium 103 were concentrated more in Rangia from downstream stations (salinity range 6-15 parts/thousand), whereas cesium 137 was more abundant in the same species from freshwater stations (salinity range 0-6 parts/thousand). It was found that a high salinity and zinc concentration suppressed the concentration of zinc 65 in animals and sediments, while high temperature and pH had the opposite effect. In experiments testing the interaction of salinity, temperature, and radioactivity, it was observed that both salinity and temperature changed the LD-50. Above 20

6. PUBLIC HEALTH AND SAFETY
6. PUBLIC HEALTH AND SAFETY

degrees C. fish were more sensitive to radiation at high salinities, while below 20 degrees C. fish were more sensitive to radiation at low salinities.

SUPPORTED BY U.S. Atomic Energy Commission

6.0168, SALT-WATER ENCROACHMENT IN NORTH CAROLINA ESTUARIES

H.B. WILDER, U.S. Dept. of Interior, Water Resources Division, Raleigh, North Carolina 27607

This research is part of the program of water resources investigations conducted by the U.S. Geological Survey in cooperation with the State of North Carolina.

Purpose: To determine the variations in flow and chemical quality of water in North Carolina sounds and estuaries so that decisions may be made regarding industrial utilization of the water.

Methods: Collect and analyze water samples, plot dispersion pattern compiled and collate hydrologic information from various sources according to independently developed systems.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey
North Carolina State Government

6.0169, INFLUENCE OF SUSPENDED MICROSCOPIC SUBSTANCES ON THE METABOLISM OF MICROORGANISMS RESPONSIBLE FOR BIOLOGICAL ENRICHMENT OF WATER

R.M. PFEISTER, Ohio State University, Graduate School, Columbus, Ohio 43210

The proposed investigation is to study the interaction of environmental contaminants (defined as substance not formed biologically or naturally, and which are not normally indigenous to the water) on the microbial portion of the ecosystem. The particulate materials (detritus) will be examined on a physical, chemical, and biological basis, and the materials will be characterized using differential and gradient centrifugation in conjunction with electron microscopy. The characteristic fractions of suspended particulate material will ultimately be examined for ability to influence biological reactions. This particulate fraction of water is important to microbial relationships in the area of interfaces and biological activity. It is known that particles and molecules in solution accumulate at interfaces (this includes chemicals which can either act favorably (e.g., nutrients) or unfavorably (e.g., pesticides to organisms) and that enzymatic reactions are concentrated at membranous surfaces. Therefore, it is of significant importance to study the capabilities of natural biologicals that commonly end up in the waters on such colloidal or molecular interfacial systems.

The investigation will be confined to a small river or creek basin which enters into Lake Erie, and to the lake itself.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Cch
Ohio State University

6.0170, CLADOPHORA AS RELATED TO POLLUTION IN WESTERN LAKE ERIE

C.E. TAFT, Ohio State University, Graduate School, Columbus, Ohio 43210

The proposed research involves mapping and quantitative studies of attached Cladophora along the shorelines and on shoals adjacent to the Lake Erie basin, and of the detached Cladophora beds which drift across the lake bottom. The approach will determine the quantity of Cladophora on the basis of dry weight, its periodicity, the chemical composition relative to that of the lake water, and the relationship of Cladophora to oxygen concentrations over the beds. Studies to evaluate harvested Cladophora as special products such as fibrous filter material, food, and/or as a mulch will be initiated.

Field investigations include: 1) Aerial mapping of Cladophora beds. 2) Observations of periodic growth on the beds. 3) Quantitative measurements of Cladophora on attached and drifting beds. Laboratory investigations include: 1) Chemical analyses of Cladophora. 2) Chemical analysis of lake water. 3) Culture of Cladophora. 4) Suitability of Cladophora as a special filter medium. 5) Suitability of Cladophora as an animal food supplement. 6) Suitability of Cladophora as a specialty mulch.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Cch
Ohio State University

6.0171, MICROFLORA OF RADIATION PASTEURIZED SEAFOODS

A.W. ANDERSON, Oregon State University, Agricultural Experiment Sta., Corvallis, Oregon 97331

1. Determine the numbers and the radiation resistance of microorganisms surviving radiation pasteurization. 2. Determine whether those surviving microorganisms constitute a health hazard. 3. Determine the shelf life of such radiation pasteurized seafoods under various temperatures of storage. 4. Establish D or comparable values for radiation destruction rates of selected pathogens.

This investigation was concerned with the effects of pasteurization irradiation on the flavor and extension of storage life of shrimp and crabmeat held at 38 degrees F. The pasteurization levels selected on the basis of the flavor threshold values were 0.50 and 0.75 megarads for shrimp and 0.25 and 0.50 for crabmeat.

Chemical and bacteriological analyses were conducted on the non-irradiated and irradiated samples held at 38 degrees F. These included trimethylamine nitrogen, total volatile bases, total volatile acids, pH, and total plate counts on various selective media. Flavor evaluations were made by a trained panel for the presence and intensity of irradiated taste and odor.

SUPPORTED BY Oregon State Government

6.0172, ECOLOGICAL STUDIES OF RADIOACTIVITY IN THE COLUMBIA RIVER ESTUARY AND ADJACENT PACIFIC OCEAN

W.V. BURT, Oregon State University, Graduate School, Corvallis, Oregon 97331 (AT(45-1)-1750)

PEARCY

Neutron-induced radionuclides, originating primarily from the nuclear reactors at Hanford, Washington, are continually introduced into the Columbia River estuary and adjacent Pacific Ocean. The presence of Zn65, Cr51, Sc46, Mn54, Co60, and several other radionuclides in dilute, but often measurable concentrations, permits study of the cycling of these elements.

Studies in the estuary which have already been defined show that the levels of radioactive and distribution of radionuclides in water, sediment, and biota will concentrate on specific activities (activity of radionuclides per gram of total element) in various components of the estuarine system to determine reservoirs, routes, and rates of transfer.

In offshore waters, planktonic and nektonic organisms will be collected from discrete depths using electrical cable to monitor reaction depth and actuate opening and closing devices. A special study will be made of vertical migrations of euphausiids. Radioanalysis and stable element analysis of midwater and benthic animals from various depths will enable estimates of vertical changes in radionuclide levels and vertical transport rates. Comparisons between specific activities of zinc in animals and water will be attempted in the plume region. Study of seasonal and regional variations of gamma emitters in albacore, tuna and salmon, which have provided insight into the migratory behavior of these species will be completed.

The radioecology of benthic organisms on the continental shelf and slope is being studied along the northern Oregon coast. Stomach contents will be analyzed and food webs will be delineated and related to radionuclide distribution. A deep-sea camera linked to a sediment sampler will help relate bottom topography to the sediment and infauna. Animal-sediment relationships, which have already been shown to be important aspects of benthic radioecology, will become more meaningful when viewed in terms of specific activities.

SUPPORTED BY U.S. Atomic Energy Commission
6.0173. AN ECO-ECONOMIC EVALUATION OF WATER POLLUTION CONTROL. YAQUINA BAY, ORE.

E.N. CASTEL, Oregon State University, Agricultural Experiment Sta., Corvallis, Oregon 97331

OBJECTIVE: (1) Identify the items of economic value that will be sacrificed if pollution is not controlled in a particular case study situation. (2) Insofar as possible, determine the unit prices and physical quantities of those items of economic value identified in (1) above. (3) Determine the cost of alternative engineering plans designed to provide for varying degrees of pollution control. (4) Relate the above variables in a mathematical model that will permit the comparison of the physical, biological, and economic data to be isolated. (5) Repeat the unknown variables in (4) above to needed research in the physical, biological, and economic fields. This work will involve the establishment of a complete mathematical model which will relate all monetary elements of benefits and costs. It will be necessary to make quantitative determination of so many of the benefits and costs items as possible. It will be necessary to do away for the crucial determination of values for the unknown variables. The results of this case study will then be related to the more general problem of benefit-cost analysis in water pollution control.

SUPPORTED BY Oregon State Government

6.0174. COASTAL DIFFUSION OF POLLUTANTS

D.J. BAUMGARTNER, U.S. Dept. of Interior, Pacific Nw. Water Laboratory, Corvallis, Oregon 97330

The Georgia-Pacific Corporation, Toledo, Oregon currently discharges its kraft process pulp mill wastes to an ocean outfall which discharges approximately 6 million gallons per day through a diffuser section at a depth of 40 feet at a distance of 3000 feet off the Oregon Coast at Newport. The dilution achieved by the diffuser process and by the horizontally flowing fluid under the influence of natural forces will be investigated by frequent sampling of the near coastal waters, plus continuous monitoring of wind direction and speed. Current meters will be installed at various depths. Salinometers will be placed near the bottom to obtain information on the vertical distribution. Fresh water inflow will be estimated by stream gauging of the three principal surface streams in the area. Direct runoff and direct rainfall can be estimated. Information on tide height and frequency will be obtained from three tide gauges, while continuous information on wind speed and direction will be obtained at the entrance to the bay and other locations if necessary.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

6.0175. ESTUARINE DIFFUSION OF POLLUTANTS

D.J. BAUMGARTNER, U.S. Dept. of Interior, Pacific Nw. Water Laboratory, Corvallis, Oregon 97330

The most general characteristic of pollutants which plays a part in the assessment of their fate is concentration. Since the concentration is a function of its dilution in the environment as a result of mixing and diffusion, as well as decay of the component, it is of considerable importance to be able to determine how the concentration is distributed. In order to obtain a satisfactory relation of the concentration and the time variation of salinity at the surface. Once a week, vertical traverses of salinity will be obtained to provide information on the vertical stratification in the estuary. If necessary, additional salinometers will be placed near the bottom to obtain information on the vertical distribution. Fresh water inflow will be estimated by stream gauging of the three principal surface streams in the area. Direct runoff and direct rainfall can be estimated. Information on tide height and frequency will be obtained from three tide gauges, while continuous information on wind speed and direction will be obtained at the entrance to the bay and other locations if necessary.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

6.0176. MARINE BIOLOGICAL ASSESSMENT OF POLLUTANTAL FATE

D.J. BAUMGARTNER, U.S. Dept. of Interior, Pacific Nw. Water Laboratory, Corvallis, Oregon 97330

In almost every pollution situation, a major consideration is the impact of the degraded water quality on the organism. This is especially true where it is suspected that the pollutant will harm aquatic organisms of primary importance to man. Interpretation of bioassay tests is complicated by the fact that there has been very little information obtained to relate the controlled observations in the laboratory experiments to the actual conditions existing in the environment in the absence of pollution. Attempting to overcome some of these difficulties, investigators have begun to consider and apply in situ bioassay procedures.

The difficulties associated with this approach are related to selection and maintenance of the test animals, knowledge of their population dynamics in the natural unpolluted environment, and determination that the observations obtained under the test conditions are due to a pollutional stress rather than artifacts of the experimentation.

The first step in developing a series of procedures for analysis of problem areas is determining the amount and type of information necessary to describe the natural environmental populations. This developmental work is being tried on Yaquina Bay, Oregon, along two approaches. Information on fish usually associated with bottom or midwater habitat will be obtained at each of ten sampling stations every two weeks by means of a trawl. Continuous recording of salinities on the surface at six stations covering the trawl area will also be provided. In addition, weekly profiles of dissolved oxygen, temperature and salinity will be provided. Samples will be obtained for organic carbon analysis or PBI's or other appropriate analyses to determine possible pollutants. It will be possible to test some of the results of analysis after collection of data for one year. The second method of observation pertains to collection of crustacea in standardized substrate boxes and on substrate media suspended in the water column. These samples are collected over exposure to the environment for five weeks. Sub-samples of the organisms obtained in both methods will be analyzed for maturity, weight distribution, and stomach contents.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

6.0177. DISPOSAL TO MARINE WATERS

R.J. CALLAWAY, U.S. Dept. of Interior, Pacific Nw. Water Laboratory, Corvallis, Oregon 97330

This project is concerned with oceanography of coastal waters and estuaries necessary to protect them from the disposal of municipal, industrial, and vessel wastes. Coastal work will consider the diffusion and advection of wastes discharged from outfalls, the accumulation of wastes on the bottom near outfall, and eventually, the effect of various wastes on marine organisms. A project on the effect of wastes discharged from vessels will be initiated in 1966. Estuarine work will consider saltwater penetration, continuous monitoring of parameters, statistical and dynamical models of the environment.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

6.0178. MOVEMENT OF RADIONUCLIDES IN THE LOWER COLUMBIA RIVER


The objective of this project is to quantitatively determine the concentrations and loads of specific radionuclides that are...
6. PUBLIC HEALTH AND SAFETY

solutions and sorbed on sediments in the Columbia River from Hanford, Washington to the estuary. The spatial and temporal variation and distribution of the radionuclide concentration and loads are to be studied, and an approximate budget of the radionuclides is to be determined.

The physical, chemical and mineral properties of the suspended and streamed sediments are being studied; and these properties, insofar as is possible, will be related to sediment transport, sorbed radionuclides, and the equilibrium balance between the solute and sorbed radionuclide phases.

The extent and characteristics of sediments deposited on the streamed and sorption of radionuclides by these sediments in the natural channel, reservoir, and tidal-affected reaches are being surveyed.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

6.0179, MOVEMENT OF RADIONUCLIDES IN THE COLUMBIA RIVER ESTUARY

D. HUBBELL, U.S. Dept. of Interior, Geological Survey, Portland, Oregon 97208

Two reaches of the estuary have been instrumented for discharge determination. These will be calibrated by direct measurement of flow from a boat at different stages and through several tidal cycles during the coming year. The data will then be fitted to a one-dimensional mathematical model that has already been developed. If the mathematical model is determined to be reasonably accurate, two, other reaches will be instrumented similarly. In addition, water samples for salinity and other chemical characteristics and sediment content will be taken during all direct discharge measurements. Gross description of radioactivity in the estuary will be obtained by a sled-mounted in situ radiation detector as well as from analyses of water and sediment samples. Data compilation and integration will be augmented by a study of typical environments such as islands, tidal flats and shorelines, which can be mapped fairly easily. The mechanics of sediment transport and deposition particularly under the influence of salinity changes and flow reversal will be studied to define empirical relations to be used in calculating sediment loads.

SUPPORTED BY U.S. Atomic Energy Commission

6.0180, THE MOVEMENT OF RADIONUCLIDES IN THE COLUMBIA RIVER ESTUARY

D.W. HUBBELL, U.S. Dept. of Interior, Water Resources Division, Portland, Oregon 97208

Certain radionuclides enter the Columbia River from the Hanford installation of the U.S. Atomic Energy Commission. Part of the radionuclides remain in solution in the water, part are sorbed on the fluvial sediment, and part are taken up by the biota. As a result, each medium, by virtue of its motion, affects the distribution of the radionuclides.

Objectives of this project are to define the disposition and movement of radionuclides in the Columbia River estuary; to study the processes that influence the movement of radionuclides, particularly the sedimentation, flow and chemical processes; and to contribute to estuarine technology.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

6.0181, DETERMINATION OF SAFE LEVELS OF POLLUTION IN PUERTO RICO

A.S. VAZQUEZ, Univ. of Puerto Rico, Water Resources Research Inst., Mayaguez, Puerto Rico

Some Puerto Rico Bay are receiving raw sewage and other organic pollution in high concentrations. Damage has been done to the fish population and to the recreational use of surrounding beaches, the best example being the Bay of Mayaguez just near the campus of the College of Agriculture and Mechanic Arts where the Institute will have its headquarters.

It is proposed to investigate the degree of contamination of the bay to evaluate the proportional effect of the different factors which affect the actual and future sanitary conditions and its effects on the fish, ecology and the recreational aspect of the bay and surroundings.

This study will be carried on through the systematic measurement of parameters such as BOD, dissolved oxygen, solids, coliform group, biota, etc. Similarly, physics, chemical, and meteorological factors affecting the locality of the Mayaguez Bay will also be determined inside the bay. The goal will be to establish the relationships among the most important of the factors that enter into the problem, with the purpose of establishing criteria for prediction for similar situation in tropical bays.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Reh University of Puerto Rico

6.0182, ASPECTS OF RELATIONSHIPS BETWEEN MARINE ECOLOGY AND HUMAN HEALTH


Continuing independent and collaborative studies in marine health science upon aspects of the marine environment and biota which have a bearing upon human health. Emphasis is upon biological, particularly ecological, observations upon toxins and other harmful chemicals, beneficial substances, disease-transport mechanisms, etc.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.

6.0183, USE OF MARINE PLANKTONIC ORGANISMS FOR EVALUATING THE QUALITY OF MARINE AND ESTUARINE WATERS


This study is concerned with the development of bioassay methods and techniques, employing marine planktonic organisms, or determining the identity and of pollutants in the marine environment and for determining the short and long-term effects of lethal and sublethal concentrations of pollutants upon other organisms found in the the marine environment. This includes the development of methods for determining and measuring the effects of pollutants upon sensitive metabolic responses and enzymatic reactions both at the cellular and subcellular levels and devising methods for accomplishing such bioassays accurately and routinely.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

6.0184, COMPARATIVE TOXICITIES OF METALS TO ESTUARINE FISHES


Disposal of solid wastes at sea is being practiced by an increasing number of municipalities. Preliminary analysis of incompletely-austed incinerator wastes by atomic adsorption indicates that aluminum, iron, calcium, zinc, potassium, and lead— in that order—are most abundant. Short-term bioassays with inorganic salts of these and other metals to the mummichog, Fundulus heteroclitus, are being conducted under controlled environmental conditions. Relationships between mortality, physical-chemical environment, and concentration of test metal in solution is being investigated.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

6.0185, RADIONUCLIDES IN THE SAVANNAH RIVER ESTUARY AND ADJACENT COASTAL WATERS

C.M. PATTERSON, U.S. Atomic Energy Commission, Savannah River Plant & Labs., Aiken, South Carolina

Small amounts of radionuclides are released to the Savannah River by the Savannah River Plant 170 miles from the Atlantic Ocean. The distribution of radionuclides in the river's estuary and in adjacent coastal waters is being determined. Effects of water exchange between the estuary and ocean, sedimentation and other physical and chemical factors influencing dilution and distribution will be studied.

SUPPORTED BY U.S. Atomic Energy Commission

268
The presently proposed work considers the examination of natural waters for their lipid content, particularly their sterol content (including cholesterol and the fecal sterol coprosterol). It is hoped that a full knowledge of the sterol content of natural waters will permit the use of such analyses for sterols for recognition of pollution from domestic sewage, animal and plant wastes, etc. As these might be encountered in natural waters supplies. Both animal and plant material contains sterols, and by detecting a given key sterol in excess in a water sample it should prove possible to identify the probable origin of the sterol. Furthermore, knowledge of the sterol content should offer a fundamental basis for our improved understanding of the means by which lipids and sterols are disposed of in natural waters. Water samples have been taken from open surf, quiet bay, running tidal, and domestic sewage treatment effluents and the sterols therein analyzed by chromatographic means. In open uncontaminated waters certain phytoesters have been found but no evidences of domestic sewage contamination were obtained. Domestic sewage does contain cholesterol and coprosterol, even in fully treated sewage. The fate of these sterols as they are diluted in water sources is under study.

SUPPORTED BY U.S. Dept. of Interior - Food Water Pol. Ctl

6.6187, EFFECTS OF RIVERS ON THE METABOLISM OF TEXAS BAYS
B.J. COPELAND, Univ. of Texas, Graduate Schol, Port Aransas, Texas 78373

The overall objective of the research proposal is to seek ways to distinguish the degree to which a body of water is polluted, ascertain the contribution of rivers to the bay, and to discover quantitative and qualitative differences between polluted and unpolluted coastal waters. Comparisons of concentrations of various nutrient compounds to primary productivity and various animal and plant assemblages will be made and the river's contribution to the bay will be evaluated.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

6.6188, A STOCHASTIC MODEL FOR POLLUTION IN ESTUARIES
R.G. KRUTCHKOFF, Virginia Polytechnic Institute, Research Division, Blacksburg, Virginia 24061

The purpose of this investigation is to find a stochastic model for pollution and dissolved oxygen in estuaries. With this model it will be possible to predict the proportion of time that pollution will be above any given concentration or that dissolved oxygen will be below any given level. It is hoped that this information will result in better management of water resource systems and aid in forming more realistic restrictions on the use of estuaries for disposal of pollutants.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

6.0189, FALLOUT INVENTORY OF THE OCEANS AND RELATED MECHANISMS
J.J. FUGUAY, Battelle Memorial Institute, Richland, Wasington 99352

This study is to provide information to assess the inventory of fallout radionuclides in the several spheres of the Earth. At present, a mass balance of material released against the inventory in the atmosphere, on the land surfaces and in the sea cannot be made to the accuracy desired. Measurements of the history and distribution of radionuclides produced in weapons testing residing in the atmosphere plus those depositing on terrestrial surfaces have permitted tentative calculations of the inventory in the sea by assigning there all unmeasured inventory. From such a calculation, the rate of deposition over the ocean must be about 50% greater than over the land, but the required mechanisms are unclear. Recently, we have developed methods to establish the inventory in the sea through analysis of the water; this will contribute to the knowledge of the distribution of fallout on Earth. Investigation of the exchange processes between air and sea, and air and land, and using knowledge of debris transport and the atmospheric and terrestrial inventory of fallout, the difference in rates will be measured and the mechanisms defined.

This is a new program but applicable progress was made here under other AEC studies. Methods were developed and used for ten trace elements in sea water by neutron activation and counting on multidimensional and Ge(Li) diode gamma-ray spectrometers. Research continued on the behavior of airborne radionuclides and was expanded to include sampling at Pt. Barrow, Alaska, and Rio de Janeiro.

The behavior of 55Fe in the ocean was clarified. Tuna from the northern hemisphere were about 20 times as active as those from the southern. New techniques used cosmic-ray-produced radionuclides as tracers of the normal atmospheric aerosols. Aircraft sampling was integrated into the work.

SUPPORTED BY U.S. Atomic Energy Commission

6.0190, COLUMBIA RIVER SEDIMENT STUDIES
J. NIELSEN, Battelle Memorial Institute, Richland, Washington 99352

PNL provides analytical services for the Columbia River and estuary studies being conducted by the USGS for the AEC, aids in the evaluation of the fate of the radionuclides, especially in the area of effect of retention by sediments, and conducts geochemical studies involving mechanisms of radioactivity uptake by the sediments.

SUPPORTED BY U.S. Atomic Energy Commission

6.0191, BACTERIOLOGICAL AND ESTHETIC OF PLEASURE BOAT WASTES DISCHARGE ON SMALL HARBORS
R.W. SEABLOOM, Univ. of Washington, School of Medicine, Galveston, Texas 77550

This project is being carried on in cooperation with the Municipality of Metropolitan Seattle.

This is a new program but applicable progress was made here under other AEC studies. Methods were developed and used for ten trace elements in sea water by neutron activation and counting on multidimensional and Ge(Li) diode gamma-ray spectrometers. Research continued on the behavior of airborne radionuclides and was expanded to include sampling at Pt. Barrow, Alaska, and Rio de Janeiro.

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SUPPORTED BY U.S. Atomic Energy Commission

6.0192, INFLUENCE OF INDUSTRIAL AND MUNICIPAL WASTES ON ESTUARIES AND OFF SHORE WATER QUALITY

This project is being carried on in cooperation with the Municipality of Metropolitan Seattle.

A major objective is to study the influence of industrial and municipal waste disposal on all phases of water quality, chemical, physical, ecological, and sanitary in fresh, brackish, and saline environments. Measurements made with multiple parameter water quality recorders at four sites on the Duanish River estuary are the basis for the attempted correlations. Parameters recorded include dissolved oxygen, specific conductance, water temperature, pH, turbidity and solar radiation index. Computer programs will be written to analyze these data and to detect significant relations.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

7. MARINE GEOLOGY

7A. ECONOMIC GEOLOGY

(location, Origin, and Grade of Marine Mineral Resources.)
7. MARINE GEOLOGY

7.0001, AN APPROACH TO MARINE RESOURCE DEVELOPMENT IN ALASKA
D.W. Ross, B. Univ. of Alaska, Inst. of Marine Sciences, College, Alaska 99735

The marine resources of the State of Alaska are considered to be of great value. While some exploration and development of seafood, petroleum and minerals has occurred, little in the way of planning for such activities has been done. This project consists of a study which will provide: a basis for curriculum planning for education, an appraisal of Alaskan marine resources, establishment of priorities for research and identification of the most useful areas for early development.

A committee of ten experts, five from Alaska and five from other states, will prepare a report which is to serve as a guideline for marine resource development in Alaska. The committee members will compile existing information on Alaskan marine resources, visit specific areas of such activity and prepare the report.

SUPPORTED BY U.S. National Science Foundation

7.0002, A UNIFIED APPROACH TO WATER, FOOD AND POWER IN A COASTAL DESERT COMMUNITY
C.N. Hedges, Univ. of Arizona, Inst. of Atmospheric Physics, Tucson, Arizona 85721

The University of Arizona is developing a combination system for providing power, water and food. The system is designed for use, initially at least, in a coastal desert area.

Power is generated by a diesel-electric set. Waste energy from the diesel engine is utilized to heat seawater for a humidification desalination plant. The waste seawater from the desalination plant is used to provide the temperature and humidity control for a closed-environment greenhouse. Carbon dioxide from the diesel engine exhaust is used in the closed greenhouse to accelerate plant growth.

Various experimental components of the system have been constructed and tested at the Environmental Research Laboratory, Tucson, Arizona. A pilot facility is being developed at Puerto Penasco, Sonora, Mexico, in cooperation with the University of Sonora.

SUPPORTED BY Rockefeller Foundation

7.0003, SAMPLING CAMPAIGN ON CORONADO BANK, OFF SOUTHERN CALIFORNIA

DAVIS

The project commenced field operations in May 1968 with a comprehensive survey involving seismic, magnetic, surficial dredge and grab sampling and underwater photography of the Coronado Bank above the 100 fathom contour. The shallowest water depth encountered in this preliminary work was approximately 57 fathoms (342'). Thus far, the deepest penetration of bottom sediments on the bank has been mostly surficial, measuring less than 2 feet, and recovery of an undisturbed core has not been attempted.

The anticipated sampling campaign on Coronado Bank will provide the first truly three-dimensional measurement of sediments overlying the bedrock surface and hopefully the first undisturbed core sample. The purpose of this project is not only to measure and evaluate the phosphate content and target reserves, but also provide the opportunity to test systems for deep water drilling capability. The surficial sampling just completed (as outlined in Project VIII-C-1) has not been analyzed as of this writing, and therefore results regarding P205 content are not available to report. However, photographic recovery via underwater television indicates large areas of unobstructed sand bottom with occasional boulder-sized nodules. Several smaller areas indicated a relatively high density of phosphate nodules. Seafloor bathymetry, bottom characteristics and depth of overburden to the bedrock are presently being determined.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

7.0004, ANALYSIS AND INTERPRETATION OF DATA FROM GEOPHYSICAL AND GRAVIMETRIC SURVEY OF CORONADO BANK, OFF SOUTHERN CALIFORNIA

MCFADDEN

Background information regarding potential California offshore phosphorite target areas has been provided in a two-volume portfolio of technical papers concerning the subject. This compilation has been circulated to all Team members.

The collection contains 46 papers, as well as a selected bibliography of 40 additional references.

The target selection was made on the basis of several factors. First, previous work done by Drs. K.O. Emery, R.S. Dietz, F.P. Shepherd, and others indicated that Coronado Bank has potential as a prime phosphorite area. The second basis for target selection was related to water depth and size of the target area. Coronado Bank, above the 100 fathom line represents an area of approximately 18 square miles, most of which is relatively flat and unobstructed. Also, visibility for underwater photography and videotape television work was considered to be very good. The third basis for selection concerned the logistics: The Coronado Bank target area is in close proximity to San Diego which offers harbor protection for craft the size of the R/V CRIPPLE CREEK.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

7.0005, GEOLOGICAL, GEOPHYSICAL, OCEANOGRAPHIC, AND ECOLOGICAL DATA ON WORLDWIDE BASIS, ON AREAS OF HEAVY METALS POTENTIAL

A survey of existing mineral resource and sampling data has been in progress to establish the location and general character of known and potential areas of seafloor mineralization in the Pacific Coast continental shelf. During the past year, major emphasis has been placed on nearshore precious-metal placers in the northern California-Oregon heavy-metal placer areas. Based on collected data, several potential offshore target areas for each of these were selected for field studies involving both drilling and deposit characterization.

Results of USGS reconnaissance missions and data from other sources have pointed up five nearshore heavy-metal target areas off the Oregon coast and two areas off northern California. Climatological data for these areas have been reviewed and analyzed with the selection of August and September for drilling operation which are to be conducted from the R/V VIRGINIA CITY.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

7.0006, MARINE HEAVY-METALS PRODUCTION INFORMATION, ON WORLDWIDE BASIS

Information on worldwide offshore minerals production has heretofore been collected and disseminated on an informal basis or as an incidental part of other MMTC data collection efforts. With inception of this project, heavy-metals production information will now be collected, analyzed and disseminated on a formal project basis, with a view to worldwide coverage. Major emphasis will be placed on the characteristics of the deposits, mining history and recorded production, mining and sample processing systems employed, the recoverability factor, operating costs, and a number of other technological aspects of the operations.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

7.0007, EVALUATION OF CONTEMPORARY ACOUSTIC, MAGNETIC AND GRAVIMETRIC METHODS FOR DETERMINING SIZE AND SHAPE OF DEPOSITS

Study and analysis of available marine geophysical instrumentation and techniques to date at this Center have been largely
concentrated on acoustic subbottom profiling and marine magnetometer systems as related to the previous broad geophysical project and development of the Center's inhouse capability with respect to geophysical instrumentation. Under this current project, a detailed study and analysis of all present state-of-the-art acoustic, magnetic, gravimetric, as well as related bore-hole logging instrumentation and techniques having possible application to marine characterization activities in the marine environment will be conducted on a formal project basis.

Included in this effort will be appraisal of contemporary bottom and subbottom profiling, magnetometer/gradiometer, and gravimeter system versions. The down-hole geophysical logging techniques applicable or adaptable to the marine environment. Detailed comparisons will be made of each suite of systems with a view to definition of their performance capabilities for characterizing placer deposits of variable thickness, composition, and environment.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

7.0008, FEASIBILITY STUDY OF THE USE OF ELECTRICAL METHODS FOR DETERMINING SIZE AND SHAPE OF DEPOSITS


Preliminary investigative work on a towed electrical self-potential system for delineating oxidized mineral deposits or ore bodies at the seafloor was initiated at this Center during FY 68 during which time the Project Leader was employed on the Center's geophysical staff. Following recent modifications to the original prototype system and development of more sensitive electrodes, the system has shown promise of becoming a useful tool for delineating self-potential anomalies in mineral deposits at sea. Self-potential or spontaneous potential technique for many years has been successfully used on land for logging oil wells and sea. Self-potential or spontaneous potential technique for many years has been successfully used on land for logging oil wells and the marine version, the down-hole geophysical logging now appears to be feasible. The marine aqueous environment has a tendency to somewhat mask reduced mineral bodies, but this is not considered to be a problem. Further, the aqueous environment allows for continuous traversing and recording in contrast to land deposits, where the technique involves the laborious task of emplacing and wetting each electrode for sufficient contact. Contact on land is difficult due to the insulating properties of dry earth and clays, whereas, contact with the highly conductive seawater is relatively easy.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

7.0009, OREGON-NORTHERN CALIFORNIA PLACER DEPOSITS


Reconnaissance surveys by the USGS and the Department of Oceanography of Oregon State College have outlined five areas off the southern Oregon coast and two areas off the northern California coast which indicate zones of concentrations of heavy minerals. Preliminary plans were started in the second quarter of FY 1968 in cooperation with USGS for testing these promising areas by drilling. The team concept of project coordination and management was initiated with the appointment of a team-coordinator-manager and members of the team representing all components of MMTC. Meetings of the team members have been held to acquaint each member with the problems of the other members, to keep avenues of liaison open, and to coordinate the various efforts towards a preparation completion date of July 1, 1968.

Close liaison with the USGS Office of Marine Geology and Hydrology at Menlo Park has been maintained to exchange technical data and coordinate the planning activities. Drilling sites as planned by the USGS have been transferred to navigation charts to aid in closer ship's positioning.

A review of data received from the U.S. Naval Oceanographic Office in Washington, D.C. concerning wind, sea, and swell conditions in the coastal areas concerned, indicates that approximately 50 per cent of July and August will be suitable for drilling operations. The remainder of the year would provide less than 50 per cent available drilling time.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

7.0010, MARINE GEOLOGY OF THE CALIFORNIA CONTINENTAL BORDERLAND WITH EMPHASIS ON FUTURE ECONOMIC DEVELOPMENT AND GENERAL RESOURCE VALUE

D.S. Gorsline, Univ. of Southern California, Graduate School, Los Angeles, California 90007

Presently includes studies of the heavy metal and heavy mineral content of coastal beaches and the shelf off southern California, clay mineral contribution from principal streams, general sediment mineralogy in river bottoms and beaches, sedimentary characteristics of marine basins in the Borderland, phosphorite distribution and internal structures, and special projects covered in part by contract funds including geology and sediment distribution of Lake Tahoe and clay mineralogy of shelf sediments off the northwestern Alaska coast.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey


L. Fischman, Economic Associates Inc., Washington, District of Columbia

The study is designed to provide an initial survey of the mineral and botanical resources of the United States' continental margins, along with a preliminary appraisal of their potential economic value and the status of their development. The goal is to furnish data upon which analytical evaluation of Federal policies and programs can be based.

The most significant materials potentially producible from the marine environment will be covered with the choices based upon occurrence, apparent public interest, and relative importance in the total U.S. economy. Materials which will receive the greatest attention include: oil and gas; manganese; phosphorus and phosphates; sulfur; aggregates; calcium carbonate; gold; titanium; thorium; and fresh water.

Demands as well as estimated supplies over the next 25 years will be projected based upon review of existing studies and source data. Production from existing potential non-oceanic sources will be considered for purposes of these projections. Also, the state-of-the- art and costs of extraction will be described along with potential impact of Federal research and development, or conservation programs upon the development of these marine materials. Means of Federal encouragement of the creation of the needed equipment and institutions will be explored.


7.0012, DEVELOPMENT OF OFFSHORE SOURCES OF SAND SUITABLE FOR BEACH RESTORATION AND NOURISHMENT


This study is to locate and quantitatively assess those offshore deposits of sand suitable for beach restoration and/or nourishment. The present geographical limits of the study are from New Hampshire to the Florida Keys along the Atlantic Coast in water depths of 15 to 100 feet below low water datum. The method of exploration is twofold: (1) Geophysical (acoustic) surveys or the bottom and shallow subsurface data in selected areas; and (2) The extraction of short (10-15 feet) cores of the unconsolidated sediments. These data are analyzed to develop two and three dimensional maps delineating areas of usable sediments which may be exploited economically. Concurrent studies are in progress to develop and refine methods of offshore dredging and delivery of the material from the dredge to the shore.

SUPPORTED BY U.S. Dept. of Defense - Army
7. Marine Geology

7.0013, Distribution of Heavy Metals, Western Gulf of Mexico

This study is being performed in coordination with the Louisiana diagenetic changes occurring in the submerged part of the Delta. Gold, platinum, chromium, tin, etc., during this history, and the geochemistry, and economic potential of heavy metals such as gold, platinum, chromium, tin, etc., but future work will be broadened to meet the needs of the total goals. This study is being performed in coordination with the Texas A & M University under a joint research contract.

Supported by U.S. Dept. of Interior - Geological Survey

7.0014, Mississippi Delta

Determination of Pleistocene and Recent history of the Mississippi Delta, the geologic parameters that control distribution, geochemistry, and economic potential of heavy metals such as gold, platinum, chromium, tin, etc., during this history, and the diagenesis occurring in the submerged part of the Delta. This study is being performed in coordination with the Louisiana State University under a joint research contract.

Supported by U.S. Dept. of Interior - Geological Survey

7.0015, Oregon-California Black Sands

The overall objective is to evaluate the potential for economic concentrations of heavy metals and heavy minerals in beach and offshore sands along the Pacific Coast from the mouth of the Coos River in Oregon southward to the mouth of the Klamath River in California, and the heavy metal transport of major streams supplying the area. This work is being performed in coordination with the Department of Oceanography, Oregon State University, and the Department of Geology, University of Oregon, under joint research contracts.

Supported by U.S. Dept. of Interior - Geological Survey

7.0016, Resources of the Bering Continental Margin

Three-dimensional geologic-geophysical analysis of the Bering Shelf to appraise the mineral and energy resources on and beneath the sea floor, study of geologic processes operating in the Bering Sea that govern formation or concentration of mineral resources, collection of data essential to the wise utilization of these resources and the development of the geologic history of the region. Project covers USGS work in direct conjunction with the University of Washington contract.

Supported by U.S. Dept. of Interior - Geological Survey

7.0017, Seward Peninsula Nearshore

Objectives are to assess the heavy-metal potential of nearshore areas adjoining the Seward Peninsula and submerged areas adjoining Little Diomede Island, Fairway Rock, King Island, and Sledge Island with emphasis on a search for submerged gold and tin placers, to establish the geomorphic history of these submerged areas, with emphasis on the identification of former positions of the shoreline, former extensions of the subaerial drainage systems, and evidence of late Tertiary and Quaternary tectonic movements; and to establish the detailed history of the last rise in sea level.

Supported by U.S. Dept. of Interior - Geological Survey

7.0018, Marine-Fluvial Interface, Coastal Oregon

Objectives of this study are: (1) To determine age and origin of marine terraces and their relation to prominent fluvial terraces, including both those exposed and submerged, and to compare the style of terrace deformation relative to that of older structures; (2) to study weathering reactions to determine possible role of weathering in generating economically important heavy metal placer deposits and the possible stratigraphic significance of soils; and (3) to evaluate the heavy metal deposits in the area.

Supported by U.S. Dept. of Interior - Geological Survey

7.0019, Nearshore Heavy Metal Deposits of the Gulf of Alaska

The primary objective is to establish the abundance and distribution of heavy metals in nearshore marine deposits of the Gulf of Alaska, particularly in the known black sand areas of Kodiak Island, Yakutat Bay and Lituya Bay, to relate the concentration and distribution of heavy metals to the geologic history of the Tertiary and Quaternary periods; and to contribute to the understanding of principles of heavy metal concentration and nearshore depositional processes as they relate to glacial terraces. To achieve these long-range goals, a coordinated five-year program between the University of Alaska and the USGS has been established under a joint research contract.

Supported by U.S. Dept. of Interior - Geological Survey

7.0020, Northern California Offshore Black Sands

The primary objective is to establish the abundance and distribution of heavy metals in nearshore marine deposits along the coast of California north of latitude 38 degrees. This is a southern continuation of the southwest Oregon black sands area. This work is being performed in coordination with the Scripps Institution of Oceanography under a joint research contract.

Supported by U.S. Dept. of Interior - Geological Survey

7.0021, Heavy Metals and Sedimentation Process of the North Carolina Shelf

Heavy metal sampling on the North Carolina continental shelf south of Cape Hatteras is underway. In addition, sampling for heavy metals analysis will be carried out in Pamlico Sound on the barrier island beaches, and in estuaries and rivers. The sampling program will be coordinated with other projects concerned with interpretation of shelf history and sedimentation processes. Aspects to be investigated include heavy mineralogy, feldspar mineralogy, quartz grain morphology, grain staining, as well as more routine parameters such as size and percent CaCO3.

Supported by U.S. Dept. of Interior - Geological Survey

7.0022, Oregon-Washington Nearshore

Primary objective is to evaluate the economic potential of heavy metals in submarine and subaerial deposits of Quaternary age along coastal Oregon north of latitude 44 degrees N and along coastal Washington; preparation of land-sea geologic transects for areas containing significant deposits of heavy metals (black sands) to show distribution and thickness of deposits and relation to geologic framework.

Supported by U.S. Dept. of Interior - Geological Survey

272
7.0023, GEOPHYSICAL AND GEOCHEMICAL STUDY OF RED SEA MINERAL DEPOSITS  
J.M. HUNT, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543

A six-week cruise will be made in the central and southern part of the Red Sea into the Gulf of Aden - an area known for extensive vulcanism. Plans are to (1) Make in situ measurements of the suspended matter in the brines. (2) Determine if the three brine pools are cooling off with a decrease in brine, or are heating up. (3) Determine the presence and distribution of the hydrothermal vent through a combination of mineral analysis, and variation of strategically located heat flow measurements. It also may be possible to determine the magnitude and time of the last hydrothermal event from these data. (4) Determine the probable nature of fluids emanating from the vent by analyzing interstitial water in cores taken as close to the vent as possible. (5) Determine the size of the mineral deposits with more controlled seismic profiling plus long cores. (6) Determine the size of vulcanism south of 27 degrees N into the Gulf of Aden and the possible presence of other mineral deposits in this southern area. (7) Examine the suspended matter in the brines. (2) Determine if the three brine pools are cooling off with a decrease in brine, or are heating up. (3) Determine the presence and distribution of the hydrothermal vent through a combination of mineral analysis, and variation of strategically located heat flow measurements. It also may be possible to determine the magnitude and time of the last hydrothermal event from these data. (4) Determine the probable nature of fluids emanating from the vent by analyzing interstitial water in cores taken as close to the vent as possible. (5) Determine the size of the mineral deposits with more controlled seismic profiling plus long cores. (6) Determine the size of vulcanism south of 27 degrees N into the Gulf of Aden and the possible presence of other mineral deposits in this southern area. (7) Extend our knowledge of the stratigraphy and micropaleontology of the Red Sea into older stages of the Pleistocene. (8) Make surface and subsurface plankton trawls from the Red Sea into the Gulf of Aden to obtain the information needed for more precise paleoecological interpretation of the fossil distributions in the cores.

SUPPORTED BY U.S. National Science Foundation

7.0024, POTENTIALLY-ECONOMIC SAND AND SILT DEPOSITS IN LAKE ONTARIO, NEW YORK  
D.L. WOODROW, Univer. of Rochester, Graduate School, Rochester, New York 14627

The geometry, thickness and regional extent of widely spaced submerged beaches in Lake Ontario between Rochester and Buffalo will be measured. The offshore gravel, sand and silt deposits lying between 10 and 100 feet depths will be studied to determine their economic quality as well as that of the landward silt and sand deposits, and to demonstrate controls on beach size and time of formation. A fourteen day cruise over the area to be studied will be made taking continuous recording fathometer traces and sub-bottom profiles. Cores, dredge samples and underwater television pictures will be taken at selected sites; cores will be split and photographed on board ship, and SCUBA divers will take still photographs of the bottom and collect samples of organic materials. Lithographic logs of the cores, and grain-size and mineralogic analyses of the sands will be made. Summary maps will be compiled from bathymetric data, subbottom profiles and sediment data.

SUPPORTED BY U.S. National Science Foundation

7.0025, FORMATION AND DEGRADATION OF MANGANESE NODULES BY MARINE BACTERIA  
H.L. EHRLICH, Rensselaer Polytechnic Inst. . Graduate School, Troy, New York 12181 (NONR)

This study involves the role of the marine microbial flora in the formation and degradation of manganese nodules. The nodules, which occur abundantly on the ocean floor, contain a high percentage of manganese along with rare elements such as cobalt, nickel, titanium, and tellurium. The nodules constitute a potential source of these valuable elements. The physiology of manganese nodules has intrigued oceanographers since the discovery of these nodules during the Challenger Expedition of 1873-1876. The mode of formation of the nodules, and the probable role of marine bacteria in their formation, is of direct interest to oceanographers.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0026, MARINE MINERAL RESOURCES OF THE NORTH CAROLINA CONTINENTAL MARGIN  
O.H. PILKEY, Duke University, Graduate School, Beaufort, North Carolina 28516

This project, Plan summary has been provided to the Science Information Exchange

7.0027, SYMPOSIUM ON THE MINERAL RESOURCES OF THE WORLD OCEAN  
J.A. KNAUSS, Univ. of Rhode Island, Graduate School, Kingston, Rhode Island 02818

The purpose of this task is to conduct a symposium on the mineral resources of the world ocean. The symposium will be held at the Naval War College, Newport, Rhode Island, on 10-12 July 1968 to discuss the ocean in geologic time, its mineral resources, new technology and engineering in the ocean, and public policy positions concerning the ocean. The symposium is co-sponsored by the Navy, the Geological Survey and the University of Rhode Island.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0028, STRUCTURE, MINERALOGY, AND CHEMICAL COMPOSITION OF MARINE MANGANESE NODULES  
R.K. SOREM, Washington State University, Graduate School, Pullman, Washington 99163

The fine details of structure, mineralogy, and chemical composition of marine manganese nodules will be studied. A suite of about fifty nodules representing nine ocean bottom stations off the coast of Baja, California, will be investigated. The fundamental approach involves the preparation of high-quality polished sections, the recognition and cataloging of microscopic textures, the identification of minerals present and their mode of occurrence, and determination of the chemical composition of different parts of each nodule and its relationship to textures and minerals. Those relationships which appear to be primary in any one part of a nodule may then be interpreted in terms of the probable environmental conditions at the time of formation of that part. All special features such as erosion zones, pockets of fossils and clastic grains, and cross-cutting veinlets will be interpreted in terms of nodule growth history. Finally, all of the data will be correlated and summaries of the relationships will be shown in graphic and tabular form and an attempt will be made to explain the origin of the nodules studied.

SUPPORTED BY U.S. National Science Foundation

7B. GENERAL GEOLOGICAL STUDIES

7.0029, MARINE GEOLOGY OF CONTINENTAL MARGINS  
J.R. CURRAY, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

This unrestricted grant was awarded and has been used as supplementary support for the geological and geophysical research work of the investigator on sediments, structure and history of continental margins. It has supported a variety of projects covered primarily by federal grants. It also enabled completion of a study of the Holocene history of a wide strand-flat, barrier-lagoon system in Nayarit, Mexico. Lateral stabilization of the shoreline following the Holocene transgression can be demonstrated at 4750 years B.P., with seaward progradation starting between 4500 and 3600 B.P. This progradation has been by successive addition of beach ridges built atop longshore bars. Coastal climatic changes occurred at 3600 and 1500 B.P., which resulted in changes in longshore drift direction.

SUPPORTED BY Chevron Research Company

7.0030, CONTINENTAL MARGIN GEOLOGY  
J.R. CURRAY, Univ. of California, Scripps Inst. of Oceanography, La Jolla, California 92038 (NONR)

The objective of this task is to understand the nature of the continental margin. The deep structure of the bottom is explored by reflection profiling, and the information col-

273
7.0031, TECTONIC AND GEOLOGICAL HISTORY OF THE SOUTHWEST PACIFIC REGION
H.W. MENARD, Univ. of California, Scripps Inst. of Oceanography, San Diego - La Jolla, California 92038

It is proposed to mount a major expedition to the Southwest Pacific during April-December, 1967 to study the tectonics, regional geologic history, oceanography and geochemistry of the general area bounded by Australia and the Kermadec-Tonga trench-New Zealand structural line. Associated studies would be made in the trench, and in the equatorial region to the north, on the initial and final expedition legs, and on the land masses adjoining the region.

The proposed expedition, the fifth in a series of Department of Earth Sciences combined summer research expeditions and graduate student field research programs, will follow the pattern of previous expeditions in attempting to integrate work at sea and on land to provide a comprehensive regional study, and in covering a broad spectrum of geological, geophysical, and geochemical studies by staff members and students. Geological and geophysical studies will include reconnaissance and detailed bathymetric surveys with precision depth recording, seismic profiles, sub-bottom seismic profiles, heat flow, magnetic, and gravity measurements, coring and dredging, and geological mapping and radiometric age determinations on associated continental and island areas within and around the region. Oceanographic and geochemical studies will be made on the water masses, their isotopic composition and dissolved gas concentrations, and on gases, water vapor, and dust transport in the marine atmosphere, sediments cores will be dated and subjected to mineralogical and chemical analysis.

SUPPORTED BY U.S. National Science Foundation

7.0032, DEEP FLOW, WATER CHARACTERISTICS, TOPOGRAPHY AND SEDIMENTS IN THE CENTRAL PACIFIC OCEAN
J.L. REID, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

It is proposed to measure the currents, various water properties, and sediments at abyssal depths on the continental and island areas in and around the region. Oceanographic and geochemical studies will be made on the water masses, their isotopic composition and dissolved gas concentrations, and on gases, water vapor, and dust transport in the marine atmosphere, sediments cores will be dated and subjected to mineralogical and chemical analysis.

SUPPORTED BY U.S. National Science Foundation

7.0033, SEA FLOOR ROUGHNESS
UNKNOWN, Univ. of California, Graduate School, San Diego - La Jolla, California 92038 (N00014-67-A-0109-0009)

Investigation of near bottom sea water properties and crustal geophysics are of interest to determine what influence these parameters have on sound propagation.

The improved deep tow equipment will be used to study bottom properties with particular emphasis on roughness, sound absorption, slope and magnetic properties and their effects on acoustic transmission and propagation. Documentation studies of crustal velocity anisotropy will be conducted. Observations and analyses of magnetic field anomalies near seamounts and major oceanic rises and ridges will continue.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0034, PUERTO RICO COOP - MONA PASSAGE

Three-dimensional geologic and geophysical analysis of the Puerto Rican shelf necessary for wise utilization of submerged land such as disposal areas for mine tailings, and assistance to the University of Puerto Rico in the development of course of training in marine geology. Evaluate oil and gas, sand and gravel, and mineral potential (including heavy metals). This study is being performed in cooperation with the Department of Industrial Research, Puerto Rico Economic Development Administration.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

7.0035, MARINE GEOLOGY OF THE SAN FRANCISCO BAY

The objectives of this project are: (1) to prepare the geologic maps of the fault bounded bedrock basin and its structure and tectonic history, the genesis, areal distribution, thickness, composition, physical and chemical parameters, and geologic history of the unconsolidated sediments of the Bay and the bordering areas of present and former marshlands; (2) to determine the earthquake and other geologic hazards associated with the sediments; (3) to contribute to the geologic history of a significant segment of the San Andreas fault system in support of the earthquake program; (4) to determine the gold content of the fine and coarse Bay sediments derived by erosion and hydraulic mining of the Mother Lode area and deposited in the Bay; and (5) to contribute data basic to the better understanding of the hydrology of the San Francisco Bay.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

7.0036, CENTRAL CALIFORNIA CONTINENTAL MARGIN

The objectives of this study are: (1) to prepare intermediate scale geologic maps of the Pacific Coast continental shelf and slope between Pt. Conception and San Francisco; (2) to obtain shallow subsurface detail relating to rocks and structures underlying the sea floor of the area; (3) to assess the geologic conditions in terms of resources that may exist within the area; and (4) to provide geologic knowledge that is needed to explore the resources of adjacent land areas, and to evaluate potential hazards related to geologic conditions within this segment of the San Andreas Fault system.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

7.0037, SUBSURFACE GEOLOGY OF HOGSTY REEF, AN ATOLL IN THE SOUTHEASTERN BAHAMAS
M.M. BALL, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124

The subsurface geology of Hogsty Reef, an atoll in the southeastern Bahamas, will be studied in order to solve two specific problems: (1) To determine the relative stand of a small atoll with respect to sea level during the last Pleistocene glacial cycle; (2) To study the paleogeomorphology of a Bahamian atoll with a view toward substantiating the proposed atoll nature of the Bahamas and comparison with the subsurface geology of some classic atolls of the Marshall Islands. Samples from three 70 meter drill holes on the atoll will be analyzed by petrographic and geochemical means to determine the nature of the underlying strata.

Hogsty Reef is a small atoll, the coral reef on which were probably killed off by lowered water temperatures during the
Wurmian. If subaerial erosion was an important atoll process during
the glacial epochs, its effects should be well shown on Hogsty. However, lines of evidence indicate that Hogsty may be underlain by Pleistocene aeolian dunes near the present reef surface. Determination of the basement rock will be of use in worldwide studies of atoll dynamics.

Several lines of evidence suggest that the Bahamas have been atolls during the Tertiary. The aeolian dunes, if present, should be of minimal thickness and the drill cores should penetrate the Pleistocene-Tertiary boundary. The nature of underlying biogenic deposits will indicate the past geological environment.

SUPPORTED BY U.S. National Science Foundation

7.0038, SUBMARINE GEOLOGY OF THE BAHAMAS AND THE WEST INDIAN ARC
R.J. HURLEY, Univ. of Miami, Institute of Marine Science, Miami - Coral Gables, Florida 33124

This grant is for continued support of geological studies in the Bahamas and West Indies that have been supported by NSF Grants GP-2750, GP-2952 and GP-4197.

Following two largely exploratory cruises in the Lesser Antilles, two particular problems will be investigated. The existence of the Barahina Ridge, consisting of flysch sediments, on the southern continuation of the axis of the negative gravity anomaly of the Puerto Rico Trench, suggests partial filling and then compression of the southern part of a once more extensive trench. Understanding the geologic history of these features should provide a valuable insight on the nature of deep sea trenches. The second problem involves the detailed geology of the island arc ridge near Guadeloupe where the single arc bifurcates to a double arc. There is evidence that a second (recent) phase of volcanism in the island are occurred to the west of the earlier activity in the northern Antilles, forming the double arc.

SUPPORTED BY U.S. National Science Foundation

7.0039, GEOLOGIC SURVEY OF MARTABAN CANYON, NORTHEASTERN INDIAN OCEAN
K.S. RODOLFO, Univ. of Illinois, Graduate School, Chicago, Illinois

Martaban Canyon is a large submarine valley and canyon system incised into the Irrawaddy Delta shelf and slope. The Irrawaddy Delta is one of the major delta systems of the world, yet it is one of the least understood. Martaban Canyon indubitably influences sedi-mentation of the river, and affords many clues to the sedimentological and tectonic history of the delta. A geologic reconnaissance of the canyon system during the Interna-tional Indian Ocean Expedition has been accomplished as part of a doctoral dissertation. With this reconnaissance as planning control, it is proposed that approximately 1000 nautical miles of detailed bathymetric, gravimetric and geomagnetic track be made across the valley and canyon system and approximately 10 piston cores be taken from valley and canyon axes during the 1967 global cruise of the USC&GSS Oceanographer and that these data be evaluated in the light of local sedimentation and tectonics.

SUPPORTED BY U.S. National Science Foundation

7.0040, SEA-FLOOR SEDIMENTS AND ROCK STUDIES
R.L. CHASE, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543 (N00014-66-C0241)

This task concerns obtaining cores and dredge samples of sedimentary and basaltic rock in the North Atlantic Ocean, particularly over the mid-Atlantic Ridge, and making examinations of the content of these cores and those previously obtained in the North Atlantic Ocean and the Mediterranean and Red Seas. Core analyses include determinations of petrology, sedimentology, thermal conductivity, micropaleontology, and paleomagnetic stratigraphy. Cores will be photographed to provide permanent records. Ages of the sediments will be determined from micropaleontological analyses of foraminifera and from the remaining magnetism in the rocks (indicative of reversals in the ancient geomagnetic field). Sedimentation rates can be calculated from these age determinations.

7.0041, MARINE GEOLOGY
H.H. HESS, Princeton University, Graduate School, Princeton, New Jersey 08540

This research is directed toward the analysis and interpretation of geological and geophysical data from selected oceanic areas including the Gulf of Guinea, the Beata and Aves Ridges in the Caribbean, and the Gorda Ridge off the west coast of the United States. In addition, magnetic data over various oceanic regions will be compiled and analyzed for their relation to the concept of sea-floor spreading. Construction of bathymetric charts will be continued.

The effectiveness of naval operations is strongly dependent upon the physiography of the ocean bottom and the acoustic properties of the sediments in the areas of operation. This research program will help develop not only basic bathymetric and magnetic data, but also a predictive capability for extending this information into unsurveyed areas.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0042, GEOLOGIC INVESTIGATIONS IN PUERTO RICO & THE CARIBBEAN
P.H. MATTHEWSON, City University of New York, Graduate School, Flushing - Queens College, New York 11367

The general aims of the project are to elucidate problems of Puerto Rican and Caribbean geology, mainly in the fields of volcanic and plutonic petrology, and structural geology. Problems currently under consideration include (1) major- and trace-element distributions in volcanic and plutonic rocks, (2) geochemical definition of the rock-stratigraphic units; (3) ultramafic rocks: emplacement, petrography, mineral deposits; (4) structure and petrology of basement rocks; (5) carbonate petrology; (6) chert petrology; (7) petrology and petrography of basement rocks; (8) structural analysis.

SUPPORTED BY Puerto Rico Government

7.0043, COLLECTION, ANALYSIS, INTERPRETATION, AND PRESENTATION OF OCEANOGRAPHIC GEOLOGIC DATA IN CONNECTION WITH SUBMARINE CABLE SYSTEM DEVELOPMENT
D. HAYES, Columbia University, Graduate School, New York, New York 10027

This project is directed toward the use of the results of the recent oceanographic survey of the Pacific Ocean. The survey was supported by the Office of Naval Research as a part of its undersea survey program. Additional work will be accomplished as part of a doctoral dissertation in geology. The analyses of the data will be directed toward those aspects of the geology of the ocean floor that are pertinent to the development of submarine cable systems. The major areas to be considered will be the areas of the North Atlantic Ocean, especially on the continental slope off the United States and the Caribbean Sea.

SUPPORTED BY Bell Telephone Laboratories

7.0044, UNDERWATER GEOLOGY IN THE OSWEGO AREA OF LAKE ONTARIO
A. DELPRETE, State University of New York, Graduate School, Oswego, New York 13126

Project objective is to study the general underwater geology in the Oswego area. Research using underwater photography, both black and white and color, to obtain a permanent record of bottom conditions at selected locations along the shore thus sedimentary structures, rock outcrops, erosional features, and glacial features as preserved below surface can be recorded. Detailed study of sand samples is necessary including examination by means of a petrographic microscope. Sand should be sub-divided so that heavy minerals can be separated and studied for different areas.

Further investigations are needed in regard to local currents and related to local winds.

SUPPORTED BY State University of New York

7.0045, GEOPHYSICAL INVESTIGATIONS OF THE SOUTHWEST MARGIN OF JAPAN
M. EWING, Columbia University, Graduate School, Palladian, New York 10964

The principal investigators will coordinate their work with that of Dr. Sadanori Murauchi, National Science Museum, Tokyo. They will conduct a two-ship marine geophysical survey
7. MARINE GEOLOGY

of the southwest margin of Japan. The main purpose of the survey is to study the sediment distribution and crustal structure of the Nankei trough which extends from the mouth of Surugu Bay, Honshu, along with the foot of the island margin of southwest Japan to the southeast of Kyushu. The geophysical measurements will provide knowledge of the regional structure and may yield important clues to its development and evolution.

SUPPORTED BY U.S. National Science Foundation

7.0046. JOINT STUDY OF THE CONTINENTAL MARGIN OFF OREGON BY OREGON STATE UNIVERSITY AND THE UNITED STATES GEOLOGICAL SURVEY

L.D. KULM, Oregon State University, Graduate School, Corvallis, Oregon 97331

The study of the continental margin off of Oregon includes a three-dimensional geologic-geophysical analysis of the margin. The major objectives of the program are to determine its geologic history and to appraise the mineral and energy resources on and beneath the sea floor.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

7.0047. SEDIMENTATION, MORPHOLOGY, AND STRUCTURE—MID-ATLANTIC RIDGE

T.H. VANANDEL, Oregon State University, Graduate School, Corvallis, Oregon 97331

Since 1964, a small group of investigators, mostly affiliated with Scripps Institution of Oceanography and Woods Hole Oceanographic Institution, has carried out a program of detailed and integrated geological, geophysical, sedimentological, and stratigraphic studies of selected portions of the Mid-Atlantic Ridge. It is the purpose of these studies to establish in detail the structural configuration, sediment distribution, and geologic history of the Ridge, and to relate these to geotectonic concepts as, for example, sea-floor spreading. It is proposed to complete the analysis of all geophysical data, the study of the provenance of the sediments, and the geologic synthesis of information for the Vema Fracture area, and to undertake, in cooperation with scientists from Woods Hole Oceanographic Institution and the U.S. National Museum in Washington, D.C., a study of portions of the normal Ridge near 45 degrees North latitude, between 2 degrees and 15 degrees South latitude, and south of 29 degrees South latitude. Also a study will be made of a portion of the non-volcanic Walvis Ridge for comparison.

SUPPORTED BY U.S. National Science Foundation

7.0048. MARINE GEOLOGY AND GEOPHYSICS

D.C. KRAUSE, Univ. of Rhode Island, Graduate School, Kingston, Rhode Island 02881 (NONR)

In subaerial geology the effort is directed toward an understanding of the processes affecting sedimentation on continental shelves. The approach involves detailed studies of topographic-structural sedimentation relationships in two shelf areas of the Atlantic. One of these is the area off southern New England which has the glaciated character typical of northern hemisphere shelves. The other, Northwest Africa, is uninfluenced by direct glacial action and lies adjacent to arid, semi-arid and humid coastal areas. The geophysical program involves the use of seismic profiling, magnetometer measurements, echo sounding, coring, bottom photography and dredging in an effort to understand structure and the processes involved in forming and modifying the earth's crust beneath the oceans.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0049. MARINE GEOLOGY OF THE SUB-ANTARCTIC PACIFIC REGION

T.R. NATYUDU, Univ. of Washington, Graduate School, Seattle, Washington 98195

In January 1968, the Principal Investigator on NSF Grant GA-1248 moved from the University of Washington to the University of Alaska, Institute of Marine Science at Douglas, Alaska. At the time the Principal Investigator left the University of Washington, GA-1248 was an active research grant with approximately $30,000 in unexpended funds. This proposal represents a continuation of the previous grant, with the research to be carried out at the University of Alaska by Dr. Mayudu. The University of Alaska proposes to continue the petrographic and geochemical analyses of selected samples from deep-sea cores from the USNS Eltanin. The data will be used to help determine the lithology, origin, petrology, and distribution of the sediments on the floor of the sub-Antarctic southern Pacific Ocean in the area bounded by Latitudes 30 degrees and 60 degrees S and Longitudes 120 degrees and 180 degrees W. Preliminary studies on surface lithology and geochemistry have been completed and a surface-current distribution pattern prepared. These will allow the Principal Investigator to select areas that need concentrated research. The data obtained would be used to evaluate and locate past marine isotherms and paleocurrents, to study fluid-water diagenesis, and to determine the origin of sediments of the different sediment facies.

No out-of-continent travel is planned.

SUPPORTED BY U.S. National Science Foundation

7.0050. CLAY-INORGANIC AND ORGANIC-INORGANIC ASSOCIATIONS IN AQUATIC ENVIRONMENTS

D.W. HOCOD, Univ. of Alaska, Inst. of Marine Sciences, College, Alaska 99705 (AT(04-5)-310-5)

The overall objective of this year's proposed research is to further our understanding of the chemical processes that accompany passage of sediment systems from glacial stages to form marine sediments and the ancillary chemical effects of such processes on the local oceanographic environments. As in the past, the prime emphasis will be on the trace metal associations both in organic and inorganic processes. This year's emphasis is on studies of the trace metal exchange equilibrium between the various size fractions of the suspended minerals and the water. The effect of organic material on this exchange will also be investigated. Analysis will be made by neutron activation techniques. In addition, concerted effort is being made to fractionate the organic matter previously found to contain significant quantities of Cu and Zn. Reverse osmosis and sephadex techniques are being employed. Mineralogical data for both suspended and deposited sediments are complete for Taku estuary and is in press in Marine Geology. No evidence for major diagenetic changes in the minerals was observed in the estuary. The exchangeable cations on suspended sediments after contact with sea water show markedly different composition. The significance of this to the bioclastic processes is under study. Organic association with copper in an extractable form has been found and reported in 'Nature'. Other associations with a non-diagrammable fraction have been found and are now being characterized.

SUPPORTED BY U.S. Atomic Energy Commission

7.0051. CARBON-14 AGE PROFILE OF A HAWAIIAN REEF

W.H. EASTON, Univ. of Southern California, Graduate School, Los Angeles, California 90007

It is proposed to continue a coring program on Hana, ma reef, Oahu, by drilling four additional core holes. In the work now planned, samples at about two-foot intervals from these borings and from cores taken in 1964 will be dated by the C-14 method. A profile of the reef will then be made in which lines of equal age can be shown. The project will establish the age of the reef, the rate of rise of sea level during perhaps the past 10,000 years, the rate of vertical and horizontal growth, and the consistency of the C-14 method in dating coral reefs.

Hanauma reef offers a rare opportunity to establish rates of reef growth both vertically and horizontally. Not only is the reef isolated in a small bay, but it occupies a unique geologic position in which it apparently grew after an explosion crater was invaded by the sea. The age of samples from the bottom of the reef therefore will not only establish the age of the reef but also a time be-
for which the explosion craters were formed. The C-14 profile would be, as far as known, the first one made of a coral reef. It not only would provide a new method of profiling a reef, but the coring would enable a check with lithologic details and a check on consistency of samples for age-dating in a reef.

SUPPORTED BY U.S. National Science Foundation

7.0052, BIOLOGICAL FRACTIONATION OF STABLE ISOTOPES
I.R. KAPLAN, Univ. of California, Graduate School, Los Angeles - U.C.L.A., California 90024 (AT-11-134-134)

The overall objective of the study is to understand the distribution of certain trace elements in the marine environment. In particular, an attempt is being made to ascertain the role microorganisms and other biological systems play in controlling the distribution at the sediment-water interface. Two approaches are being taken, (1) analysis of trace elements in the interstitial water of sediments (2) investigation of the biological fractionation of stable isotopes of sulfur by microorganisms.

It has been found that the distribution of trace elements is controlled very much by the redox system of the sediment. In the presence of hydrogen sulfide, iron and nickel appear to become solubilized. Copper, Zinc, Cadmium are generally most concentrated near the surface, suggesting contribution from organic material. Uranium is concentrated in marine phosphate, and values as high as 300 ppm have been measured.

Investigation of the process of isotope fractionation (32S/33S) during sulfate and sulfite reduction by yeast and bacteria, indicates that the process is closely linked with the physiology and metabolic pathway of the organism and is not a stable equilibrium reaction. Fractionation factors depend on the oxidation state of the substrate and whether the organism is in a growing or resting stage.

New techniques for removal and analysis of trace elements in the ppb range have been developed.

SUPPORTED BY U.S. Atomic Energy Commission

7.0053, UPPER MANTLE OF OCEAN REGIONS

This is a continuation of a high-temperature high-pressure laboratory investigation of minerals and rocks that are characteristic of upper mantle materials in the earth. Previous laboratory analyses have been made on these materials to pressures of 45 kilobars, and new measurements are being made to pressures of 80 kilobars. Emphasis is on minerals that comprise tholeiitic basalt, the principal type of lava material in ocean basins and ridges. The study provides data on the distribution of melting temperatures of this rock with depth in the crust and mantle, and provides information relating to the origin of the rock in the upper mantle of the earth.

These studies are of interest to the Navy because they provide information bearing on where and by what processes rocks segregate in the upper mantle that result in the large outpouring of lava flows in the oceans, including seamounts, oceanic ridges, and oceanic islands.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0054, GEOCHEMISTRY OF NUCLEIC ACIDS
E. ROSENBERG, Univ. of California, Graduate School, Los Angeles - U.C.L.A., California 90024

Objective: a. Problem: To extract, isolate, and identify Nucleic Acids from core samples of marine samples from Mohole Project in depth from 0-170 meters beneath ocean floor. (The 170 meter sample geologically dated by fossils to be 30 x 10 to the 6th or 7th years old) b. Application: Ability to detect nucleic acids in samples would provide valuable clue to existence, type of life that is (or was) present since nucleic acids play a central role in known forms of life.

Results to Date: 1. The analyses of the rare gases helium, neon, argon, krypton and xenon in depth profiles obtained from the Pacific, Atlantic and Antarctic oceans show departures from thermodynamic equilibrium. Methods of analyses is mass spectrometric. 2. Development of geochronological techniques for the marine sedimentary column: uranium/sodium; potassium/thorium; uranium-234/uranium-238; beryllium-10; potassium argon. 3. Formation of ferromanganese nodules. Minor element composition of the ferromanganese minerals is controlled by the mineralogy and the formation of the mineral phases is depth dependent.

SUPPORTED BY U.S. Atomic Energy Commission

7.0055, MARINE GEOCHEMISTRY RESEARCH
E.D. GOLDBERG, Univ. of California, Graduate School, San Diego - La Jolla, California 92038 (AT(1-1)-34-84)

1. Determination of solubilities of neon, krypton and xenon as a function of temperature and salinity of seawaters to utilize in our field analyses interpretations. We have measured all of the noble gases in seawaters from the world oceans and have concluded that the noble gases are generally not in concentrations expected from thermodynamic equilibrium but are altered by physical processes. Better solubility values will allow a more rigorous evaluation of our results, the mass spectrometric determinations in sea water. 2. Geochemistry of fluorine through studies of its concentration in materials involved in the major sedimentary cycle. The analytical method, involving the photoactivation of fluorine in a linear accelerator, allows analyses to be made down to the 10 p.p.m. range. Our initial results have indicated a concentration in calcium carbonates precipitating from the ocean to levels of 1000 p.p.m. in corals. The chemical behavior of this element in nature is being illuminated by this work and our present studies indicate involvement in mineral formation where calcium ions precipitate or where micas are formed. 3. Developments of new geochronologies for the marine sedimentary record. The high values of thorium (100 ppm) in barites may allow Th/He dating of these minerals.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

7.0056, ALTERATION OF MINERALS
M.N. PETERSON, Univ. of California, Scripps Inst. of Oceanography, San Diego - La Jolla, California 92038 (NONR )

The objective is to investigate the origin and alteration of minerals in the sea as major processes in determining the composition of sea water and marine sediments. The approach is to expose geologically significant materials either to natural water bodies on long-life moorings, or to approximations of natural solutions under laboratory conditions. Measurements are planned on aragonite, amorphous silica, and certain phosphates and sulfates.

This research will contribute to an understanding of the geographic distribution of these minerals in the deep-ocean sediments. In addition, the results of this study will allow constraints to be placed on the use of inexpensive construction materials, such as concrete, in the deep ocean.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0057, GEOCHEMICAL STUDIES OF DEEP-SEA DEPOSITS - THEIR SOURCES AND MODES OF DEPOSITION
K.K. TUREKIAN, Yale University, Graduate School, New Haven, Connecticut 06520

During the past eight years significant advances have been made in the study of the geochemistry and mineralogy of deep-sea sediments primarily in the Atlantic Ocean. With a thorough and sound framework it is proposed to bring these studies to fruition by concentrating on the processes that might be responsible for
7. MARINE GEOLOGY

the observed patterns. This calls for work on strontium isotope studies in ancient deep-sea sediments, and weathering profiles; the composition of planktonic calcareous organisms found in tows; the variations of trace element composition of detrital material carried by streams; and systematic statistical analysis of the large amount of data on deep-sea sediments to extract additional information on regional effects in trace element (including Mn and Fe) distribution.

SUPPORTED BY U.S. National Science Foundation

7.0058, A STUDY OF THE LEAD OXYCHLORIDES AND RELATED SPECIES FOUND IN THE ANCIENT SLAGS OF LAURUM, GREECE
P.E. DESAUTELS, Smithsonian Institution, Washington, District of Columbia 20560

The action of sea water on the ancient slags from the silver mines at Laurium, Greece has created a series of interesting compounds through the centuries. Two of these species were discovered in the slags before being found in natural deposits. This slag suite has never been studied adequately as a related group and the few species described are not well done. It is also obvious that several other species are present but not described. A large quantity of material is on hand and will be systematically examined. X-ray and other standard geological techniques will be used.

SUPPORTED BY Smithsonian Institution

7.0059, ROCKS OF OCEANIC CRUST AND UPPER MANTEL EQUATORIAL ATLANTIC
W.G. MELSON, Smithsonian Institution, Washington, District of Columbia 20560

This investigation is part of program concerning the nature, origin, and development of the suboceanic mantle and deeper layers of the oceanic crust. This project concerns rocks dredged from the Mid-Atlantic Ridge in the equatorial Atlantic, and from the Romanche Trench. Determinations of mineralogy, bulk chemical composition, and petrography provide the basic data in this project. This investigation will also include experimental work on the probable stability fields of low grade metamorphic assemblages derived from basalts and peridotites, two common oceanic rocks.

SUPPORTED BY Smithsonian Institution

7.0060, CONTRACT FOR-PROCESSING OF USARP ROCK SAMPLES
T.E. SIMKIN, Smithsonian Institution, Washington, District of Columbia 20560

Since the beginning of the U.S. Antarctic program, huge collections of rocks have been brought back to the United States by field collectors, and the volume of unstudied specimens increases significantly with each passing year. One major source of the continuous influx of new specimens is the Eltanin operations, during which large numbers of unconsolidated rocks are collected by bottom trawling. At the same time, geologists have expressed the desire to obtain samples of specific groups of antarctic rocks, but most often have been unable to do so unless they do the collecting themselves. Similar situations prevailed in other fields until sorting and distribution centers were established at the Smithsonian Institution (biology) and Florida State University (sediments). This project at the Smithsonian Oceanographic Sorting Center (SOSC) provides for the preliminary identification, inventorying, and distribution to specialists of antarctic rock samples under procedures similar to those governing the processing of biological specimens by SOSC. The identification will start with megascopic work and include petrology of thin-sections of appropriate specimens. Inventorying will be closely tied to the data system for USARP specimens already in operation at SOSC (NSF Contract C-404). It is expected that most of the effort under this contract will be devoted to ocean-bottom rocks.

SUPPORTED BY U.S. National Science Foundation

7.0061, ROCKS OF THE OCEANIC CRUST
T.E. SIMKIN, Smithsonian Institution, Washington, District of Columbia 20560

Petrological studies of rocks from the ocean floor. Use of data to draw conclusions with regard to the evolution of the ocean basins.

SUPPORTED BY Smithsonian Institution

7.0062, RESEARCH ON MINERAL STRUCTURE REVEALED BY AN ELECTRON MICROSCOPE
K.M. TOWE, Smithsonian Institution, Washington, District of Columbia 20560

Uses an electron microscope to carry on research on mineral specimens and skeletal structures of biological organisms from the ocean.

SUPPORTED BY Smithsonian Institution

7.0063, CLAY CHEMISTRY

A study of the nature and identity of clays in the marine environment, and their alteration.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

7.0064, PETROLOGY AND GEOCHEMISTRY OF IGNEOUS ROCKS FROM THE OCEAN FLOOR
E. BONATTI, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124

Igneous rocks form the backbone of mid-oceanic ridges and are present in other regions of the sea floor below a layer of sediments. Collections of rocks were obtained in recent cruises of the Institute of Marine Sciences from the East Pacific Rise and the Equatorial portion of the Mid-Atlantic Ridge, as well as from sea mounts located at various distances from the ridges. The rocks recovered from the Pacific are mainly tholeiitic basalts while those from the Atlantic include peridotites and serpentinites, gabbros and basalt. Ultramafics appear to be dominant in the deeper part of tectonic fractures which displace the Ridge. A detailed petrographic and chemical study of these samples and others to be collected in forthcoming cruises will be made. Optical microscopy, X-ray diffraction, and electron microprobe will be employed for the mineralogy; X-ray fluorescence, optical spectroscopy, atomic adsorption, neutron activation, isotope dilution as well as classical gravimetric and colorimetric methods will be employed for the chemistry. In addition to the major oxides, elements will be determined; particularly, the transition metals, the rare earths; U, Th, Rb, Sr, and Sr 87/86 K/Ar age determinations will be carried out in all suitable samples.

SUPPORTED BY U.S. National Science Foundation

7.0065, NEUTRON ACTIVATION ANALYSIS OF IRON METEORITES
D.E. FISHER, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124

Work will be continued on the nuclear analysis of meteorites and related materials. Studies on the K/Ar ages of iron meteorites will be continued, AI abundances in pelagic samples will be determined, and chemical analysis of microtekites will be carried out, all using activation analysis. Cosmic C-14 in iron meteorites and cosmogenic Al-26, K-40, and Co-60 in iron meteorites will be analyzed. Fusion track determinations on crystals abstracted from meteorites will be hopefully carried out.

SUPPORTED BY U.S. Atomic Energy Commission

7.0066, POTASSIUM/ARGON DATING OF DEEP-SEA SAMPLES
D.E. FISHER, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124

The purpose of this program is the dating of marine rocks and sediments by the K/Ar method, combining this work with
other experiments currently in progress. First, the reliability of the K/Ar method for dating marine samples will be rigorously investigated. When particular mineral phases have been judged to be acceptable for dating, the technique will be applied to the following problems: 1) the dating of sediments in which low-level gamma-emitting radionuclides will have been measured, in an attempt to trace back through time the infall rate of extra-terrestrial dust and the history of the solar proton flux; 2) the K/Ar dating will be combined with geochronological and micropaleontological studies of pre-Pleistocene sediments to extend back through the Tertiary the chronology for the variations in the parameters already analyzed for the Pleistocene; 3) rocks dredged from the ocean floor in specific relation to the mid-ocean ridges will be K/Ar dated to critically test the hypothesis of spreading ocean floors.

SUPPORTED BY U.S. National Science Foundation

7.0067. THE MARINE GEOLOGY OF THE SOUTHERN OCEAN
H.C. GOODELL, Florida State University, Graduate School, Tallahassee, Florida 32306

Florida State University will continue to assist in the collection of rock material and sediment cores from the Antarctic region aboard the USNS Eltanin. Geologists at FSU will be responsible for processing the cores, their storage and sampling, and the distribution of samples to research scientists. Individual research projects based on the core and dredge samples at the Antarctic Core Facility are underway for each of the geologists and graduate students supported under that project. These include investigations into: 1) geochemistry and mineralogy of surface sediments, 2) geochemistry and petrology of indigenous volcanics, 3) paleosedimentation at the Brunshe Matuyama boundary, 4) stratigraphy and ecology of coccoliths, 5) ice-rafted sediments and Antarctic glaciation, 6) geochemistry of manganese nodules, 7) radioisotope geochemistry of carbonate and noncarbonate sediments, 8) thermal-morphology of carbonate ooze, 9) radiocarbon dating of marine sediments, 10) mineralogy and geochemistry of zeolites in sediments and volcanics.

SUPPORTED BY U.S. National Science Foundation

7.0068. STUDIES IN MARINE CHEMISTRY
R.C. HARRISS, Florida State University, Graduate School, Tallahassee, Florida 32306

2. Effect of trace elements on crystal structure and solubility of bone mineral - Hydroxyapatite is precipitated in laboratory experiments at various levels of fluoride, magnesium, and pesticide concentrations. X-ray diffraction and electron microscopy are used to determine the effect of coprecipitated trace constituents on the lattice parameters and crystal size of hydroxyapatite. Project duration 6/68-6/71.
3. Marine geochemistry of some precious metals - The sources and distribution of Pt, Ir, and Au in deep sea sediments and manganese nodules is being investigated using neutron activation analysis. Project duration 1/67 - 6/70.
4. Atmospheric chemistry of boron and fluoride - Specific ion electrode techniques are being developed to investigate the loss of boron and fluoride across the sea-air interface and the subsequent distribution of these elements in the atmosphere. Consideration is also being given to problems related to atmospheric pollution.

SUPPORTED BY Amer. Chemical Society
National Research Council of Canada

7.0069. GEOCHEMISTRY OF CARBONATE CYCLE IN THE MARINE ENVIRONMENT
K.E. CHAVE, Univ. of Hawaii, Graduate School, Honolulu, Hawaii 96822 (N00014-67-A-0387-0002)

Calcium carbonate in the surface layers of seawater tends to precipitate out spontaneously in orifices of various kinds, altering the flow patterns and affecting naval machinery. In addition, calcium carbonate particles affect light scattering and acoustical attenuation and scattering. This research is investigating the processes of carbonate precipitation and, in particular, the effect of organic chemicals in seawater on the precipitation, dissolution, dispersal and deposition of these carbonate particles.

The research involves a survey of suspended minerals in seawater in the South Atlantic and Caribbean and in the Hawaiian and Line Island areas of the Pacific using research vessels for the collection of samples; laboratory studies of the chemical interactions between carbonate minerals and surface active organic molecules; and a study of production, dispersal and deposition of carbonate minerals in the cold waters off the California Coast.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0070. MARINE HYDROLOGY AND GEOCHEMISTRY, ATLANTIC CONTINENTAL SHELF AND SLOPE
R.H. MEADE, U.S. Dept. of Interior, Water Resources Division, Woods Hole, Massachusetts

Objectives: (1) To determine the rates and loci of fresh water (both surface and ground waters) and salt water along the Atlantic Coast, and to understand the influences of different factors on mixing processes. (2) To determine the chemical compositions of surficial sediments and older sedimentary rocks of the Atlantic Continental Shelf and Slope - including the composition of their interstitial waters - and to understand their areal and stratigraphic variations. (3) To determine the amount of suspended matter and to understand the dispersal of sediments in coastal waters.

Approaches: (1) Information on salinity (the main index of mixing of fresh and salt waters) and its variations in coastal waters is being compiled in atlas form, largely from existing data. (2) Chemical analyses (major and selected minor elements) are being made of surficial bottom sediments from the continental shelf and slope, and of rocks and interstitial waters that lie below the shelf and slope. Concentrations of suspended matter have been measured gravimetrically, and suspended constituents have been identified microscopically.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

7.0071. GEOCHEMISTRY OF MID-ATLANTIC RIDGE SEDIMENTS
J.L. BISCHOFF, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543

The purpose of this investigation is to study the mineralogy, interstitial water chemistry, and geochemistry of series of close-spaced cores to be taken during the summer of 1968 in conjunction with a geophysical and paleontological survey of the mid-Atlantic ridge, primarily in the area from 33 degrees to 45 degrees North. Review of previous work indicates many gaps, particularly regarding detailed work, in the correlation of data from the above fields of study.

SUPPORTED BY U.S. National Science Foundation

7.0072. RADIOELEMENT STUDIES IN THE OCEANS - GEOLOGY AND GEOCHEMISTRY ABOUT THE MID-ATLANTIC RIDGE
V.T. BOWEN, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543 (AT(30-1))

To increase our understanding of the processes removing radioelements to the sediments, and producing special sediment conditions for such removal, as well as to improve our knowledge of the significance of bottom sources of supply to element geochemical cycles we have undertaken, often on samples collected for other purposes, studies of the geochemistry of the mid-Atlantic Province.

SUPPORTED BY U.S. Atomic Energy Commission
7. MARINE GEOLOGY

7.0073, ANALYSES OF ROCKS COLLECTED IN THE INDIAN AND ATLANTIC OCEANS
R.L. CHASE, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543

The main objective of this study is to analyze igneous, sedimentary and metamorphic rocks dredged from the Indian Ocean during the IIOE as well as from the Puerto Rico Trench, the Barre island Scarp, the Mid-Atlantic Ridge and the Mediterranean Sea. Petrologic, chemical, magnetic, X-ray and isotopic analysis will be performed on the samples. This will be evaluated with regard to seismic, magnetic, gravity and paleontological evidence to further define the composition, structure and history of the ocean crust.

SUPPORTED BY U.S. National Science Foundation

7.0074, BIOGEOCHEMISTRY OF TERRESTRIAL & EXTRATERRESTRIAL ORGANIC MATTER
E.T. DEGENS, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543

Objective: Purpose: To determine the diogenetic fate of organic matter in marine sediments. To synthesize primordial organic material in oceanic crust.

Application: Origin of life; formation of oil.

Approach: The changes in fossil organic matter are followed by modern chemical analytical techniques.

Progress: October 1965 - April 1966. A rapid method for analysis of purines and pyrimidines in sediments has been developed. The biochemistry of some sulfur reducing bacteria that live at 90 degrees C (approximately) showed the presence of hypoxanthine in place of adenine in DNA.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

7.0075, ISOTOPIC AND TRACE ELEMENT STUDIES IN OCEANIC VOLCANIC ROCKS
P.W. GAST, Columbia University, Graduate School, Palisades, New York 10964

A program of combined trace element studies (Rare Earth Elements, alkali metals and U, Th, and Pb and isotopic studies (Pb and Sr) in several volcanic areas in the Atlantic is proposed. The specific objectives of this study are: 1. To characterize the source or sources of volcanic liquids in a given region with respect to their Pb and Sr isotopic composition. 2. To relate the source isotopic compositions to U/Pb ratios of observed magmas. 3. To relate variations in Rare Earth Elements ratios, U/Pb, Th/U, K/Rb and Ra 226/U ratios to degree of partial melting and fractional crystallization that are involved in magma forming and transport processes.

SUPPORTED BY U.S. National Science Foundation

7.0076, URANIUM GEOCHEMISTRY IN (MODERN) CARBONATES USING THE FISSION TRACK METHOD
G.M. FRIEDMAN, Rensselaer Polytechnic Inst., Graduate School, Troy, New York 12180

The purpose of the proposed research is to define the geochemical relationships between uranium and carbonate material from a spectrum of carbonate depositional environments. Sample suites consist of sediments and carbonate hard parts of living organisms from hypersaline, marine, brackish, and fresh water environments, and land dwelling organisms. The results of uranium analyses will be examined with respect to environment, mineralogy, stable isotope data, and other available trace element data. The effect of carbonate diagenesis on uranium content and distribution will be examined on samples of known history. Water samples from the above environments will be analyzed in order to relate uranium content of environment to uranium content of carbonate material.

All uranium analyses will be obtained by routine fission track techniques. The carbonate mineralogy will be determined by conventional X-ray methods.

SUPPORTED BY U.S. Atomic Energy Commission

7.0077, SEDIMENT MINERALOGY (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION)
D.A. WOLFE, U.S. Dept. of Interior, Radiobiological Lab., Beaufort, North Carolina 28516

Sediments have the capacity to scavenge many radionuclides from sea water. There is, however, little agreement as to the effect of this phenomenon on the food web of the sea. Will this scavenging action enhance or reduce the uptake of radioactivity by the biota? If organisms have the capacity to utilize the organic matter in sediments as a source of nourishment, sediment-sorbed activity could be passed along the food web to eventually reach man. Conversely, by adsorbing radioactive materials from sea water, sediments could reduce the possibility of contamination in many pelagic animals.

In order to determine the role of sediments in the cycling of radionuclides in the estuarine environment and to gain some insight into sediment-animal relationships, experiments on sediment-sorption of radionuclides are being carried out in the laboratory and in the field. Observations are made on the capacity of natural sediments and selected clay minerals such as montmorillonite, to scavenge radionuclides (zinc-65, cesium-127, and chromium-51) from sea water of varying salinity. Also, the partition of these radionuclides between the sediments, and biota of outdoor ponds will be studied.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

7.0078, RELATIONSHIPS BETWEEN PHOSPHATE AND OTHER CHEMICALS AT THE WATERSUBSTRATE INTERFACE IN WESTERN LAKE ERIE
N.W. BRITT, Ohio State University, Graduate School, Columbus, Ohio 43210

This project is designed to determine the chemical and physical relationships between the water and sediment in western Lake Erie. Little is known about the seasonal or longterm changes which have occurred or are occurring at various depths in the sediment and the overlying water. The specific areas of investigation include chemical determinations of the total phosphate, organic content, iron, sulfate, and arsenic content of the sediment and overlying water throughout the year.

Determination of the physical composition of the sediment may give an indication of the rate and amount of siltation. Redox potential and pH determinations should give an indication of some of the chemical changes occurring in the sediments and overlying water.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rch
Ohio State University

7.0079, CARBON ISOTOPE GEOTHERMOMETRY
W.M. SACKETT, Univ. of Tulsa, Graduate School, Tulsa, Oklahoma 74104

The isotopic composition of the organic carbon in a suite of oceanic plankton samples has shown an apparent temperature dependence. Substantiation of this dependence may lead to another paleotemperature tool for marine sediments.

Development of the carbon isotope geothermometer will be attempted through detailed isotopic analyses of additional plankton samples, controlled growth of unicellular green algae at different temperature and comparison of the isotopic organic carbon composition of selected intervals of cores of deep-sea sediments with other paleo-temperature interpretations.

SUPPORTED BY U.S. National Science Foundation

7.0080, AGE RELATIONS OF IGNEOUS ROCKS FROM THE MID-ATLANTIC RIDGE
J.B. CORLISS, Oregon State University, Graduate School, Corvallis, Oregon 97331

The project has evolved into a study of rare earth and other trace element distributions in basalt and gneisses from selected portions of the Mid-Atlantic Ridge for which detailed morphological and structural information exists. The elemental abundances are determined by instrumental activation analysis. These results and the associated petrology of the rocks are to be
integrated with other knowledge to gain insight into (1) variations in upper mantle composition beneath the ridge, (2) genetic relations between common rock types of the Ridge, and (3) effects of the alteration of the rocks on the sea floor.

SUPPORTED BY Amer. Chemical Society

7.0083. IGNEOUS AND SEDIMENTARY ROCKS FROM THE NORTH WALL OF THE PUERTO RICO TRENCH
A. J. NALWALK, Univ. of Pittsburgh, Graduate School, Pittsburgh, Pennsylvania 15213

NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY Society of The Sigma Xi

7.0084. ISOTOPIC AND CHEMICAL COMPOSITION OF ORGANIC CARBONATES
M. L. KEITH, Penn. State University, Graduate School, University Park, Pennsylvania 16802

It is proposed to investigate the variability and specific ranges of carbon and oxygen isotopic composition, and possible relationships to chemical composition of modern organic carbonates, with particular emphasis on suites of samples from marine biologic communities. A principal objective is to develop an understanding of characteristic compositional variations which can be attributed to vital effects of carbonate-secreting organisms. Accordingly, it is proposed to expand the current investigation of coral and algal carbonates to encompass other organic carbonates which vary widely in isotopic or elemental composition or which differ in composition from one taxonomic group to another. It is hoped that systematic data on composition and ecology will provide an improved basis for interpreting the genesis of limestones.

It is proposed further to investigate the variability of isotopic and elemental composition of organic carbonates by systematic analysis of the carbonates of co-habitant organisms, and to examine and interpret the relationships among isotopic and chemical parameters. Proposed stages of investigation include: (1) Chemical analysis of Javanese reef samples on hand, mainly coral and algal carbonates, whose isotopic composition has already been measured. Some of these show systematic relationships between C13 and O18, as yet unexplained; (2) Collection and analysis of additional specimens from the Javanese reefs, including asteroids, barnacles, crinoids, crustaceans, echninoids, and foraminifera, as well as additional specimens of calcareous algae; (3) Systematic study of organic carbonates from one or possibly two additional reef communities, for comparison with the Javanese reef carbonates.

SUPPORTED BY U.S. National Science Foundation

7.0085. STABLE ISOTOP/E FRACTIONATION IN ECHINODERM CALCITE
J. N. WEBER, Penn. State University, Graduate School, Universi-
ty Park, Pennsylvania 16802

A recently reported study of the carbon and oxygen isotopic composition of calcite deposited by echinoids (sea urchins and sand dollars) has shown that these marine organisms fractionate carbon and oxygen isotopes up to as much as 13 permil with respect to the calcium carbonate secreted by other animals such as molluscs under the same ambient conditions. Isotope fractionation was demonstrated to be largely genetically controlled and the influence of environmental conditions was shown to be relatively unimportant. A striking correlation between isotopic composition and taxonomy was evident, and the calcite from each of the 260 individuals from polar to tropical seas and from littoral to abyssal depths was clearly not in isotopic equilibrium with the seawater environment.

The proposed work would include analyses of recent sea urchins, namely the starfish, brittle stars, crinoids, and sea cucumbers. Preliminary analyses have shown that calcites of these echinoderms are out of isotopic equilibrium with the environmental. One of the most important elements of this research will be to determine the mechanism involving the carbon and oxygen isotopes fractionation by echinoderms. This will include studies of the variations in the amino acids, and kinetic isotope fractionation during decarboxylation as a function of metabolism rate. It is also proposed to compare isostopic distribution patterns in recent fossils. It is anticipated that the above studies should provide a new approach to echinoderm phylogeny using fossil skeletons as indices.

SUPPORTED BY U.S. National Science Foundation

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7. MARINE GEOLOGY

7.0086. TRACE ELEMENT AND STABLE ISOTOPE STUDIES OF CORAL REEF CARBONATES

J.N. WEBER, Penn. State University, Graduate School, University Park, Pennsylvania 16802

This proposal is a continuation of NSF grant GA-290, and it is concerned with the distribution of trace elements and stable isotopes in coral reef carbonates. The main objective is to determine the past environmental conditions that existed when the ancient reefs were formed in the geologic column.

(1) It is proposed to determine the extent of carbon and oxygen stable isotope fractionation during calcification of the major carbonate contributing marine invertebrates.

(2) To determine trace and minor element distributions within the marine invertebrates.

(3) To understand the development and distribution of ancient reefs, and to understand the effects of diagenesis, tending to alter the chemical and/or isotopic composition of these reefs.

SUPPORTED BY U.S. National Science Foundation

7.0087. RADIOCARBON DATING OF A HAWAIIAN REEF PROFILE

E.A. OLSON, Whitworth College, Graduate School, Spokane, Washington 99218

The objective of this proposal is to elucidate the pattern and chronology of reef development in Hanauma Bay, Oahu, Hawaii through radiocarbon dating of four cores. For each of the four core samples obtained, age measurements will be made of top and bottom material plus four samples spaced throughout each core. It is hoped to establish 1) the age of the reef, 2) the rate of rise of sea level during the past 10,000 years, 3) the rate of vertical and horizontal growth, and 4) the consistency of the C14 method in dating coral reefs.

SUPPORTED BY U.S. National Science Foundation

7D. GEOPHYSICS - STRUCTURAL GEOLOGY

(origin and Evolution of Ocean Basins; Geophysical Studies of Oceans; Seismic Propagation.)

7.0088. STUDIES OF EARTHQUAKES IN THE CAPE MENDOCINO AREA

B.A. BOLT, Univ. of California, Graduate School, Berkeley, California 94720

This is a new task in partial support of teleseismic local earthquakes recorded at two stations in northern California (Arcata and Mineral) to the main station at Berkeley, California, and in support of studies on earthquakes originating at sea near Cape Mendocino, California. Teleseismic earthquake recordings at the Arcata and Mineral stations to the Berkeley station will permit more rapid and accurate determinations of earthquake origins and epicenters in the area off the coast of Cape Mendocino than is now possible with the existing station network tied in to Berkeley.

More earthquakes occur off the coast of Cape Mendocino than anywhere within California. These quakes are sometimes large enough to cause damage to harbor facilities and such naval installations as underwater cables. It is of interest to know about the occurrences of these earthquakes, particularly their epicenters and magnitudes, to determine whether they could have been the cause of observed damage. Teleseismic data from Arcata and Mineral will increase the accuracy of presently located epicenters and origin times in this region.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0089. INELASTIC SEISMIC EFFECTS

P. LIEBER, Univ. of California, School of Engineering, Berkeley, California 94720 (N00014-67-A-014-0003)

This research is directed towards determining the effects of earth inelasticity on seismic surface wave propagation and on earthquake mechanisms. The dispersion, selective absorption, and attenuation of seismic Love waves propagating in an inelastic model of the earth's crust and mantle are being quantitatively evaluated and compared with observed seismic surface-wave data. The technique will then serve as a basis for refining the inelastic parameters used in the earth model.

The propagation of acoustic waves through the ocean and underlying rocks is important in certain Naval operations. This program should help provide a basic understanding of these propagation properties. In addition, the analytical capabilities being developed in this program may prove useful in studying hydrodynamic processes which, although acting deep within the earth, have a strong influence on surface features and properties.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0090. CONTINUITY OF CLIPPERTON AND CLARION FRACTURE ZONES

M.N. BASS, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

A continuous reflection profile along 91 degree W longitude failed to confirm the continuity of structure between Clipperton fracture zone and the Santa Elena Peninsula, Costa Rica, which is suggested by the geology and structural trends and which has been proposed by other investigators. This raises a more general question about the continuity of fracture zones, particularly those like Clarian and Clipperton, whose topographic expression is, as now known, sporadic. It is proposed to run about ten reflection and gravity profiles across those segments of Clarion and Clipperton in which local topographic relief is subdued or wanting.

SUPPORTED BY U.S. National Science Foundation

7.0091. REFLECTION PROFILING OF THE SEA FLOOR

J.R. CURRAY, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

This proposal is for supplemental funds and time to make it possible for completion of specific research projects already in progress. These projects include reflection profiling of the floor of the Pacific Ocean, continued studies of the continental margin off Western North America, studies of coral atolls in the southwest Pacific, and investigations of different parts of the Clipperton and Clarion Fracture zones.

SUPPORTED BY U.S. National Science Foundation

7.0092. STRUCTURE OF OCEAN BASINS

R.L. FISHER, Univ. of California, Graduate School, San Diego - La Jolla, California 92038 (NOR)

The objective is to interpret the topography and structure of the deep ocean floor in terms of the controlling processes. For several years, attention has been concentrated on the southwest Pacific and the Indian Ocean. This work entails preparation of very detailed bathymetric charts based on all available data and on new soundings made for the purpose. During the coming year, two segments of the Mid-Indian Ocean Ridge will be explored by geophysical and geological methods. Observations and samples made during 1967 on the expedition NOVA will be analyzed.

Operations which utilize underwater sound are strongly dependent upon the physical properties of the sediments in the areas of operation. In addition, naval operations such as magnetic navigation, can be made more effective if prior knowledge of the earth's magnetic field is available. This program will help provide not only basic bathymetric and magnetic data, but also a predictive capability for extending this information into uncharted areas.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0093. ROCK SAMPLING AND GEOPHYSICAL STUDIES IN THE TONGA KERMADEC TRENCH SOUTHWEST PACIFIC

R.L. FISHER, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

This proposal is primarily to cover acquisition of a camera system to photograph the bottom and sides of the Tonga-Kermadec Trench prior to dredging these areas. Localities for photography and dredging will be selected on the basis of reflection profiling carried out during a major expedition to the Southwest Pacific during April - December 1967.

SUPPORTED BY U.S. National Science Foundation

282
7.0094, STUDY OF EARTH NOISE ON LAND AND SEA BOTTOM
F. GILBERT, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

Objective: This investigation is aimed at a description and understanding of the seismic background noise on land and the sea bottom. The research will investigate the use of large land arrays and ocean bottom seismographs to observe and record earthquakes, explosions and seismic noise in wave number space. These seismic sources will be utilized to study the splitting of continental waves at the ocean bottom and to develop a seismograph system for the deep ocean. A portion of this research will continue to use and further develop the ocean bottom seismograph system developed earlier in this program. In close conjunction with the land work definitive measurements of the propagation of seismic signals along the continental boundary will be made and thus study the transition zone which couples the oceanic wave guide to the continental guide.

SUPPORTED BY U.S. Dept. of Defense - Air Force

7.0095, DEEP OCEAN AS RECIPIENT OF VOLATILES AND SOLUTES
J.S. HANOR, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

A detailed study will be made within a selected area in the eastern Pacific of the lateral and stratigraphic distribution of barium, manganese, iron and other elements indicative of hydrothermal activity. The purposes of this study are: 1) to locate and identify specific loci for the hydothermal injection, 2) to determine if these correlate with known periods of tectonism, volcanism, and mineralization on the oceanic crust, and 3) to ascertain whether the distribution is consistent with ocean floor spreading from the East Pacific Rise.

SUPPORTED BY U.S. National Science Foundation

7.0096, RECENTLY PRECIPITATED DOLOMITES AND ASSOCIATED MINERALS
M.N. PETERSON, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

Rates of crystal growth and sequences of formation of phases, of dolomite and associated Ca-Mg carbonates, with added emphasis on the formation of authigenic silicates, including clay minerals and inorganic carbon.

SUPPORTED BY Amer. Chemical Society

7.0097, MOHOLE SITE STUDIES
G.G. SHOR, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

The National Academy of Sciences Site Selection Committee, Advisory to the Mohole Project, recommended in September 1965 that detailed seismic surveying along the Hawaiian Arch in the vicinity of the Mohole site northeast of Maui is necessary prior to making further plans. It was also recommended that further reconnaissance geophysical survey along the arch be conducted.

The problems connected with the Hawaiian Arch that need to be solved prior to mantle drilling in 1968 are: 1. to the mantle at the present site is required. 2. The possibility of even shallower sites along the Arch needs to be investigated. 3. The possibility of seismic anastomosis at the site needs to be solved. There is much indication that mantle seismic velocities may vary with azimuth. If so, calculations to the mantle might be affected. This possibility is sight but it requires checking. 4. Sediment cores from the Hawaiian site and along the Arch are required for bearing strength determinations. A 65,000 - 75,000 pound landing base must be supported on the bottom during drilling. The shear strength of the sediments must be determined so that the landing base can be designed. 5. Gravity and magnetic observations need to be extended in the area both for background information and as a guide for seismic surveying.

The University of California at San Diego, Scripps Institution of Oceanography, will conduct the surveys in cooperation with the Universities of Hawaii and Wisconsin, to accomplish these objectives. Oregon State University has also agreed to provide a vessel, the R/V YAVINA.

SUPPORTED BY U.S. National Science Foundation

7.0098, GRAVITY FIELD AT SEA
P.M. SPIESS, Univ. of California, Graduate School, San Diego - La Jolla, California 92038 (NONR)

This research is directed toward the measurements of the earth's gravity field over the oceans and the investigation and interpretation of the anomalous variations which we observed. During the coming year, gravity data taken on the recent NOVA expedition to the Southwest Pacific will be reduced and analyzed. The accuracy of interpreting gravity systems which are used extensively by the Navy is presently limited by insufficient knowledge about the earth's gravity field and deflections of the vertical. In support of efforts to remedy this limitation, this program is (1) providing gravity data over the world's oceans and (2) contributing to the basic understanding of gravity variations which is necessary for the prediction of deflections of the vertical.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0099, DETECTION OF DEEP-SEATED ANOMALIES IN ELECTRICAL CONDUCTIVITY UNDER THE GULF OF CALIFORNIA
V. VACQUIER, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

It is thought that the Gulf of California is part of the world ridge-rift system which intersects the North American continent via the East Pacific Rise and, as a consequence, may be an example of the earliest stage of continental drift. In searching for a plausible mechanism explaining the East Pacific Rise and the splitting of the Gulf of California-the high heat flow in both areas suggests that the ultimate source of energy is thermal. This proposal presents a program to investigate the depth of these sources of thermal energy beneath the Gulf of California. Magnetic time variations in three components will be measured across the Gulf using islands for station sites. The analysis of these variations should determine whether or not the Gulf is a rift caused by hot mantle material. A similar study made across the Rio Grande rift belt demonstrated a correlation between surface heat measurements and the geomagnetic time variations, and forms the basis for the present proposal. The personnel manning the astrometric observatory sites (GP-4639) will be used to man some of the three component magnetometer stations.

SUPPORTED BY U.S. National Science Foundation

7.0100, HEAT FLOW MEASUREMENTS
V. VACQUIER, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

It is proposed to investigate the heat flow of the previously unstudied areas of the Melanesian subcontinent and of the Philippine Basin. The latter area was investigated by S. Uyeda and colleagues of the University of Tokyo under the U.S. Science Program. The measurements in the Melanesian subcontinent should determine whether or not this region is at the intersection of an ocean basin and a highly faulted oceanic rise. Following this is a proposed comparison of heat flow measurements and magnetic time variations across areas of known high heat flow off the coast of Central America. While detailed heat flow measurements investigate the size and depth to the near-surface igneous activity and analysis of the magnetic time variations should determine the spatial distribution of the source of this activity. It is also intended to study the significant difference discovered, during the ATES 1966 cruise of R/V ARGO, between the in situ method and the
7. MARINE GEOLOGY

normal indirect on-deck methods of measuring thermal conductivities of ocean bottom sediments. Finally, it is planned to analyze the absolute changes in bottom water temperature in the Pacific during the past four years to test the assumption that the bottom water temperature in the deep ocean is constant with time. This is the basic assumption governing the measurement of the outward flow of heat through the ocean floor.

SUPPORTED BY U.S. National Science Foundation

7.0101. GEOLOGICAL OCEANOGRAPHY - ACOUSTICAL PROPERTIES OF SEDIMENTS

Objective: To determine those environmental factors affecting acoustical uses of the ocean. To investigate and define the physical properties of the ocean bottom sediments and the statistical character of the bottom topography and relate to acoustical scattering and attenuation.

Approach: Using submersibles and surface vessels, make in situ measurements of sound velocity in sediments, obtain cores in both deep and shallow water and analyze for properties of interest. Develop and use in situ probes. Make photographic and echo-sounding records of bottom topography and roughness, both macro- and micro-relief. Make laboratory analyses and do routine core analysis under contract with the University of Rhode Island.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0102. HYDRAULICS AND DYNAMICS OF ESTUARIES

Hydraulics and dynamics of inlets and estuaries, including both flow and sedimentation and erosion processes will be studied in models and the field, with theoretical analysis. Estuarine erosion as a result of wave action and high water levels will be a specific part.

SUPPORTED BY U.S. Dept. of Defense - Army

7.0103. MARINE GEOLOGY STUDIES, GULF OF MEXICO-CARIBBEAN REGION

Long-range objectives are: (1) A systematic and coordinated study of the tectonic framework of the Gulf of Mexico-Caribbean region; as a means of determining how the geologic setting affects modern sediment patterns and how tectonic movements affected the accumulation of thick sequences of sedimentary rock in the past; and (2) an appraisal of the marine resources of the region and an understanding of the relation of occurrence and distribution of these resources to geologic processes.

SUPPORTED BY U.S. Dept. of Defense - Geological Survey

7.0104. WESTERN PACIFIC ISLANDS

In the Hawaiian Island group the objective is to determine the submarine extent, sequences, and kinds of recent lava flows off Hawaii, thus supplementing the onshore studies of volcanism of the Hawaii Volcano Observatory. Investigations will continue off Island Territories including the Trust Territory of the Pacific. These are concerned with specific problems of structure and changing sea level that have come into focus as a result of the geologic mapping of these islands by the U.S. Geological Survey.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

7.0105. ARCTIC BASIN HEAT FLOW

This task investigates the distribution of earth-heat flow throughout the Arctic Ocean Basin and, insofar as possible, identifies the controlling factors. Field studies are conducted aboard drifting ice stations. Direct measurements are made of thermal gradients in bottom sediments by means of lowered thermal probes. Bottom cores are retrieved for subsequent laboratory analysis of thermal conductivity. Values of heat flow at each locality are calculated by multiplying temperature gradient by thermal conductivity and correlated with similar data derived in continental arctic regions to establish a world-wide pattern of heat flow.

Establishment of a heat flow pattern in the Arctic Basin is essential to understanding the region's crusted history and distribution of zones of volcanism and volcanic activity. Heat flow data in combination with other available geophysical evidence, further determine the nature of materials and processes in the earth's crust.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0105. GEOPHYSICAL SURVEYING AND CHARTING

Objective: Develop high speed survey techniques which will increase, by a factor of three or more, the rate of data acquisition for charting deflection of the vertical. Charting deflection of the vertical presently involves classical mathematical solutions to gravity survey data.

Present survey capabilities are not adequate to chart deflection of the vertical in the desired time frame. High speed platforms (40 knots or better) could operate in conjunction with these survey ships thereby increasing the volume of data available for the standard reduction technique and possibly a technique could be devised to determine directly the deflection of the vertical by passing the standard classic mathematical solution thereby reducing the amount of survey required for each area. Determine minimum repeat airborne survey effort required to correct world magnetic charts for secular variation in order to attain chart accuracy.

Approach: Participate in the DOD triservice helicopter gravity measuring system (HGMs) test. Evaluate test results and develop specifications and techniques for navy utilization of HGMs. Test gravity meters on board other types of high speed platforms and develop techniques for this utilization. Determine the feasibility of directly measuring deflection of vertical from a ship or aircraft. Prepare specifications for a deflection of vertical sensor. Procure, test and evaluate a deflection of vertical sensor. Determine a best mathematical model for the world magnetic field. Isolate harmonics which vary with secular variation. Determine relationship of these harmonic fields with geologic zones. Delinate areas requiring repeat surveys.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0107. SEAMOUNT INVESTIGATION

Objective: To complete the analysis of geophysical data obtained during FY 1968. Present these data in oral and written form. Schedule and participate in two cruises on a ship of opportunity basis.

Approach: After final data reduction the geophysical results obtained in FY 68 will be analyzed. These results will be illustrated and prepared for presentation at a scientific meeting. The results of last FY show that the seamount in question warrants further study. A small survey of this seamount by the USNS SHOUP is planned in FY 69 (2nd Quarter). This will enable gravity data to be collected which will greatly aid in further interpretations. Another cruise aboard the USNS COMPASS ISLAND is planned with Hudson Laboratories. This will enable the investigators to use the technique of acoustic sounding to detect seamounts. A geothermal probe plus thermal conductivity device will be obtained, and will aid in testing why the seamount under study has an uncommon magnetic anomaly pattern. These devices are scheduled for use in the first quarter - FY 1970.

SUPPORTED BY U.S. Dept. of Defense - Navy
7.0105. ACOUSTIC PROPERTIES OF SEDIMENTS

Objective: To conduct basic research to investigate the acoustic properties of bottom sediments in order to provide a basic understanding of the interrelationships between the acoustic and physical properties of the sea floor and subbottom.

Approach: Investigations will be conducted in the field and laboratory to determine the acoustic properties, such as compressional and shear wave sound speed, and absorption, of sediments collected from a variety of physiographic provinces and to determine fundamental relationships with sediment physical properties. Statistical methods will be used to identify significant relationships in order to develop quantitative predictions of the acoustic properties of sediments. Shear and compressional wave sediment sound speed measurements will be made as a function of hydrostatic and overburden pressure, as well as temperature. In situ sound speed and absorption measurements will be made by seismic methods and by utilizing ocean bottom hydrophones and in situ sound speed and absorption measurements will be made by hydrostatic and overburden pressure, as well as temperature. In situ sound speed and absorption measurements will be made by hydrostatic and overburden pressure, as well as temperature. In situ sound speed and absorption measurements will be made by hydrostatic and overburden pressure, as well as temperature. In situ sound speed and absorption measurements will be made by hydrostatic and overburden pressure, as well as temperature. In situ sound speed and absorption measurements will be made by hydrostatic and overburden pressure, as well as temperature.

7.0109. OCEAN-SEDIMENTS AND CRUSTAL STRUCTURE IN THE BHAMIAN-CARIBBEAN AREA
M. BALL, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124 (NONR)

Objective: Navy needs for deep-sea salvage and other operations and for installation of engineering structures in the Bahamian-Caribbean region require knowledge of ocean sediment and rock structures in that area. These activities are affected by variations in crustal structures, particularly those associated with the unusual and unusually steep continental slopes in the area. This research will provide knowledge on the structures and composition of sediment layers and crustal rocks in the Caribbean Sea, across continental slopes off eastern Florida and the Lesser Antilles Islands, and in the Bahamian region.

Approach: Seismic reflection and refraction measurements will be made from a ship to determine sediment thicknesses and crustal rock structures across the continental-oceanic transition zone. Sediment cores and bottom photographs will be obtained to determine sediment composition and evidence of bottom currents. Magnetic measurements will be made with a ship-towed magnetometer to determine structures beneath sedimentary rocks.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0110. GEOLOGICAL AND GEOPHYSICAL INVESTIGATION OF THE BHAMA BANK
M.M. BALL, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124

A geophysical and geologic investigation of the continental to oceanic crustal transition zone at the eastern edge of the Great Bahama Bank will be carried out as a continuation of past research. Objectives during the two years period are to complete bathymetric mapping of the study area, construct networks of magnetic and reflection seismic profiles over the study area, and extend and cross tie existing gravity data to serve as a basis for constructing approximate crustal models. In connection with these aims it is hoped to define and interpret the shallow structures that reconnaissance measurements have revealed in Exuma Sound and in the Atlantic Ocean to the east, and identify the rock and sediment types and ages involved in these structures. Ultimately it is the objective of the project to determine the nature and configuration of boundaries within the crustal transition zone above and including the Mohorovicic.

SUPPORTED BY U.S. National Science Foundation

7.0111. A STUDY OF THE STRUCTURAL RELATIONS BETWEEN THE MID-PACIFIC OCEAN RIDGES AND FRACTURE ZONES
A. MALAHOFF, Univ. of Hawaii, Graduate School, Honolulu, Hawaii 96822

The structure and physiography of the fracture zones and ridges of the mid-Pacific have obvious bearing on the origin of the Pacific Ocean Basin and the stress patterns that gave rise to these mid-oceanic features. The mid-oceanic features have obvious tectonic and stress relations to the margins of the Pacific, where land located slip-strike faults and north-south aligned magnetic anomalies near the California coast contrast sharply with the largely east-west striking anomalies of the Molokai and Murray Fracture Zones near the Hawaiian Islands. Therefore a pilot geologic and geophysical study over the whole length of such a fracture zone as the Murray would do much to resolve where the north-south striking magnetic anomalies give way to the east-west striking ones and how the fracture zone is related to such prominent features as the Hawaiian Ridge, the Marcus-Necker Ridge, the Line Islands Ridge and other fracture zones, such as the Molokai. The Molokai Fracture Zone and its relationship to the Hawaiian Ridge has already been studied intensively in the neighborhood of the Hawaiian Islands. A pilot study as outlined above is proposed in the following program: (1) Total force magnetic surveys in a broad swath across the postulated strike of the Murray Fracture Zone (2) Seismic reflection studies to detect any vertical displacements in the sedimentary layers along the postulated strike of the Murray Fracture Zone (3) Precision echo-sounding surveys to accurately map the bathymetric features in the proposed area of survey (4) Selected gravimetric profiles across the Marcus-Necker Ridge (5) Dredging of hard rock samples along the Marcus-Necker Ridge and sedimentary coring in the basins adjacent to the ridge and (6) Bottom photography along the crest of the Marcus-Necker Ridge.

SUPPORTED BY U.S. National Science Foundation

7.0112. GEOPHYSICAL AND GEOLOGICAL STUDY OF THE DARWIN RISE
G.P. WOOLLARD, Univ. of Hawaii, Graduate School, Honolulu, Hawaii 96822

Two two-month research cruises will be made to the area of the Darwin Rise in the western central Pacific. Observations will include bathymetry, seismic reflection, shallow refraction, gravity, magnetics, heat flow, bottom photography and sediment coring. The intent is to generate an adequate geophysical description of the area so that conflicting theories concerning the nature of the feature and its relationship to the evolution of the ocean basin can be examined. This one year program is in the nature of a reconnaissance to set the stage for more definitive studies which will include deep refraction measurements.

SUPPORTED BY U.S. National Science Foundation

7.0113. MARINE GEOPHYSICAL STUDIES IN THE PACIFIC OCEAN
G.P. WOOLLARD, Univ. of Hawaii, Hawaii Inst. of Geophysics, Honolulu, Hawaii 96822

The Navy must understand the physical properties of the oceanic environment and the processes affecting them in order to execute its missions effectively. Objectives of this task meet these Navy needs and in the study of the deflection of the vertical (local distortion of the earth's shape as determined by gravity and satellite data), the study of bottom roughness & biological distributions in the ocean depths, the development of an improved capacity for accurately charting ocean positions, and the development of technique for predicting gravity in unsurveyed areas.

The contractor will acquire data at sea generally in the vicinity of the Solomon Islands. Data will include bathymetric, heatflow, gravity, seismic profiles, seismic refraction, magnetic, sediment-core and ocean current data. These data will be analyzed at the university and used to determine the structure of the earth's crust, to infer the processes which are responsible, and to obtain the critical qualities outlined above.

SUPPORTED BY U.S. Dept. of Defense - Navy
7. MARINE GEOLOGY

7.0114. SEARCH FOR FERROMAGNETICALLY TRAPPED MAGNETIC MONOPOLES OF COSMIC RAY ORIGIN

B. LAI, Mass. Inst. of Technology, Graduate School, Cambridge, Massachusetts 02139

The existence of elementary particles carrying magnetic charge was predicted by Dirac in 1931, and appears even more plausible on light of current theory, despite the failure of several attempts to find them. Dirac's 'monopoles' may be too mas-

sive to have been produced in three synchrotron experiments (Berkeley, CERN and Brookhaven), and too rare to have been observed directly among the cosmic radiation. However, incident monopoles may have been accumulating in ferromagnetic minerals, where they would remain permanently trapped with substantial binding energy. Incident monopoles, whether of primary origin or produced by energetic events in the atmosphere, should arrive with energies of 10 to 100 electron volts, enough to cause considerable penetration and dispersion in surface rock. A sufficient depth of ocean water, however, would decelerate monopoles without immobilizing

them and allow them to follow lines of the Earth's magnetic field to the bottom, where they would be trapped and accumulate, near the surface. Sediments from great ocean depth therefore represent the most promising terrestrial source of magnetic monopoles. Magnets generating very intense, continuous magnetic fields have been used to extract monopoles from a variety of materials, and detect them by scintillation counters and nuclear emulsions. Results are as yet inconclusive, and the method is being refined for application to quantities of sediment sufficient to represent a significant area-time product of total cosmic radiation flux. Magnetic monopoles might account for the high-energy component of cosmic radiation, for the observation of 'extensive air showers', for the energy emission of 'gamma' rays, and for reversals of the Earth's magnetic field as deduced from paleomagnetic studies. They would also provide a theoretical basis for the quantiza-

tion of electric charge.

SUPPORTED BY U.S. Atomic Energy Commission

7.0115. MARINE GEOPHYSICS

F. PRESS, Mass. Inst. of Technology, Graduate School, Cambridge, Massachusetts 02139 (NONR)

This project concerns (1) developing heat flow instruments and making heat flow measurements across the mid-Atlantic Ridge and the Caribbean, Mediterranean and Red Seas aboard various research vessels; (2) analyzing the heat flow data in these areas and correlating them with other recent geophysical data obtained by various organizations; and (3) compiling, reducing, and in-

terpreting available geophysical data for the entire Caribbean area.

A detailed study of the structure of the oceanic crust will be conducted. Seismic and magnetic data will be used to construct models of the crust and upper mantle. The results should provide useful information about the thickness, extent, volume and layering of the continental rise. Work completed to-date by scientists of Woods Hole Oceanographic Institution and of other oceanographic organizations indicates that the continental rise off eastern North America is a large depositional feature formed mostly during the Cenozoic Epoch. It is planned to make continuous seismic profiles sup-

ported by magnetic and gravity measurements along about 7500 km of ship track arranged in ten profiles between Grand Banks and Florida during July and September 1967. Necessary techniques and equipment (except for replacement parts) are already in operation and can easily be applied to the proposed pro-

gram. The results should provide useful information about the thickness, extent, volume and layering of the continental rise.

SUPPORTED BY U.S. National Science Foundation

7.0119. ANALYSIS OF SEISMIC DATA COLLECTED DURING THE INTERNATIONAL INDIAN OCEAN EXPEDITION AND IN THE CARIBBEAN SEA

J.R. HERSEY, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543

The purpose of this study is to analyze seismic reflection profiles and bathymetric data, to construct structural models where data warrant and to relate seismic results to the accompa-

nying gravimetric and magnetic data as well as the analysis of rock samples.

A single major cruise to the Indian Ocean has enabled the recording of continuous seismic reflection profiles across the North Atlantic Ocean, in the Mediterranean Sea, and the Indian Ocean. In the Indian Ocean, the principal sedimentary structures of the Somali Basin and those of the Seychelles-Mauritius ridge have been explored by means of several long, crossing profiles. Red Sea crisis-cross profiles define a central area of rift and bor-

dering area of stratified rock (probably sediments). In the Mediterraneaan detailed structural study of the Lebanese shelf was made followed by a crisis-cross profile over the Nile Delta and central sedimentary basins of the eastern Mediterranean. Later a detailed survey of the Ligurian Sea was conducted followed by a single profile through the Balearic Basin and the Strait of Gibral-
tar, and thence northward to Plymouth, England. Over the outer ridge north of Puerto Rico a complex and detailed seismic refra-

ction profile was recorded.

SUPPORTED BY U.S. National Science Foundation
This task concerns measurement of the earth's magnetic field, using proton precision magnetometers towed from Woods Hole ships. Magnetic profiles will be interpreted in terms of sea floor spreading and other geologic structures; the magnetic data will be related to other parameters, as bottom topography, heat flow, gravity anomalies, and rock type. Detailed measurements are planned for parts of the mid-Atlantic Ridge.

The magnetic studies contribute to an understanding of rock types beneath the ocean floor, which affect deflections of the vertical, underwater sound propagation, salvage and rescue operations, and engineering structures.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0121. GEOTHERMAL INVESTIGATIONS IN OCEAN REGIONS
G. SIMMONS, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543

A two-year program to investigate geothermal problems in oceanic regions is proposed. Emphasis is placed on measurements of heat flow through the Atlantic Ocean floor, mainly utilizing WHOI research vessels. Instrumentation is requested to take advantage of research cruises proceeding to or crossing regions of interest, and new techniques will be developed to attack some of the outstanding problems in this field. Special studies and detailed surveys are planned to investigate sources of variability in heat flow values in some regions, and models will be studied for comparison with results from those surveys.

In a broad sense, the principal goal of the proposed investigations is to improve our understanding of the dynamic processes within the earth as reflected in the geothermal flux. More specifically, it is planned to investigate (a) the significant regional heat flow variations in the Atlantic, and their possible relationships with geological structure, and (b) the source of local variability in heat flow values from the ocean floor, with the aim of improving the reliability of measurements in some regions.

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7.0122. GEOTHERMAL STUDIES IN DEEP-SEA DRILL HOLES
R.P. VONHERZEN, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543

It is proposed to measure the heat flux from the earth's interior on programs which drill and sample sediments from the deep ocean floors. Such measurements on the Deep Sea Drilling Program, for example, should establish 40 - 60 very reliable heat-flow values at sea, to which the 2000 oceanic measurements already obtained by conventional techniques may be compared. Furthermore, it may be possible to obtain reliable measurements from other research and commercial drillings on the continental shelves and slopes, areas which are not normally accessible to standard oceanic techniques. The proposed measurements will result in oceanic values by techniques which are more nearly similar to those made in continental bore holes, thereby allowing a more reliable comparison between these fundamentally different regions.

Initial efforts will involve development of suitable instruments and techniques.

SUPPORTED BY U.S. National Science Foundation

7.0123. GEOTHERMAL INVESTIGATIONS IN OCEAN REGIONS
R.P. VONHERZEN, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543 (N00014-66-C0241)

This task is a continuing investigation on the heat flux conducted through the earth's surface in selected regions of the Atlantic Ocean. Measurements of heat flow are made from ships with probes at various points on the ocean floor, particularly on the mid-Atlantic Ridge and the Vema Fracture Zone. Water temperature distribution near the bottom at station locations is also determined. Heat flow is analyzed in terms of the geologic province, bottom topography, sources of the heat, and depth of source. Instrumental developments are made to improve the measuring system.

This program attempts to improve the measurements of heat flow in oceanic areas and determine the relation of heat flow to bathymetry, sediment structures and thicknesses, and to crustal and subcrustal rocks. Heat flow studies thus improve our understanding below the sea floor; these materials affect such Navy relevant problems as underwater sound propagation, gravity and magnetic fields of the earth, ocean engineering construction, and salvage and rescue operations.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0124. GREAT LAKES RESEARCH - COASTAL AREA SEDIMENTATION
J.H. SAYLOR, U.S. Army, Lake Survey, Detroit, Michigan 48226

Data on energy sources (waves, winds, currents) impinging on selected coastal reaches along the Great Lakes will be collected and studied to learn how environmental energy affects sediment movement, characteristics, and distribution in beach and nearshore areas. Results will be used to derive relationships needed for mathematical models. Investigations will devise methods of establishing rates of coastline change and how to forecast the future behavior of the coastline. Information is needed for the design and location of harbors, marinas, industrial plants, and recreational areas.

Data collection at Little Lake Harbor on Lake Superior was completed in 1964, and a report was presented at the 7th Conference on Coastal Engineering held in Tokyo, Japan.

Preliminary investigations were conducted at Pentwater, Mich on the eastern shore of Lake Michigan during 1967. An intensive field program is planned at Pentwater during the spring and fall of 1969.

SUPPORTED BY U.S. Dept. of Defense - Army

7.0125. GENERAL COASTAL INLET STUDIES
J.B. TIFFANY, U.S. Army, Waterways Experiment Sta., Vicksburg, Mississippi

The objective of this research project is to develop means for computing discharge and velocity distribution through tidal inlets leading to determination of tidal prisms and water surface elevations in inner bay systems; and to determine the factors involved in both inner and outer bar formation, the shoaling of inlet channels, and the stability of inlet shape and location. The following four facilities are being used to conduct necessary investigations:

1. Facility A. This is a facility in which inlets of various shapes can be modeled to a relatively large scale, and tests conducted therein under varying tidal conditions to establish discharge coefficients, flow patterns, and other factors required to compute discharges over the range of head differentials. 2. Facility B. This facility consists of an 'ocean' in which tides of various amplitudes and periods could be generated, a lagoon which could be varied in areas and shapes, and a connecting section between the two in which inlets of various shapes could be modeled on a small scale by standard fixed-bed model techniques. 4. Facility C. This facility consists of a movable-bed model ocean, equipped with apparatuses for reproducing tides, waves, littoral currents, and other significant forces; a fixed-bed lagoon which could be varied in area and shape; and provisions for connecting the two by means of a movable-bed inlet section in which inlets of various shape could be modeled by movable-bed model techniques.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0126. EXPLOSIVE WAVE PROPAGATION

Theoretical studies will be conducted on (1) the propagation of explosive pulses in layered media by using new methods of in-
7. MARINE GEOLOGY

version of the Laplace integral equation; (2) the equation-of-state of matter in the interior of the earth. In addition, methods of digital analysis of seismic data will be extended in an attempt to better resolve closely spaced yet discrete frequency components. Work will continue on improving the seismic travel-time curves for P-waves.

The analytical techniques developed for use in studies of explosive wave propagation and the results obtained from these studies will contribute to a detailed understanding in the use and analysis of underwater sound signals, including the propagation in the layered sediments and rocks beneath the ocean.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0127. PARTIAL SUPPORT OF A PROGRAM OF EDUCATION & RESEARCH IN MARINE SEISMOLOGY AND GEOMAGNETICS

M. EWING, Columbia University, Graduate School, New York, New York 10027

NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY New York State Science & Technology Found.

7.0128. MARINE GRAVITY

M. TALWANI, Columbia University, Graduate School, New York, New York 10027

Continuous surface ship gravity data will be acquired in part aboard R/V VEMA and in part aboard R/V ROBERT D. CONRAD. This work will include instrument development primarily aimed at decreasing the errors in gravity measurement. An accuracy of about 2 mgal is obtainable with present instrument and navigation techniques. By developing analog computers to correct for the off-levelling error associated with stabilized platforms, it is hoped to diminish the error below 1 mgal.

Naval-don fixes are obtained by means of satellite navigation receivers that work with U.S. Navy’s satellite navigation system. PDP-8/S computers aboard VEMA and CONRAD reduce these fixes. The computers do complete track adjustment on board ship.

SUPPORTED BY U.S. National Science Foundation

7.0129. GEOPHYSICAL INVESTIGATIONS IN THE TAIWAN-PHILIPPINE-NEW GUINEA REGION

M. EWING, Columbia University, Graduate School, Palisades, New York 10964

The purpose of the project is two-fold: (1) to continue the cooperative program with our Japanese colleagues to investigate geophysically unexplored regions of the oceans, (2) to help strengthen and promote new interest in the science cooperative program between the United States and Japan.

The main purpose of the work is to make seismic-refraction measurements of the following morphological units: (1) Taiwan-Luzon ridge, (2) Manila trench, (3) Celebes-Sulu Sea basins, including the Sulu archipelago, (4) West Caroline - East Caroline basins including the Caroline - New Guinea rise, and (5) Bismark Arch-New Britain trench system. Since the Snellius Expedition of 1929-1930, very little marine geological information has been collected in the proposed region of study; aside from the pendulum gravity measurements of Vening Meinesz no significant amount of marine geophysical data has been obtained. Therefore, the survey route is designed to provide data by seismic measurement, gravity, magnetics, coring, heat flow, etc., on a host of geophysical-geological problems.

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7.0130. GEOPHYSICAL STUDIES ON THEY SHIP S.Ship, etc., in an attempt to make seismic refraction measurements at sea. This technique has the advantage of permitting the receiving ship to occupy a station amidst an array of buoys spaced in any pattern deemed suitable for the problem being studied. Multiple receiving points permit far more detail than is usually possible to obtain with the conventional two-ship technique; the ability of the mother ship to receive near its buoy spread (while the accompanying ship shoots the forward half of the profile, whence the procedure is reversed) removes the disadvantages associated with single-ship buoy seismology.

The Lamont vessel will also obtain continuous measurements of gravity, magnetics, bathymetry and bottom sedimentary layering (seismic profiling). The purpose of the joint survey is to measure the crustal section from the Australian continental margin off Townsville across the Coral Sea Plateau, Coral Sea Basin to the Louisiade Arch of Southwestern New Guinea. The exact locations of seismic profiles and ship’s tracks will be decided as the work progresses. The geophysical measurements will provide knowledge of the regional structure and may yield important clues as to its development and evolution.

SUPPORTED BY U.S. National Science Foundation

7.0131. MARINE SEISMOLOGY

W. EWING, Columbia University, Graduate School, Palisades, New York 10964 (N00014-67-A0108-0004)

Objectives of this research include: (a) the continuing investigation, on a world-wide basis of the distribution of unconsolidated sediments and the nature and origin of these sediments and their structural features; (b) determination of sound velocities in the sediments utilizing sonobuoys together with pneumatic and other sound sources in wide-angle reflection profiles; (c) studies of crustal and upper mantle structure using seismic refraction techniques; and (d) the continued development of improved hydrophone arrays and recording techniques for use in seismic reflection profiling.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0132. RESEARCH IN OCEAN PROPERTIES

W.M. EWING, Columbia University, Graduate School, Palisades, New York 10964

Objective: To determine those environmental factors affecting acoustical uses of the ocean; to observe and develop theory and model for predicting underwater sound propagation using deep ocean water paths including near bottom phenomena; to observe, define and obtain acoustical target strengths of volume scatterers.

Approach: Data collection using ocean research vessels such as VEMA and CONRAD (AGOR-3). Make detailed surveys under precise navigational control in selected areas including continuous profiling of bottom and sub-bottom topography, reflectivity measurements, refraction measurements, bottom photography and deep sea cores as necessary. Monitor deep scattering layers quantitatively on the Precision Depth Recorder and obtain quantitative measurements of reverberation levels at selected times and places. Correlate these measurements with results of biological sampling programs supported by other agencies. This approach includes the development of instruments for determining ocean floor ambient noise, seismic characteristics of the immediate sub-bottom structure, bottom structure, bottom reflectivity and the small scale topography of the ocean floor.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0133. GEOPHYSICAL STUDIES FROM ELTANIN IN 1968

D.E. HAYES, Columbia University, Graduate School, Palisades, New York 10964

Lamont Geological Observatory of Columbia University has carried out geophysical oceanography research on the Antarctic Research Vessel U.S.N.S. Eltanin under GA-894 and earlier grants. Proposed research would include: (1) Seismic-reflection program to yield data on the boundaries between different sediment layers beneath the ocean floor and to indicate the thickness and attitude of the layers. (2) Gravity program, using a sea
gravimeter installed last year for the interpretation of the composition and structure of the Earth's crust beneath the areas surveyed. (3) Magnetic program to yield data to extend interpretation of sea-floor spreading and paleomagnetic epochs into the areas south of Australia and New Zealand. LGO proposes to continue data reduction and publication. It is proposed to include two Australian scientists in the research party on the Eltanin as a part of a cooperative program between LGO and the University of New South Wales. The cruises planned would reach into an area in which little geophysical oceanography data is now available and which is of great geophysical interest because it includes a junction of the Pacific, Indian and Atlantic Ocean Ridge Systems. These programs by LSO, coordinated with research done on the Eltanin by other institutions, constitute an interdisciplinary approach to the problems of measuring and understanding the ocean environment in one of its least explored regions.

Five shipboard technicians (2 from Australia) will be on the Eltanin.

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7.0134. GEOMAGNETIC STUDIES
J.R. HEIRTLER, Columbia University, Graduate School, Palisades, New York 10964
This program is involved with studies of geomagnetic micropulsion phenomena in the frequency range from 0.1 to 0.0001 cps. During this extension, work will continue on determining the propagation characteristics of these relatively short period geomagnetic fluctuations including their group and phase velocities and their degree of continuity from one location to another. In addition, a small study will be carried out on the perturbation in the local geomagnetic field which is expected to occur during passage of a Saturn rocket through the earth's ionosphere.

Naval capabilities in magnetic navigation and other areas are affected by the time variations of the earth's magnetic field. A full understanding of the propagation and vertical structure of these variations permit the development of adequate techniques for removing or minimizing their effects.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0135. MAGNETICS
J.R. HEIRTLER, Columbia University, Graduate School, Palisades, New York 10964 (N00014-67-A0108-0004)
The objective of this program is to measure and interpret variations in the earth's magnetic field. Emphasis will be placed upon continuing efforts in the growing field of paleomagnetic stratigraphy and in magnetic studies which bear on the concept of ocean-floor spreading. Studies of magnetic anomalies in the following geographical areas should be completed: circum-Pacific trenches, Norwegian Sea, and a second study of the Reykjanes Ridge.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0136. GEOTHERMAL MEASUREMENTS
M.G. LANGSETH, Columbia University, Graduate School, Palisades, New York 10964
This program is directed toward determining the heat flow through the ocean floor and relating the observed variations to topography, to properties of the underlying sediments, crust, and mantle, and to fluctuations in bottom water temperatures. In addition, measurements of the vertical temperature profile throughout the water column will continue to be made. A multiple instrument package which includes a new thermal probe will be used extensively to provide closely spaced sets of data on the water-sediment interface.

A knowledge of the ocean's temperature structure from top to bottom is important in many operations. Space and time variations in the flow of heat out of the ocean-bottom sediments affect the temperature structure. This research program will help provide, on a world-wide basis, an understanding of the heat flow variations as well as information on the thermal structure itself.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0137. HEAT FLOW AND MAGNETICS IN THE PHILIPPINE SEA
M.G. LANGSETH, Columbia University, Graduate School, Palisades, New York 10964
The Lamont investigators will work with Dr. Masashi Yasui, Oceanographic Section, Maizuru Marine Observatory, Japan Meteorological Agency and his associates. The will examine the magnetics and heat flow in the Philippine Sea, in and around the Bonin Trench and Mariana Arc and Trench and over the inner arc ridges. The purpose is to study the magnetic lineation pattern, if any, and the heat flow to ascertain if this part of the ocean floor seems to be spreading more rapidly in the eastern Pacific.

SUPPORTED BY U.S. National Science Foundation

7.0138. HEAT FLOW MEASUREMENTS
M.G. LANGSETH, Columbia University, Graduate School, Palisades, New York 10964
Heat flow through the ocean bottom will be measured during the field program of the Lamont ships in conjunction with the sediment coring program. A new instrument will be developed and used to make closely spaced heat flow measurements along with water velocity and turbidity near bottom as well as bottom photography. The effect of small-scale topography on heat flow will be studied especially in the mid-ocean ridge province.

SUPPORTED BY U.S. National Science Foundation

7.0139. STUDY OF RELATIONSHIP BETWEEN EARTHQUAKES AND TECTONIC MOVEMENTS IN ALASKAN FAULT ZONE
J. OLIVER, Columbia University, Graduate School, Palisades, New York 10964
The technical objectives of this grant are to develop better understanding of the relationship between earthquakes and tectonic movement which is expected will lead to more accurate prediction of the occurrence of destructive earthquakes.

The proposal is to study recent tectonic and seismic activity associated with two or more major Alaskan faults. The study will emphasize the combined use of several geologic and geophysical techniques in a single program. Specifically, the program will include investigation of (1) the amount, sense and rate of displacement in past and present tectonic movements; (2) the recent and present seismicity; (3) the relationship between current tectonic movement and seismicity; (4) the possibility of the future occurrence of earthquakes and tectonic movement. Some studies have provided evidence that a reversal in the direction of tectonic movement occurs at the time of an earthquake. The number of shallow microearthquakes recorded in the Denali fault valley indicates that the fault is currently active.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

7.0140. DEEP EARTHQUAKES AND ISLAND-ARC TECTONICS AND STRUCTURE
J. OLIVER, Columbia University, Graduate School, Palisades, New York 10964
A three-year extension, including a small additional field program, of a study of deep earthquakes in the Fiji-Tonga region of the southwest Pacific (NSF GP-2539) is proposed. Discoveries of major importance have resulted from the current research and certain seismic phases have been found with special features which imply a major revision of conventional ideas of island-arc structure. Results to date include indication of anomalously low attenuation of seismic waves in or near the zone of deep earthquakes in the upper mantle and discovery of a number of systematic relationships between the configuration of seismic zones, focal mechanisms, and physiographic features of island arcs in the southwest Pacific. The proposed program calls for the continued maintenance of the network of five seismograph stations installed in the Fiji-Tonga region during the current project, operation of portable seismographs for special measurements, and the data analysis to investigate the following topics: mechanism of deep earthquakes as revealed by information in the wave form of the seismic signals and analysis of the sequence of
7. MARINE GEOLOGY

occurrences in time and space; variations of attenuation and velocity of seismic waves in the upper mantle near the zone of
earthquakes; and further study of the relationships among focal mechanisms, the configuration of the seismic zones, and other
island-arc features. The proposed research will continue to be a
valuable contribution to the U.S. Upper Mantle Program.

SUPPORTED BY U.S. National Science Foundation

7.0141, SEISMOLOGICAL RESEARCH RELATED TO
WORLD-WIDE SEISMIC DATA
P.W. ROMERO, Columbia University, Graduate School, Palisades, New York 10964

The purpose of the research will be to investigate the properties
of seismic sources, the distribution of these sources in space
and time, the structure and state of the earth's crust, and
the variation of wave propagation; and to relate these phenomena and information to problems of earthquake prediction.

Using recordings of seismic waves available from the stations of
the World-Wide Standardized Seismograph Network of ESSA,
make analytical studies of body and surface waves, detailed in-
vestigations of regional seismicity, generate computer programs for
the study of focal mechanisms, seismicity, spectral analysis, and
seismic wave propagation.

The comparison of precisely determined hypocenters with
the distribution of large-scale geological and geophysical features such as deep-sea trenches, gravity anomalies, volcanoes, and frac-
ture zones. Long-period seismograms were used successfully in
determining the sense of strike-slip displacement on a number of
major fault zones on the mid-oceanic ridge system.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

7.0142, GRAVITY
J.L. WORZEL, Columbia University, Graduate School, Palisades, New York 10964 (N00014-67-A0108-0004)

This research is directed toward the measurement of the earth's
gravity field over the oceans and the investigation and interpre-
tation of the anomalous variations observed. Regional
gravity anomaly maps will be extended and updated by the addi-
tion of new obtained data. Studies of the anomalies over deep-
sea trenches, island arcs, and mid-ocean ridges will continue. In-
vestigations of the Caribbean area and the Philippines are ex-
pected to be completed. Further improvement in the accuracy of
the gravity data is planned and two new gravity sensors are to be
tested.

The accuracy of inertial navigation systems is presently limited by insufficient knowledge about the earth's gravity field
and deflections of the vertical. This program is (1) providing
gravity data over the world's oceans, (2) developing and evaluat-
ing new techniques and instruments for obtaining more accurate
gravity measurements at sea, and (3) helping to provide the basic
understanding of gravity variations which is necessary for the pre-
diction of deflections of the vertical.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0143, ESTUARINE SEDIMENTARY MODELS
G.S. VISHER, Univ. of Tulsa, Graduate School, Tulsa, Oklahoma 74104

The primary aim is to provide information for a general
process-response model for the tidal-estuary-distributary en-
vironmental association, and to test the hypothesis that texture
may be used directly in the identification of specific sedimentary
processes. Work on fluid flow in natural stream channels has
demonstrated the association of textures with specific flow regimes. In addition, recent textural studies of clastic sediments
suggest the possibility that texture may be used directly in deter-
mining ancient sedimentary processes in a more specific manner
than previously possible. An observation program to test these
hypotheses will be carried out in the estuary of the Altamaha
River.

The data will be used to develop a statistical model of the
area for comparison to ancient rocks, and to evaluate the effects of
differing sedimentary processes on grain size distributions.

SUPPORTED BY U.S. National Science Foundation

7.0144, PACIFIC GEOPHYSICS
G. BODVARSSON, Oregon State University, Graduate School, Corvallis, Oregon 97331 (NONR)

This task is a continuation of a marine gravity program in the
Northeast Pacific Ocean. It concerns making gravity measure-
ments aboard ship with an ONR-owned LaCoste and Romberg
gravity meter 5-9, determining gravity anomalies from these measure-
ments, and determining crustal and mantle structures that are in
agreement with these anomalies and other available geophys-
ical data (particularly seismic data). The program also con-
tributes to an evaluation of the accuracy of the meter under differ-
ent sea conditions. New methods for machine handling and inter-
preting the gravity data will be investigated.

This program benefits the Navy in that gravity measurements at
sea are of importance for local determination of the shape of
the seafloor and deflections of the vertical. The knowledge obtained on crustal structures has application to sound transmission in the
oceans. Analysis of the reliability of the meter measurements is
important for data evaluation with this and other meters of the
same make.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0145, (U) OCEANIC CRUSTAL AND MANTLE STRUC-
TURE - ITS ORIGIN AND EFFECT ON EXTERNAL FILEDS
G. BODVARSSON, Oregon State University, Graduate School, Corvallis, Oregon 97331

OBJECTIVE: This research, which is directed toward deter-
mining the nature and origin of the oceanic sediments and crustal
rocks in the NE Pacific, will provide (i) basic data on the earth's
gravity and magnetic fields and on the acoustical properties of
sediments, and (ii) increased capability for the prediction of
these fields and properties in unexplored areas. Effective use of
present and future sonar and magnetic detection systems in an-
ti-submarine warfare requires an increased understanding of the
acoustical properties of marine sediments and of the earth's mag-
netic field. In addition, the future developments in the accuracy of
inertial navigation systems, which are extensively used in Naval
ships and submarines, require an increased knowledge of the earth's
gravity field.

APPROACH: Shipboard measurements of the gravity, mag-
netic and heat flow fields will be made in selected areas of the NE
Pacific. Information on the thickness, structure and character of
the oceanic crust and upper mantle will be generated and modified to
agree with the field data. Satisfactory structural models will then be considered in terms of the forces and processes which could
have led to their formation.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0146, MARINE GEOPHYSICS
G. BODVARSSON, Oregon State University, Graduate School, Corvallis, Oregon 97331

A seismic 'air gun' type of profiling unit will be purchased
and used aboard The R/V YAQUINA to measure thicker sediments and structures of sediments in areas off the coast of the
northeastern part of North America. The particular areas include the continen-
tal shelves and slopes west of California, Oregon and Washington, and in deep water in the areas of the Mendocino Escarpment, the
Gorda and Juan de Fuca ridges, the Cascadia and Tufts abyssal plains, the Gulf of Alaska, and the Cocos Ridge off South Amer-
ica. Many, but not all, of these seismic measurements will be
made in conjunction with cruises scheduled for other purposes.

The seismic reflection measurements provide data on thickness, the layering and structures of sediments at many locali-
ties off the northwest coast of the U.S. These sediments greatly af-
fect the long-range propagation of underwater sound, the instal-
lation of engineering structures and salvage and rescue opera-
tions.

SUPPORTED BY U.S. Dept. of Defense - Navy

290
7. MARINE GEOLOGY

Objective: Naval operations along continental margins can be made considerably more efficient if the local variations in bottom sediment properties and in magnetic field strength are either known or predictable. This research will provide (1) basic bathymetric, geomagnetic, and sedimentary information on the continental margin off of Washington, and (2) a better understanding of the relations between the acoustic absorption in sediments and the mechanical properties and structures of the sediment.

Approach: A field observation program utilizing continuous seismic reflection and magnetic profiling, short-pulse echo sounding, bottom photography, and bottom sampling will be carried out. From these data, sediment properties, ages, and structures will be determined. Specific parts of the seismic reflection data will be analyzed for the reflectivities of particular subbottom reflecting horizons and for the acoustic absorption between selected horizons.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0152, DETAILED STUDY OF THE OCEANIC CRUST BY MEANS OF DEEP SEISMIC PROFILING
C.R. LISTER, Univ. of Washington, Graduate School, Seattle, Washington 98122 (NONR)

The purpose of this study is to initiate geophysical surveys on the continental shelf off Washington State. The scientific plan for geophysics at the University is to begin a detailed survey of a deep-ocean area reasonably close to home. This survey will include spreading within the continental margin, with many of the heat lost on the sides of the seamount. The most useful supplementary geophysical tool is a sub-bottom profiler, powerful enough to penetrate km of sediment but not necessarily needing to penetrate any of the hard rock. Such a device is requested as a part of the proposed research.

SUPPORTED BY U.S. National Science Foundation

7.0153, THE MAGNETIZATION OF SUBMARINE BASALTS AND ITS EFFECT ON MARINE MAGNETIC ANOMALIES
R.T. MERRELL, Univ. of Washington, Graduate School, Seattle, Washington 98122 (NONR)

OBJECTIVE: An understanding of the origins of marine magnetic anomalies, which form a part of the noise environment, will allow more adequate predictions to be made of the magnetic field characteristics likely to be encountered in unsurveyed areas. This research is directed toward determining the relative importance of self-induced magnetic reversals in marine basalts and the effects of such self-reversals on the interpretation of marine magnetic anomalies.

APPROACH: Several rock samples, whose orientation with respect to the north-south and vertical directions is known, will be collected from Cobb Seamount off the Washington Coast. Laboratory tests on these samples will be carried out to determine the location of the north magnetic pole at the time the sampled rock was formed. Further testing will be done to determine whether magnetic self-reversals have occurred and to study the origin of remnant magnetization. Utilizing the results of these tests, analyses of magnetic, gravimetric and bathymetric data over Cobb Seamount will be made to determine the validity of assumptions on rock magnetization which are frequently used in such analyses.

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291
7. MARINE GEOLOGY

7.0154. GRAVITY SURVEY ARCTIC OCEAN
R.J. WOLD, Univ. of Wisconsin, Graduate School, Milwaukee, Wisconsin

The Beaufort Sea overlies a broad continental shelf which comprises a significant portion of the Arctic Ocean Basin. Accordingly, this shelf is basic to any attempt to define and interpret geophysical structure of the Arctic Ocean. This task will enable the contractor to conduct studies in gravity, seismic refraction, refraction tomography, and the lithosphere as a convenient stable platform. Data thus obtained will contribute to knowledge of flattening of the geoid in Polar areas, bathymetry and geologic nature of the continental shelf.

These studies have important bearing on greater and more precise geodetic and navigational control in this region.

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7E. HISTORICAL GEOLOGY

(interpretation of History of Oceans, Ocean Floor, and Coastal Areas. See Also Chapters 7f Paleontology and 7e Geochemistry.)

7.0155. GEOLOGIC HISTORY OF BERMUDA AND ITS RELATIONSHIP TO THE WORLD PLEISTOCENE
F.T. MACKENZIE, Bermuda Biolog. Sta. For Res., Saint George, Bermuda

An integrated stratigraphic, paleontological and bathymetric study of Bermuda is planned as a basis for interpreting sea level changes during the Pleistocene. Sea level changes have been important events in earth history and have exerted a strong influence on present-day sedimentation and coastal processes, as well as biogeography. An understanding of sea level fluctuations is best gained from investigations of tectonically stable areas, such as Bermuda was during Tertiary and Quaternary time.

Because the position of transition zones between marine limestones and olistolites give information concerning past sea levels, detailed stratigraphic study will be an integral part of the proposed work. Paleontological data will help define time-stratigraphic units, especially in terrestrial deposits. Bathymetric investigations will aid in recognizing submerged Pleistocene terraces.

The proposed coordinated study will hopefully lead to: 1) an interpretation of the geologic history of Bermuda, 2) the definition of a Pleistocene sequence uncomplicated by tectonic activity, and 3) the establishment of a "side gauge" with which other Pleistocene sequences on the continents and other areas may be compared.

SUPPORTED BY U.S. National Science Foundation

7.0156. GEOLOGIC HISTORY OF PACIFIC FAUNAS
E.C. ALLISON, San Diego State College, Graduate School, San Diego, California 92115

It is proposed to study fossiliferous rock samples obtained from dredge hauls taken from the Pacific sea floor. Immediate objectives of the research are to provide insights into certain fundamentally important paleobiological problems such as: 1) histories of the East Pacific barrier, based in part on distribution patterns of tropical shallow marine organisms, 2) origin and evolution of the Galapagos Islands fauna, and 3) development and changes of isolated reef faunas. Long range objectives aim at providing information relative to such problems as: a) age and geologic history of sea floor structures, b) extent and chronology of sea level changes during recent geological history of ocean basins, c) history of marine faunas, especially insular marine forms, and d) distribution of past climatic belts.

SUPPORTED BY U.S. National Science Foundation

7.0157. QUARTERNARY ENVIRONMENTS AND BIOTAS
C.J. HUBBS, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

The project includes many disciplines and approaches such as: paleoecology, paleoecology, paleozoogeography, paleooceanography, paleohydrology, geology, and archaeology, and involves the use of such tools as isotope analyses, past and present temperature and faunal surveys, computer analyses, and collection and processing of material from kitchen middens.

The results of the study will have bearing on the distribution of littoral plants and animals, and constitutes one of the most basic parameters in the interpretation of past as well as present temperature and in the biota.

Further efforts are to be made to obtain measurements of paleotemperatures using a mass spectrometer. Geomorphic as well as faunal and climatologic data are to be collected for the Sangamon Interglacial (a fossil forest unit). Geophysical studies of the Galapagos Islands fauna, and d) distribution and climatology of the eastern North Pacific is of sufficient depth that it undoubtedly will be possible to reconstruct major events of eastern Pacific History in the last several millennia from documentary and sedimentary records. The proposed study will consist of an effort to reconstruct several thousand years of the recent geologic, climatologic and historical history of the eastern North Pacific from all available records.

SUPPORTED BY U.S. National Science Foundation

7.0158. THE POSTPLEISTOCENE OCEANOGRAPHY AND BIOLOGY OF THE EASTERN NORTH PACIFIC
J.D. ISAACS, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

As a result of intense oceanographic and marine biological studies particularly in the last 15 years, the eastern North Pacific is one of the best known and best understood oceanic regions on earth. Knowledge and understanding of part of this region (the California Current System, per se), ranks as one of the most complete in the world. In a major part, this stems from some 22,000 oceanographic and biological stations occupied in the last 15 years by the California Cooperative Oceanic Fisheries Investigations of which the Marine Life Research Program of the Scripps Institution of Oceanography is a major component. Also, broader pertinent understanding has been derived from many other expeditions and studies in the Pacific. These studies are continuing.

The present understanding of the biology, oceanography, and climatology of the eastern North Pacific is of sufficient depth that it undoubtedly will be possible to reconstruct major events of eastern Pacific History in the last several millennia from documentary and sedimentary records. The proposed study will consist of an effort to reconstruct several thousand years of the recent oceanographic, climatologic and biological history of the eastern North Pacific from all available records.

SUPPORTED BY U.S. National Science Foundation

7.0159. INVESTIGATION OF QUATERNARY SEA LEVEL CHANGES IN THE CAROLINE AND MARSHALL ISLANDS
W.A. NIERENBERG, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

The object of this study is to investigate evidence for a postglacial high sea level stand that is reported from the Southwest Pacific. This evidence conflicts with many investigations from both sides of the Atlantic where carbon-14 dates indicate rapid postglacial sea level rise followed by a gradual rise to the present level. The Caroline and Marshall Island areas have been chosen for the study because reports of their uniformly submerged 15-18 meter benches appear to indicate stability; boring in Eniwetok show recent coral growth above these platforms, probably extending slightly above present sea level; the reefs provide excellent material for dating; and there are many reports of plus 2 meter benches on the islands. The plan would involve two months of field investigation in the area on a Scripps Institution ship. The work would combine sounding lines, continuous reflection profiling, dredging, shallow drilling, measurements of distribution and standing crop of growing corals by submersible or submarine terraces, and subsequent analyses and dating of selected samples.

It is hoped that the study will reveal (1) whether these island masses have actually been stable, (2) the age and origin of the
submerged platforms, and (3) will test the validity of the supposed postglacial coral growth above present sea level.

SUPPORTED BY U.S. National Science Foundation

7.0160, RADIOLARIA IN SEDIMENTS
W.R. RIEDEL, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

The objective is to study the Tertiary history of the Radiolaria and apply the results to the interpretation of deep Pacific sediment cores. The paleo-distribution of fossil organisms in cores is compared with bathymetric, geological, and geophysical observations. The system of classification of the organisms is also continually modified to reflect the evolutionary relationships of the various species. During the coming year, attention will be concentrated on this aspect of the work. Cores from NOVA expedition now in progress will be studied.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0161, PALEOTEMPERATURE RESEARCH
C. EMILIANI, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124

Within the framework of oxygen isotope geochemistry, the proposed research program has four major goals: 1) to determine the depth habitats of Tertiary pelagic Foraminifera 2) to continue Paleotemperature analysis of JOIDES (Blake Plateau) drill cores J-3, J-Y, and J-6 3) to begin Paleotemperature analysis of Pleistocene cores from the southern hemisphere 4) to continue and extend spectral analysis to Tertiary sections of cores from Blake Plateau.

SUPPORTED BY U.S. National Science Foundation

7.0162, FLORIDA CORAL REEF STUDIES
H.G. MULTER, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124

The proposed research deals with certain Florida coral reefs, their biological make-up, areal extent, relationship to rocks on the mainland, and particularly their place in the geologic evolution of south Florida. This work is an extension of studies carried out under GP-5250. In order to better understand the sequence of events and environmental conditions that led to the formation of the Florida Keys, the Atlantic Coastal Ridge of the mainland of Florida, and the Everglades of south Florida, it is necessary to obtain additional information relating to the rock foundation underlying the living coral reef tract, the rock formation beneath Florida Bay, and the linear extent of the Key Largo limestone west of Key West.

It is therefore planned to drill several core holes to obtain subsurface information relative to these problems. One series of holes will be drilled from the outer edge of the living reef across the width of the reef-flat toward the keys in order to obtain information on the back-reef and fore-reef relationships. Drill cores will also be taken in the Florida Bay to determine the nature of the substrate on which the soft bottom sediments lie. These data should help bridge the gap between the keys and the mainland. Additional holes west of Key West will provide information relative to the base on which the line of keys west of Key West have formed.

The proposed study is expected to further our understanding of the ancient Key Largo reef which was the major control for late Pleistocene sedimentation in south Florida. Of broader significance, the research will have a particular bearing on reconstruction of major events in the geologic history of the younger Pleistocene of south Florida.

SUPPORTED BY U.S. National Science Foundation

7.0163, THE SEDIMENTARY AND DIAGENETIC RECORD OF ENVIRONMENTAL PARAMETERS IN RECENT BAHAMIAN TIDAL FLATS
R.N. GINSBURG, Johns Hopkins University, Graduate School, Baltimore, Maryland 21218

In view of the importance of the sedimentary record to the interpretation of the past history of the earth's surface and the geochronological evolution of the atmosphere and oceans, it is of utmost importance to know which environmental parameters leave their record in sediments and how precisely variations in these parameters are reflected in sedimentary and other geological features. To determine what information from the activity of living organisms, water chemistry, tidal ranges, weather, and climate are recorded in the sediments it is proposed to study the Recent tropical tidal flat environment. This environment was chosen for study because it has been established to be a major contributor to the sedimentary record throughout geologic time, especially in the Precambrian and lower Paleozoic eras. The same suite of sedimentary features (laminations, thin bedding, mud cracks, intraformational breccias, algalstromatolites, abundance of dolomite) that are so characteristic of the earliest carbonate rocks in the geologic record have recently been discovered in some modern tropical tidal flats, making such tropical areas primary targets for this type of research. The proposed study will provide a calibration for more precise interpretation of environmental parameters operating during deposition of those vast thicknesses of ancient tidal flat deposits.

SUPPORTED BY U.S. National Science Foundation

7.0164, GEOLOGICAL STUDIES IN NORTHERN LAKE MICHIGAN
J.L. HOUCH, Univ. of Michigan, School of Engineering, Ann Arbor, Michigan

Northern Lake Michigan is the locale of several unsolved problems pertinent to the bedrock geology of the region and to the postglacial history of the lake. Most of the existing geological knowledge of the area stems from land-based exploration and drilling; most of the critical areas are offshore and, prior to the existence of properly equipped research vessels, could not be examined. Suitable research ships are now available and, aided by underwater photography, television and scuba diving, offer promise of solution of hitherto insoluble problems.

Two aspects of postglacial geology to which this research may make new contributions are (1) the altitudes and areal extent of submerged shorelines of old lake stages, in the area which has undergone postglacial upwarp, and (2) the depth and nature of sedimentary deposits now occupying depressions in the lake basin left at the recession of the last glaciation. Previous work in the southern and central parts of the lake, which have not undergone upwarp indicates that submerged shorelines can be traced and that seismic profiles and long core samples yield useful information of postglacial events.

SUPPORTED BY U.S. National Science Foundation

7.0165, PLEISTOCENE OCEANOGRAPHY AS RECORDED IN DEEP SEA SEDIMENT CORES
D.B. ERICSON, Columbia University, Graduate School, Palisades, New York 10964

The research to be accomplished is to confirm the reality of the faunal record from the Pacific by cross correlation, and to work out a chronology of climatic events in the Pacific region in order to establish the relationships between synchronous events in the Pacific and the Atlantic.

A better understanding of this difference between the temperature regimes of the two oceans during the Pleistocene may be expected to bring us closer to a real understanding of the cause of the ice ages.

Evidence in several cores from the equatorial and southern Pacific strongly suggests that the sequence of temperature changes of near surface waters of the Pacific during the late Pleistocene differ markedly from that of the North and equatorial Atlantic. The evidence as it now stands indicates that the temperature changes of the Atlantic as recorded in the sediments were brought about by the ice sheets on the adjacent continents,
7. MARINE GEOLOGY

whereas those of the Pacific were directly due to variations in radiant energy from the sun. It seems that the curve of temperature variations in the Pacific follows the pattern postulated by G.C. Simpson, who developed the hypothesis that ice ages were due to increased precipitation in high latitudes brought about by greater evaporation from the equatorial waters of the oceans, in consequence of larger output of radiant energy from the sun.

SUPPORTED BY U.S. National Science Foundation

7.0166. A PALEOMAGNETIC STUDY OF TERTIARY AND PLEISTOCENE OCEANIC CORES
N.D. ODPYKE, Columbia University, Graduate School, Palisades, New York 10964

It has already been shown by the principal investigator that certain oceanic cores faithfully reflect the reversal history of the earth's magnetic field during the last 3.5 My. It is proposed to extend this work as far back in time as is feasible. In cores with low sedimentation rates it should be possible to extend this stratigraphy to the Miocene Pliocene boundary. In order to extend the study further into the past it will be necessary to use cores which contain overlapping sections.

During the early months of 1966 research was begun at Lamont Geological Observatory on the paleomagnetism of deep-sea cores. Work has already been completed on cores from the circum-Antarctic region and from the North Pacific basin. We have found that unoriented piston cores from high and intermediate latitudes preserve a record of the changes in polarity of the earth's magnetic field. Previously reversals have been reported in short gravity cores from the Pacific Ocean and from the experimental Mohole core.

Because the time of these reversals of polarity is now known for the last 3.5 My, it is possible to use the magnetic stratigraphy to attack many problems in oceanography.

SUPPORTED BY U.S. National Science Foundation

7.0167. PALEONTOLOGICAL EVIDENCE OF CYCLES IN THE EARTH-MOON SYSTEM
W.B. BERRY, Univ. of California, Graduate School, Berkeley, California 94720

Technical Objective. To study past history of the moon through studies of the length of day and month compared with a year by a relationship of marine invertebrate shell growth to environmental cycles; interpretations of growth layers in fossil shells.

Approach. Continuation growth experiments and study of fossil shells in thin section. Marked specimens observed in natural environment for 18 months; study of marginal increments and frequency distribution of naturally occurring 'wild' samples applied to interpretation of growth layering patterns seen in fossil shells.

Progress: Comparison of marginal shell increments with seasons of the year gives evidence of annual growth for several Venericid species in colder temperate waters. Annual layers are distinguishable from erratic growth rings reflecting disturbances such as temporary burial or removal from water; annual layers more distinct in shells of cold water species. Gain in evidence that shell growth reflects annual fortnightly and diurnal variations in environment.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

7.0168. TAXONOMY AND STRATIGRAPHY OF CALCAREOUS NANOPLANKTON IN MARINE SEDIMENT SEQUENCES
W.R. RIEDEL, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

Calcareous nanoplanктон (coccoliths, diatoms and similar forms) have been shown to be very useful for precise stratigraphic correlations of marine strata. There remain, however, considerable segments of geologic time, and large areas of the world, for which there is no published information on these nano fossils. It is proposed to work on the calcareous nanoplankton from the California Miocene, in addition to other sub-surface strata in the Pacific. The California Miocene is extremely rich in fossil shells, particularly oysters, bivalves, and gastropods. A field program has already been completed on cores from several sites in the Pacific. This project will continue research on the Miocene and Cenozoic sediments of the California Miocene, with the following objectives: (i) determining the distribution of calcareous nanoplankton in the California Miocene, (ii) identifying the distribution of calcareous nanoplankton in the California Miocene, and (iii) using the distribution of calcareous nanoplankton in the California Miocene to infer paleoenvironmental conditions.

SUPPORTED BY U.S. National Science Foundation

7.0169. STRATIGRAPHY AND PALEOECOLOGY OF FOSSIL SILICOFLAGELLATES FROM ANTARCTIC DEEP-SEA CORES
Y.T. MANDRA, San Francisco State College, Graduate School, San Francisco, California 94132

Brief Description of Research Project: San Francisco State College proposes to carry out comprehensive research of fossil silicoflagellates from Antarctic deep-sea sediments. Silicoflagellates have been investigated in a very few marine sedimentary formations on land where their value for correlation and interpretation of palaeo-ecology has been shown. Almost no research has been done on silicoflagellates from deep-sea sediments. The project would include a study of the tops and bottoms of approximately 70 selected cores collected during cruises of the USNS Eltanin. This would allow a determination of the age range of each core in relation to silicoflagellate stratigraphy. Approximately 300 selected samples from these cores, representing zones recorded as having a high content of silicious material, would be processed for the separation of their contained silicoflagellates from other silicious microfossils.

Two genera of silicoflagellates, Dictyoacha and Distephanus, have been shown by the principal investigator to be temperature sensitive. He has developed a technique using the ratios of the frequencies of these two types to determine the temperatures of ancient seas. This project would apply this technique to deep-sea cores for the first time. The works of Watkins at Florida State University and Hayes at Lamont Geological Observatory have shown a positive correlation with other organisms and magnetic reversals. Of particular significance would be the correlation of extinction and appearance of genera and species of silicoflagellates in relation to magnetic reversals.

This program does not involve any work on the USNS Eltanin.

SUPPORTED BY U.S. National Science Foundation

7.0170. MIOCENE FISHES AND FISH FAUNAS AS DETERMINED FROM A STUDY OF FOSSIL OTOLITHS
J.E. FITCH, State Dept. of Fish & Game, Terminal Island, California 90745

The California Miocene is extremely rich in teleost (bony fish) remains, particularly otoliths, but to date the only faunas known are based upon skeletal material and upon scales embedded in Miocene diatomites and shales. A primary objective of this proposed study is to collect, identify, describe and illustrate the Miocene teleost fauna represented by otoliths. Secondary objectives would include: (i) determining palaeoecology by comparing Miocene faunal assemblages with those of today to see if logical conclusions can be reached, (ii) comparing Pacific coast Miocene families and genera with those from the Atlantic and Gulf coasts to see if deductions can be made regarding zoogeography, affinities, and migrations, and (iii) determining if fish faunas from various deposits represent normal seasonal mortalities or catastrophic die-offs. (These data can be obtained by examining otoliths for indications of digestive action resulting from ingestion by predator species, and by noting marginal zones in those otoliths which have retained annual growth characteristics.)

SUPPORTED BY U.S. National Science Foundation

7.0171. LIVING AND FOSSIL ZOOPLANKTON, AND RELATED PROBLEMS OF PALEOECOLOGY
E.S. DEEVEY, Yale University, Graduate School, New Haven, Connecticut 06520

294
The research will encompass the following: 1. Quantitative studies of fossil Cladocera, especially Bosmina species, are to be conducted in sediment cores from New England and New Zealand lakes in which living populations are also being studied. More than 14,000 years of quantitative record is available in Rogers Lake, Connecticut. The New Zealand sections provide various kinds of control, the climatic history having been similar while the biotic diversity is lower. The possibility is being tested that certain species-substitutions are related to size-specific predation. 2. Population studies of zooplankters are planned under controlled conditions of temperature and food supply. The chief item needed for interpretation of fossil assemblages is information on instar length and number in Bosmina, but the plan is to attack the more general problem of niche diversification via cyclomorphosis. 3. Ionic regulation is to be examined in entomoesic plankters of different size-specific types and in benthos of the Lake. It is proposed to sample the lake and study the problem of smearing. 5. Finally, certain aspects of tropical paleoecology will receive continued attention.

SUPPORTED BY U.S. National Science Foundation

7.0172, INVESTIGATIONS ON THE CRUSTOSE CORALINES OF THE NORTH ATLANTIC
W.H. ADLEY, Smithsonian Institution, Washington, District of Columbia 20560
Collection of crustose corallines by SCUBA-diving and with an underwater research vehicle from the coasts of the entire North Atlantic, to study their systematic, biogeography, ecology, and sedimentology, and to develop a North Atlantic monograph for the group.

SUPPORTED BY Smithsonian Institution

7.0173, EVOLUTION OF PROVINCIAL DISTRIBUTION PATTERNS IN CHEILOSTOME BRYOZOA
A.H. CHEETHAM, Smithsonian Institution, Washington, District of Columbia 20560
Seemingly high endemity at both generic and specific levels in Late Cretaceous and Tertiary cheilostome Bryozoa is being studied. Samples now on hand will be supplemented by collecting, especially in areas bordering the North Atlantic. Interpretation of the response of benthic and epilithic cheilostome groups to shifting barriers and corridors will be made.

SUPPORTED BY Smithsonian Institution

7.0174, LA JOLLA MARINE GEOLOGY LABORATORY
Liaison with Bureau of Commercial Fisheries, Scripps Institution and other oceanographic agencies in the area. Electron and light microscope identification of micropaleontologic floras for age and ecologic determinations.

SUPPORTED BY U.S. Dept. of Interior - Interior Geological Survey

7.0175, BIOSFACES STUDY OF BENTHONIC FORAMINIFERA IN OCEAN SEDIMENT CORES
W.D. BOCK, Univ. of Miami, Graduate school, Miami - Coral Gables, Florida 33124
Benthonic species of Foraminifera from core material obtained during the 1968 JOIDES drilling program will be studied for morphologic variation through time to determine the paleoecologic conditions of the time sequence represented in each core. The ultimate goal of the study will be to establish a 3-dimensional distribution of single species in the geologic record. In addition, it may be possible to discern boundary conditions for reproductive rates at low temperatures.

SUPPORTED BY U.S. National Science Foundation

7.0177, CALCAREOUS NANOFOSILS FROM PALEOCENE - EOCENE DEPOSITS
S. GARTNER, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124
Paleocene - Eocene calcareous nanofossils have been intensively studied during the past decade, and several nanofossils zonations have been proposed for this stratigraphic interval. Most previous studies, however, have been on isolated samples or on sections covering limited intervals, so that the zonations completely differ. The interval penetrated by JOIDES coring 3 and 4 offers a unique opportunity to test previous zonations, to modify and supplement them; and to establish a reference standard for this interval for future study of early Tertiary oceanic sediments. This opportunity will be exploited.

SUPPORTED BY U.S. National Science Foundation

7.0177, STUDY OF FOSSIL SEA TURTLE COLLECTION AT THE INSTITUT ROYAL DES SCIENCES NATURELLES, BRUSSELS, BELGIUM
R. ZANGERL, Field Museum of Nat. History, Chicago, Illinois 60605
The late Cretaceous and Tertiary strata of Belgium have produced what is thought to be one of the finest collections of fossil sea turtles in existence. Louis Dollo, the dean of vertebrate paleontologists of Belgium, is largely responsible for this collection, and he intended to work it up. But this never happened, and the collection has remained unstudied since early in the century. A few years ago, Dr. Casier (a paleoichthyologist) worked on some of the skull material but has not yet published. He will be co-author of the present effort.

The Belgian material is most important because much of the material is very well preserved (whole skeletons). It is hoped that the Eocene specimens will shed light on the London Clay forms, described by Richard Owen, but in need of revision. A correspondent in England is currently working on the British material and an exchange of information is planned at the end of the principal investigator's stay in Brussels.

SUPPORTED BY U.S. National Science Foundation

7.0178, STRATIGRAPHIC STUDY OF RADIOLARIA IN DEEP SEA QUATERNARY SEDIMENTS
C. NIGRINI, Northwestern University, Graduate School, Evanston, Illinois 60201
Recent research has shown that it is possible to distinguish between low, middle and high latitude radiolarian assemblages. It is now proposed to use this knowledge in the interpretation of Quaternary stratigraphy, using deep-sea core material from selected localities in the three major ocean basins. Radiolarian assemblages, correlated with similar foraminiferal series, would allow an extension of deep-sea Quaternary stratigraphy into non-calcareous sediments. The study will be based on cores already in the collections of Lamont Geological Observatory and Scripps Institution of Oceanography. Support is requested for the principal investigator, and for the purchase of some supplies and equipment.

SUPPORTED BY U.S. National Science Foundation

7.0179, NORTH AMERICAN POST-Oligocene CYTHERID OSTRACODS
P.A. SANDBERG, Univ. of Illinois, Graduate School, Urbana, Illinois
This study is underway on the systematica, morphology, ontogeny, distribution, and ecology of North American Late Cenozoic and modern brackish water cythereid Ostracoda. Abundant preserved material collected from coastal waters is now available. Preliminary results indicate that along the Atlantic coast the ostracods of modern low salinity environments and ancient facies interpreted as deposited in low salinity environments are really much more like those of the Gulf Coast than was previously believed. Confusing phylogenetic and taxonomic problems involving morphologically very similar, congeneric species, particularly of the common genera Cytherura and Porisocytheridea,
7. MARINE GEOLOGY

have been worked out. Frequently, the solutions of the problems was facilitated by presence of differing modes of ontogenetic development in species with very similar adult forms.

Detailed information on morphology and ontogeny of the ostracods will be utilized in further recognition and elucidation of phylogenetic trends within and between the various genera.

SUPPORTED BY U.S. National Science Foundation

7.0180, MEASURING PAST OCEANOGRAPHIC CONDITIONS
J.R. DODD, Indiana University, Graduate School, Bloomington, Indiana 47405

Skeletal microstructure, trace chemistry, and mineral composition of some invertebrate skeletons are affected by the temperature and salinity of the sea water in which they grow. Work on some species indicates that from these relationships determination of temperatures and salinities of the geologic past is possible by analysis of fossils. More work needs to be done to make these techniques generally applicable.

A series of experiments utilizing radioactive tracers (especially Calcium-45 and Strontium-85) is underway. These experiments are designed to determine variation with environmental parameters of calcification rate in the total skeleton and in various parts, the relative rate of calcite to aragonite deposition in the skeleton, and the rate of uptake of various trace constituents (especially strontium). It is hoped to determine the variation in these rates with temperature and salinity and perhaps other parameters.

SUPPORTED BY U.S. National Science Foundation

7.0181, COMPARATIVE STUDIES OF LATE MESOZOIC AND EARLY CENOZOIC HERPETOFANAS
R. ESTES, Boston University, Graduate School, Boston, Massachusetts 02215

This investigation is a continuation of the research initiated under NSF grants G-18905, GB-1683, and GB-4304. The evolutionary and faunal history of the American herpetofauna is little known. Few useful fossils are available and many are unpublished. The work involves study of a series of geographically and temporally associated fossil samples in midcontinental North America. These samples come from similar depositional environments and span approximately 100 million years of geologic time. Preliminary studies indicate presence of a widely distributed, coastal plain herpetofauna, which once lived on the shores of North American epicontinental seas.

Strong resemblance to elements now South and Central American occurs in the lizards and other terrestrial forms, while the aquatic fish and amphibian fauna shows closest resemblances to the present-day coastal fauna of the Gulf Coast of North America. Comparisons of this fauna to similar forms in Europe has disclosed little similarity between the two continents during the period studied, mainly from Late Jurassic to Early Cenozoic time. Real similarities are perhaps more likely to emerge in comparison with South American fossils. After continued study of American, European, and South American materials is completed, a more consistent picture of the evolutionary and faunal changes involved will be available than exists at present.

SUPPORTED BY Amer. Chemical Society

7.0182, STRATIGRAPHIC AND TAXONOMIC-PHYLOGENETIC STUDIES ON PLANKTONIC FORAMINIFERA
W.A. BERGGREN, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543

It is planned to investigate the planktonic foraminifera and their use in formulating a unified global stratigraphic zonation for detailed information of the type sections of the Cretaceous and Tertiary stages, which are located in western Europe. The program will involve several methods of study including: detailed biostratigraphic investigations of selected stratigraphic sequences in North and South America, western Europe, eastern Europe, North Africa, Asia Minor and Oceania; and detailed structural analysis of the planktonic foraminifera using the electron microscope, x-rays, peel-replicas and similar methods. It is planned to integrate the program with the JOIDES deep sea coring program.

SUPPORTED BY U.S. National Science Foundation

7.0183, ELECTRON MICROSCOPY OF CALCAREOUS AND SILICEOUS PLANKTON FOR PALEOECOLOGIC AND PALEOClimATIC STUDIES
A.W. BE, Columbia University, Graduate School, Palisades, New York 10964

This if for the continuation and expansion of present work to include electron microscopic studies on the taxonomy, zoogeography and ecology-paleoecology of Bacillariophyta, Coccolithophorids, and foraminiferal shell structure in ocean waters and marine sediments.

This work is a tripartite investigation using the facilities of the Lamont electron microscope laboratories.

SUPPORTED BY U.S. National Science Foundation

7.0184, A MICROPaleONTOLOGICAL STUDY OF DEEP-SEA CRETAceous AND TERTIARY SEDIMENT
M. EWING, Columbia University, Graduate School, Palisades, New York 10964

The objectives of this study are: (1) to identify and describe Cretaceous and Tertiary microfossil assemblages (foraminifera, radiolaria, diatoms and coccoliths); (2) to investigate the past distribution and ranges of microfossil species; (3) to study the relationship of the physical properties of the sediments to the flora and fauna; (4) to relate these cores to reflecting horizons on seismic profile records and to map the distribution of pre-Pleistocene sediments on portions of specific topographic highs (e.g. Mid-Atlantic Ridge, East Falkland Plateau and East Pacific Rise).

From a preliminary study of the pre-Pleistocene cores, it is evident that on certain areas of ocean floor pre-Pleistocene sediments are within reach of the corer. These localities are: (1) the northern scarp and crest of the Rio Grande Rise; (2) the top of the East Falkland Plateau; (3) the rugged crest and steep flanks of the Agulhas Plateau; (4) the top and flanks of the northeastern end of the Walvis Ridge; (5) the steep flanks of some structural fracture zones; (6) an upcleft area of the prominent seismic reflector layer A, northeast of the Bahamas.

SUPPORTED BY U.S. National Science Foundation

7.0185, PALEONTOLOGY OF LATE CENOZOIC ANTARCTIC RADIOLARIA AND DIATOMS
J.D. HAYS, Columbia University, Graduate School, Palisades, New York 10964

Several hundred deep-sea cores from the Southern Oceans, off Antarctica, have been studied by Lamont Geological Observatory for their contained radiolaria and diatoms. Systematic and stratigraphic studies of these planktonic, silicified protists, combined with radiometric dating and paleomagnetic polarity measurements, have led to the establishment of a precise stratigraphic sequence covering the last five-million years. Correlation of the radiolarian zones with radiometric dates and paleomagnetic-episode boundaries has shown that the faunal boundaries are isochronous in sediments covering large areas. This permits the detailed determination of rates of sedimentation and other aspects of the late geologic history for large areas of the Antarctic Ocean floor. Studies of recent and fossil diatoms have indicated cold-water and warm-water species, whose paleodistribution indicates the shifting position of the Antarctic Convergence and, indirectly climatic changes. The project will continue to examine the silicous-microfossil content of cores taken by the Eltanin and the Glacier for continued refinement of the radiolarian and diatom zones and for the extension of these zones and related conclusions into the areas to be sampled during the next year.

296
No personnel from this project will be on the Eltanin or the Glacier.

SUPPORTED BY U.S. National Science Foundation

7.0186, MODERN FORAMINIFERA OFF OREGON
G.A. FOWLER, Oregon State University, Graduate School, Corvallis, Oregon 97331

The object of the proposed study is to make a detailed examination of the foraminifera from the sea floor off the coast of Oregon. This is an almost unexplored area and is from the standpoint of foraminiferal ecology. Findings are expanding and augmenting existing knowledge on this and other parts of the world. Results of current investigations demonstrate considerable variation in data from three discrete samples at each station and between closely spaced profiles in the shelf. It is important to determine to what extent the variance of faunal trends occurs. Sufficient samples for this have been obtained already and are partially processed. One year is needed to complete the study.

SUPPORTED BY U.S. National Science Foundation

7.0187, STUDY OF RADIOLARIA IN SURFACE SEDIMENTS OF THE NORTHEAST PACIFIC OCEAN
H. LING, Univ. of Washington, Graduate School, Seattle, Washington 98195

Literature related to or mentioning the occurrence of Radiolaria in the Northeast Pacific indicates that this microorganism is one of the most abundant, widely distributed, and persistent biogenic elements in the surface sediments of the Northeast Pacific Ocean. Yet, no detailed study of Radiolaria from this area has previously been attempted.

The principle objective of this study will be to carry out a taxonomic study of Radiolaria in approximately 50 surface sediment samples from the Northeast Pacific Ocean that are part of the sediment collection of the Department of Oceanography, University of Washington. The taxonomic study is a necessary initial step in a more comprehensive study, to be attempted later, of the relative abundances of the defined taxa in assemblages and the distribution of the fauna in areas of warm mass distribution.

SUPPORTED BY U.S. National Science Foundation

7.0188, INTERSTITIAL WATER OF GLACIAL-MARINE SEDIMENT
C.M. HOSKIN, Univ. of Alaska, Graduate School, College, Alaska 99775

The problem to be investigated is concerned with (1) the amount and salinity of pore water in glacial-marine sediment, and (2) the nature of the transition from a fresh water environment at the glacier terminus through the estuarine conditions in glacier bays to a normal marine environment. The expected results will be quantitative data to be used for a first evaluation of any possible potential for production of subsurface water from these glacial-marine sediments. Gravity cores will be taken in the recent sediments of the glacier bay district of Southeast Alaska. Cores will be done on traverses from glacier terminus through the estuary to the normal open marine. Research vessels and laboratory facilities of the Marine Institute of the University of Alaska at Douglas will be used for the field work. Laboratory work in College, Alaska, will be concerned with measurements of content and salinity of pore water, and porosity, permeability, and grain size of the sediment. Water content will be determined by centrifugation. Salinity of the pore water will be done by titration with silver nitrate using potassium dichromate as the end-point indicator. Porosity (pycnometer and calculation) and permeability (constant and variable head permeameters) determinations will be made with methods now in use by the Hydrologic Laboratory of the United States Geological Survey at Denver. Grain size analysis will be made by Tyler ro-tap for sand and by pipette for silt and clay. Mineralogic composition of the sediment will be determined using standard petrographic techniques.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rch University of Alaska

7.0189, SEDIMENT AND VOLCANIC STUDIES
Y.R. NAYUDU, Univ. of Alaska, Inst. of Marine Sciences, College, Alaska 99775 (NONR)

The problem to be investigated is concerned with the deposition of sediments throughout the northeast Pacific Ocean as they were deposited during and since the Pleistocene ice ages. Core and dredge samples will be obtained on ships, and the samples will be analyzed in the laboratory to determine their stratigraphy, petrology, and origin. Methods of analysis include chemical, optical, x-ray diffraction, specterscopic, trace-element, and conventional particle size distribution. Submarine volcanism is being studied by means of petrographic analyses of volcanic glass samples. Leaching of submarine basalt flows has been shown to result in concentrations of manganese nodules. Studies are being continued on this formation of manganese nodules.

These investigations provide information on the distribution and rate of deposition of sediments deposited in the Northeast Pacific Ocean during Pleistocene and recent times. Determinations on the origins of these sediments makes possible reasonable estimations of sediment laying in portions of the northeast Pacific not yet surveyed.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0190, SEDIMENTARY GEOCHEMISTRY
G.D. SHARMA, Univ. of Alaska, Inst. of Marine Sciences, College, Alaska 99775

This investigation pertains to the study of authigenic minerals found in the sea water. Various chemical species when added to synthetic sea water precipitated amorphous minerals. The effects of relative concentrations of the species added and the nature of the precipitate is currently underway.

SUPPORTED BY Union Oil Company of California

7.0191, SUBMARINE GEOLOGY OF GASTINEAU CHANNEL, JUNEAU, ALASKA
G.D. SHARMA, Univ. of Alaska, Inst. of Marine Sciences, College, Alaska 99775

The primary aim of this study was to determine the nature and thickness of sediment in the Gastineau Channel. A Bolt pneumatic continuous profiler was used to determine the sub-bottom structure in the channel. Three longitudinal and twelve traverse profiles were obtained. Nearly fifty bottom grabs and a few cores were obtained to determine the nature of sediments. The size parameters of these bottom grab samples were computed from weight percentages determined by wet sieving and pipette analyses. The sediments in Gastineau Channel were predominantly silt with varying components of sand and clay. Near shore sediments were sand with minor fractions of pebble and cobbles. The thickness of sediments in the channel varied from zero to approximately 450 feet. The channel consisted of a shallow basin near Juneau bounded by a sill near Juneau Island. Southeast of the sill the channel deepened gradually and thickness of sediment increased more and there were no sediments on the sill.

SUPPORTED BY Global Marine Incorporated University of Alaska

7.0192, DIAGENESIS IN SEDIMENTS
G.D. SHARMA, Univ. of Alaska, Inst. of Marine Sciences, College, Alaska 99775

Diagenic alterations were induced in sediments in a model representing shallow marine shelf deposits by injecting synthetic sea water under partial pressure of carbon dioxide. The sediments from the model were then removed and studied under a petrographic microscope. This study has included the interrelation of the chemistry of the interstitial fluid and the mineralogy of the
7. MARINE GEOLOGY

Sediments, the factors controlling the formation of silica and calcite cements, the processes responsible for transforming sediments into hard rocks, and the sequence of these processes. The petrographic analyses indicate that during early diagenetic events, cements are transformed into the intergranular spaces only. The calcite cement crystalized as fine-grained crystals around the grains, and extends into the pore space subsequently resulting in rim cementation. Further studies to delineate the sources of the cements and the chemical environment of their precipitation are currently underway.

SUPPORTED BY Amer. Chemical Society

7.0193, SEDIMENTOLOGY AND GEOLOGIC HISTORY OF HUMBOLDT BAY, CALIFORNIA
R.W. THOMPSON, Humboldt State College, Graduate School, Arcata, California 95521

This is a basic research project with the following principal objectives: 1) To assess the physical characteristics of bottom sediments in the various morphologic environments of Humboldt Bay and the immediate surroundings; 2) To account for these characteristics in terms of physical, chemical and biological processes acting in the bay; 3) To apply the information gained in 1) and 2) toward interpretation of sediments encountered in borings beneath the bay and surrounding environs, and finally 4) To work out the recent geological history of bay development.

SUPPORTED BY Amer. Chemical Society

7.0194, RADIOISOTOPIC SAND TRACER STUDY, POINT CONCEPTION, SANTA BARBARA COUNTY, CALIFORNIA
J.R. TEERINK, Univ. of California, Graduate School, Davis, California 95616

Problem: There is a need for an investigation of the littoral material movement around headlands along the California coastline in order to improve capabilities in the planning, design, construction and maintenance of coastal works.

Solution: The U.S. Atomic Energy Commission and all participating agencies, including the Department of Water Resources, accepted and approved a proposal to investigate the mechanics of littoral transport around Point Conception, California, by tracing sand grains tagged with radioisotopes.

Following site selection, preliminary tests were made of several isotopes and a tracer meeting engineering, scientific and health requirements was selected. Minor changes in instrumentation and improvements in the field techniques were developed. Results obtained from the first year's study were encouraging. The basic tools are now available to meet several of the study program objectives, i.e., tracing material around a headland and qualitative mechanics of transport.

SUPPORTED BY California State Government
U.S. Dept. of Defense - Army
U.S. Dept. of Defense - Navy
U.S. Atomic Energy Commission
U.S. Natl. Aero. & Space Adm.

7.0195, INDIAN OCEAN FORAMINIFERA AND SEDIMENTS
O.L. BANDY, Univ. of Southern California, Graduate School, Los Angeles, California 90007

Primary emphasis will be given to the completion and publication of the following studies: (1) sedimentology of the Andaman Sea by Kelvin S. Rodolfo, (2) foraminiferal biofacies of the Andaman Sea by William E. Frelich, (3) sedimentology of a profile across the Mozambique Channel by Douglas Sherman and Donn Gorsline, (4) foraminiferal biofacies of the southwestern Indian Ocean by Edith Vincent, and (5) ecophenotypic studies of selected foraminiferal species by Orville L. Bandy, William E. Frelich, and Edith Vincent. Sedimentology of the Andaman Sea will be completed by September, 1966; foraminiferal biofacies of the Andaman Sea could be completed by about March 1967; sedimentology of the Mozambique Channel will probably be completed by the end of September; foraminiferal biofacies of the western Indian Ocean will be completed by September, 1967; and a series of ecophenotypic investigations will be completed during the coming year.

During Cruise 17 of the R/V ANTON BRUUN in the summer of 1966, a valuable series of bottom samples were collected off South America in the region of the Nasca Ridge. It is planned to make comparisons of benthic zonation, species variation, and foraminiferal ecology between the Indian Ocean and those populations collected in the current Bruun program.

SUPPORTED BY U.S. National Science Foundation

7.0196, SAND RIPPLES
R.O. STONE, Univ. of Southern California, Graduate School, Los Angeles, California 90007

A study is being made of sand ripples, as a major form of sediment movement under both subaerial and subaqueous conditions. Using cameras and other equipment, measurements are being made of relevant properties, such as structure, size, shape, rate of movement, and age; and forces, such as wind and current velocity, wave characteristics, and sediment abundance. Analyses are being made to identify significant variables, thresholds and movements of movement, and the degree to which ripples are indicators of other beach and near-shore environmental conditions. A better understanding of sediment movement in the near-shore and beach zones is directly applicable to naval problems. This study may also lead to ability to predict local environmental conditions through remotely sensed or otherwise acquired information on sand ripple characteristics.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0197, (U) THE EFFECTS OF OCEANIC PROCESSES ON THE DEPOSITION OF RIVER SEDIMENTS
R.J. GIBBS, Univ. of California, Graduate School, Los Angeles - U.C.L.A., California 90024

Objective: An increased ability of the Navy to plan and carry out the operations involving ocean-bottom engineering, subsurface search and rescue, and bottom-influenced activities depends on the area of operation. These properties in turn depend largely upon the age and composition of the sediments and upon the processes by which they have been transported and deposited. This research should provide a comprehensive understanding of these sedimentary parameters on the continental margin off the mouth of the Amazon River and a better understanding of similar processes applicable to other large river systems.

Approach: Material from cores and dredges and samples of suspended sediment-in-transport have been obtained from previous field investigations in the area off the Amazon and will be analyzed in the laboratory for their composition, size distribution, and age. The analytical results will be mapped geographically and quantitatively related to similar results which already describe this sedimentary material at its source. From these relationships conclusions will be drawn concerning the rates and types of transportation, deposition, and alteration of the sediments as they move from the mouth of the Amazon River to the deep-sea floor.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0198, DEPOSITIONAL PROCESSES MARGINAL TO LARGE ANTARCTIC ICE SHELVES
C.A. NELSON, Univ. of California, Graduate School, Los Angeles - U.C.L.A., California 90024

UCLA will investigate the sedimentology, especially the depositional processes, of modern glacial marine sediments from the Antarctic Ocean near the margins of large ice shelves. Short piston cores, long piston cores, and dredge samples are available from the Weddell Sea, Ross Sea, and other areas that can be compared in several parameters with extensively investigated glacial marine sediments of Paleozoic age from Antarctica, South America, South Africa, Australia, and India. Such comparisons will be significant in determining the environments of deposition of the ancient deposits about which there have been many theories.

SUPPORTED BY U.S. National Science Foundation
SEDIMENTATION AT MARINE-FLUVIAL INTERFACE, SW OREGON
R.L. JANDA, U.S. Dept. of Interior, Water Resources Division, Menlo Park, California

Purpose: To obtain data on the origin and geologic history of Quaternary sediments, including black sands known to contain economically significant heavy minerals.

Methods: Surficial deposits and soils will be mapped in detail and a petrographic study will be made of them. Available drillers’ logs and geophysical information will be compiled and supplemented with test drilling where necessary to provide an understanding of the characteristics of the deposits and associated fluids at depth.

Stream gages and sediment sampling sites will be established to provide information for computation of sediment loads. Techniques and equipment for sampling the bed load of gravel bed streams will be developed.

Level surveys, fathometer surveys, and plane table mapping will be used to study changes in beach slope and volumetric changes in estuaries.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

SEAFLOOR STUDIES - DEPOSITIONAL AND EROSION PROCESSES
R.F. DILL, U.S. Navy, Undersea Warfare Center, San Diego, California 92140

Objective: To determine environmental factors affecting the acoustical uses of the oceans and the stability of structures and equipment emplacement on the sea floor.

Approach: Observe and determine the nature of depositional and erosional processes, especially: (1) those elements affecting the distribution of sediments their transport, accumulation, and lithification. (2) those elements affecting the stability of slopes and bearing capacity. (3) those features and relationships which prove the ability to predict sea floor sediment conditions in ocean areas not yet extensively studied (4) those aspects which affect basic sediment distribution patterns.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

DATING MARINE SEDIMENTS
E.D. GOLDBERG, Univ. of California, Scripps Inst. of Oceanography, San Diego - La Jolla, California 92038 (NONR)

Work continues on investigation of the kinetics of supply of terrigenous components to elastic deep-ocean sediments. Aeolian materials in particular are being studied, using direct collection of wind-borne dust for periods of a few days, material trapped in glacier ice (whose geochronology is known) for periods of centuries and fractions, and oceanic cores (dated by Pb-210, K-Ar, and U disintegration techniques) for millennia. Wind-transported solids are identified by mineralogy, size analysis, and geometry of ore particles.

SUPPORTED BY U.S. Dept. of Defense - Navy

SAND TRANSPORT
D.L. INMAN, Univ. of California, Scripps Inst. of Oceanography, San Diego - La Jolla, California 92038 (NONR)

The objective is to understand the mechanics of sediment movements by waves, currents, and winds, and hence of formation of sedimentary structures such as beaches and bars. Studies are conducted in the intertidal zones at depths accessible to divers, and in deeper water, especially in submarine canyons, by various means, including deep-sea research vehicles. Studies of flow in submarine canyons continue, with focus on synoptic measurements of the wind field above the wave and of currents and pressure in the canyons and on the adjacent shelf. An array of digital wave staffs will measure the onshore flux of wave energy and detect the presence of wave mode. Nearshore circulation cells are being studied under controlled conditions in the laboratory and at selected beaches on the Pacific coast, and along the Gulf of California.

The character of nearshore and oceanic sediments and of the wave and current processes by which they are eroded, transported, and deposited is of considerable importance.

This program will contribute significantly to an understanding of nearshore sedimentary processes.

SUPPORTED BY U.S. Dept. of Defense - Navy

MARINE SEDIMENTS
T.H. VAN ANDEL, Univ. of California, Scripps Inst. of Oceanography, San Diego - La Jolla, California 92038 (NONR)

The purpose is to relate ocean sediments to the bathymetry, structure and geologic and geophysical properties of the sea floor and to understand the historical and physical processes which determine these relationships. During the coming year, as part of the R/V ARGO cruise around the world, a study will be conducted on the Mid-Atlantic Ridge at about 10 degrees South, using satellite navigation and the shipboard computer to permit planning a reasonable sampling program immediately following the geophysical survey. The work is planned in part to test the theory of seafloor spreading.

This program, in addition to providing much valuable bathymetric and magnetic information, will help provide a predictive capability for extending this information into un surveymed areas.

SUPPORTED BY U.S. Dept. of Defense - Navy

SEDIMENT STRUCTURE
E.L. WINTERER, Univ. of California, Scripps Inst. of Oceanography, San Diego - La Jolla, California 92038 (NONR)

This research is concerned with modern sediments and ancient sedimentary rocks in tectonically active regions such as the border zones between continents and oceans, and geosynclines, in order to understand the structure and character of these entities and the occurrence, composition, and mechanical properties of the sediments. During the coming year, bathymetric, seismic, and geomagnetic observations and dredge and core samples collected in the Coral Sea during expedition NOVA will be worked up.

SUPPORTED BY U.S. Dept. of Defense - Navy

MEASUREMENT OF SURFACE CHARGE ON PARTICLES SUSPENDED IN SEA WATER
P.S. WANGERSKY, Dalhousie University, Graduate School, Halifax - Nova Scotia, Canada

The purpose of this research was to investigate the nature of the electrostatic surface charge on particulate material, living and dead, suspended in sea water, and to ascertain the effects of this surface charge on the formation of large aggregates from smaller suspended material. This electrostatic charge, expressed as the so-called ‘zeta potential’, is measured by impressing the rate of movement of particles in this field.

The zeta potentials of a number of living marine organisms largely diatoms, were studied. All of the living organisms displayed zeta potentials around -40 mv in seawater. When the organisms were killed by suspension in liquid nitrogen, their zeta potential went to zero.

Particles made by bubbling air or nitrogen through filtered seawater generally displayed zeta potentials around -30 mv when re-suspended in distilled water, and around -10 mv in seawater. As the zeta potential dropped below -15 mv, clumping of the smaller particles into larger aggregates could be seen. Particles formed by swirling or bubbling sea water displayed the same kinds of surface charges as the naturally occurring particles.

SUPPORTED BY U.S. National Science Foundation
7. MARINE GEOLOGY

7.0206. FEASIBILITY OF THE APPLICATION OF PALYNOLOGICAL INVESTIGATION OF DEEP-SEA SEDIMENTS TO MAJOR GEOLOGICAL PROBLEMS
J.J. GROOT, Univ. of Delaware, Graduate School, Newark, Delaware 19711

The distribution of pollen and spores in deep-sea sediments is mainly determined by distance from land. At a distance exceeding 350 miles from shore the number of non-reworked pollen is usually too small (lesser than 10 grains per gram of sediment) to be effective palynological study, except where very favorable conditions for dispersal by oceanic circulation exist, as in the Argentine Basin. However, for large areas the position of sediment samples does not appear to have a significant influence on their pollen content, suggesting that atmospheric transportation is of small importance relative to transportation by currents. Most samples contain some reworked pollen; distinguishing the latter on the basis of stain acceptance cannot be done with certainty at present. The presence of reworked pollen is perhaps the greatest difficulty facing marine palynological research. In view of this difficulty, palynological study should be done in conjunction with other investigations pertaining to the stratigraphy of deep sea sediments. Spectra of non-reworked pollen in deep-sea sediments reflect the vegetation of the neighboring continent and the vertical distribution of these spectra are mainly determined by vegetational and climatic change.

SUPPORTED BY University of Delaware

7.0207. RECENT MARINE AND NONMARINE SEDIMENTS AND MICROFAUNA OF DELAWARE COASTAL AREAS
J.C. KRAFT, Univ. of Delaware, Graduate School, Newark, Delaware 19711

It is proposed to study recent sedimentary environments and their associated microfauna as a basis for interpreting the geographic and stratigraphic distribution of similar environments in the geologically recent past. The coastal area of southern Delaware is proposed for study because it contains highly varied shoreline transitional environments which should show distinctive microfaunas, sediments, and sedimentary structures. Knowledge of the interrelations of these modern environments will increase our capability to interpret paleoenvironments. Specifically it is planned to 1) study the sediment and microfaunal distribution patterns of the shallow-water bays, bay mouth bar, inlet, marsh, and nearshore marine environments, 2) determine what combinations of sediment type, microfaunal occurrence, and sedimentary structures are characteristic of each environment, 3) relate microfaunal distribution to water salinity, temperature variation, and other physical and chemical aspects of the environment, 4) study the nature of the boundaries between the various environments of deposition, and, time permitting, map and interpret the areal distribution of recent sediments of the Delaware Coastal Plain.

SUPPORTED BY U.S. National Science Foundation

7.0208. CHANGES IN SEA LEVEL IN NORTHERN TUNISIA
R.H. BENSON, Smithsonian Institution, Washington, District of Columbia 20560

Examination of evidence of sea level in the last 3000 years in the vicinity of Carthage and Utique, Tunisia as shown by changes in coastal sedimentation in relation to archeological sites.

SUPPORTED BY Smithsonian Institution

7.0209. DIOSTRATIGRAPHY OF MID-ATLANTIC RIDGE SEDIMENTS
R. CIFELLI, Smithsonian Institution, Washington, District of Columbia 20560

The project involves the study of planktonic Foraminifera from the Mid-Atlantic Ridge. The purpose is to establish the stratigraphic relationships of sediments and other rock types on the Mid-Atlantic Ridge with the goal of determining the time sequence of events in the history of the Atlantic Ocean.

SUPPORTED BY Smithsonian Institution

7.0210. NATURE OF INTERTIDAL EROSION ON CORAL ATOLLS
F.R. FOSBERG, Smithsonian Institution, Washington, District of Columbia 20560

An attempt to determine the relative roles of biological agents as compared to such physical ones as abrasion, solution, temperature change, etc., in the intertidal erosion of coral limestone. Involves field studies in collecting of samples of surfaces, and the examination of these by optical microscopy and electron microscope replica photography to see if different surface features can be associated with different erosional agents.

SUPPORTED BY Smithsonian Institution

7.0211. GEOLOGICAL AND HYDROGRAPHIC STUDY OF THE WILMINGTON SUBMARINE CANYON AND ADJACENT AREAS
M. LIGHT, Smithsonian Institution, Washington, District of Columbia 20560

A program of investigation has been undertaken by the staff of the Division of Sedimentology, U.S. National Museum, Smithsonian Institution with active cooperation and support of the U.S. Coast Guard Oceanographic Unit, this program has as long-term objective, the detailing of the geometry and sedimentary processes associated with submarine canyons in general. One of the major purposes of this study is the formulation of a sedimentary model for modern canyons located on shelves off low coastal regions which are apparently tectonically stable. The selection of the Wilmington Submarine Canyon for this study was in part determined by logistics, i.e., its proximity to major ports which facilitates repetitive runs over the same area and ease of operating with various marine geological and oceanographic techniques.

Thus far four cruises, of 7 days each, have been made to the Wilmington Canyon and adjacent areas. Operations conducted during these cruises included bottom sampling with Boomerang corers and dredges, bottom observations with underwater camera and television instrumentation, sub-bottom seismic profiling, and XBT and STD casts. The next cruise scheduled during February 1969 will include bottom current measurements. Thus far, four papers have been published in various journals. CG Report 173-22, "Photographic Investigation of Sediment Texture, Bottom Current Activity, and Benthonic Organisms in the Wilmington Submarine Canyon" is now in-press.

SUPPORTED BY U.S. Dept. of Transportation - Coast Guard

7.0212. COASTAL AND CONTINENTAL SHELF SEDIMENTATION
J.W. PIERCE, Smithsonian Institution, Washington, District of Columbia 20560

To determine the distribution, source, dispersal patterns and transport processes of the sediments of a stable continental shelf and coast in the southern hemisphere.

SUPPORTED BY Smithsonian Institution

7.0213. INTERPRETING THE ORIGIN AND DISTRIBUTION OF COASTAL SEDIMENTS
D.J. STANLEY, Smithsonian Institution, Washington, District of Columbia 20560

a. Problems pertaining to distinguishing subtle differences of sands deposited on beaches, dunes, and tidal channels are being examined in the Sippewissett Marsh area, Cape Cod, Massachusetts and Sable Island off Nova Scotia using sedimentary petrography, and primary structures. Data is being integrated for interpretation by using statistical methods. Mr. Bottner is processing data with computers. b. The dispersal patterns of sediments in a micro-fjord on the coast of Nova Scotia is also being interpreted using minerology, texture, seismic profiles, and analysis of Foraminifera (Dr. F. Mediolli).

SUPPORTED BY Smithsonian Institution

300
7. MARINE GEOLOGY

7.0214, MODERN VERSUS RELICT SEDIMENT PATTERNS ON CONTINENTAL MARGINS
D.J. STANLEY, Smithsonian Institution, Washington, District of Columbia 20560
a. To map and evaluate the distribution of sediments and morphology along the Nova Scotian Shelf and to relate patterns to relict (pre-Holocene) and to modern processes. Problems of Pleistocene ice sheets, fluvial processes, tectonic outcrops, seasonal ice flow over the shelf and recent transgression of the sea must be evaluated. b. Effects of recent eustatic low stands of sea level have affected the morphology of the Bermuda platform. These are being interpreted with high resolution seismic profiles. c. An attempt to investigate sediment transport processes at continental shelf depth is being attempted by observations made in the Man-in-Sea project.
SUPPORTED BY Smithsonian Institution

7.0215, SEDIMENT DISPERSAL PATTERNS IN SUBMARINE CANYONS AND SUBSEA FANS
D.J. STANLEY, Smithsonian Institution, Washington, District of Columbia 20560
The purpose of this study is to compare and interpret sedimentation patterns in modern canyons and subsea fans and their probable counterparts in the fossil record. Seismic profiles, bottom current data, photographs, cores and grab samples are collected in modern canyons off Nova Scotia, the eastern U.S., the West Coast, and possibly the Caribbean area. Direct observations are to be made in some of these with deep submersibles and via the Man-in-Sea project. Fossil canyon deposits in southern France, the Carpathians, and California are being mapped for a detailed comparison with modern canyon fills.
SUPPORTED BY Smithsonian Institution

7.0216, RADIOISOTOPIC TRACER STUDY TO INVESTIGATE THE MECHANICS OF LITTORAL TRANSPORT AROUND POINT CONCEPTION, CALIFORNIA
A study to develop techniques to measure sediment movement in the littoral zone is specifically designated for the Point Conception area of the Pacific coast. The basic development program includes a radiation monitoring system capable of measuring underwater television equipment will be made at several locations. The system is adaptable to sediment transport in both fresh and salt water to depths of 175 fathoms. The detector monitor will follow sand tagging of 133Xe, thus providing no significant radiation hazard and no alteration of the hydraulic properties of sand indigenous to the test area. The radiation detection system utilizes scintillation type detectors. Data collection is obtained on punch tape and digital readout from a 400-channel analyzer. Data may be simultaneously coordinated with depth, salinity, and temperature during the monitoring operation. Cooperative program of federal and state agencies, including: U.S. Army, Corps of Engineers; U.S. Navy, Pacific Missile Range; U.S. Air Force, First Strategic Aerospace Division, SAC; National Aeronautics and Space Administration; U.S. AEC, Oak Ridge National Laboratory; State of California, Department of Water Resources.
SUPPORTED BY U.S. Atomic Energy Commission

7.0217, MECHANICS OF SAND MOVEMENT BY WAVES
Investigations will be made of the mechanics of sand movement by waves by studying experimental models in a laboratory, by making field measurements and observations, and by analytic theoretical work. Laboratory tests will involve the basic mechanics of sand grain movement under wave action, studying individual grain stresses and movement; data will be obtained in both the field and laboratory on the quantitative movement of sand by waves for different shore configurations, and attempts will be made to relate these to incident wave and current conditions; field measurements will be made of the basic mechanics of sediment transport, particularly by the use of labeled sand grains which can be followed and identified over some distance of movement; the effect of different types of structures on sediment movement will also be examined.
SUPPORTED BY U.S. Dept. of Defense - Army

7.0218, UTILIZATION OF RADIOACTIVE TRACERS IN BEACH STUDIES
The feasibility of utilizing radioactive and fluorescent tracers in beach studies is being followed and investigated. Preliminary tests familiarizing staff personnel with such techniques are carried out. Study is made to utilize and alter laboratory techniques for field application.
SUPPORTED BY U.S. Dept. of Defense - Army

7.0219, COASTAL PROCESSES - SOUTH TEXAS
A topical study of coastal sediments of Padre Island and Laguna Madre to understand the processes involved in transport and deposition of large volumes of sediment along a coastline, the formation and migration of a barrier island, the rate of deposition and geochemistry of sediments in the adjacent lagoon, and the influence of sources, sedimentary components and hydrography on the distribution and diagenesis of selected trace elements.
SUPPORTED BY U.S. Dept. of Interior - Geological Survey

7.0220, SEDIMENT MOVEMENT AND BOTTOM CONDITIONS IN THE DELAWARE ESTUARY MOUTH AREA
The main objectives of this project are to study the local movements of sand waves or ripples and to study bottom sediment transports generally. These will be correlated with tidal currents and quality of water changes. If feasible the effects of catastrophic events, such as floods, hurricanes, or prolonged strong winds, as well as the effects of biological activity on bottom sedimentation will be studied also. Direct continuous observations of sediment movement utilizing underwater television equipment will be made at several locations. At one or more favorable sites, a screen will be fixed in the bottom and the progress of sand saves moving with tidal currents will be followed with the television camera using video tape equipment where practical. Bottom sediment sampling and quality-of-water measurements will be made periodically during the visual observations.
SUPPORTED BY U.S. Dept. of Interior - Geological Survey

7.0221, DISTRIBUTION OF ELEMENTS IN FLUVIAL AND BRACKISH ENVIRONMENTS
To determine the distribution of major and minor elements in solution, adsorbed, or in solid form in streams, to study the variation in mineralogy and exchange capacity of stream sediments, and their importance in transporting various elements, to investigate methods, such as fluorescent tracers, for following sediment movement into the marine environment and to determine changes in adsorbed ions as sediment moves into the ocean.
SUPPORTED BY U.S. Dept. of Interior - Geological Survey
7. MARINE GEOLOGY

7.0222, SUBAERIAL AND SUBAQUEOUS FLOW OF SLURRIES
This study is determining the mechanical behavior of slurries and processes of slurry flow, in laboratory and field, to elucidate the control such processes exercise on the transportation and deposition of heavy minerals, and particularly heavy metals, in the marine environment. This work is being conducted by Stanford University under research contract.
SUPPORTED BY U.S. Dept. of Interior - Geological Survey

7.0223, UNIVERSITY OF SOUTHERN CALIFORNIA CONTRACT - CHANNEL ISLANDS AND BASINS SOUTHERN CALIFORNIA CONTINENTAL MARGIN
Objectives of the study include: (1) Detailed identification of mineral components in sediments at the mouths of all active streams that flow into the Continental Borderland; (2) sampling selected representative major drainage systems and their offshore extensions; (3) to obtain subbottom profiles of the shelf off the Point Conception-Gaviota region to provide information on relative ages of shelf surfaces and sediment thicknesses. This study is being performed in coordination with the University of Southern California under a joint research contract.
SUPPORTED BY U.S. Dept. of Interior - Geological Survey

7.0224, TRANSVERSAL DRIFTS IN BOTTOM PROFILE
R.G. DEAN, Univ. of Florida, School of Engineering, Gainesville, Florida 32601
Physical relationships between changes in the transversal profile due to sediment transport and the physical mechanisms causing such transport are sought under field conditions in the surf zone of the ocean. Pertinent parameters to be measured are the quantity of sand transport, waves (height and direction), water particle velocities, wind, tide, bathymetry, and sediment characteristics. All instrumentation and experimental facilities have been completed on the previous project for which this renewal proposal is being written.
The method of approach is to measure the time histories of the pertinent parameters over half a tidal cycle, i.e., four to six hours. Since we are measuring over a relatively short time interval a stationary process can be assumed and the techniques of spectral analysis will be employed to correlate the various parameters. This correlation allows direct cause and effect relationships to be obtained. In this manner, insight into the sediment transport phenomena and basic processes occurring in the littoral zone of the ocean can be found.
SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

7.0225, AN INVESTIGATION OF THE MASS PHYSICAL PROPERTIES OF CARBONATE MUD SEDIMENTS
J. MORELOCK, Florida Institute of Technology, School of Engineering, Melbourne, Florida 32901
The prime objective of this study is to investigate the mass physical properties of (carbonate) mud sediments. The samples for this study will be collected during a field period of two weeks. Undisturbed samples of carbonate mud will be taken from the western side of Andros Bank in the Bahama and from the bay area west of the Florida Keys. The Department of Oceanography at Texas A & M University will supply additional cores from Canapeche Bank, Mexico. These are all sites of carbonate mud deposition.
Approximately six months will be devoted to the measurement of the physical properties of these sediments. The properties which will be investigated include grain-size analysis, water content, bulk density, void ratio and porosity, specific gravity of solids, shear strength, and consolidation characteristics. The samples will be analyzed for sediment size distribution, organic content, specific gravity of solids, void ratio, porosity, bulk density, vane shear strength, direct shear strength, and consolidation characteristics. C-14 dates will also be determined.
SUPPORTED BY U.S. National Science Foundation

7.0226, DEEP-SEA SEDIMENTS AND VOLCANIC ROCKS OF MID-OCEAN RIDGES
E. BONATTI, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124 (NONR)
Objective: Navy needs for deep salvage and other operations require knowledge of sediment and rock structures of mid-ocean ridges. These structures and their relations to the development of rocks are affected by the tectonic (structural) development of the ridges. This research will provide knowledge about the structures and compositions of sediment layers on or near the ridges, and the composition and origin of volcanic rocks on ridges and seamounts.
Approach: Seismic cores and volcanic rock dredge samples will be obtained from selected sites over the Mid-Atlantic Ridge and East Pacific Rise. These samples will be analyzed in the laboratory for chemical composition, for mineralogical and altered mineralogical constituents, and for trace elements in the rocks and overlying water samples. The origins of these materials and their relation to the development to the ridges will be determined; this will provide knowledge on the origin and structural development of ocean ridges.
SUPPORTED BY U.S. Dept. of Defense - Navy

7.0227, THE GEOCHEMISTRY, MINERALOGY AND ORIGIN OF PELAGIC SEDIMENTS IN AREAS OF HIGH HEAT FLOW AND FRAC TURE ZONES
K. BOSTROM, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124
It is proposed to study the effect of high heat flow on the geochemistry, mineralogy and origin of pelagic sediments. Sediment samples from a few selected crossings of fracture zones and high heat flow areas on rises in the Pacific, Indian and Atlantic Oceans will be studied. A geological and geophysical survey of the Easter Island fracture zone, parts of the East Pacific Rise and the Calapagos Rise, that are situated between these fracture zones will also be made.
The investigations are expected to clarify: (1) the relations between heat flow and chemical composition of pelagic sediments on rises of various ages, (2) to what extent fracture zones are centers for mineralizing processes, (3) the rate of sedimentation of the sediments and their various constituents, (4) the rate at which various constituents are leached out of sediments during diagenesis, and (5) whether the introduction of material from the lower crust and upper mantle must be invoked as an explanation of these sediments.
SUPPORTED BY U.S. National Science Foundation

7.0228, EFFECTS OF DEEP SEA SEDIMENTS ON S UDDEN IMPACT, AS FROM DISASTER VEHICLES
H. FROHLICH, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124 (NONR)
Objective: Navy needs for extricating disaster vehicles buried in deep-sea sediments requires knowledge of the physical properties of such sediments and their response to sudden impact. This research aims at developing such knowledge through laboratory measurements, theoretical analyses, and in situ measurements at sea of the penetration of different shaped free-falling probes into sediments.
Approach: Laboratory measurements will be made on the penetration of various shaped blunt probes, dropped from different heights into barrels filled with compacted ocean sediments. Field tests will be made in Florida lakes using free-falling probes to determine transient and terminal drag coefficients in the sediments. A theory of surface friction will be developed on the basis of the laboratory and field observations, which should be useful in the design of a deep-sea sediment shear testing device. This device will provide in situ measurements that should indicate rates of penetration of free-falling probes into sediments. Sediment cores will be obtained to determine shear strengths at the test sites.
SUPPORTED BY U.S. National Science Foundation

302
7. MARINE GEOLOGY

7.0229, OCEANOGRAPHY, PLEISTOCENE GEOLOGY AND SEDIMENTS OF LITTLE BAHAMA BANK
A.C. NEUMANN, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124

The proposed research includes continuation of the studies on biological erosion of the coasts and Pleistocene geology of the islands as subsidiary aims, the main emphasis being given to a study of the physical energy of carbonate environments. A wave, current, and tide recording tower has been constructed in the Bight of Abaco which is part of the study area. It is proposed to determine the contribution of wave and tide in the size distribution of suspended sediment during normal and storm conditions and to relate these data to concurrently obtained wave and current data, to study the effect of oscillatory bottom currents on the natural baffle produced by turtle grass, and to compare the oscillatory bottom currents computed from surface wave characteristics to those measured directly by a Doppler current meter. By means of an energy frequency spectrum, an attempt will be made to summarize the nature and intensity of the physical energy at the bottom over seasonal intervals and to show the relative increment due to single storms.

SUPPORTED BY U.S. National Science Foundation

7.0230, ROLE OF WIND-BORNE CONTINENTAL DUST IN OCEAN SEDIMENTATION PROCESSES
J.M. PROSPERO, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124 (NONR)

Objective: Navy operations require knowledge of the distributions, sources and rates of deposition of sediment in the oceans. The aim of this research is to determine the significance of airborne material of continental origin to various oceanic processes.

Approach: Airborne material is being collected on Barbados following a trans-Atlantic trajectory from Africa. Other dust and ocean particle is being collected from research vessels in the Caribbean Sea and off the coast of Mexico. The material is being analyzed to determine mineralogical and minor -- and trace -- element contents as signatures of source regions. In the sea water, the masses and size distributions of suspended matter are being determined and related to the composition of the sea water and underlying sediments.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0231, A SEDIMENTOLOGIC STUDY OF MOBILE BAY AND PERDIDO BAY
H.C. GOODELL, Florida State University, Graduate School, Tallahassee, Florida 32306

This is an environmental study of Perdido and Mobile Bay estuaries in Mobile, Alabama, of the distribution of sediments and the three dimensional sedimentary stratigraphy of the deposits in this study in order to write the recent marine geological history of both areas and to predict future sedimentation rates based on past histories.

SUPPORTED BY Alabama State Government

7.0232, GEOMICROBIOLOGICAL WEATHERING PHENOMENA OFF ANVERS ISLAND
D.A. WARNKE, Florida State University, Graduate School, Tallahassee, Florida 32306

This award will permit completion of laboratory analysis of materials collected on Anvers Island, Antarctica, during two previous field seasons. The work includes differentiation and identification of bacterial populations, use of percolation columns for data on bio-weathering of different types of rocks, determination of particulate carbon from autoclaved Millipore filters and deep-frozen water samples and completion of determination of selected nutrients from interstitial water of sediment cores. Modal analyses of rock specimens are planned to furnish precise petrographic control of microhabitats. These methods are used to determine the participation of bacteria in the process of chemical weathering of different rock types in the various microenvironmental settings observed in the field; and of the methods by which these nutrients are introduced to the near shore environment.

This terminal year of research will be conducted at Florida State University; the work will complement investigations on filamentous fungi and marine yeasts carried out concurrently at the University of Miami.

SUPPORTED BY U.S. National Science Foundation

7.0233, MAGNETIC PROPERTIES OF ANTARCTIC MARINE SEDIMENTS AND ROCKS
N.D. WATKINS, Florida State University, Graduate School, Tallahassee, Florida 32330

Florida State University has, under NSF Grant GA-602 and GA-1123, made closely-spaced measurements on the submarine-sediment cores taken in the Antarctic regions where the Earth's magnetic field is very steep. FSU will continue to determine the vertical complement of the magnetic polarity on samples at 10-cm intervals on almost all cores recovered from the Eultan. Selected specimens will be demagnetized and three components of natural remnant magnetism measured. These data are being and will continue to be coordinated with a number of other research projects at FSU in geological oceanography and geochronology. Research of particular significance being carried out under this project is the correlation of magnetic reversals with extinction and rapid evolution of fossil microfauna from the same core.

No research on the USNS Eultan is contemplated at this time.

SUPPORTED BY U.S. National Science Foundation

7.0234, COMPARISON OF ANCIENT AND MODERN COASTAL CLASTIC SEDIMENTARY ENVIRONMENTS
J.D. HOWARD, Univ. of Georgia, Marine Institute, Sapelo Island, Georgia 31327

Two classic regions, representing ancient and modern depositional environments, have been chosen as primary study areas in which a joint approach will be undertaken to establish the pertinent features common to both and to evaluate these parameters as environmental indicators. It is proposed to carry out detailed field investigations of the near-shore sedimentary record in the Upper Cretaceous inter-tonguing marine and nonmarine rocks of east-central Utah and the shallow shelf and coastal plain sediments of the Recent and Pleistocene of coastal Georgia. Secondary study areas are the Upper Cretaceous rocks of the Rock Springs Uplift, Wyoming, and the San Juan Basin, New Mexico, and the Revent and Pleistocene deposits of the Texas Gulf Coast.

The three principal objectives in the proposed study will be:

(1) To determine physical and organic features in modern coastal clastic sedimentary environments which are likely to be preserved and which are applicable to the interpretation of similar ancient environments. Particular emphasis will be placed on the relationships between ancient trace fossils and their modern counterparts.

(2) To investigate the patterns of shallow-marine paleocurrent systems. Although terrestrial paleocurrents are relatively well understood, shallow marine paleocurrent dispersal systems have not received due attention.

(3) To determine effects of diagenesis on sedimentary textures and structures in selected Recent, Pleistocene, and Upper Cretaceous coastal clastic environments.

SUPPORTED BY U.S. National Science Foundation

7.0235, THE POTENTIAL SOURCE, TRANSPORT AND DEPOSITIONAL PATTERNS OF CLASTIC SEDIMENTS IN PORTIONS OF COASTAL GEORGIA
J.D. HOWARD, Univ. of Georgia, Marine Institute, Sapelo Island, Georgia 31327

The purpose of this study is to examine the qualitative and quantitative aspects of clastic sediments in the Sea Island Section of the Georgia Coast. Two levels of investigation are included. (1) A detailed study of representative beach (Sapelo Island). In this part of the study weekly beach profiles are made at variations of
7. MARINE GEOLOGY

the beach topography. At the time of profiling, sand samples are collected for grain-size and composition analysis and physical data as to sea state are recorded. (2) In the second part of the study, oriented and undisturbed sediment samples are taken, using an N.E.L. Spade Corer. These samples are analyzed for directional properties of sedimentary structures as well as for sediment grain-size and composition. Physical data include current strength and direction, temperature and turbidity are also collected at sampling stations. This portion of the study includes subtidal environments of the shelf and estuaries of the Georgia coast. An Arrhaim bed-load sampler is being used in an attempt to collect samples of the traction load on the shelf.

SUPPORTED BY U.S. Dept. of Defense - Army

7.0236, ALPINE LIMNOLOGY PROJECT
A.H. WOODCOCK, Univ. of Hawaii, Graduate School, Honolulu, Hawaii 96822

Studies of direct significance to marine science do not necessarily end when one moves from the sea to the shore, especially at an island location like Hawaii. The Institute of Geophysics of the University of Hawaii has encouraged and supported work on Lake Waiau, an alpine lake near the 4 km level and close to the summit of the volcano Mauna Kea, Hawaii.

The recent survey of lake bottom deposits has revealed, through carbon dating, sediment ages extending into the late Pleistocene. The lake, resting within the crater of Waiau Cone, is a natural trap for particles falling from the upper part of the atmosphere. Also, numerous coarse ash layers among the sediments tell a story of local ash eruptions. Oceanographers, concerned with understanding deep-sea cores in this region, are finding the lake deposits useful. The study of Lake Waiau and other bodies of perched water on Mauna Kea was started in 1965 and is continuing.

SUPPORTED BY U.S. Dept. of Defense - Army

7.0237, KINEMATICS OF SEDIMENTS IN BREAKERS
R.L. MILLER, Univ. of Chicago, Graduate School, Chicago, Illinois 60637

Laboratory and field studies are being conducted to determine the kinematics of sediment particles in breakers. Turbulence patterns, velocity fields, initial particle motion, accelerating and decelerating settling velocities, and sediment trajectories are being measured for various sizes and densities of beach sediments as related to beach profiles, bottom roughness conditions and breaker type. Results of these studies will establish more accurate concepts of coastal dynamics.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0238, PALEOSALINITY DETERMINATION BY THE BORON IN ILLITE METHOD
B.F. BOHOR, State Geol. Survey, Urbana, Illinois

A direct relationship exists between the amount of boron in natural waters and their total salinity. The clay mineral illite takes up boron and fixes it into its lattice from natural waters in proportion to the amount of boron present in solution. Therefore, the paleosalinity of strata containing illite can be determined by measuring the amount of boron contained in purified illite from that strata.

Shales, clays, limestones, and coals from the Illinois Basin are being analyzed for boron in order to determine their relative paleosalinity and, by analogy, their inferred environments of deposition. The rocks and coal ashes first must be treated to obtain the pure illite clay mineral fraction -- this is done by centrifugation and differential solution. This technique eliminates most of the variables associated with using boron as a measure of paleosalinity. Then the pure illite residue is analyzed for parts per million boron by optical emission spectrography. Faster and more sensitive methods of colorimetric analysis also are being investigated for boron analysis. The project was initiated in 1965.

SUPPORTED BY Illinois State Government

7.0239, KAOLINITE AS RELATED TO ENVIRONMENT OF DEPOSITION

Poorly crystallized detrital kaolinite occurs in all sedimentary environments. Generally, kaolinite is segregated within a particular facies and predominates in fresh and brackish water deposits. Superseded on the sedimentary distribution of kaolinite is a distribution of authigenic kaolinite which more accurately reflects the geochemical conditions and diagenetic changes at the site of deposition. Processes related to authigenic kaolinite formation are fundamental to the development of chamosite and glauconite.

Coal and related organic-rich environments are known to develop quantities of well-crystallized authigenic kaolinite. Salient variations in Eh, pH, and chemical equilibria are dominant in the development of this variety of kaolinite. Measures of the quantity and character of authigenic kaolinite are being made on coals of the Illinois Basin to reveal the distributional changes in an area where large quantities of information are available which pertain to environmental analysis.

Analytical methods include quantification and crystallinity determination by X-ray diffraction, scanning electron micrographs of textural relations, chemical and mechanical isolation of authigenic kaolinite from low-temperature ash samples, and gross observations of outcrop and core samples.

Considerable research is also being done on associated brackish and marine units to establish the mineralogic variations caused by changes in depositional environment in the Illinois-Pennsylvanian sequences.

SUPPORTED BY Illinois State Government

7.0240, ENVIRONMENT OF DEPOSITION OF ARGILACEOUS SEDIMENTS
N.F. SHIMP, State Geol. Survey, Urbana, Illinois

Our studies, just completed, indicate that boron is adsorbed on clays independent of composition so that for a given content of less than 2 microns of clay, marine muds have 30 to 45 ppm more boron than fresh-water muds. In addition, the total boron-clay pair are effective environment differentiators.

Comparison of boron in muds offshore of the Mississippi delta and in streams of its hinterland is currently in progress to evaluate many of the geologic controls that have been proposed for boron and test its efficiency as a discriminating core. Cores through the modern delta are available to us, and some 200 mud samples from throughout the Mississippi hinterland, an area of well over a million square miles, have been collected. No one has ever before studied boron over an entire single drainage basin and its equivalent marine muds. The geologic and climatic contrast of the Mississippi's watershed permits an evaluation of the role they play in boron abundance in muds and in the weathering cycle. In addition, we shall determine whether boron can be used to determine shoreline position in a deltaic sequence.

SUPPORTED BY Illinois State Government

7.0241, BIOGENESIS OF CARBONATE SEDIMENTS, BAHAMA ISLANDS
W.W. HAY, Univ. of Illinois, Graduate School, Urbana, Illinois

As an outgrowth of studies initiated under NSF grant GP-1991, the Principal Investigator plans to further study the biogenesis of carbonate sediments around Bimini and Turtle Rocks in the Bahama Islands. Field studies will be carried out to sample statistically the faunal communities and to determine what contribution to the sediments has been made by specific organisms. In addition to identification of magapectiforms and animal remains, it is planned to carry out scanning electron and chemical studies of skeletal materials to further quantify the contribution that specific animals may make to carbonate sediments.

It is already clear that some of the skeletal microstructure is formed by light or electron optical means will permit the identification of almost every kind of grain in a bioclastic deposit within the study area, at least to superfamily and often to a lower taxonomic level. Thus it will be possible to determine the relative contribution of
each taxonomic group to a clacarenite deposit and make a quantitave comparison with the living benthos. Chemical studies, which will be extended in this study, have already shown results that are strongly at variance with presently known data, suggesting that certain chemical components of skeletal remains may be controlled by phyletic rather than environmental factors.

The proposed study will also include the tracking of tidal currents by means of radionuclide tracers developed at the University of Illinois. Tidal currents are important with respect to the distribution of bottom communities and must be taken into account if meaningful information on biogenesis of sedimentary deposits is to be obtained.

SUPPORTED BY U.S. National Science Foundation

7.0242, FABRIC OF MARINE MUDS
R.N. GINSBURG, Johns Hopkins University, Graduate School, Baltimore, Maryland 21218 (NONR)

A detailed study is being continued on the structure and fabric of marine (and bay) muds to determine the extent to which they are affected by erosion, and the aggregates of finer particles and of only finer particles. Initial work will be with shallow water muds, where it has been found that organically bound aggregates (including fecal pellets) are widespread. Subsequent work will be done with deep sea muds. A technique is being developed of sample preparation through freeze drying and fixing with resins that will permit analyses of mud fabrics to be made without the usual damage that occurs when muds dewater as a result of being exposed to the atmosphere.

This type of analyses is different from the conventional grain size analyses of sediments, in which aggregates are destroyed. A proper interpretation of the fabric of muds is needed to assess physical properties of marine sediment.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0243, EXPERIMENTAL AND THEORETICAL RESEARCH ON TURBIDITY CURRENTS
M.P. TULIN, Hydronautics Incorporated, Laurel, Maryland

Equipment will be designed and constructed with which laboratory experiments can be conducted on the nature of turbidity currents. Theoretical studies will be made on the growth, steady state flow, and the decay mechanisms of turbidity currents. Experimental verifications of the theoretical work will be made using the laboratory equipment. The role of turbidity currents in sediment erosion and deposition will be investigated.

Knowledge of the methods of sediment transport and of sediment erosion and deposition in the oceans are important for the Navy because these affect the structure and composition of the ocean floor and the sub-bottom.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0244, ESTUARINE SEDIMENTATION PROCESSES
M.O. HAYES, Univ. of Massachusetts, Graduate School, Amherst, Massachusetts 01003

Detailed studies are being made of sedimentary processes and resultant sediment patterns in various New England estuaries selected as representative of different types of hydrographic conditions, all subject to a large tidal range. Field measurements are being obtained on tidal current velocities, temperature-salinity variations, sediment and sand-wave movement, channel shape and position changes, and other environmental factors for the three major estuarine zones: tidal channel and lower sand flats, intertidal sand flats, and salt marsh.

This study should contribute to an improved basis for the prediction of estuarine environmental conditions.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0245, SEDIMENT-FLUID INTERACTIONS
J.B. SOUTHARD, Mass. Inst. of Technology, Graduate School, Cambridge, Massachusetts 02139

The aim is better understanding of two problems of sediment-fluid interaction: dune mechanics and action of internal waves on sediment beds. The experiments are designed to study the most fundamental aspects without destroying relevance to the oceans. The work will be in a combined flume and wave tank 45 feet long.

Work on bottom sediment movement and dune formation should provide better understanding of changes in bottom topography, perhaps leading to prediction of such changes. Enhanced understanding of fluid-sediment dynamics should aid in design of bottom-mounted structures and in understanding some of the bottom characteristics important to other operations.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0246, QUANTITATIVE AND QUALITATIVE CHARACTERISTICS OF MATERIALS CONTRIBUTING TO SEDIMENTATION IN LAKE ERIE
J.F. CARR, U.S. Dept. of Interior, Biological Laboratory, Ann Arbor, Michigan

Collecting devices are being used to obtain materials as they settle from the water column but before reaching the bottom. Measurements are made of the percentage of the various components (plankton, clay, detritus, etc.) making up the sediments. In addition, measurements are made of sedimentation rate, oxygen demand, percent organic matter, nutrient content, and (hopefully) geographic origin of the material.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

7.0247, LAKE SUPERIOR CORING III
W.R. FARRAND, Univ. of Michigan, Graduate School, Ann Arbor, Michigan

The research herein proposed consists of two phases, (a) completion of studies begun in 1961 and 1962, and (b) continuation of the study of Lake Superior bottom sediments by means of a series of cores to be provided by the Carnegie Institution of Washington.

During 1961 and 1963 about 500 miles of continuous seismic profiler traverses were run in southern and western Lake Superior, and eleven cores were obtained by means of a shipboard drilling rig. The sediment study is nearly complete, but less than half of the seismic profiles have been reduced. In order to bring this project to completion, it is proposed to finish the sediment study (carbonate and humus analysis, heavy mineral study, varve stratigraphy), reduce the remaining seismic provisions, and to write the final report.

The second phase of this proposal is a sedimentological study of a series of cores, possibly as many as 100, which will be recovered during the 1966 heat flow study program of the Department of Terrestrial Magnetism Carnegie Institution of Washington. These cores will be 4 to 5 meters long and will provide a great increase in our knowledge of the floor of Lake Superior.

SUPPORTED BY U.S. National Science Foundation

7.0248, PRE-DELTA SEDIMENTATION IN THE ST. CLAIR RIVER DELTA AREA
A.L. POPRIK, Wayne State University, Graduate School, Detroit, Michigan 48202

NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY Society of The Sigma Xi

7.0249, MICROPLANKTON OF THE BEARPAW SHALE OF MONTANA AND NORTH DAKOTA
H.W. NORTON, Hope College, Undergraduate School, Holland, Michigan 49422

NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY Society of The Sigma Xi

7.0250, SHOALING PROCESSES
J.B. TIFFANY, U.S. Army, Waterways Experiment Sta., Vicksburg, Mississippi
7. MARINE GEOLOGY

The scope and objectives of this engineering study are as follows: (a) To determine the basic laws involved in the movement and disposition of muddy sediments; (b) to determine the effects of epeiric scour and deposition on sedimentation; (c) to develop techniques for radiotrace tracing of sediment movement and deposition; (d) to develop an in-place turbidity meter; (e) to determine the effects of stabilization of deposits on shoaling; (f) to determine the effects of flocculation on shoaling; (g) correlation of prototype data to determine the similarity, or lack thereof, of shoaling processes among estuaries or groups of estuaries; (h) classification of sediments which form shoals in estuaries or other tidal waterways improved for navigation; (i) to determine the facts which affect hydraulic and shoaling conditions in navigation slips and tributary channels which are improved for navigation; (j) to standardize sediment and soil sampling techniques in tidal waterways and to determine suitable methods for the packaging and transportation of samples; (k) to develop reliable methods for the predicting tides and currents in tidal waterways. Field investigations and laboratory studies are presently being conducted under the auspices of the Committee on Tidal Hydraulics to accomplish many of the objectives listed above. The lack of adequate space on this form prohibits discussion of each individual investigation under this project.

SUPPORTED BY U.S. Dept. of Defense - Army

7.0251, RADIATION, DOSIMETRY, CORRELATION AND DATING OF CALCAREOUS DEEP-SEA CORES
N.M. JOHNSON, Dartmouth College, Graduate School, Hanover, New Hampshire 03755 (AT(30-1)13860)

The sequence and age of various pelagic carbonates will be analyzed by modern methods of thermoluminescent dosimetry. Pliocene-to-Recent calcareous core sections will be correlated on the basis of their self-contained radiation dosimetry. The purpose of the study will be to extend the chronology of deep-sea sedimentation beyond the limit of carbon-14 and the isotopic desequilibrium methods.

SUPPORTED BY U.S. Atomic Energy Commission

7.0252, EARLY DIAGENESIS OF CARBONATE SEDIMENTS IN A SUPRATIDAL EVAPORITIC SETTING
H.D. HOLLAND, Princeton University, Graduate School, Princeton, New Jersey 08540

A field and laboratory study is proposed, to determine the sedimentary and early diageneric features of shelf carbonate sediments. The Persian Gulf has been selected for study. Early diageneric processes affecting carbonate sediments under evaporitic supratidal conditions are to be examined. The role of fluids in the early diagenesis of mineral phases and of the non-carbonate organic fraction of the sediments is central to the study.

The data and processes found to be important will enable the history of ancient carbonates to be more readily understood and may indicate whether or not shelf carbonate sediments are likely petroleum source beds.

SUPPORTED BY U.S. National Science Foundation

7.0253, RECENT SEDIMENTATION BY TIDAL AND LONGSHORE CURRENTS ON A CARBONATE BANK IN LOWER FLORIDA KEYS
V. JINDRICH, State University of New York, Graduate School, Binghampton, New York 1980

No Summary has been provided for use of Science Information Exchange.

SUPPORTED BY Society of The Sigma Xi

7.0254, STRATIGRAPHIC RELATIONS BETWEEN A COQUINA, FACIES OF THE YORKTOWN FORMATION AND GRAVEL AND SEDIMENT AT CHUCKATUCK, VIRGINIA
N.K. COCH, City University of New York, Graduate School, Flushing - Queens College, New York 11367

During a geological investigation of southeastern Virginia from 1961 to 1965 a shoreline complex in the uppermost part of the Late Miocene Yorktown Formation was discovered and briefly studied by Coch (1965). This shoreline complex is composed of bars of biofragmental sand with intervening lagoonal muds. The present study is aimed at determining the Late Tertiary changes in sea level and to try and account for the missing Late Tertiary-early Quaternary sediment record in the area.

SUPPORTED BY Society of The Sigma Xi

7.0255, CORRELATION OF SUBMARINE VOLCANIC ASH BY CATHODO-LUMINESCENCE
J. DONAHUE, City University of New York, Graduate School, Flushing - Queens College, New York 11367

Volcanic ash layers in deep sea sediments are extremely valuable in correlation since they represent isochronous markers. Standard techniques for identifying the layers are however, laborious. Cathodo-luminescence offers a means of identifying layers quickly by means of their specific mineralogic composition. My present work involves using identified mineral standards to determine the luminescent properties of the various mineral species. Preliminary work indicates that minerals have unique luminescent properties.

The second phase of work involves examination of volcanoc ash layers to determine their mineralogy. Determinations made up to this point indicate that this method will allow rapid identification of individual ash layers for correlation.

SUPPORTED BY City University of New York

7.0256, QUATERNARY OF THE HUDSON RIVER ESTUARY
W.S. NEWMAN, City University of New York, Graduate School, Flushing - Queens College, New York 11367

We are examining the form and sediments of the Hudson River Estuary from Kingston south to the Narrows. Both published and unpublished data find the valley's bedrock thalweg at inconsistently varying elevations: about -200 feet at Kingston, more than -200 feet near Marlboro, at almost -400 feet at Newburgh, more than -700 feet at Storm King, a similar depth at the Tappan Zee Bridge, at about -300 feet opposite Manhattan Island, but only about -200 feet near the Narrows. The bedrock valley form confirms its identity as a fiord. However, the valley cutting age remains uncertain.

The sediment in the valley consists of till-outwash, lacustrine silt, fluvial sand, estuarine organic silt and tidal marsh peat. Paleontological analyses of bore samples adjacent to Long Island, just south of the Bear Mountain Bridge, suggest the estuary has been in existence for at least 12,000 radiocarbon years. Archeological shell middens at Croton and Montrose Points indicate the estuary achieved salinities of 5 o/oo or more 4-6,000 years B.P., more than twice those presently obtained at these localities. Decrease in salinity is probably due to estuarine clogging by sediments in the sense of Emery (1967).

A marine transgression curve constructed from the Long Island data implies the locality suffered post-glacial isostatic rebound followed by subsidence during the past few thousand years.

SUPPORTED BY City University of New York

7.0257, LITHOLOGICAL AND MICROPALEONTOLOGICAL INVESTIGATION OF OCEAN SEDIMENT CORES
D.B. ERICSON, Columbia University, Graduate School, New York, New York 10027

Scientists at Lamont Geological Observation have reported the discovery of a sedimentary boundary between the Pliocene and the Pleistocene. Because core lengths available could reach this depth only where considerable overburden had been lost through slumping, there is a gap of unknown thickness representing about 200,000 years of deposition. By continued examination of the cores available at Lamont, it is hoped that other cores will...
be found, in which the younger sections have been thinned by slumping and whose stratigraphy can be correlated to overlap with cores containing the late Pliocene and Pleistocene sections. There will then be available a complete record of Pleistocene climatic events and the means of estimating a complete Pleistocene chronology, as well as a better understanding of the conditions associated with the glaciation of that period.

SUPPORTED BY Texas Instruments Incorporated

7.0258, GRANT FOR STUDY OF SEA FLOOR CORES AND PHOTOS
M. EWING, Columbia University, Graduate School, New York, New York 10027
NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE
SUPPORTED BY Bear Creek Mining Company

7.0259, ANALYSIS OF PHYSICAL AND CHEMICAL PROPERTIES OF DEEP SEA CORES
D. HORN, Columbia University, Graduate School, New York, New York 10027
NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE
SUPPORTED BY Texas Instruments Incorporated

7.0260, MARINE GEOLOGY
G. NEUMANN, New York University, Graduate School, New York, New York 10003 (NONR)

The objective of this research is to describe quantitatively the sediment transport mechanism active off the coast of California and to draw from this description general conclusions which are applicable to coastal regions around the world. During the contract the current regimes in the San Pedro and the Santa Barbara Channels will be studied as they relate to suspended sediment load transportation. In addition work will continue in the Redondo submarine canyon, with emphasis on the bulk properties and strength of sediments in the canyon’s head, axis, and fan.

The character of nearshore and oceanic sediments and of the wave and current processes by which they are eroded, transported, and deposited is of considerable importance to operations involving ocean-bottom and nearshore engineering and construction, and search and rescue. This program will contribute significantly to an understanding of nearshore sedimentary processes.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0261, FACTORS EFFECTING RATES OF ORGANIC DEPOSITION AND QUALITY OF WATER
L.C. MARSH, State University of New York, Graduate School, Oswego, New York 13126

This is exploratory research concentrating on the swamps at Port Bay, Beaver, and Sterling, all located rather close to Oswego. Both depth and aerial extensions of the swamps and related bogs are needed. It is hoped to identify the sources of bog vegetation and to relate the swamp to the underlying clay deposits. Such deposits appear important to water flow restrictions and subsequent internal chemistry. Extensive sampling will be followed by radiocarbon dating and pollen analysis.

SUPPORTED BY State University of New York

7.0262, COLLECTION, REDUCTION, AND INTERPRETATION OF SEISMOLOGIC AND PHOTOGRAPHIC DATA
M. EWING, Columbia University, Graduate School, Palisades, New York 10964

The study of sedimentation processes and distribution of sediments in the ocean basins will be continued, the ultimate purpose being to improve the knowledge of the history of the oceans and of the marine portion of the entire geologic record. Seismic profiles, bottom photographs, nephelometer, and current measurements incorporated with a sediment sampling program can be expected to answer many questions about the ages of the ocean basins, the processes and rates of sediment accumulation, and about past environmental factors such as regional climatic variations and oceanic circulation.

SUPPORTED BY U.S. National Science Foundation

7.0263, RESEARCH IN CORE ANALYSIS
W.M. EWING, Columbia University, Graduate School, Palisades, New York 10964

Objective: To determine those environmental factors affecting acoustical uses of the ocean. To make acoustic models of the ocean bottom, conduct in-situ observations and experiments. Upgrade theory with advancing state-of-the-art.

Approach: Analyze bottom cores and measure parameters which determine the acoustic properties of sediments. Laboratory analysis will include such items as shear strengths, bulk properties, carbonate content, grain size analysis and computer runs to provide information on the relationship that exists between these properties. Comparison with cores from other surveys will be made.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0264, MARINE SEDIMENTS
C. FRAY, Columbia University, Graduate School, Palisades, New York 10964 (N00014-67-A0108-0004)

This program includes the systematic collection, preliminary description, and cataloging of sediment cores and dredge samples. Data are sent to the Oceanographic Data Center. The core collection will continue to be used in support of other researchers, both inside and outside the laboratory. The shipboard coring program will concentrate on the selective sampling of sediments and structures delineated by the sub-bottom reflection data.

A knowledge of the physical, chemical, and biological properties of ocean-bottom sediments is important to operations which involve the interaction of both acoustic waves and man-made structures with marine sediments. This program will provide (1) information on a number of these properties and the processes and factors which control them, and (2) a stock of cores which are available to and used by other investigators in their research programs.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0265, SEDIMENTS IN BAFFIN BAY AND THE EFFECTS OF AN ARCTIC ENVIRONMENT ON MARINE SEDIMENTATION
G.M. FRIEDMAN, Rensselaer Polytechnic Inst., Graduate School, Troy, New York 12181

OBJECTIVE: The Navy needs environmental data as they affect salvage and recovery, DRV and other operations. Such data are also needed because they affect engineering structures which in the future will probably be installed on the ocean floor. This research is specifically designed to provide a suite of data describing sedimentary properties on the floor of Baffin Bay. Such data will improve our knowledge of the sea floor and of sedimentation processes in the Arctic.

APPROACH: The contractor, jointly with the U.S. Naval Oceanographic Office in 1967 collected data and core samples in Baffin Bay. They are currently analyzing these data and materials to study the source of the sediments, their biological content and the water contained in their pore spaces. The results will be related to the physiographic province, ocean currents and ice-rafting which are thought to control sedimentation in Baffin Bay. The results will be extrapolated to predict sedimentary conditions in other Arctic regions.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0266, DIAGENESIS OF CARBONATE SEDIMENTS
G.M. FRIEDMAN, Rensselaer Polytechnic Inst., Graduate School, Troy, New York 12181

This study is concerned with the geochemistry of interstitial waters in shallow-water carbonate sediments.
7. MARINE GEOLOGY

Cores have been sampled and waters extracted from carbonate sediments off Bermuda and the Red Sea. Analyses for trace element concentration are underway. Florida Bay and Florida offshore cores will be sampled during the winter months.

SUPPORTED BY Amer. Chemical Society

7.0267, CARBONATE SEDIMENTATION IN THE TONGUE OF THE OCEAN, BAHAMAS
O.H. PILKEY, Duke University, Marine Laboratory, Beaufort, North Carolina 28516

This project is to study in detail carbonate sedimentation on the floor of the Tongue of the Ocean. The study will involve a general description and analysis of ten piston cores with particular emphasis on detection of the effects of lowered sea levels and the differentiation of glacial and interglacial sediments. A preliminary study of short cores from the Tongue of the Ocean has indicated that carbonate mineralogy may reflect sea level changes. Other sediment parameters may be likewise affected. The biosedimentary study of short cores from the Tongue of the Ocean has in-

SUPPORTED BY U.S. National Science Foundation

7.0268, A RECONNAISSANCE OF COASTAL EROSION IN NORTH CAROLINA
L.J. LANGFELDER, Univ. of North Carolina, School of Engineering, Raleigh, North Carolina 27600

Three different approaches are being used to delineate areas of erosion and accretion along the North Carolina Coast. These are (a) the use of aerial photography, (b) the use of wave refraction techniques, and (c) observations of the present configuration of the beaches.

The aerial photography portion is utilizing measurements from selected control points to the beach on aerial photographs made over the last 30 years. The wave refractions portion is utilizing existing swell data and wave refraction procedures using an existing computer program. The present configuration has been observed during the life of the project by multiple field surveys. The results of the three methods will be compared in the final report.

SUPPORTED BY North Carolina State Government

7.0269, HEAVY MINERAL DISTRIBUTION OF THE WHITE OAK ESTUARY-BOGUE INLET AREA, NORTH CAROLINA
P.A. DANIELS, Bowling Green State University, Graduate School, Bowling Green, Ohio 43402

NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY Society of The Sigma Xi

7.0270, DEPOSITION RATES BY THE PROTACTINIUM METHOD
W.M. SACKETT, Univ. of Tulsa, Graduate School, Tulsa, Oklahoma 74104 (AT(1-1)-1540)

This project will continue to study the behavior of uranium and thorium series nuclides in the ocean and sediments. The distribution of 238U, 230Th, and 231Pa and total unsupported 230Th and 231Pa on cores taken on the crest of the East Pacific Rise will be determined in order to investigate the possibility that 234U and 230Th may be mobilized by sub-surface thermal activity and migrate to the sediment-water interface. The collection and sampling of the cores (aboard the Oceanographer) and the analyses will be performed by the principal investigator. Results show that manganese nodules are being deposited very slowly. 230Th and 231Pa are practically useless in determining rates as the unsupported activity decreases to zero a few mm from the nodule surface. The anomalously low 230Th/231Pa activity ratios (less than the theoretical productive ratio of 10.8) have been substantiated. Fourteen elements were determined by atomic absorption photometry. The concentration of Sr and Co were found to decrease with oceanic depth for both Atlantic and Pacific nodules whereas Fe, Pb, and Ti showed a depth dependence only in Pacific nodules. Uranium-thorium series nuclides are being determined in a suite of continental river and near shore marine sediments. For the samples analyzed to date, the 234U/231Pa activity ratio is, within experimental error, the theoretical supported value of 21.6 for both types of sediments. The 230Th/234U activity ratio is less than one for both river and near shore ocean sediments but has a value of 1.4 for an anaerobic mud in an Oklahoma lake. This study is continuing and should prove useful in understanding the geochemical cycle of uranium-thorium series nuclides.

SUPPORTED BY U.S. Atomic Energy Commission

7.0271, PROPERTIES AND ORIGIN OF SEDIMENTS ON THE CONTINENTAL MARGIN OFF WESTERN U. S.
J.F. BYRNE, Oregon State University, Graduate School, Corvallis, Oregon 97331

This research will provide (1) basic data on bathymetry, on ocean-bottom currents, and on the acoustical and physical properties of marine sediments and (2) an improved capability for predicting the interactions of sound energy and man-made objects with the ocean floor. The research is directed toward determining the nature and origin of the continental margin off the western United States, and toward evaluating the various processes by which sediment is eroded, transported, and deposited in this region.

APPROACH. Shipboard programs involving ocean-bottom current measurements, bottom photography, sediment sampling, and continuous sounding will be carried out. Bottom samples will be examined in the laboratory for their texture, mineralogical composition, and faunal content. From these combined laboratory and field data, inferences will be drawn concerning the present and past patterns and mechanism of sediment movement from the shoreline to the deep-sea floor.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0272, ABBYSSAL PLAIN SEDIMENTATION AND STRATIGRAPHY OFF OREGON
L.D. KULM, Oregon State University, Graduate School, Corvallis, Oregon 97331

It is proposed to carry out research on sedimentation and faunal stratigraphy on Cascadia Abyssal Plain and its associated deep-sea channels. The area of investigation will include the eastern portion of Tufts Abyssal Plain, with primary emphasis on Cascadia Channel. Sedimentary and faunal data from piston cores, detailed bathymetric surveys of specific features, and geophysical data will be used to establish the basic framework of sedimentation on Cascadia and Tufts Abyssal Plains. A better understanding of the processes that are instrumental in the development of certain deep-sea plains should result from this work. The studies of the stratigraphic distribution of planktonic microorganisms in the deep-sea sediments will provide time lines for correlation of events between cores and information on past climatic conditions. These data will make it possible to examine the complex interrelationships between changing palaeoclimatic conditions and sedimentation rates, sedimentary processes, and sediment texture and composition, which are known to have had a profound effect on the development of Cascadia Abyssal Plain. The influence of prominent deep-sea channels on the transportation and dispersal of shallow water terrigenous sediments into regions distant from the continent will be investigated. The turbidity current deposits of Cascadia Channel will be studied in detail for a distance of some 2000 km; an attempt will be made to reconstruct the flow regime of the channels. In addition, deep-sea channel and interchannel deposits will be compared. An attempt will be made to evaluate the relative importance of turbidity-current versus ocean-bottom current deposition in the area under investigation.

SUPPORTED BY U.S. National Science Foundation
7. MARINE GEOLOGY

7.0273. DEEP-SEA SEDIMENTS - THEIR PROPERTIES AND PROCESSES OF FORMATION
T.H. VANNESDEL, Oregon State University, Graduate School, Corvallis, Oregon 97331

Objective: In support of present and future ocean-bottom engineering, search and rescue and other operations, this research provides (i) basic data on bathymetry, on ocean-bottom currents, and on the acoustical and physical properties of marine sediments, and (ii) an improved capability for predicting the interactions of sound energy and man-made objects with the ocean floor. The research is directed toward determining the three dimensional nature of the mechanisms and products of sedimentation in the Panama Basin. This sedimentation regime will then be related to the geologic and oceanographic settings of the basin.

Approach: A shipboard reconnaissance survey of the Panama Basin will be undertaken this year utilizing echo sounders, a seismic reflection profiler, bottom sediment samplers and current meters. The compositional and physical properties of the sediment samples will be analyzed in the laboratory. The preliminary knowledge of the distribution, nature and source of the sediments gained from these initial field and laboratory studies will be used to define the proper areas and most worthwhile approaches for making more detailed field examinations during the next three or four years.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0274. STRATIGRAPHY OF RECENT INTERTIDAL SEDIMENTATORY DEPOSITS OF THE SHEEPSHEAD MUDFLAT, NEW JERSEY
E.R. FORCE, Lehigh University, Graduate School, Bethlehem, Pennsylvania 18015

No Summary has been provided for use of Science Information Exchange.

SUPPORTED BY Society of The Sigma Xi

7.0275. DELAWARE ESTUARY SEDIMENTATION STUDY

Sediment transport processes in the Delaware estuary are being studied to determine the rate of shoal development. Measured sediment loads delivered to the Delaware estuary by Coastal Plain streams are much less than the annual estimated volume of estuarine sedimentation. Therefore, other sources of sediment must be identified to balance the sediment budget.

Salinity, sediment concentration, turbulence, and many other parameters are known to affect the rate of sediment flocculation. However, little is known about the quantitative effects of the environment upon sedimentation rates. Through field and laboratory experiments the most significant parameters will be identified; these parameters will then be related to rates of sedimentation measured in the field. Results of this study will be used to estimate changes in the present shoaling pattern due to man-made modifications of water quality and the physical geometry of the estuary.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

7.0276. RELATION OF SEDIMENT STRUCTURES AND FLOW DIRECTIONS OF COASTAL CURRENTS
G.D. KLEIN, Univ. of Pennsylvania, Graduate School, Philadelphia, Pennsylvania 19104

The principal objectives of this research are to map the orientation of directional current structures in coastal sediments, relate their orientation to the flow directions of depositional currents, and determine the applicability of the flow regime concept to coastal current systems. The work will complete research recently carried out under NSF grant GA-407. The study is designed to strengthen the interpretive basis of paleocurrent analysis, which has been developed largely from the mapping of directional current structures of ancient sedimentary rocks, largely at (1) what relations exist between micro-sedimentary structure and the geotechnical and acoustic properties of the sediments.

309
7. MARINE GEOLOGY

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0281, SEDIMENTATION
W.R. BRYANT, Texas A & M University System, Graduate School, College Station, Texas

This research is aimed at determining the characteristics of marine sediments in the Gulf of Mexico. The relationships between the acoustic and geotechnical properties of these sediments will be studied under closely controlled conditions of temperature, loading, and saturation. Investigations of submarine slope stability and the role which slumping plays in the modification of submarine slopes will be continued. In conjunction with the geophysics program, this research will also involve continuing studies of the regional geology along the eastern and western margins of the Gulf of Mexico.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0282, CORING OF THE VARVED SEDIMENTS IN SAANICH INLET
A.W. FAIRHALL, Univ. of Washington, Graduate School, Seattle, Washington 98122

Cores will be retrieved from the varved sediments of Saanich Inlet, Vancouver Island, to the depth of bedrock (150 feet below bottom) for study and dating of the sedimentary sequence.

SUPPORTED BY U.S. National Science Foundation

7.0283, THE FORMATION OF DOLOSTONE AND CHERT IN THE UPPER MIDDLE CAMBRIAN OF THE GREAT BASIN
J.C. KEPPER, Univ. of Washington, Graduate School, Seattle, Washington 98122

The partial geographic distribution of the distinctive, regional limestones - dolostone - chert lithostromes in the upper Middle Cambrian of the Great Basin is known. I suggested, in a preliminary study, that much of the dolostone was formed on the sea floor and just below the depositional interface during early diagenesis. The purpose of the present study is to establish further petrographic criteria for the time of formation of the different types of dolomite - sea floor, diagenetic, and post-diagenetic - and of the associated laminated cherts. Etched and/or stained thin sections and slab are used. The percentage of insoluble material with respect to rock type and the stratigraphic distribution of such material is under study. Optical and x-ray analysis of a few samples shows kaolinite in the clays is considered important in the cracking of dolostone laminae prior to the formation of the associated intraformational breccias. The role of these clays in the chemical environment and their effect as stratigraphic permeability barriers is to be studied.

Sedimentographic sections have been sampled and measured in western Utah (Marjum Limestone of the Fish Springs Range), eastern Nevada (Highland Peak Formation), and eastern California (Bonanza King Formation). At least 15 sections will have been examined by September 1967. Hypotheses regarding the physical - chemical conditions which produced these rocks will be developed from this study.

SUPPORTED BY U.S. National Science Foundation

7.0284, RADIOLARIA IN PACIFIC SEDIMENTS
H. LING, Univ. of Washington, Graduate School, Seattle, Washington 98122

Through previous studies of the detailed taxonomy and geographic occurrences of Radiolaria in the surface sediments of the eastern subarctic region of the North Pacific significant biographic differentiation have been established. The proposed study will be made to refine and extend the observed pattern of distribution into the central North Pacific.

SUPPORTED BY U.S. National Science Foundation

7.0285, DEEP SEA SEDIMENTS IN THE NORTH PACIFIC FROM STUDIES OF THEIR RADIOLARIAN CONTENT
H.Y. LING, Univ. of Washington, Graduate School, Seattle, Washington 98122 (NONR)

Objective: Effective naval operations require a knowledge of the acoustic properties of ocean-bottom sediments. These properties are strongly related to sediment composition and to the processes by which the sediment was deposited. This research, in addition to providing direct information on sediment types and their distribution within the North Pacific Basin, will lead to a better understanding of the sedimentary and oceanographic environments within which these sediments are being and have been deposited.

Approach: Deep-sea sediment cores obtained in the central North Pacific by University of Washington scientists together with specimens from sediment cores taken by other research groups will be analyzed for their Radiolarian content. Variations in the number and type of Radiolaria with respect to depth in a core will be related to variations in the textural and compositional characteristics of the sediments and to their geologic age. Based on the observed variances, correlations between cores of clearly defined sedimentary layers will be attempted. The area of study will be extended to include the entire subarctic North Pacific and the distributional pattern of Radiolaria will be related to the oceanographic environment of this region.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0286, STRATIGRAPHY OF UNCONSOLIDATED SEDIMENTS ON THE CONTINENTAL SHELFS OF THE CHUKCHI AND NORTHERN BERING SEAS
D.A. MCMANUS, Univ. of Washington, Graduate School, Seattle, Washington 98122

The continental shelf in the Chukchi and Bering Seas is of particular geological significance because of the sediments, and to their geologic age. Based on the observed variances, correlations between cores of clearly defined sedimentary layers will be attempted. The area of study will be extended to include the entire subarctic North Pacific and the distributional pattern of Radiolaria will be related to the oceanographic environment of this region.

The proposed investigation has as its objectives: (1) the description of cores of the entire section of unconsolidated sediment on the continental shelves of the Chukchi and Bering Seas; (2) the interpretation of the subbottom profile records of the continental shelves of the Chukchi and Bering Seas; (3) the stratigraphic correlation of sedimentary units; and (4) the origin of sedimentary environments. The study of transgressive sedimentary sequences also must draw upon data on the water properties. Data upon the origin, distribution, and interaction of water masses of the Arctic Ocean and contiguous waters are available at the University, and will be augmented during the time of the proposed research by concurrent physical and chemical oceanographic studies in the area.

The proposed investigation has as its objectives: (1) the description of cores of the entire section of unconsolidated sediment on the continental shelves of the Chukchi and Bering Seas; (2) the interpretation of the subbottom profile records of the continental shelves of the Chukchi and Bering Seas; (3) the stratigraphic correlation of sedimentary units; and (4) the origin of sedimentary environments. The study of transgressive sedimentary sequences also must draw upon data on the water properties. Data upon the origin, distribution, and interaction of water masses of the Arctic Ocean and contiguous waters are available at the University, and will be augmented during the time of the proposed research by concurrent physical and chemical oceanographic studies in the area.

SUPPORTED BY U.S. National Science Foundation

7.0287, PROPERTIES AND ORIGIN OF SEDIMENTS IN THE NORTHEAST PACIFIC OCEAN
D.A. MCMANUS, Univ. of Washington, Graduate School, Seattle, Washington 98122 (NONR)

OBJECTIVE: In support of present and future ocean-bottom engineering, and sub-surface search and rescue operations, this research will provide (1) basic data on the bathymetry, ocean-bottom currents, and the acoustical and physical properties of marine sediments in the North Pacific Ocean and (2) an improved capability for predicting the interaction of sound energy and man-made objects with the ocean floor. The research is directed toward determining the nature and origin of the sediments which have been and are being deposited off the continental margin of Washington and Vancouver Island.

SUPPORTED BY U.S. National Science Foundation
7. MARINE GEOLOGY

7.0291. DRAINAGE PATTERN DEVELOPMENT ON TIDAL MARSHES
R.J. LYON, Stanford University, Graduate School, Palo Alto - Stanford, California 94305

A study is being made of factors controlling origin of drainage channels in tidal marshes, and of processes by which these complex systems develop. The relationships of drainage pattern types to specific environmental variables are being identified. Multispectral air photography, combined with ground measurements of incident and reflected light, is being used as an additional research technique.

Operations in tidal marshes are handicapped because there is little knowledge of the fundamental mechanisms of these environments which are dominated and characterized by constantly reversing tidal flow. Tidal marshes are common coastal features throughout the world, and it is essential that these areas be understood so that operations can be properly planned, and equipment appropriately designed and utilized.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0292. STUDY OF BEACH NOURISHMENT ALONG THE SOUTHERN CALIFORNIA COAST
J.R. TEERINK, State Dept. of Water Resources, Sacramento, California

Problem: Evaluate the full impact of the combined effects of coastal and tributary watershed development on shoreline changes and prepare a long-range plan for timely nourishment of eroding beaches from land and offshore sand sources.

Solution: Develop an effective and economical plan for replenishing the beaches in Southern California in the following manner: 1. Review geological processes contributing to erosion and shoreline changes. 2. Determine need for beach nourishment. 3. Assess the effects of existing and proposed coastal and tributary watershed structures on the natural movement of sand. 4. Develop semiquantitative sediment delivery rates from coastal watersheds under present and anticipated future development. 5. Delineate sources and determine volumes and physical characteristics of suitable material for beach nourishment for inland sand sources. 6. Develop the economics of a comprehensive artificial beach nourishment program that would provide sufficient quantities of beach material of the proper size and weight to prevent erosion of the beaches.

SUPPORTED BY California State Government

7.0293. SEA FLOOR STUDIES - TOPOGRAPHY AND SHAPE OF THE SEA FLOOR
C.J. SHIPEK, U.S. Navy, Undersea Warfare Center, San Diego, California 92140

Objective: To determine environmental factors affecting the acoustical uses of the ocean; determine the characteristics of the sea floor that affect propagation of acoustic energy and the stability of bottom structures useful in surface navigation.

Approach: Conduct investigations to determine: (1) the extent and nature and significance of micro-relief of sea floor (2) the genesis of topographic features (3) the topographic control of sedimentation. Systems for quantitatively assessing the roughness of sea floor microtopography in support of acoustic prediction will be utilized both in photogrammetric analysis of existing photographs and reduction of special continuous line optical profiling data which can be taken either from a submersible or a surface vessel.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0294. SEA FLOOR TOPOGRAPHY
H.W. MENARD, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

The objectives of this research in marine geology are to determine and study the physiography, nature, structure, and origin of the ocean bottom and of the materials composing it. In these studies it is to be made of bathymetric data in conjunction with supplementary information from bottom photographs, cores, dredges, magnetic measurements, and reflection profiling

SUPPORTED BY U.S. National Science Foundation
7. MARINE GEOLOGY

records. In the coming year, emphasis will be placed on investigations into the origin of abyssal hills.

The effectiveness of naval operations which utilize sound propagation is strongly dependent upon the physiography of the ocean bottom and the acoustic properties of the sediments in the areas of operation. The processes which determine the physiography of the sea floor also exert a strong influence on sediment properties including sound reflectivity. The bathymetric information and increased understanding of deep-ocean sedimentary processes which this program is providing should contribute significantly to the operational capabilities of the Navy.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0295. SUBMARINE CANYONS
F.P. SHEPARD, Univ. of California, Scripps Inst. of Oceanography, San Diego - La Jolla, California 92038 (NONR)

The objective is to understand the processes, past and present, forming or modifying subsurface features at moderate depths, especially submarine canyons. Most of the data is bathymetric, supplemented by bottom cores and other collections and direct observations by divers and deep research vehicles. Much of the coming year will be devoted to a study of coastal erosion and progradation based on a large collection of photographs made over many years. In addition, it is planned to bring much unpublished work to completion.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0296. EVOLUTIONARY DEVELOPMENT OF CUSPATE FORELANDS
J.W. PIERCE, Smithsonian Institution, Washington, District of Columbia 20560

To investigate the processes involved in and the natural development of a cuspate foreland and associated continental shelf and coastal plain.

SUPPORTED BY Smithsonian Institution

7.0297. COASTAL MORPHOLOGY
R.J. RUSSELL, Louisiana State University, Coastal Studies Institute, Baton Rouge, Louisiana 70803 (NONR-1575(03))

Beaches and coastal areas are being studied in a wide variety of environmental regions throughout the world as a factual basis for formulating fundamental concepts on the physical processes, distribution and interrelations of coastal phenomena. Emphasis is currently placed on the study of alluvial coasts in the tropics and on the dynamics of shore processes. In addition, an investigation is being made of the availability of significant coastal data and systems of handling these data.

Many operations such as personnel survival and rescue, construction, and supply and communication activities, places heavy demands for detailed and accurate information on the coastal zones of the world. At present, while the store of such information is increasing, it still falls far short of the requirements. Data on the nature and characteristics of coastal features obtained, and the theories being developed, provide a basis for more reliable prediction of conditions in deltaic and tidal-flat areas.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0298. PHYSICAL GEOGRAPHY OF TROPICAL COASTAL LOWLANDS
H.J. VANN, State University of New York, Graduate School, Buffalo, New York 14214 (NONR-4501(00))

Field studies are being made of tropical coastal lowlands to determine their physical characteristics, distribution and relationships of landforms, watersways and vegetation, and rates and causes of change. Study areas are selected which exhibit differences in particular properties of the environment, such as tidal range, size and abundance of incoming sediments, rainfall amounts and periodicity, and flow rates of rivers. The studies seek to define and explain the influences such environmental differences have on the formation of features and on coastal processes. CUSPATE FORELANDS

These detailed studies of tropical coastal zones provide the Navy with data needed in establishing a more accurate basis for predicting environmental conditions likely to be encountered in poorly known tropical areas.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0299. SUBMARINE TOPOGRAPHY
B.C. HEEZEN, Columbia University, Graduate School, Palisades, New York 10964

The broad objectives of this research in marine geology are to study and determine the physiography, nature, structure, and origin of the ocean bottom and the materials composing it. In these studies, use will be made of echo sounding data in conjunction with supplementary data from bottom photographs, cores, dredges, bottom current measurements, and reflection profiling records. The physiographic diagram of the southwest Pacific should be completed in the near future.

Many operations are related to the physiography of the ocean bottom and the properties of the sediments in the areas of operation. The processes which determine the physiography of the sea floor also exert a strong influence on sediment properties. The physiographic diagrams, echo soundings, and the increased understanding of sedimentary processes which this program is providing should contribute significantly to the capabilities of the Navy.

SUPPORTED BY U.S. Dept. of Defense - Navy

7.0300. REDUCTION AND INTERPRETATION OF PHYSIOGRAPHIC DATA ACQUIRED ABOARD LAMONT RESEARCH VESSELS
B.C. HEEZEN, Columbia University, Graduate School, Palisades, New York 10964

The principal aims of the proposed submarine geological research are the delineation of submarine geological features and the explanation of these features and distributions in terms of processes, morphological evolution and history. The starting point of any study of the sea floor is the accumulation and analysis of topographic data. The continuously recorded precision echo-grams are studied directly for a detailed knowledge of local conditions but for regional studies data must be reduced to charts and profiles. Such profiles are then examined for systematic variations and for unique features and preliminary physiographic province maps are compiled.

The submarine topography program at Lamont has been directed towards improving the precision and resolution of echo-sounding systems; developing rapid data processing and reduction techniques; reducing the data and plotting them as profiles as well as on charts; developing digital computer methods of topographic analysis: interpreting the morphologic data in conjunction with sediment data obtained through coring, bottom photography and seismic reflection and refraction measurement as well as in conjunction with gravity and magnetic data; the production of physiographic diagrams of oceanic regions; and the general synthesis of the submarine geology of entire oceans.

SUPPORTED BY U.S. National Science Foundation

7.0301. REGIONAL COASTAL CHANGE
H.G. RICHARDS, Acad. of Nat. Sci. of Phila., Philadelphia, Pennsylvania 19103 (NONR(C)00005-67)

Through the study of marine mollusks and other invertebrates of the coastal zones, interpretations are being made of pre-Recent climatic and ecologic conditions related to coastal deposition and erosion. Shorelines and coastal forms are being dated so that a reliable chronology of coastal events may be constructed and correlated with Pleistocene shoreline developments in various regions of the world.

Improved knowledge of the sequence, timing, and regionality of past coastal changes provides a rational framework against which to judge and interpret the magnitude, duration and causes of present coastal changes. Identification of the past regional geographic conditions that accompanied periods of coastal erosion or deposition should assist in improving long-term predictions of environments.

312
7. EXPERIMENTAL VERIFICATION OF WIDE SWATH OCEAN BOTTOM CONTOURING WITH SPLIT BEAM RECEIVERS

M.A. CHARMIEC, Raytheon Company, Portsmouth, Rhode Island

Experiments attempting to verify the concept of using sonar split beam receivers (BDI's and SSI's) for wide swath ocean bottom contouring were carried out with the cooperation of the U.S.S. Hammerhead, SSN-663, while this attack class submarine transited from Puerto Rico to St. Croix. Outputs for s and bottom half split beams were recorded and concurrent pictures taken of the SSI display. The recorded outputs were later played back through a BDI receiver and further displayed on a 10' CRT and on a Sanborn Strip Chart recorder. Each sweep of the display represented an ocean bottom contour taken in an athwartship direction. Various depression angles were attempted which resulted in athwartship bottom contours of various lengths and orientations with respect to the ship. A map was prepared which stacked a sequence of consecutive profiles representing a three mile wide swath one mile long starting four miles away from the ship and extending to seven miles. Considerable information was contained in each trace, and trace to trace correlation was evident resulting in patterns which may represent bottom hills and valleys. No actual bottom model of this area is available so the validity of the map cannot be checked.

SUPPORTED BY Raytheon Company

7.0303, SEA USE

C.R. ABBEY, Honeywell Incorporated, Seattle, Washington

Project SEA USE is a comprehensive, multi-year scientific and engineering program utilizing Cobb Seamount. Cobb Seamount is 270 miles west of Grays Harbor, Washington, and rises from depths of 9000 feet to within 120 feet of the surface of the Pacific Ocean. Of the many seamounts in the Pacific, Cobb Seamount rises closest to the surface. Because of the location of the pinnacle in the photic zone and its basically undisturbed deep ocean environment, the seamount site is ideally suited for marine science and engineering activities.

The objectives of Project SEA USE are: to characterize the chemical, physical, geological and biological features of the seamount and its environs; to demonstrate that man can occupy, perform meaningful scientific work, and do underwater construction at a seamount far distant from land based support and facilities; and to apply presently available deep-ocean technology in integrated support of a scientific program.

An instrumented mast will be firmly anchored to Cobb Seamount and provide a stable platform for precise measurements of tides, currents, air-sea interactions and weather data. Project SEA USE commenced in fiscal year 1968 and is anticipated to be a continuing multi-year program.

SUPPORTED BY Washington State Government

8. ENGINEERING AND TECHNOLOGY

8A. AQUACULTURE - FISH GUIDING

(technology of Artificial Culturing of Seafood Organisms, FishGuiding, Guiding Over Dams, See Also Chapter 5.)

8.0001, CONSTRUCTION OF A NEW SERIES OF SMALL REPETITION PONDS AND RESEARCH ON THE FACTORS LIMITING FISH PRODUCTION IN IMPOUNDED WATERS

H.S. SWINGLE, Auburn University, Graduate School, Auburn, Alabama 36830

A NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY Rockefeller Foundation

8. ENGINEERING AND TECHNOLOGY

8.0002, SYSTEMS ENGINEERING AND DEVELOPMENT OF COMMERCIALLY VALUABLE MARINE RESOURCES IN THE DELAWARE AREA

F.C. DAIKER, Univ. of Delaware, Graduate School, Newark, Delaware 19711

The University of Delaware will conduct a project to develop methods of systems engineering for growing and marketing shellfish. The project will involve the culture and selective breeding of oysters under controlled conditions, including the biology of spawning, larval growth, survival, growth, size under economical and disease-free conditions, breeding for early maturity and good market qualities. Environmental control will be a key factor. In addition, the influence of climatic water balance on conditions in the estuarine and coastal waters will be investigated, and experiments will be conducted on potential means of opening live shellfish by mechanical, sonic, thermal or electrical methods. A program will be initiated for the training of extension agents to work with industry. Graduate students will participate in all aspects of the project, under the Departments of Biology, Agricultural Engineering, Civil Engineering and Geography, and under the Agriculture Extension Program.

SUPPORTED BY U.S. National Science Foundation

8.0003, THE STATUS AND POTENTIAL OF AQUACULTURE


The project was undertaken to provide insight into such problems as: 'Should the Federal government initiate a substantial effort to develop aquaculture in the near future?'; 'What is the potential for aquaculture in the War on Hunger?'; and, 'What is the potential for selected aquaculture to improve U.S. fisheries?'. A survey of the current status of aquaculture in the world was conducted which included description of the potential species from various geographical areas. These studies described general biological characteristics; methods of cultivation and yields. Part 1 of the study identified general principles; range of yields; position of aquaculture in the food economy of a country; projections for expansion; and constraints to development. Part 2 concerned invertebrate and alg.e culture as practiced in various countries and the last section dealt with the culture of marine fish in Great Britain; pelagic marine fishes; brackish water trout and salmon in fresh, brackish, and salt waters; warmwater pond fish; and Soviet fish.


8.0004, CULTURE OF POMPANO IN BRACKISH WATER PONDS

W.G. PERRY, Rockefeller Wildlife Refuge, Grand Chenier, Louisiana 70643

Pompano, one of Louisiana's valued delicacies was considered for pond culture on Rockefeller Wildlife Refuge. The supply of pompano is limited seasonally and the cost of obtaining them is high. Raising pompano in ponds could result in a year round supply and a new fishery industry for the state.

The objectives of this study are: 1. Determine optimum stocking rates. 2. Determine optimum feeds and feeding rates. 3. Determine possible production per acre, survival, food conversion and susceptibility to diseases. 4. Develop methods of management and harvest to produce maximum yields per acre.

SUPPORTED BY Louisiana State Government

8.0005, CULTURE OF ATLANTIC CROAKER IN BRACKISH WATER PONDS

W.G. PERRY, Rockefeller Wildlife Refuge, Grand Chenier, Louisiana 70643

The objectives of this study are as follows: 1. To determine production per acre, food conversion, survival and general desirability as a food fish. 2. To develop methods of management for production of maximum yields in brackish water ponds.

313
8. ENGINEERING AND TECHNOLOGY

The young croakers were obtained in a natural canal, near the Gulf of Mexico and placed in six 0.1 acre ponds at known stocking rates. The ponds will be harvested in late October. Several ponds will be observed for another year in order to determine effects of winter temperatures and to gain information on second year growth.

SUPPORTED BY Louisiana State Government

8.0006, CULTURE OF BLUE, CHANNEL, AND WHITE CATFISH IN BRACKISH WATER PONDS
W.G. PERRY, Rockefeller Wildlife Refuge, Grand Chenier, Louisiana 70642

The rapid increase in catfish farms in Louisiana is a good indication that the demand for this freshwater fish is growing. Several large land owners had approached us asking about the possibilities of raising catfish in coastal Louisiana. Until recently, we could advise them that the freshwater fish could not be grown in waters with salinities of over 1.5 ppt. This, as expected, cut the available acres down considerably.

Fish were stocked in 0.1 acre ponds to determine growth, survival, food conversion and to determine if the freshwater fish could be grown in brackish waters.

The project was initiated in 1967 and will end in 1969. A preliminary report was given at the 22nd Annual Meeting of the Southeastern Association of Game and Fish Commissioners, October 1968, Baltimore, Maryland.

SUPPORTED BY Louisiana State Government

8.0007, DEVELOPMENT OF TECHNIQUES FOR THE AQUACULTURE OF POMPANO
R.E. HILLMAN, William F. Clapp Laboratories, Duxbury, Massachusetts 02332

Pompano fry are collected from the surf in Daytona Beach, Florida and transported to the holding ponds on the grounds of the Florida Marine Research Laboratory of Battelle Memorial Institute in Daytona Beach. Fish are then cultured through the adult stage. It is the purpose of the project for developing the optimum conditions for artificial rearing of pompano and to identify the problems inherent in such a task. The effective salinity, temperature, feeding rate, crowded conditions, etc. on the fish are being studied; in addition, studies of the pathology of fish under these unusual parameters are being carried out, as are methods for laboratory spawning of the pompano.

SUPPORTED BY Battelle Memorial Institute

8.0008, PURCHASE OF MATERIALS FOR & CONSTRUCTION OF FLOATS, RACKS, BAGS, AND TRAYS FOR THE SUSPENSION OF VARIOUS TYPES OF CULTCH
W.S. MILLER, State Conservation Department, Oakdale - Long Island, New York

Purchase necessary materials and construct floats and/or racks to suspend various types of cultch in bulk or as individually strung shell, plastics, ceramic or other fabricated materials which are demonstrated to suspend adult oysters as brood stock.

The work involved in this phase is to be begun immediately upon approval and will be completed prior to the initial time of spawning.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish. New York State Government

8.0009, THE PURCHASE AND INTRODUCTION OF CULTCH MATERIALS
W.S. MILLER, State Div. of Fish & Game, Oakdale - Long Island, New York 11769

Purchase and introduce large quantities of natural shell cultch and experimental materials to rafts and on hard bottom areas of pond at optimum time, as determined by continual biological monitoring of spawning and larval development.

The handling and placement of cultch materials in Oyster Pond will involve the participation of: William S. Miller, Senior Aquatic Biologist, Pieter Van Volkenburgh, Conservation Biologist.

Part 3 of 4.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish. New York State Government

8.0010, METHODS OF REARING EGGS AND LARVAE TO JUVENILE STAGES
C.R. ARNOLD, U.S. Dept. of Interior, Marine Game Fish Research Lab., Narragansett, Rhode Island 02882

This initial phase of a longer-term study to evaluate agricultural potential of selected game fish and associated organisms includes design and construction of a closed circulating sea water system with appropriate components for filtering waste metabolites and controlling bacteria. The system will be designed to allow determinations of water conditions including flow rate, turbidity, oxygen and salinity, for hatching eggs and rearing larvae of marine fishes to the juvenile stage. Optimal conditions will be evaluated on the basis of survival and development of eggs and larvae.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

8.0011, CHARTING OF SUBTIDAL OYSTER BEDS AND EXPERIMENTAL TRANSPLANTING OF SEED OYSTERS FROM POLLUTED SEED OYSTER BEDS
G.R. LUNZ, State Div. of Comm. Fisheries, Charleston, South Carolina 29401

The South Carolina oyster industry is based almost entirely on intertidal oysters, yet subtidal beds do exist. Two such beds are known to produce more seed per unit of area than the famous James River, Virginia, seed beds. In the past, attempts to expand the growth of oysters subtidally have not been entirely successful. However, by locating areas with comparable environmental conditions to existing deep water beds, and by transplanting deep water seed to them, an attempt will be made to demonstrate a way to expand the industry.

Exploration for deep water growing sites in the more than 3200 miles of creeks and rivers within the State will begin as soon as the project can be activated. Several hundred bushels of seed oysters from the Wando and the Santee Rivers (existing deep water beds) will be moved to the new locations. Survival, growth, and quality of these transplanted oysters will be studied by regular sampling.

Continuing the program next fiscal year, larger amounts of oysters will be moved to test the possibility of introducing a system of oyster culture not now being practiced.

A two man team, yet to be employed, will conduct the survey. The entire project will be under the supervision of Bears Bluff Laboratories.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish. South Carolina State Government

8.0012, OYSTER SEED PROPAGATION STUDY
C.S. SAYCE, State Dept. of Fisheries, Olympia, Washington

The objective of this phase is the development of an adequate supply of naturally-caught local Pacific oyster seed for industry. This is needed to replace dwindling supplies of imported oyster seed which have been necessary to maintain the Washington Pacific oyster industry at its present level. Field samples of plankton and water samples will be taken during July, August, and the first half of September to determine concentrations of and distributions of Pacific oyster larvae during their pelagic existence. Plankton observations will include the vertical distribution as well as horizontal distribution of oyster larvae. Time, distribution and intensity of oyster setting will be recorded by seven clutching stations located throughout the bay. Areas which appear to have had the best natural spatfalls in past seasons will be investigated to determine ways of utilizing their potential in producing more oyster seed. A study of antifouling chemicals to prevent settling of barnacles, Bryozoa, and Crepidula larvae on
8.0013. FISH TRANSPORTATION  
W. J. EBEL, U.S. Dept. of Interior, Biological Laboratory, Seattle, Washington 98102

One of the important techniques of fisheries management is the transportation of living fishes, sometimes for long distances. The solution of fish-passage problems in Columbia River Basin may require that anadromous fish be carried around dams or other obstructions, either as downstream migrant young or as adults migrating upstream to spawn. In either case, they are subjected to various hazards which may cause serious mortality, immediate or delayed. The purpose of this investigation will be to develop safe and efficient short- and long-range methods of transporting wild anadromous fish and to improve on contemporary methods of transportation.

Current efforts are concentrated on developing a system to detect magnetically tagged adult salmon and to separate them from untagged fish in a fishway. These tags, which are placed in porting wild anadromous fish and to improve on contemporary methods of transportation. The study will be conducted in Willapa Bay, Pacific County, Washington by the Willapa Shellfish Laboratory staff. Part 2 of 2.


8.0014. PROTECTION OF FINGERLING SALMON IN TURBINES  
C. W. LONG, U.S. Dept. of Interior, Biological Laboratory, Seattle, Washington 98102

This project is directed toward the assessment of losses of young salmon during passage through Kaplan turbines and the development of methods to reduce these losses. The passage of juvenile salmon at dams on the Columbia-Snake river watershed is a problem of attrition. When all low-head dams are completed, some stocks of fish may have to pass as many as 10 projects to reach the sea. Problems of passage will be further compounded in the near future when many more turbines will be installed and fish now enjoying relatively safe passage through spillways will be forced to use the turbines as their only means of egress to downstream areas.

Equipment and techniques are being used to investigate the causes of loss of fish in prototype facilities at Ice Harbor Dam and elsewhere in the Columbia Basin. Fish protection methods fall into three general categories: (1) Operating turbines to minimize mortality, (2) Eliminating lethal agents in turbines, and (3) Bypassing fish around turbines.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

8.0015. FISH GUIDING  
J. R. PUGH, U.S. Dept. of Interior, Biological Laboratory, Seattle, Washington 98109

Fish-guiding techniques examined by this project have included the use of electrical fields, louvers in combination with electricity, and large panel nets in conjunction with self-cleaning traps. Also studied was the distribution of fish in the natural environment as related to application of fish-guiding devices. Reports of these investigations are in final stages as project nears completion.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

8.0016. FISHWAY RESEARCH (BONNEVILLE LABORATORY)  
C. R. WEAVER, U.S. Dept. of Interior, Biological Laboratory, Seattle, Washington 98102

These studies are designed to provide information applicable to the improved efficiency of fish facilities at Corps of Engineers projects in the Columbia Basin. The investigations are carried out in the Fisheries-Engineering Research Laboratory at Bonneville Dam. Financing is by the Corps and direction of research is under supervision of the Corps Technical Advisory Committee. A large laboratory area permits construction of full-scale fish facilities for study of the performance and behavior of adult migrating salmon that can be diverted from an adjoining fishway at the dam. Current and proposed studies include examination of the responses of salmon to various jet velocities, submerged orifice flows, temperature conditions, and barrier facilities. Techniques for TV monitoring of fish passage are being explored and developed for use in remote control counting of fish at dams. Special aspects of the behavior of juvenile salmon in turbine intakes are also being examined.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

8.0017. DIVING MEDICINE  

Objective: Provide biomedical data in support of manned underwater operations in which personnel are exposed to increased pressures. Equipment now available and under development cannot be used with safety and efficiency at depth. Medical problems are presented by: increased pressures of respired gases, producing abnormal pressures and quantities of gases dissolved in the body; and hazards to personnel presented by the wet, cold, dark environment, and toxic, infectious, or predatory marine life.

Approach: Phase I: Data collection and analysis of factors limiting depth, time, and performance of personnel immersed in water and breathing gas under ambient pressure. Factors to be examined are: physical and physiological characteristics of breathing mixtures; nutrition, metabolism, energy requirements and thermal balance; comparisons of the pharmacological and toxicological actions of chemicals in the altered environment; studies of the interrelation of man, microorganisms, and marine life during prolonged underwater living. Phase II: Definition of the most limiting factor or factors. Phase III: Removal of limitations through modification of the environment or by protecting the individual. Effort is primarily split between the Naval Medical Research Institute, Bethesda, Md., and the Submarine Medical Center, New London, Conn.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0018. SUBMARINE MEDICINE  
J. P. POLLARD, U.S. Navy, Bureau of Medicine & Surgery, Washington, District of Columbia 20390

Objective: Support advanced underwater systems through the application of the results of biomedical research. Present life support systems, while workable, are short of the ideal for health, performance and safety of the crew. Further problems are anticipated with the entry into the fleet of small modules for prolonged habitation. The physiological, microbiological, pharmacological, and human performance standards will indicate the need for all indicate the need for and direction of medical and/or engineering solutions to biomedical problems.

Approach: Achievement of this objective involves the following phases: Simulation of the artificial environment under controlled conditions in the laboratory; study of laboratory animals and later of humans in the controlled environment; observation of the medical or engineering solutions to problems defined; biomedical monitoring of submarine personnel and operations to determine the success of solutions achieved, and to provide early detection of biomedical problems. Effort primarily at the Submarine Medical Center, New London, Conn.

SUPPORTED BY U.S. Dept. of Defense - Navy

315
8. ENGINEERING AND TECHNOLOGY

8.0019, SWIMMER HIGH DEFINITION SONAR

Objective: Develop acoustic equipment to enhance a swimmer's underwater vision capability. In turbid waters and during night operations viability is often limited to several inches and a swimmer is effectively blind if he must depend on his unaided vision. This equipment will sufficiently enhance a swimmer's underwater perceptive ability to facilitate underwater construction, maintenance and repairs, and search of ship hulls for foreign objects.

Approach: The approach through industry and Navy labs is divided into, four phases: preliminary design, design development, field tests, and reporting. The preliminary design phase will delve into the areas of signal processing, miniaturization, and acoustical beam forming in order to obtain information on state-of-the-art.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0020, ONE ATMOSPHERE DIVERS SUIT

Objective: Develop a hard, self-contained diving suit that will maintain the diver at atmospheric pressure (14.7 PSIA) within the suit. The suit will be operational to 600 feet (continental shelf) and will be capable of extended working period up to 6 hours. At the end of this 6 hour period the diver can be brought directly to the surface with no decompression required. Using present diving equipment, including both hard hat gear and the various self-contained equipment, working dives below 200 feet impose severe decompression penalties on the diver. As an example, a surface supplied hard hat diver working for 2 hours at 250 feet, is required to spend approximately 15 hours additional time in the water for the required decompression to bring him to the surface. For the diver using self-contained equipment and saturation diving techniques, this same decompression time could be spent in a dry compression chamber, but the personnel and equipment required to perform this type diving is extensive and quite expensive. An atmospheric suit of this type will eliminate the decompression problems and physiological penalties associated with all of the present diving systems. This development effort will advance the state-of-the-art in deep diving technology and will greatly extend the Navy's deep diving capabilities. To meet fleet requirements the suit will conform to the U S Navy diving manual, and be compatible with existing support equipment (diving tender, etc.) wherever possible.

Approach: The program will be executed in several phases with the majority of the effort contracted to private industry. The first phase of the program will involve a joint and seal feasibility study. The second phase will involve design, fabrication, and test of a complete arm assembly to 600 feet. If the results of the first two phases are successful, one contract for the development of the complete suit, tested to 600 feet, will be recommended, since this approach will be the most expedient and economical for the Navy.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0021, ADVANCED HEAT SOURCES AND THERMAL INSULATION MATERIALS FOR SWIMMER HEATING
F.J. ROMANO, U.S. Navy, Washington, District of Columbia

Objective: Investigate and develop advanced heat sources and thermal insulation materials for cold water protection of swimmers. Present heating techniques are based on electric battery power sources, and are therefore severely limited by the size and weight of the batteries required. Due to the heat transfer characteristics of present suit materials (1000 watts of supplementary power are required to maintain a swimmer in 29 F water. For a typical 6-hour mission involving a swimmer, 120 pounds of batteries would be required. From the size and weight of the batteries involved, it is safe to assume that the average swimmer could not handle or swim with such a self-contained package. The present effort will be directed toward investigating and developing new and improved insulation materials, and demonstrating feasibility of advanced heat sources for underwater suit applications.

Approach. Investigation will be conducted to determine state-of-the-art and capabilities of heat sources and thermal insulation materials. Basic heat transfer data will be developed for many materials, since very little data is available for these materials at depth. As a result of the in-house study the materials and heat sources deemed promising will be further investigated developed through industry based on advanced insulators, tradeoffs will be made between the insulators and heat source requirements. As a part of this basic work, heat requirements for various water depths and temperatures will be established.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0022, DEEP DIVING DECOMPRESSION EQUIPMENT AND TECHNIQUES

Objective: Develop the equipment and techniques to safely and efficiently decompress divers, who are in either a saturated or unsaturated condition, from depths as great as 1000 feet. Diving tables have been developed from depths of 380 feet when using hard-hat equipment and an 84/16 percent ratio of helium/oxygen breathing gas. Saturation diving schedules to depths of 600 feet are being developed under engineering development system S46-19, deep submergence man-in-the-sea. The necessity of providing the capability to dive to even greater depths is stated and has been proclaimed by the President's Council on Marine Sciences as part of an effort to make more effective use of the sea: Equipment to deliver the diver to these greater depths, sustain his life, provide him with the capability to communicate, navigate, locate objects and propel him about at these depths are being developed under separate task areas. This task area objective is concerned with safety and efficiently returning him to surface atmospheric conditions upon completion of his job.

Approach: The achievement of this objective involves several distinct areas of work in industry and at Navy labs: development of decompression schedules (depth vs. time); development of the pressure complexes and control equipment which will provide the required atmospheres; development of recompression schedules for treatment of decompression sickness; and the development of diver performance evaluators which can be used to determine precise adjustments required in the general schedules to fit different categories of divers physical makeup.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0023, SUBMERGED OPERATIONS COMMUNICATIONS (SUBCOM)

Objective: To provide the swimmer with reliable, intelligible underwater communication. The equipment will satisfy present underwater communication demands, in particular: diver to diver, vehicle intercom, diver to surface craft or any related communication problem. The equipment must operate to depths of at least 1000 feet thus necessitating use of speech conversion equipment to eliminate effects due to high pressure, helium enriched breathing environments.

Approach: Achievement of the objective through industry and Navy labs involves: (a) Develop basic diver to diver communication equipment to satisfy present requirements, serve as an interim system, and provide a testing platform for future development. (b) Utilize basic unit for development of high power vehi- cle and submarine mounted units and use in helium speech conversion. (c) Develop systems and equipment which can be used to determine precise adjustments required in the general schedules to fit different categories of divers physical makeup.

SUPPORTED BY U.S. Dept. of Defense - Navy

316
8.0024, THERMALLY SUSTAINED PRESSURE OSCILLATIONS IN LIQUID HELIUM APPARATUS
R.J. HOWSON, Mass. Inst. of Technology, School of Engineering, Cambridge, Massachusetts 02139

The phenomenon of thermally sustained pressure oscillations which frequently occur over liquid helium and other liquefied gases is modeled and analyzed. The model is a distributed system with a linear temperature gradient. The interaction between the vapor motion and heat transfer is analyzed to derive an expression for the time history of the pressure oscillations.

Cyclic interpretation of the pressure history results in a relationship between four parameters, which control the behavior of the oscillations. The four parameters contain information on amplitude of motion, characteristic lengths of the tube, thermal conductivity, specific heat ratio and viscosity of the gas undergoing the oscillations and boundary layers.

The effect of changes within the parameters on the theoretical behavior of the oscillating system shows good agreement with behavior of oscillations in previous experimental apparatus when similar changes are made.

SUPPORTED BY Massachusetts Institute of Technology

8.0025, THE THERMODYNAMIC PROPERTIES OF NITROGEN-OXYGEN MIXTURES
R.L. STEELE, Mass. Inst. of Technology, School of Engineering, Cambridge, Massachusetts 02139

This thesis includes a survey of the literature through 1967 on the methods of determination of the thermodynamic properties of nitrogen-oxygen mixtures in the vapor-liquid region. The virial expansion, empirical equations of state, and theoretical constants, excess functions, latent heats, and graphical methods are considered.

The methods just enumerated are evaluated for their simplicity, feasibility, and accuracy. On the basis of the state of the art and the availability of appropriate data, the thermodynamic diagrams are constructed for 1, 5, 10 and 20 atmospheres of pressure in the two phase region. Diagram coordinates are enthalpy-composition and entropy-composition. The diagrams at atmospheric pressure show good correlation with known data, while those at higher pressures are best estimates using excess functions and idealizing assumptions.

SUPPORTED BY Massachusetts Institute of Technology

8.0026, THE PURCHASE AND INTRODUCTION OF BROOD STOCK
W.S. MILLER, State Div. of Fish & Game, Oakdale - Long Island, New York 11769

Purchase and introduce substantial numbers of adult oysters on rafts and hard bottom prior to attaining ripeness as a spawning stock. Oysters will be used from a shoal, warm water environment earlier in the season and from a deep, cold water environment later in the season when the initial group has completed spawning.

This phase will be accomplished in accordance with the timing of natural and/or conditioned spawning of the oyster stocks involved and the conditions present in Oyster Pond.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

8.0027, LIFE SUPPORT RESEARCH
H.R. SCHEINER, Ocean Systems Incorporated, Tonawanda, New York 14150

Objectives of this research are concerned with the extension of human capabilities underwater; they are proprietary to Ocean Systems, Inc.

SUPPORTED BY Ocean Systems Incorporated
8. ENGINEERING AND TECHNOLOGY

Following this will be development of a conceptual design for three shipping systems based on the tug-barge concept - a bulk carrier, a break-bulk carrier, and a unitized cargo carrier, and economic analysis of the opportunities that may exist for the American Merchant Marine in 'tug-barge' shipping systems.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8.0031. MARINE TRANSPORTATION ANALYSIS MODEL
P.B. MENTZ, U.S. Dept. of Commerce, Maritime Administration, Washington, District of Columbia 20235

The Marine Transportation Analysis Model is designed to examine the economic characteristics of various ship systems for a specified trade route. The model has been programmed in FORTRAN IV and is being run on a Honeywell 200 computer. Marine systems able to be accommodated include those with various cargo handling capabilities such as break-bulk ships, container ships, and barge carrying ships.

The trade route may contain up to 10 domestic and 30 foreign ports with service among any number of feeder loops in conjunction with the main ship route. Cargo flow data is accepted as input to the model in a portpair format. An operational analysis is carried out within the program for each subsystem so as to provide appropriate values for the parameters used in the simplified cost structure.

The results of the routine are in the form of annual net cash flow (after amortization) to the ship operator, and annual government subsidy cost (construction-and-operating-differential). Both are computed for 10 variations of ship sailing frequency; each of these variations considering 5 values of ship speed. The output can be used to measure relative marine transportation system performance.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8.0032. ANALYSIS OF INLAND CARGO CONSOLIDATION CENTERS

Purpose: To develop a technique for determining the functions, locations, and sizes of optimum inland consolidation centers designed for inland cargo handling and/or receiving regions.

Description: A mathematical model and an algorithm were developed and programmed for a computer solution to the problem of determining optimum location of centers for the consolidation of less-than-carload lots of break-bulk cargo into container loads for export, and for the handling and unloading of import containers for domestic cargo distribution. The model calculates the savings to the shipping community accruing by using consolidation centers and transporting cargo over land in full containers, rather than transporting the more costly less-than-carload lots.

Data from the Delaware River Port Authority on exporters and importers in Illinois, Indiana, Ohio, Michigan, and Wisconsin were used to exercise the computerized model. In addition, the data was geographically plotted manually by amount exported per day from all exporting cities in these states to provide guidance for computer runs, and insight into the data not readily attainable from formalized computer techniques.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8.0033. AN OPTIMUM LOADING SEQUENCE FOR CONTAINERSHIPS
A.E. IOANNIDES, Mass. Inst. of Technology, School of Engineering, Cambridge, Massachusetts 02139

A model is developed for the optimum loading sequence of containerized cargo of varying densities and destinations. The loading time and cost are taken as the measures of effectiveness and the loading process has to satisfy certain constraints resulting from stability and strength considerations. Table 3, 4, 5, 6, 7, and 8 show the computer programs used and some sample results.

SUPPORTED BY Massachusetts Institute of Technology

8.0034. OPERATION OF BARGE TRAINS IN A SEAWAY
UNKNOWN, Stevens Institute of Technol, Graduate School, Hoboken, New Jersey 07030

Purpose: To investigate the relative resistance and controllability performance of a single line pushed barge trains versus pull tow barges, and the magnitude of connecting forces between pushed barges.

Description: This research is an integral part of an overall barge study being conducted both at M.I.T. and Stevens Institute Preliminary resistance and controllability tests have been conducted for the first phase of this project, representing both push and pull barge fleets of one to three barges with towboat in single line formation; the dimensions of the barges being 195 ft. draft and the towboat 112.5 ft.

A preliminary analytical study was carried out which indicated that stern skegs are a necessity for pull tows to achieve controllability. Investigation of variable angle skegs is under way.

In the second phase main emphasis will be on the measurement of barge connecting forces and the effect of changing the barge beam.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8.0035. THE FEASIBILITY OF REDUCED CARGO GEAR INSTALLATION ONBOARD BREAK-BULK CARGO SHIPS
UNKNOWN, Control Systems Research Inc., Arlington, Virginia

Using a representative voyage as a test case, this investigation found it feasible to use mobile, self-powered cranes, aboard break bulk cargo liners to replace at least part of the conventional cargo handling gear generally found onboard.

Ninety-three percent of all cargo drafts were found to be less than 2000 lbs. and 97% of all drafts were less than 3000 lbs. Hence, two or three rubber-tired 12.5 ton (commercial rating) hydraulic cranes could be utilized onboard a typical Marion type ship with a resultant reduced capital investment in conventional cargo gear of $155,000 to $290,000 per ship. Annual savings could range from $13,000 to $28,000, including both capital and operating expenses.

Other fringe benefits result from the clear deck space resulting from elimination of kingposts, which space can be utilized for carrying additional containers on deck; smaller ship service generator capacity; simpler hull construction; and the possibility of using the mobile cranes on the shore or pier, if needed. Such an arrangement also permits changes in cargo operations or future alteration for 'all container' cargo at a smaller loss to the operator in invested cargo gear.


SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8D. COASTAL ENGINEERING

(see Also Sub-chapters E, M, and N of This Chapter.)

8.0036. CRITERIA FOR THE DESIGN OF SMALL CRAFT HARBORS
R.Y. HUDSON, Calif. Inst. of Technology, Graduate School, Pasadena, California 91109

The objective of this study is to develop design criteria for small-craft harbors by theoretical and experimental research on: (a) response of small vessels to floating docks and piers, to the action of short-period wind waves and seiches; (b) response characteristics of various harbor shapes and dimensions relative to wave period and wave absorbing characteristics of the perimeter walls to waves entering the harbor; (c) the design of protective works (offshore and inshore breakwaters, overlapping jetties, wave resonators, wave traps, etc.) to reduce wave energy entering the harbor, and develop criteria for selection of harbor-entrance plans for waves at start of storm.
8. ENGINEERING AND TECHNOLOGY

By contract with California Institute of Technology, a report, 'Wave-Induced Oscillations of Small Moored Vessels,' by F. Raichlen was completed. This report is concerned with the response of small vessels moored to fixed docks.

SUPPORTED BY U.S. Dept. of Defense - Army

8.0037, DESIGN OF RUBBLE WAVE-ABSORBER
The theoretical aspects of wave absorbers (natural sand beaches, wave traps, and resonators, and rubble-mound absorbers) were reviewed and the findings related to actual situations. A special theoretical investigation was conducted to determine the feasibility of using rubble mount or other construction materials for absorbing wave energy entering harbors. The scale effects related to wave absorbers were studied and solutions proposed to correct scale effects. Tests will be conducted in future years to develop a more accurate method of measuring the short period wave reflection — absorption characteristics of rubble mounds. Tests of rubble-mound wave absorbers will also be conducted to determine the ratio of reflected to incident wave heights as a function of structure slope, porosity of cover layer, thickness of cover layer, weight and shape of armor units, dimensions of waves and depth of water. Studies will be conducted to: (a) investigate the energy transmitted through and over rubble-mound structures to develop design criteria for protection of harbor areas; (b) determine the wave-absorbing characteristics of sand beaches, wave traps, and resonators.

SUPPORTED BY U.S. Dept. of Defense - Army

8.0038, ANALYSIS OF AN ATTEMPT TO CONTROL BEACH EROSION AT SCIENTISTS CLIFFS, MARYLAND
L.P. SCHULTZ, Smithsonian Institution, Washington, District of Columbia 20560
Our analysis shows that the height of sand accumulated next to a groin is proportional to the height of the groin; the width of the beach is proportional to the length of the groin out to the non- spill-over height during storms.

SUPPORTED BY Smithsonian Institution

8.0039, COASTAL WORKS EVALUATION FOR CHECKING, IMPROVING AND DEVELOPING DESIGN RELATIONSHIPS AND CONSTRUCTION TECHNIQUE
Data are obtained and studied on the behavior of shore improvement projects during and after their construction. The data are obtained in cooperation with appropriate field offices insofar as practicable. Protective works studied include beach fills which serve to rehabilitate and/or nourish shore segments, as well as gravity or cantilever type shore structures of both monolithic and rubble construction. Projects currently being followed also involve sand bypassing at improved inlets, permeable and impermeable groins, jetties and breakwaters, and reconstruction of protective sand dunes. Utilizing the collected data, applicable design relationships, both functional and structural, are evaluated. Study objectives are Improvement of existing design relationships and construction techniques, or development of new ones.

SUPPORTED BY U.S. Dept. of Defense - Army

8.0040, METHODS OF BYPASSING SAND PAST INLETS
Data are collected and compiled at all known places where by works of man, sand is passed across natural or improved inlets of the shore. Inlets such works presently include: (a) offshore breakwater and lee sand-trap to be periodically emptied by floating hydraulic dredge plant; (b) fixed pumping plant and pipe line system at jetted inlet to provide continuous bypassing; (c) periodic dredging with floating hydraulic dredge plant in overly-widened channel in a jetted inlet; (d) weir-type jetty and retention basin to be periodically emptied by floating hydraulic dredge plant; and (e) mechanical removal and transport by truck haul from updrift accumulation to downdrift eroded area at a fixed littoral barrier. Quantitative and qualitative data, both physical and economic, are to be compiled and analyzed with the view toward development of relationships which will serve as guide lines or criteria in the design of sand transfer systems.

SUPPORTED BY U.S. Dept. of Defense - Army

8.0041, DEVELOPMENT OF CRITERIA FOR ARTIFICIAL BEACHES
The study is to develop beach fill design criteria, and to establish a systematic procedure for the investigation of the characteristics of littoral material. Program involves 2 steps: (1) Develop design criteria for beach fill through application of statistical principles to special test data; (2) Reexamination studies of completed artificial fill projects to obtain data for comparative evaluation of developed design criteria. Data which have been derived under the functional study of fill projects are utilized in step 2 procedures of developing the criteria for artificial beaches. Studies through contracts with educational institutions are being carried out regarding the use of statistical principles by repetitive collection of field data at one location. High speed computers are utilized in the analysis of the field data.

SUPPORTED BY U.S. Dept. of Defense - Army

8.0042, RUBBLE-MOUND Prototype STUDIES
Prototype rubble-mound structures, including structures with pre-cast armor units, are subjected to programmed surveillance for damage or movement of armor units by wave action in order to correlate such data as are obtained with that previously obtained from hydraulic model and theoretical studies. Armor units at selected positions in the structure are permanently tagged, positioned by survey measurement, and subsequently checked semi-annually, or after each major storm, to determine the degree of movement of the units. Wave gaging instrumentation is installed to provide continuous sampling of incident wave action, and survey measurements of adjacent beach and bottom are also taken periodically. Data are currently being measured at three locations on the Pacific Coast which include a rubble-stone jetty; a jetty with pre-cast quadrupod armor units, and a shore-connected breakwater constructed with a rubble-stone stem and monolithic concrete head.

SUPPORTED BY U.S. Dept. of Defense - Army

8.0043, LOCALIZED SCOUR AROUND PILING SUBJECT TO FIRST-ORDER STOKIAN WAVES
M.R. CARSTENS, Georgia Inst. of Technology, School of Engineering, Atlanta, Georgia 30312
Scour around a single cylindrical vertical pile subjected to first-order Stokian waves has been studied experimentally on an oscillatory-flow water tunnel. The water moves over the bed with a period of about 3.5 seconds. From an initial flat-bed condition scour- hole depth as a function of time has been observed as a function of time. Two bed materials were 0.297 mm glass beads and 0.185 mm Ottawa sand. File diameters were as follows: 0.375 in., 0.751 in., 0.875 in., 1.244 in., 1.732 in., and 1.99 in. The majority of the runs were performed with a water-motion amplitude large enough to maintain a flat but moving bed during the run. A few runs with smallest pile were made with a water-motion amplitude small enough to maintain a flat immobile bed (except around the pile). Results have been analyzed by mass-transport concepts: transporting rate equations for inflow and outflow. Similarity relationships have been sought. Final report for Contract No. DACW72-67-C-00017 (Georgia Institute of Technology) will be issued in November 1968.

SUPPORTED BY U.S. Dept. of Defense - Army

319
8. ENGINEERING AND TECHNOLOGY

8.0044, WAVE FORCES ON BREAKWATERS
V.T. Chow, Univ. of Illinois, School of Engineering, Urbana, Illinois

Shock pressures created by wave water breaking against vertical barriers are examined. These waves were studied in a laboratory using small-scale oscillatory waves in a flume fitted with a beach slope and test wall. The variation of pressure with both time and position on the wall was measured for several wave profiles with heights ranging from 1.11 inches to 3.29 inches with periods ranging from 1.38 seconds to 1.94 seconds, and two beach slopes, 1/25 and 1/10. The magnitude of the shock pressure was observed for each of the wave conditions tested. From analysis of the data, the shock pressure was found to decrease with both wave height and wave length and to be proportional to the cube root of the wave energy. With the cooperation of U.S. Army Corps of Engineers, the experimental work was conducted at the U.S. Army Waterways Experiment Station.

SUPPORTED BY University of Illinois
U.S. Dept. of Defense - Army

8.0045, STABILITY OF RUBBLE-MOUND BREAKWATERS
R.Y. Hudson, U.S. Army, Waterways Experiment Sta., Vicksburg, Mississippi

The objective of this project is to develop formulas and design criteria from which the action of waves on rubble-mound breakwaters can be determined with sufficient accuracy to provide economical and safe designs of full-scale structures.

SUPPORTED BY U.S. Dept. of Defense - Army

8.0046, HARBOR DESIGN STUDIES
R.Y. Hudson, U.S. Army, Waterways Experiment Sta., Vicksburg, Mississippi

The objective of this project is to determine criteria for designing harbors and harbor structures to obtain optimum wave protection for medium and large-size vessels. This will be accomplished by determining the optimum arrangement of breakwaters and navigation entrances to harbors to obtain the maximum wave reduction in the harbor, and to determine the effect of wave-front curvature on the amount of distribution of wave energy that enters a harbor through navigation openings of various dimensions and orientation with respect to the direction of wave approach. Additional tests will be run to determine effects of the so-called Mach stem phenomena on the optimum orientation of breakwaters and vertical-wall pier; the relationship between the rate of wave attenuation in channels through shallow reef areas, and channel length, width, depth, and side slope; the effect of extending fill seaward along entrances of channels, through shallow reef areas, on wave pattern at the entrance of the channel and wave propagation through the channel; the relationship between harbor basin geometry and harbor response to wave energy reaching the basin via the entrance channel.

SUPPORTED BY U.S. Dept. of Defense - Army

8.0047, WAVE DAMPING SYSTEMS
H.F. Miller, Uniroyal Incorporated, Wayne, New Jersey

Using corporate funds, Uniroyal, Inc. has been studying wave damping systems over the past five or six years. These portable mechanical devices will attenuate wave height when moored as breakwaters. Models have been constructed and evaluated at the laboratory scale. Prototypes of the more promising systems have been constructed and evaluated in small-scale field trials. New concepts are being tested as the project continues.

SUPPORTED BY Uniroyal Incorporated

8E. GENERAL OCEAN ENGINEERING

8.0048, DEVELOPMENT OF AN ADVANCED MISSILE IMPACT LOCATING SYSTEM FOR THE EASTERN TEST RANGE
C.D. Leedham, General Motors Corporation, Goleta, California 93017

Design, fabricate and install an improved, advanced missile impact locating system for use down range from Cape Kennedy in the Eastern Test Range for evaluation of accuracy of certain ballistic missiles. This system will use underwater acoustics, telemetry and advanced signal processing techniques ashore.

SUPPORTED BY U.S. Dept. of Defense - Air Force

8.0049, DEEP OCEAN TECHNOLOGY
R.L. Knight, North Amer. Rockwell Corp., Long Beach, California 90803

The Deep Ocean Technology Program is a long-term series of interrelated experimental hardware development projects whose objectives are to generate, expand, and exploit deep ocean technology to fulfill future military and non-military requirements. This study was undertaken to develop capability in all areas associated with the selection of a site for a manned bottom installation (MBI). In conduct of the study, the methodology associated with site selection was developed. The methodology defined the study approach and the requirements and operational considerations associated with the program objectives. The study was limited to sites on the continental shelf with a selected environment and over the operations. Site characteristics have been identified, categorized (chemical, physical, biological, geological) and tabulated. The parameters which must be measured to define the site characteristics have been established and the associated instrumentation to conduct the measurements have been identified. The instrumentation was limited to state-of-the-art or near term (under development). Technological voids in survey equipment have been noted. Correlation of the data have been provided by the establishment of a generalized site survey sequence.

SUPPORTED BY North American Rockwell Corporation

8.0050, OCEAN ENGINEERING RESEARCH
J. Gilheany, Catholic University of America, Graduate School, Washington, District of Columbia 20017 (NONR-00014-67-A-0377-0003)

Research is underway involving six faculty project directors and 21 graduate students in the areas of (1) Submersibles and Ocean Cable Dynamics, (2) Metals and Alloy Marine Corrosion Studies, (3) Vibrational properties of transducers, (4) Optical homodyning and optical instrumentation, and (5) Wall effects on fluid flow. Physical structure of sea water.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0051, DEEP SUBMERSION SYSTEMS
G. Segel, Westinghouse Electric Corp., Annapolis, Maryland 21204

During the past year, research continued in areas of technology for 20,000 foot operating depth for application to advanced manned submersible survey vehicles applicable to OLSOR (object location, small object recovery) systems. This program involves the selection of materials and materials utilization for personal safety, flotation and vehicle structures; recovery concepts; environmental analysis; emergency buoyancy systems and power conversion for propulsion.

SUPPORTED BY Westinghouse Electric Corporation

8.0052, OCEAN ENGINEERING STUDIES
H. Beck, Hudson Laboratories Inc., Dobbs Ferry, New York (NONR)
8. ENGINEERING AND TECHNOLOGY

This task provides a unified study of engineering problems (such as feasibility, optimum instrumentation and techniques) encountered in the various programs of the laboratory and the Navy research community. Examples are data processing techniques, data acquisition and transmission systems and displays. It also includes continuing work on development and handling of sound sources and receiver packages; underwater instruments and structures including arrays, cables, covers, explosives, side-looking sonars, etc., and studies of ships and shipboard equipment relating especially to the research needs of the laboratory.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0053. PSYCHOPHYSICAL EFFECTS OF XENON FLASHTUBES
J.T. MONTONYE, Univ. of Rochester, Graduate School, Rochester, New York 14627

The Coast Guard is seeking information on the psychophysical characteristics of flashtubes that can be of advantage in aids to navigation. The present research at the University of Rochester, which is being performed by a Coast Guard officer pursuance of a Master of Science Degree in Optics, is directed toward an explanation of the physical characteristics of flashtubes that contribute to their conspicuousness above threshold. A special 'Visual Research Stroboscopic Unit' on which pulse repetition rate, length and energy level are variable, has been built for the work. Externally triggered, the unit allows various scintillated flash characteristics.

Ironically, the work will basically use threshold observations to determine the physical characteristics of flashtubes that are responsible for their conspicuousness above threshold. It will essentially duplicate the Blackwell and Moldauer temporal forced-choice retinal locus work of 1958 (Detection Thresholds for Point Sources in the Near Periphery) at a background brightness of 10 to the minus 3 power Foot-Lamberts, but using flashtube rather than incandescent sources. By comparison with the Blackwell results, which showed uniform sensitivity across the central retina for a 10 to the minus 3 power F-L background, and the execution of some additional supra-threshold observations, it is expected that a determination of the relative effects of flashtube temporal, spectral and intensity characteristics on conspicuousness will be obtained. A number of practical side-effects are anticipated from the work, some of which may be the following: (1) Distribution of energy for flash lengths probably less than the critical duration that will give optimum conspicuousness. (2) Conspicuousness as a function of supra-threshold level for each of the six scintillation characteristics. (3) Measurement of the threshold and/or .2 microlux illumination level equivalent fixed intensity of each scintillation flash characteristic.

SUPPORTED BY U.S. Dept. of Transportation - Coast Guard

8.0054. ACOUSTIC LUNEBERG LENS
W.J. TAULIS, North Amer. Rockwell Corp., Anaheim, California

Objective: To develop a water inflatable acoustic lens.

Approach: Design, procure and test a breadboard model at sea.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0055. PRESSURE INSENSITIVE VELOCIMETER
H.T. PATTEN, Bunker Ramo Corporation, Canoga Park, California

The pressure insensitive velocimeter is an instrument to measure the speed of sound in water, or other fluid media, and is designed to be exposed directly to ambient pressures at great depths greater than 20,000 ft.) without benefit of a pressure vessel to house the electronics. The instrument uses the classic sing-around mode whereby the output frequency of the instrument is equal to the reciprocal of the transit time between transmitter and target. Utilizing pressure insensitive electronic components throughout allows a significant reduction in instrument size and weight and enhances the dimensional stability of the sound path. A precision tunnel diode-heralded zero crossing detector to reduce electronic time delay errors and improve the input acoustic dynamic range was used. Compensation for changes in path length due to compressibility of invar standoffs was achieved by voiding the rear of the target, allowing simple and highly predictable diaphragm action to provide the necessary delta. Instabilities from all causes (electronic and mechanical) is less than plus or minus 1/50,000.

SUPPORTED BY Bunker Ramo Corporation

8.0056. MICROWAVE RADIOMETER DEVELOPMENT
C.V. FALCO, Aerojet General Corporation, El Monte, California 91734

TECHNICAL OBJECTIVE: The technical objective of this work unit is to develop new techniques for the measurement of thermal radiation intensity of the earth's surface and atmosphere. The distinguishable features are water, ice, dry land, swampland, dense vegetation, dense clouds, heavy rainfall, etc.

APPROACH: The initial work will be modifying and testing a microwave radiometer operating at 19.35 Gtiz which was delivered on a prior GSFC contract. An engineering model radiometer will be used for contract effort while 'in-house' work will be conducted with a breadboard model radiometer. The areas of development will include but not be limited to antenna control, antenna beamwidth, antenna efficiency, phase shifting techniques, receiver noise figure, receiver bandwidth, calibration techniques.

PROGRESS: A breadboard model, an engineering model, and ground support equipment were delivered on contract NAS 5-9680 with Job Order Number 622-160-44-03-84. The breadboard model is at GSFC for laboratory investigations. The engineering model with control and data recording equipment was installed on the NASA Convair 990 and flight tested for instrument evaluation.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0057. DEEP SUBMERGENCE DISSOLVED OXYGEN TRANSUDER
M.W. GREENE, Beckman Instruments Inc., Fullerton, California 92634

Objective: To develop an instrument capable of in-situ measurement of dissolved oxygen in the ocean at depths down to 3000 meters.

SUPPORTED BY Beckman Instruments Incorporated

8.0058. CTFM SONAR
F.J. HESTER, U.S. Dept. of Interior, Fishery Oceanography Ctr., La Jolla, California

Development under a Bureau of Commercial Fisheries contract, this Continuous Transmission Frequency Modulated (CTFM) sonar was designed with a high-resolution frequency analyzer to detect Doppler shifts caused by motion and body flexure of target fish. The sonar scans at a speed fast enough to follow rapidly moving tuna schools which are difficult to follow with conventional pulsed sonar. On completion 2 years ago the CTFM sonar was installed on the small Bureau research vessel, Miss Behavior operated by the BCF La Jolla Laboratory.

It was found that tuna usually travel at 5-6 knots and change course frequently. Whenever their body orientation changes, their sonar echoes fade rapidly. Since there is about a 40 db difference in target strength between the presentation of a broadside and a head or tail aspect on these fish, the spacing and orientation of the individuals in the school make it very difficult to maintain contact at ranges greater than 100 meters. Even these short ranges might work-hy in seining operations but the speed and rapid course changes necessary to stay with a school are such that often the school can out-maneuver the vessel and contact is lost. The same problem does not apply to contact made with schools of chubbers at the same ranges, perhaps because of the small internal intervals. For such fish the rapid scan rate of the
8. ENGINEERING AND TECHNOLOGY

CTFM sonar made it possible to estimate school size and movement at any instant. The sonar experiments were concluded at the close of FY 1968 and a final report is in preparation. In summary, it is not expected that the CTFM sonar will be applicable to commercial tuna operations as a tactical tool although it has a place in the sonar array of a fishery research vessel.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

8.0059, OPERATIONAL EVALUATION OF NSRT SYSTEM
J.F. SAUR, U.S. Dept. of Interior, Biological Laboratory, Palo Alto - Stanford, California

With increasing use of sea surface temperature information on both for research and synoptic forecasting in weather and fisheries, it is necessary that the quality of the sea temperature observations be improved. A suitable system which eliminates much of the instrumental and personnel errors must be developed and thoroughly tested before a large-scale program can be launched to install the systems on merchant ships, fishing vessels and other ships which report these observations. This program is designed to obtain the necessary test data and experience with such a system.

The general objective is to conduct a thorough field test of NSRT units like the two prototypes obtained from Yellow Springs Instrument Co. to: (a) Determine if such systems manufactured in larger quantities retain the quality and accuracy built into the two prototypes; (b) Establish a measure of the longevity and failure rate from a sample of at least 25 units; (c) Develop and test modifications to the instrument which may be deemed necessary in the course of these tests; (d) Obtain a large sample of reliable data as to what degree the temperature stratification causes temperatures accurately measured in the seawater intakes (near surface) to differ from conventional bucket (surface) temperatures; (e) Measure ocean temperatures accurately measured in the seawater intakes (near surface) to differ from conventional bucket (surface) temperatures; (f) Measure ocean temperatures accurately measured in the seawater intakes (near surface) to differ from conventional bucket (surface) temperatures; (g) Measure ocean temperatures accurately measured in the seawater intakes (near surface) to differ from conventional bucket (surface) temperatures; (h) Measure ocean temperatures accurately measured in the seawater intakes (near surface) to differ from conventional bucket (surface) temperatures.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

8.0060, HOLOGRAPHIC STUDIES OF MARINE ORGANISMS
H.P. SILVERMAN, T.R.W. Incorporated, Redondo Beach, California (NONR)

The investigator proposes to demonstrate that holography, the use of lasers in the photographic recording of three dimensional images, can be used effectively in those biological study problems which require observation of dynamic activity throughout a volume of water without excessive loss of resolution. He suggests specifically, the application of the technique to studies of plankton productivity is situ, including enumeration and identification of organisms; locomotion with time lapses in nanoseconds; feeding; setting, and other activities of organisms in approximately the 0.5 to 3 millimeter range.

One of the major problems in biological oceanography research has been the lack of equipment permitting in situ observations. The so-called deep scattering layer which probably interferes with the transmission of acoustic energy underwater has never been clearly characterized because of this lack. The holograph, if it fulfills its promise, will permit direct observation of the density of the biological components of the water sample, measurement of particle size, and size range, and even identification of the organisms present. On this basis, it will be possible to determine the role of the 'layer' in acoustic, as well as optical, interference. The conditions under which fouling and boring by biological organisms occur will be determined, and a great many other mechanisms by which biological pests operate will be elucidated.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0061, INVESTIGATE METHODOLOGY FOR MEASURING OCEANIC PROPERTIES LEADING TO THE TOTAL ENVIRONMENTAL SURVEY OF A SELECTED OCEAN AREA
F.B. CHMELIK, Lockheed Aircraft Corporation, San Diego, California 92101

The initial work on this project pointed out the need for a variety of tools and sensors suitable for a deep submersible to use in measuring oceanic properties. Efforts were then directed toward the conceptual design of an in-situ filter/sampler, a deep submergence radiation detection device and a self-generating tube that could be inserted into the sea floor for obtaining core samples or directly measuring mass physical properties.

SUPPORTED BY Lockheed Aircraft Corporation

8.0062, MARINE RADIOLOGICAL INSTRUMENTATION
T.R. FOLSOM, Univ. of California, Graduate School, San Diego - La Jolla, California 92038 (NONR)

The purpose of this project is to develop and improve instrumentation and techniques for the measurement of very small amounts of radioactivity in the oceans, and to apply these measurements in oceanic circulation. The work involves special sampling equipment for use aboard 'Ships of Opportunity', the laboratory analysis of the samples, and the instrumentation development.

This task has direct application to the measurement of the fate of radioactive material from waste disposal and other nuclear waste disposal and other nuclear waste. It is also contributing to our knowledge about mixing processes in the ocean which affect those parameters influencing sound characteristics of the oceans.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0063, COMPUTER PROCESSING OF MICROSCOPE IMAGERY
J.L. HARRIS, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

This research is directed toward increasing the state-of-the-art of resolving power in optical microscopy. The approach involves utilizing a prior knowledge as to the maximum size of the object and employs computer processing of digitized image information. The initial funding for this research was received during FY66. The support is on a continuing basis and therefore no termination date has been set.

SUPPORTED BY Amer. Optical Company

8.0064, BIOLOGICAL INSTRUMENTATION
J.M. SNODGRASS, Univ. of California, Graduate School, San Diego - La Jolla, California 92038 (NONR)

The investigator advises and assists in bio-instrumentation research with hydrobiologists who require specialized equipment in their studies. Instrumentation for analysis of physiological or behavioral responses of organisms to natural or artificial stimuli will be especially considered. Methods for accurate measurement of environmental factors as they relate to or are perceived by biological organisms are investigated. Some pieces of equipment new in use are being studied in regard to adaptation to solid state sensors and microminiaturization.

Research in biological orientation and hydrobiology yield information of immediate and long range potential value to the Navy. The development of new concepts regarding information theory, biological transducers, environmental navigational clues, etc., represents a far-reaching and much needed change of viewpoint from which many new ideas for analogues may be expected to emerge.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0065, INSTRUMENT DEVELOPMENT
J.M. SNODGRASS, Univ. of California, Graduate School, San Diego - La Jolla, California 92038 (NONR)

The objective of this task is to develop new techniques and equipment which are reliable and suitable for supporting oceanographic research. During the coming year, emphasis is upon technical guidance for the development and production of satel-
lute navigation receivers and the installation of computers on research ships. Efforts are being made to develop an in situ oxygen meter for use at sea. Consulting services on oceanographic telecommunications are being provided to the Navy and the U.S. Government.

The results from this task provide many instruments or concepts necessary for developing environmental data collection systems. Many of the instruments and techniques initially conceived and/or developed under this task, like the expendable bathythermograph, already have become part of standard usage.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0066, HOLOGRAPHIC INSTRUMENTATION FOR MARINE PLANKTON STUDIES
J.D. STRICKLAND, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

The project is to design and fabricate an underwater laser-camera combination which will enable holograms to be taken of the plankton in about 100 liters of water in such a manner that the animals will be viewed in an undisturbed condition making it possible to document any small-scale patchiness and aggregations of ecological significance. We hope to make a preliminary evaluation of cinematic holography as a tool for studying the behavior (feeding, breeding and swimming, etc.) of zooplankton in a relatively undisturbed state.

SUPPORTED BY U.S. National Science Foundation

8.0067, NEW SEA GRAVITY METER
N. BROWN, Bisbett Berman Corporation, Santa Monica, California 90404 (N00014-67-C-0430)

A new sea gravity meter has been designed and a prototype is now being constructed. The meter will be tested in the laboratory when completed. The meter consists of a quartz-cantilever beam with an ultra-sensitive capacitance transducer to measure changes in gravity as small as 0.1 mgal. The meter is expected to operate successfully on a stable platform for a large range of vertical ship accelerations, up to and exceeding 100,000 mgal. The cost of the meter is anticipated to be considerably less than U.S. made commercial meters now on the market. Sea tests of the meter are planned within a year if the laboratory performance and cost of construction prove to be satisfactory.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0068, FREQUENCY TIME RESEARCH ENGINEERING

Technical Objectives: To study the feasibility of worldwide time synchronization by means of multiple frequency VLF transmissions including systems engineering, design, and fabrication of component units.

Approach: Two or more closely spaced VLF frequencies, whose phase relationships are precisely specified and accurately controlled, are broadcast by means of time sharing from NBS Radio Station WWVL. Upon reception, if propagation fluctuation is not too severe, the relative phases of these signals with respect to local time signals permit establishment of time synchronization. Engineering parameters, such as optimum frequencies and necessary transmitter power, need to be determined.

Progress: WWVL power amplifier has been redesigned—eliminating the L-C tank circuit and reducing the number of electronic tubes in the PA. The antenna feed system was redesigned and permits matched conditions into the 500 ohm open wire line. The design of the generation and control system to convert WWVL to three frequency operation is progressing. Preliminary design has been completed.

Two third-order servo frequency drift correctors have been built similar in design to one now in use in Section 253.04.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

8. ENGINEERING AND TECHNOLOGY

8.0069, UNDERWATER HOLOGRAPHIC IMAGING
D. GABOR, Columbia Broadcasting System, Stamford, Connecticut

Objective: To investigate the holographic imaging technique as an underwater sensor.

Approach: Conduct research, design and develop experimental equipment in support of further refinement of the holographic technique.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0070, BIOTELEMETRY

The AIBS has established, and now maintains, the Bio Instrumentation Advisory council, a clearing-house through which biologists avail themselves of advice and assistance from physicists and engineers on appropriate techniques, approaches, and instrumentation for biological research. The Council understands biological requirements for the development of improved equipment and technological advances, and keeps abreast of developments in electronics, electrical engineering, and telemetry as they relate to instrumentation. Support is provided from several sources, including ONR and NASA.

One phase of Oceanic Biology Programs has as an objective, understanding of reception and responses to environmental cues or stimuli by biological organisms. This knowledge applies to Navy operational requirements in such areas as: ship-ordnance navigation and guidance, target detection and discrimination, and survival. Instrumentation and operating techniques are necessary to identify and respond to these environmental cues for improved Naval operations.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0071, AUTOMATED FLOW SYSTEM CALIBRATION

Research and development to utilize small digital computers for the automatic readout of instrumentation, automatic control of fluid flow systems calibration, and calculation of performance data. Immediate application is for aircraft flow systems, with benefits anticipated for NBS flowmeter calibration work.

Evaluate and develop transducers and systems for the measurement and control of flow parameters, with signals suitable for input to computers which will be adapted or used to accomplish the automatic calibrations and automatic data processing.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

8.0072, VISUAL RANGE METERS

To provide a stable nucleus of specialists, operating in a technical environment, competent to apply the results of basic research and of lessons of the past and the resources of NBS to current aviation lighting and marking problems; to maintain and utilize a photometric and illuminating engineering laboratory competent to make and interpret the specialized measurements required in the development of aviation lighting equipment and systems; to make the required measurements and studies; to develop improved instrumentation for measuring the atmospheric factors affecting visual range; to provide a better knowledge of the threshold constants of the eye applicable to service conditions; to develop the application of these data to the control of the operation of aircraft landing and taking off in conditions of poor visibility (example: Fog Conditions). This is NBS Mission Component 1.6, Research and Development for another agency.

When we are advised of the needs of the sponsor, tasks are initiated to obtain the required data and recommendations formulated on these data are forwarded. Individual tasks usually require from 3 to 24 man-months. Current tasks are: 1. Development of a back scatter visibility meter suitable for use on aircraft carriers. 2. Development of an improved cable-fault locator. 3. Continuing development of the NBS transmissometer and related com-
8. ENGINEERING AND TECHNOLOGY

The prime objective is to transfer force measuring devices and systems submitted to NBS by industry, standards laboratories, and other government agencies to provide information helpful in the design of a water tunnel facility. The calibration of current meters by NBS serves as a quality control measure for the performance of current meters designed which will yield current meter (or other velocity measuring) data appropriate for oceanic processes. The results obtained will replace the existing towing tank current-meter calibration section.

The presently available data on the performance of current meters in the simulated working section of the water tunnel, together with the data obtained in the pitot tube calibration of the working section suggest that a water tunnel facility can be designed which will yield current meter (or other velocity sensing device) calibrations fully equal or superior in quality to those now obtained in the present towing tank. Repeated calibration of various types of current meters in the 20-inch diameter water tunnel section are continuing and will be compared with calibrations obtained in the towing tank.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

8.0075. STRUCTURE OF TURBULENCE

To apply high-speed digital computing techniques to the measurement of the statistical properties of turbulence and thereby provide significantly new data which will extend our knowledge of turbulent processes. Using these techniques the nearly isotropic turbulence field produced by a grid and the shear turbulence in a boundary layer will be investigated. Special attention will be given to the measurement of higher-order correlations and joint probability density distributions of the velocity fluctuations and the fluctuating velocity gradients. The results obtained will have application to problems in aerodynamics, hydrodynamics, atmospheric turbulence, diffusion and mixing processes, etc.

This project continues the NBS work on the development and application of various measurement techniques to the solution of important fluid dynamic problems.

The basic idea in applying high-speed digital computing techniques to the measurement of turbulence is to employ the digital computer together with the hot-wire instrumentation to form a measurement system capable of performing the large number of complex operations that a detailed study of the statistical properties of turbulence requires. Hot-wire instrumentation converts the velocity fluctuations to voltage fluctuations, which are then recorded on multi-channel magnetic tape. The signals are then digitized and fed into a 7090 computer which when appropriately programmed provides a quantitative measure of the various statistical properties of turbulence. Apart from the interpretative analysis, the problems associated with programming, a number of technical aspects have to be investigated. These are appropriate instrumentation for obtaining high quality records, sampling procedures, digitizing procedures, noise and nonlinear behavior of the hot-wire.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

8.0076. BASIC ACOUSTICAL STANDARDS AND MICROPHONE CALIBRATION

The basic idea in applying high-speed digital computing techniques to the measurement of turbulence is to employ the digital computer together with the hot-wire instrumentation to form a measurement system capable of performing the large number of complex operations that a detailed study of the statistical properties of turbulence requires. Hot-wire instrumentation converts the velocity fluctuations to voltage fluctuations, which are then recorded on multi-channel magnetic tape. The signals are then digitized and fed into a 7090 computer which when appropriately programmed provides a quantitative measure of the various statistical properties of turbulence. Apart from the interpretative analysis, the problems associated with programming, a number of technical aspects have to be investigated. These are appropriate instrumentation for obtaining high quality records, sampling procedures, digitizing procedures, noise and nonlinear behavior of the hot-wire.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.
8.0077, PHOTOGRAPHIC STANDARDS

Methods of testing the characteristics of photometric systems are developed and interlaboratory comparison programs are arranged to validate procedures before they are standardized. The fundamental concepts, terminology, and notation for measurements of characteristics are investigated theoretically and proposed for standardization.

The final draft of a USA standard method of measuring the resolving powers of photographic films, plates, and papers has been approved and the illustrations of test patterns on the 'borderline' of resolution have been re-evaluated. Two draft USA standards for optical density have been written. We are cooperating in the revision of existing national and international standards for films for permanent records and the storage conditions for the preservation of such film records and the preservation of colored photographs. A study of the theory of optical wedges has been completed and will be reported to the Optical Society of America in March. We sent a delegate to the meetings of the ISO committees on photography and cinematography in Moscow in June 1967. A paper 'A Half Century of Photographic Standardization in the United States' was presented at the annual meeting of the Society of Photographic Scientists and Engineers and is being prepared for publication.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

8.0078, NUMERICAL CODE CONVERTER

The main objective is to determine the feasibility of designing a practical field instrument for measuring humidity based on the adiabatic saturation equation. Such an instrument would be useful in meteorology, particularly when an accurate and portable instrument is needed. It has the potential of extending the accuracy of the psychrometric method by about one order of magnitude. The plan is to fabricate a prototype instrument, using dewatering to insure adiabatic conditions; resistance thermometers, thermocouples, thermistors for temperature measurement; continuous automatic water feed to the wicking; constant flow sampling; and heated air to prevent freezing of the wicking. Tests will be performed using the NBS two-pressure generator as a source of known humidity.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

8.0079, WATER CURRENT METERS

To provide calibration service for water current meters to the U.S. Geological Survey. The provision of this service is one way in which NBS meets its responsibility for providing the basis for accurate and uniform mechanical measurements throughout the Nation's scientific community, industry and commerce. Water current meters are towed through still water at various constant speeds from 0.25 to 8.0 feet per second to determine the relationship between the speed and the revolutions per second of the meter turbine. The relationship is usually given by one or more straight line equations.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

8.0080, NAVAL AIRCRAFT LIGHTING

Objectives: (1) The development of standards, instrumentation and measurement techniques in the field of photometry to satisfy the updating of Naval Aircraft lighting specifications, (2) The monitoring of such specifications to insure that they are met, and the revision of such specifications to include recent advances in photographic and electronic technology, and (3) The development of specialized lighting equipment with responsibility up to installation and test on aircraft to demonstrate feasibility, (4) The establishment of and the monitoring of photometric test facilities in government and the aircraft industry to assure correlation of measurements between laboratories, and (5) The technical monitoring of research, development, and human factors contracts as directed by the project sponsor. The functions of the project are germane to the NBS mission in that they closely parallel areas of photometry and colorimetry in which the Bureau has an interest, particularly in the development of low-level photometric reference standards, instruments, and measuring techniques used by industry. This is NBS Mission Component 1.6, Research and Development for another agency.

Approach: This is a continuing project and the approaches for solving the broad objectives outlined are varied. The problems can be classified as follows: 1) The development of standards, instruments and test methods and 2) Services provided the sponsoring agency. As for the standards, a continuing program is carried out for improving the source, instruments and methods employed in measuring the photometric characteristics of aircraft instruments and lighting equipment and the dissemination of information through reports, specifications, and the participation in professional societies. The services accrue directly to the sponsor and the funding for completion of any task undertaken is established by that agency. These services include the monitoring of specifications and technical aspects of contracts, as well as the development of prototype lighting equipment for exploring new concepts, and the furnishing of technical advisory services.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

8.0081, HUMIDITY STANDARDS AND MEASUREMENTS

The development of suitable primary and secondary standards for the calibration of humidity equipment; the development of calibration techniques; and the investigation of properties, constants and behavior of water vapor and water vapor-gas systems. This project falls within the National Bureau of Standards mission to develop and maintain the national stands for physical measurement, to develop transfer standards and standard instruments and to undertake research in support of the above.

(1) Research and development is being conducted toward developing and adiabatic psychrometers that could be used as a secondary or field standard. (2) An investigation is being made of the effect of pressure of air on various saturation coefficients and using the results for computing f-factors and interaction virial coefficients. (3) Research is being undertaken to extend the range of the National Bureau of Standards gravimetric hygrometer.

Air water content affects evaporation from rivers, ice, oceans, etc. Need to know water content in pressure suits and sealed submersibles. Weather Modification forecasts radio propagation (i.e., Navigational needs).

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

8.0082, AEROLOGICAL INSTRUMENTS

Development of improved instrumentation for measurement of such parameters as humidity and condensation nuclei for the study of weather modification and for cloud physics investigations. This project falls under the mission of the National Bureau of Standards to conduct research on basic measurement techniques and instrumentation. It should lead to improved instrumentation of increased accuracy for obtaining better weather forecasts, better understanding of cloud physics, and of the problems associated with atmospheric refractive index as it affects radio propagation.

A microwave hygrometer for field use consisting of two microwave cavities operating at 12 GHz, one cavity flushed with test gas and the other containing dry gas has been developed and is undergoing test. It will then be field tested.

Reporting Interval: March 16 to December 31, 1967.

Laboratory operational and electronic correction testing completed on the microwave hygrometer. An electronic calibration was obtained on read-out vs. frequency. The instrument operates continuously and unattended. It has a total range of 100 N-units. The read-out, in the form of a trace on a strip-chart recorder, can be
8. ENGINEERING AND TECHNOLOGY

selected so that full scale corresponds to dewpoints of plus 40 degrees C to minus 50 degrees C, minus 5 degrees C to minus 50 degrees C or minus 30 degrees to minus 50 degrees C. Extensive humidity calibrations and field tests remain, to determine the operational characteristics of the instrument.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

8.0083. HUMIDITY SENSORS


Tests on the long-range stability of the barium fluoride element were performed over a nine-month period. During this time, the element maintained its calibration to plus or minus 10% RH. A method was developed of measuring the surface temperature of the element by means of a vacuum-deposited palladium film. This film has a resistance of 50 ohms, and a temperature coefficient of .0033 (compared to a bulk coefficient of .0038). The element was used in a cooperative field experiment at Davis, California, with the University of Wisconsin and University of Washington to measure water vapor flux. Comparisons with a lysimeter yielded agreements in flux of 25 to 50%. A paper entitled 'Study of the Storage Stability of the Barium Fluoride Film Electric Hygrometer Element' was published in the NBS J. Res., 71C, 199 (1967).

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

8.0084. HUMIDITY CALIBRATION


To provide calibration service for reference quality humidity instruments to the public and other Government agencies. The provision of this service is one way in which NBS meets its responsibility for providing the basis for accurate and uniform humidity measurements throughout the Nation’s scientific community, industry and commerce.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

8.0085. APPLICATION OF NUCLEAR TECHNIQUES TO MARINE MINERALS TECHNOLOGY


The Bureau of Mines marine minerals research program includes a study to determine the feasibility of nuclear and radioisotope techniques for both the delineation and characterization of marine mineral deposits, and the control of mining operations. Thus far, the effort has been concentrated on in situ activation analysis techniques. Elemental analyses were performed on four types of sea floor minerals of potentially commercial value: phosphorite, manganese nodules, sand (spiked with gold), and red clay. Elemental concentrations were determined by characteristic radiation emitted after irradiation by neutrons of different energies and at different flux levels.

The project was intended to serve as a start for a long-range program designed to produce, by about 1970, a Mineral Detection Probe. This instrument package will be built to probe, from sea floor to bedrock, the vertical dimension of an unconsolidated mineral deposit and provide at least semi-quantitative and, hopefully, quantitative analyses. The system will not require the drilling of a hole prior to its use; therefore, the speed of evaluating a submerged beach or stream placer mineral deposit will be greatly increased and the total exploration and evaluation cost considerably decreased. For this reason, the probe is thought to have eventual commercial possibilities.

SUPPORTED BY U.S. Atomic Energy Commission

8.0086. ULTRAVIOLET ABSORPTION AND LUMINESCENCE


Development and testing of the Fraunhofer Line Discriminator for marine geologic and hydrologic studies.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

8.0087. NUCLEAR OCEANOGRAPHIC TECHNIQUES

N. ANDERSON, U.S. Navy, Research & Dev. Department, Washington, District of Columbia

This is a jointly sponsored program concerned with the evaluation of proposals and experimentation on various isotopic techniques for the measurement of oceanographic parameters. Previous unofficial cooperation led to the Deep Water Isotope Current Analyzer and the Nuclear Sediment Density Meter. The Naval Oceanographic Office will perform such tasks as: 1. Conduct studies and experiments on the applications of isotopic techniques to the measurement of oceanographic parameters. The studies and experimentation will be conducted both in the laboratory under controlled conditions and at sea under operating conditions. In addition, some isotopic techniques and systems from other DID contractors will be introduced into this joint program. 2. Conduct studies and experiments on the Nuclear Sediment Density Meter in order that it can be modified to best meet Navy requirements. 3. Re-analyze and evaluate the Deep Water Isotope Current Analyzer in order to determine its full potential in naval oceanographic applications. Comparisons with conventional current sensors will be made. 4. Assist DID in evaluating new oceanographic techniques. 5. Exchange information with DID in fostering new techniques. 6. Make recommendations for Navy utilization of isotopic techniques found to advance the state-of-the-art. 7. Assist DID in maintaining liaison with other branches of the Navy for planning conferences, etc., both classified and unclassified.

SUPPORTED BY U.S. Atomic Energy Commission

8.0088. VISIBLE REGION INSTRUMENTATION FOR OCEANOGRAPHIC SATELLITES


Objectives: (1) To investigate and evaluate all visible region passive instruments for over-water surveying and (2) to delineate which oceanic features can be observed by visible region instrumentation and ascertain optimum specifications for films, filters, and instrumentation.

Approach: (1) A continuing review of the state-of-the-art for visible region instruments to observe ocean phenomena will be maintained. (2) Planned experiments over ocean test sites to test new instrumentation will be conducted. (3) Plan and execute experiments using airborne platforms to acquire and evaluate data for various ocean features (shoals, currents, bottom topography, sediment distribution, etc.), a. Sensors - 1. Color and multiband cameras. b. Proposed Contractor - Experimental Astronomy Lab., Massachusetts Institute of Technology, c. Allocation of Resources - Manpower 50%, Overhead, 50%.

Problem Addressed: Controlled experiments over the ocean are difficult to achieve and information, at present, is minimal. Film-filter tests need to be expanded for environmental measurements (currents, temperature, water mass identification) and the use of targets and controls for resolution and contrast loss is needed. Test sites, transportation, and control of aerial and surface data require difficult planning and execution. MIT has a good start on resolving these problems.

SUPPORTED BY U.S. Nat'l. Aero. & Space Adm.

8.0089. HYDROGRAPHIC SURVEY TECHNIQUES


Objective: Develop improved techniques and equipment to accelerate the collection and improve the quality of hydrographic data to meet DOD needs for the production of hydrographic and amphibious combat charts for support of various naval weapons. Data acquisition will be accelerated by at least a factor of five. Scheduled development extends through FY 73. With present methods only 300 miles of survey lines can be accomplished in one day by one survey ship. The new surveying techniques and equipment will accomplish 1500 miles of survey lines per day per ship. This effort is directed toward solving problems within the scope of mapping, charting, and geodetic functions as defined in DOD studies and in the report, June 1966, published by the panel on oceanography of the President's Science Advisory Committee.

326
8. ENGINEERING AND TECHNOLOGY

functioning in the severe marine environment. The device now under development uses an infrared absorption technique to measure the difference between the input and output energy of the discharge. The difference is equivalent to the energy absorbed by the oil. Originally, research was aimed at the 3.4 micron energy region where hydrocarbons have a sharp absorption peak, but problems with opaqueness of water caused a change to the 1.6 micron region.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8.0094. X-RADIOGRAPHIC AND ELECTRONIC FLUOROSCOPIC EQUIPMENT
A.F. RICHARDS, Univ. of Illinois, Graduate School, Urbana, Illinois

This grant will provide toward the total estimated cost for a Norelco 150 MX x-ray machine with electronic fluoroscopic display apparatus and a specimen handling system. It is anticipated that the fluoroscopic display feature, which obviates the need of highly skilled radiologists, will pay for itself in the first three to five years of operation.

The first specific use of the equipment will be for the study of deep-sea sediment cores in which a Polaroid photograph of a lens magnified, image intensified display will record the optimum radiographic image for each portion of the sample tube x-rayed. The very slight degradation of picture quality by this method, compared to conventional film radiography, is not expected to be important.

The x-ray machine will feature simplified controls and an automatic tube load mechanism. The image intensification tube will have dual field feature giving a choice of nine inch field or electronic expansion of the central six inch field to nine inches. The system also has capabilities of stereo and color radiography.

SUPPORTED BY U.S. National Science Foundation

8.0095. TRANSDUCER RESEARCH
J.N. DAVIDSON, Westinghouse Elec-tric Corp., Annapolis, Maryland

The research and development of a deep submersion spherical transducer was initiated. It will be continued during 1968 because of its potential as a deep omnidirectional target or receiver over a broadband of frequencies. No other shape or configuration has this characteristic. The first sphere that was tested for verification of design, failed in dynamic stress. An analysis showed that the sphere was faulty in construction since failure occurred at a stress far below the allowable dynamic stress.

Objective: To further the state-of-the-art in the field of low frequency sources and receivers of acoustical radiation. Also, to extend the understanding of mutual coupling effects in multielement arrays.

Approach: Research work and testing will continue in the areas of improved underwater encapsulating materials and techniques, sealing techniques, absorbers, decoupling techniques, and other mechanisms applicable in general to underwater acoustic transducers.

The principal research effort for 1968 is in the area of low frequency, high power, high efficiency Tonpilz transducer elements. One phase will investigate an element suitable for use in a planar or conformal surface ship array and a second phase, an element suitable for use in a deep-diving submarine array. In conjunction with research projects carried on by other groups, it is hoped that these transducers can be wed to the amplifiers to obtain subsystem optimized for power handling, efficiency, bandwidth, and element interaction.

Studies will also be carried out on the Cassegrain principle as applied to small acoustic transducers for high frequency surveillance.

Work previously begun on the composite cylindrical transducer, the spring-mounted, free-flooded Tonpilz element, the disc bender transducer, and the planar array study will be continued and/or completed. It is also planned that a study be carried out in small tank calibration techniques and array mutual coupling effects. It is further hoped that the hybrid computer (Underseas) research into element design and analysis can be extended to
8. ENGINEERING AND TECHNOLOGY

cover arrays of elements with mutual coupling or interaction effects included.

SUPPORTED BY Westinghouse Electric Corporation

8.0096, ADVANCE SONAR SYSTEMS
T.G. DELL, Westinghouse Electric Corp., Annapolis, Maryland 21204

Objective: To further the state-of-the-art in high resolution and special purpose sonar. Also to extend the understanding of limited warfare sensor requirements.

Approach: Research work and testing will continue to provide improved special purpose and high resolution sonar equipment. Investigation will determine whether the hydrofoil sonar and the extended focal length transducers conceived in 1967, under UN-67-3R, have application to the special requirements of limited warfare.

The principal research in 1968 will be in three main tasks: namely, (1) completion of the feasibility model of the hydrofoil sonar initiated in 1967; (2) study and testing of new techniques leading to extended focal length high resolution sonar; and (3) study of testing devices and techniques that have application for display of high resolution sonar data.

The high resolution, high data rate hydrofoil sonar initiated in 1967 will be completed and testing will be conducted in the Acoustic Test Facility. If successful, a co-operative testing program on a hydrofoil will be pursued. The sonar technique also has application as obstacle avoidance sonar for manned submarines.

Investigation into several potential techniques to increase the focal length of focused transducers will continue. Solution of the problem is required for reconnaissance sonar applicable to swimmer delivery vehicles, and the riverine warfare.

Present devices used to display high resolution side looking sonar are either of extremely limited performance or extremely complex. A study will be made of state-of-the-art techniques and devices to determine if improvements can be devised to provide a quick access, high resolution, high contrast, and economically feasible device.

SUPPORTED BY Westinghouse Electric Corporation

8.0097, NOISE LIMITATION UPON AEROMAGNETIC MEASUREMENTS
S.J. BANK, Roff Analytic Study Assoc., Silver Springs, Maryland 20910

Objective: To acquire additional basic knowledge of the extent to which airborne magnetometers are physically limited by various forms of natural background noise.

Approach: Refine Methods for obtaining geologic noise spectra from the total magnetic field, and conduct detailed analyses of the effect of the ocean surface upon magnetic gradients.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0098, SUPERCONDUCTING MAGNETOMETER SYSTEMS EVALUATION
J. MICOL, Arthur D. Little Incorporated, Cambridge, Massachusetts

This task is to perform a Superconducting Magnetometer Systems Evaluation in order to determine whether the development of such devices will materially benefit the U.S. Navy. Several designs for these magnetometers are based upon phenomena occurring in thin superconductive films. This evaluation will combine (1) the operational usefulness of such very sensitive field and gradiometer magnetometers, (2) the limitations on performance of these devices, (3) realistic specifications which can be established for a new airborne operationally useful magnetometer and (4) based on the foregoing, the identification of areas in which research and development are required, the general nature of the program and their estimated costs and durations.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0099, INERTIAL TECHNIQUES
D.P. KELLY, Mass. Inst. of Technology, Graduate School, Cambridge, Massachusetts 02139 (NONR)

The goal is to apply modern inertial techniques to the measurement of the change in horizontal velocity with depth. Ensemble is a free-falling, recoverable, hydrodynamically-tuned vehicle which when acted upon by horizontal currents will be translated sideward without rotation. The horizontal displacements would be sensed by an inertial system and stored together with depth information. The coming year's work will consist of laboratory experiments and of design of an accelerometer system for a prototype field model. When the limit to which a free-fall probe can be tuned for vertical stability is discovered, the decision can be made as to the necessary requirements for additional internal gyroscopic stabilization of the accelerometer platform.

The development of a successful system would permit accurate measurement of vertical profiles of horizontal currents without mooring or accurate navigation. Such measurements would be useful in deep water engineering tasks, in ascertaining the mixing and dilution rates of adjacent layers, and in determining space distribution of time changes in the sound propagation field.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0100, AN INVESTIGATION OF THE S/N FATIGUE LIFE GAGE
G.F. LIVINGSTON, Mass. Inst. of Technology, School of Engineering, Cambridge, Massachusetts 02139

The S/N fatigue life gage is a small sensor which is similar in appearance to a foil strain gage. The S/N fatigue life gage is bonded to the surface of a mechanical structure using standard strain-gage techniques. The S/N gage changes resistance permanently as a continuous function of fatigue experience. This gage was developed by Mr. Darrell R. Harting of the Boeing Company, Seattle, Washington. The gage is produced commercially by Micro-Measurements, Inc. and distributed by W. T. Bean, Inc., Detroit, Michigan.

This investigation describes the results of a series of reverse bending tests on S/N fatigue life gages which were mounted on Ti-6Al-4V titanium specimens. Each S/N gage was subjected to various constant strain loadings for varying numbers of cycles.

The results of this investigation show that the performance of the S/N fatigue gage under random cyclic loading is predictable. Another result of the tests indicates that the S/N gage experiences an above normal increase in resistance well in advance of actual gage failure. Finally it was observed that a decrease in S/N gage resistance will occur; immediately after the mean cyclic strain level is lowered; and whenever the gage is subjected to any substantial rest period.

SUPPORTED BY Massachusetts Institute of Technology

8.0101, MARINE GRAVITY
C.G. WING, Mass. Inst. of Technology, Graduate School, Cambridge, Massachusetts 02139 (NONR)

This task will continue the construction and development of a new shipborne gravity meter that is expected to have a higher operating accuracy and lower cost than do existing competitive meters. The system consists of a dable vibrating string accelerometer, which is a modification of surplus accelerometers developed for the space program, mounted on a Sperry Mark 19 gyrocompass. Work this year will include improving the instrumentation and evaluating the meter at sea on different ships and in different sea states. Instrumental developments include finding the simplest solution to the Eotvos gravity errors associated with marine navigation.

Knowledge of the earth's gravity field is important for calculating the deflections of the vertical, needed for navigation. This task attempts to develop a meter that will provide more accurate gravity measurements at a lower cost.

SUPPORTED BY U.S. Dept. of Defense - Navy
8. ENGINEERING AND TECHNOLOGY

8.0102, DEVELOPMENT OF FISHNET BATHYKROMOGRAPH
J.E. CROSSEN, U.S. Dept. of Interior, Biological Laboratory, Woods Hole, Massachusetts
Purpose: To develop an instrument system that can measure the time, duration, and depth of each haul made by New England groundfish fishermen as a precise measure of fishing effort.

To provide acceptable hardware for a model of a standard system that will minimize the total cost of the complete operation from data collection to the printing of the final report. Specifically, to provide 20 fish-bathy-kromographs (FBK's) (DSE) for analogue readout including calibration equipment, and spare parts kits in accordance with contract 014-17-0007-820 and the assurance that the acceptance criteria have been met.

Approach: Contract development of the model system to a commercial contractor (Geodyne Corp.) with a Bureau coordinator and project leader (Mr. Crossen) in the lead Laboratory (Woods Hole). Oceanographic Instrumentation will coordinate the efforts of the Branches concerned with this project. A reliability engineering support contractor (Arine Co.) will supply services at prescribed check points.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

8.0103, SHIPBOARD GRAVITY SENSOR AND GYROCOMPASS
C.O. BOWIN, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543

A Sperry Mark 19 gyrocompass will be modified into a Mark 19c configuration and a Bosch Arma vibrating-airing accelerometer will be mounted aboard ship so as to function as a sea gravimeter similar to that developed by Von Arx and Wing.

SUPPORTED BY U.S. National Science Foundation

8.0104, INSTRUMENT STUDIES
D.C. WEBB, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543 (N00014-66-C0241)

The objective of this task is to provide advanced and comprehensive engineering support for a wide range of scientific and observational programs. This support will be achieved through the evaluation and improvement techniques, acquisition and testing of new components, and investigation of causes of failure. Work will be done in the laboratory and in the field.

It is expected that this work will generally benefit the program of the institution by improving new instruments. This in turn will improve competence available to the Navy for general oceanographic efforts.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0105, INSTRUMENTATION FOR LAKE CAYUGA HEAT RELEASE STUDY

Instrumentation has been designed, developed, calibrated, and installed for recording temperature profiles and flow rates at several points in Lake Cayuga in the vicinity of a fossil-fueled power plant. Four buoys and one rigid pole in the lake were used for the instrumentation installations, from which temperature and flow rate information is transmitted to shore via coaxial cable. (This cable also carries power for the instruments and low frequency command signals for sampling various instruments at the buoys and the pole.) The signals which measure the flow rate and temperature and are frequency modulated with an analog of the variable being measured. Time division multiplex is used for sampling of up to 24 signals from each of the buoys and the pole and to permit transmission of the data via the one coaxial cable. At the shore, the data can be extracted and recorded in digital or analog format. A digital-to-analog converter is available to permit monitoring of signals on a paper chart recorder. The sampled signals are connected to a telephone line to permit access to the data at a central location where equipment maintenance can be initiated, when necessary.

SUPPORTED BY New York State Electric & Gas Corporation

8.0106, STUDY OF PROBABILITY OF DETECTION AND FALSE ALARM RATE OF FREQUENCY ACOUSTIC TELEMETERING SYSTEM
R.A. HELTON, Raytheon Company, Portsmouth, Rhode Island

Purpose: To provide a model for a standard system that can measure the time, duration, and depth of each haul made by New England groundfish fishermen as a precise measure of fishing effort.

The objective is to provide advanced and comprehensive engineering support for a wide range of scientific and observational programs. This support will be achieved through the evaluation and improvement techniques, acquisition and testing of new components, and investigation of causes of failure. Work will be done in the laboratory and in the field.

It is expected that this work will generally benefit the program of the institution by improving new instruments. This in turn will improve competence available to the Navy for general oceanographic efforts.

SUPPORTED BY Raytheon Company

8.0107, DEVELOPMENT OF A SENSITIVITY STUDY, INSTRUMENTATION AND COMMUNICATION SYSTEM FOR A DEEP OCEAN MANNED HABITAT (ATLANTIS)
O.H. JACKSON, Raytheon Company, Portsmouth, Rhode Island

Technical Description: Conceptual development of electronic systems for a manned habitat for occupation of the ocean floor at 6,000 feet was initiated. Particular emphasis was directed to communications between habitat and surface; communication between habitat and telechiric devices; communications between men in the hyperbaric environment and the habitat; fail-safe emergency communications on several levels; navigation systems for precise localization and elevator mating; remote positioning and control of telechiric devices; long range acoustic sensing systems; sensors for the acquisition of physical, chemical biological and geological data; data handling to ensure crew safety; data handling to process and analyze the sensor information.

This effort involved basic to the evolution of the electronic systems necessary to support a long term manned mission on the edge of the shelf or on the mid-Atlantic ridge.

SUPPORTED BY Raytheon Company

8.0108, FEASIBILITY STUDY FOR A GATED-LASER, IMAGE-AMPLIFIER UNDERWATER VISION SYSTEM
T.W. SMITH, Raytheon Company, Portsmouth, Rhode Island

The growth in man's ability to exploit the oceans has made obvious the need for systems to identify underwater objects and to provide information for the direction of work. Underwater television provides a limited capability which must be extended for operation in turbid water. This program accomplishes a significant performance improvement through the application of a blue-green YAG laser for illumination, a Raytheon night vision image converter, a range gate for selecting the range of interest and a television system for delivery of the resulting images to a remote viewer. The program has included analytical study and experimental verification of results.

SUPPORTED BY Raytheon Company

8.0109, EXPERIMENTAL HIGH RESOLUTION SUB-BOTTOM PROFILING SYSTEM
G.M. WALSH, Raytheon Company, Portsmouth, Rhode Island

An experimental replica correlation echo sounder system is being developed, including transducer, power amplifier, receiver and signal processor. This system will experimentally verify performance of large time-bandwidth product (WT) signal processing for the measurement of depth and sub-bottom profiling, with potential signal processing gains of 23 db. The increased signal energy provided by the larges WT signals will significantly improve measurement resolution and provide capability for
8. ENGINEERING AND TECHNOLOGY

During the first of June, a two-man crew will investigate possible sonar sites on the Kasilof River, with the sonar unit should have a steep, sloping bank directly in front of the transducers which levels off and slopes gently to the stream bank. Migrating salmon generally will pass close to the steep bank directly in front of the transducers, when the bottom contour as mentioned above. A sonar site on the Kenai River was located during 1965. The sonar unit will be installed on the Kenai River June 1, and on the Kasilof River as soon as a suitable site can be located. Each of these installations will be operated by one temporary employee. The assistant project leader and a third temporary employee will sample upstream migrants in the immediate area of the sonar counter. Sampling will be conducted on each stream every other day. Lengths and scale samples will be taken to establish life characteristics of the sockeye salmon runs. Sonar counting and sampling of the adults will cease August 15 or as close to that date as the escapement dwindles.


8.0112, COOK INLET ESCAPEMENT ENUMERATION STUDY
A.S. DAVIS, State Dept. of Fish & Game, Juneau, Alaska

Because of the silty or glacial conditions of the major sockeye salmon systems in Cook Inlet, it is necessary to obtain escapement information by other means than counting towers, aerial or foot surveys, or other visual methods.

Bendix Pacific Corporation with the financial assistance of the State of Alaska, has developed a sonar counter which will enumerate passing fish. The experimental model of the unit was tested by the contractor on the Kasilof River in the summer of 1965. Escapement estimates of red salmon by the machine matched the visual estimates in the same time period with the State of Alaska, has developed a sonar counter which will enumerate passing fish. The experimental model of the unit was tested by the contractor on the Kasilof River in the summer of 1965. Escapement estimates of red salmon by the machine matched the visual estimates in the same time period.

During FY 68, a suite of instruments and modular components for bottom and subbottom acoustic profiling were acquired and initial modifications made to develop an advanced design, high-resolution acoustic subbottom profiling system applicable to detailed delineation of shallow water, heavy metal, placer type deposits. A new improved hydro-phone array has been designed and the electronic circuitry assembled. An ad-

330
vanced programmable subbottom profiling amplifier has been designed and fabricated to provide for programmable time-gain control, automatic gain control, and variable gain control for increased range, accuracy, and broader operating capability. The acoustic subbottom profiling system has now undergone the initial phase of conversion to a high-resolution acoustic sub-bottom profiler required for detailed characterization of shallow water placer deposits. Additional modifications will now be made to perfect the universal electronic amplifier with programmable gain and time circuits to drive the seismic records; also to the hydrophone arrays and sound sources. The outlook is for greater sensitivity, faster towing speeds, and higher quality records.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

8.0116. TESTING AND EVALUATION OF MAGNETOMETER/GRADIENTOMETER AND TOW VEHICLE SYSTEM

This project involves field testing, evaluation and modifications of the Bureau owned magnetometer/gradiometer and specially designed underwater two vehicle which was designed and fabricated during latter FY 68. The principle of the marine gradiometer system in operation involves towing of the sensor system and continuously recording the difference in the magnetic field intensity measured at the two rubidium magnetometer sensors which are separated a known distance in the towing vehicle.

Possible use of the system in the magnetometer configuration, with one of the sensors acting as a mobile magnetometer and the other as a base station transmitting the time variations in the earth's magnetic field to the mobile station by radio, will also be investigated.

Although present emphasis will be on heavy mineral placer deposits, possible application to heavy mineral lode deposits will not be overlooked. Other mineral deposits which may be associated with magnetic minerals will also be considered.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

8.0117. MOVABLE OCEAN MEASUREMENT SYSTEM
D.M. BUCK, General Motors Corporation, Goleta, California 93017 (NONR)

A special hydrophone array with associated electronics will be constructed and mounted on the Perpendicular Ocean Platform (PO). The system will be tested at the Santa Cruz Acoustic Range Facility (SCARF). In addition, a study will be made to determine the optimum spectrum analyzer configuration to be used with the system. A development breadboard model will be fabricated during latter FY 68. The principle of the marine gradiometer system in operation involves towing of the sensor system and continuously recording the difference in the magnetic field intensity measured at the two rubidium magnetometer sensors which are separated a known distance in the towing vehicle.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

8.0118. ARCTIC SEISMIC TRANSUDER EVALUATION
C.R. GREENE, General Motors Corporation, Goleta, California 93017 (NONR)

The U.S. Army Electronics Command has developed efficient seismic transducers which are used for various tasks where it is desirable to transmit signals using the ground as the conducting medium. The contractor will evaluate the effectiveness of these same transducers in transmitting, through Arctic ice, an acoustic signal to the ocean.

An efficient seismic transducer, capable of transmitting acoustic signals through an ice barrier to the sea water, would have Naval relevance in the areas of under-ice communications and navigation.

SUPPORTED BY U.S. Dept. of Interior - Navy

8.0119. TUNA PURSE SEINE NET
R.E. GREEN, U.S. Dept. of Interior, Fishery Oceanography Ctr., La Jolla, California 92038

The objective of this project is to introduce to the fishery a more efficient type of gear than that which is currently in use. A new design of fast-sinking tuna purse seine net, has been developed and is now being constructed. The net will be completed by the end of 1968 and during the subsequent years, operational experiments will be made with it at sea. If the tests on chartered commercial fishing vessels are successful, the net will subsequently be loaned to non-chartered tuna seiners for further tests and demonstration and acceptance by the existing fleet as an improvement over existing gear.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

8.0120. CONSTRUCTION SYSTEMS
UNKNOWN, U.S. Navy, Civil Engineering Lab., Port Hueneme - Point Mugu, California

Objective: Develop the technological data required for the selection of specialized work equipment and tools to perform construction operations on the sea floor. Present construction in the ocean has been largely restricted to relatively shallow depths (200 ft) with most of the work being done from the surface by lowering prefabricated components. There are limitations to this method due the effects of surface environment on movement of the platform and due to the contraints imposed by current cable technology and weight handling devices. Under this task studies and experimental effort will be undertaken to identify the problems associated with ocean construction due to the above constraints and to investigate the feasibility of using subsurface and bottom construction systems such as a submarine work boat or a bottom crawler.

Work undertaken in this area will be used for support of advanced development in construction equipment and techniques.

Approach: Identify and analyze the construction functions required to develop a construction capability. Some of the major functions to be studied are weight handling, assembling methods and excavation and trenching. Having identified the restraints, the best optimum methods for performing these functions will then be formulated and analyzed. From this analysis candidate systems for performing the construction functions will be designed and evaluated to determine what further development is required.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0121. PRECISION QUARTZ CAPACITANCE PRESSURE TRANSDUCERS
N.L. BROWN, Bissett Berman Corporation, San Diego, California 92122

The transducer being developed under this program is intended for numerous oceanographic applications where extremely high accuracy and sensitivity is required. This transducer takes advantage of the excellent elastic properties of quartz in conjunction with a technique for measuring capacitance which is extremely accurate and sensitive. This combination eliminates most of the sources of error common to other types of pressure transducers.

The transducer is in the form of two coaxial cylindrical elements fabricated in clear fused quartz. The diameter of the outer element is reduced slightly under the effect of pressure and the small deflection is detected by platinum electrodes deposited on the inside diameter of the outer piece and the outside diameter of the inner piece. The transducer capacitance is typically 75 picofarads at zero pressure and increases to 90 picofarads at rated pressure. This capacitance change can be utilized electronically in several ways which permit either a linear frequency change with pressure or a linear digital output. Existing prototypes exhibit accuracies of plus and minus .3 percent when utilized in oceanographic instruments and an accuracy of plus or minus .01 percent under laboratory conditions.

SUPPORTED BY Bissett Berman Corporation

8.0122. DEEP-SEA AUTONOMOUS VEHICLES, INSTRUMENTS, BASIC CONTROL DEVICES, AND SPECIAL COLLECTING GEAR
J.D. ISAACS, Univ. of California, Scripps Inst. of Oceanography, San Diego - La Jolla, California 92038

The objective of this project is to introduce to the fishery a more efficient type of gear than that which is currently in use. A
8. ENGINEERING AND TECHNOLOGY

This grant will provide for the continuation of work performed under NSF Grant GP-3349. The development and testing of deepsea autonomous vehicles, associated instruments, basic control circuitry, and special collecting gear. These together constitute a further development of this relatively new approach to the gathering of oceanographic data and specimens.

The autonomous or free vehicle is a versatile carrier that transports the instruments to depth and returns them to the surface for recovery. The control devices program the vehicle and control the instruments causing them to perform their required functions. Specific instruments that have been so far developed under this program include a bottom fish trap, current meter, vertical and saupling parachute net. Also, control, release and flotation devices have been developed. The following instruments are proposed for research and development: an instrument to measure the basic mechanical (engineering) properties of deep-sea sediments, a bottom camera, bottom detrital gauge, gas collector, event recorder (a device that waits for long periods to record a rare event), gentle core, large water sampler, and deep life support fish trap. The program of development works closely with investigators in the various fields. Thus, the instruments are simultaneously developed, tested, and used in the acquisition of meaningful data. Two recent cruises collected 17 near-bottom current measurements in 2,200 to 4,000 meters in three different locations for periods up to 3 days, and made 14 fish-trap drops.

SUPPORTED BY U.S. National Science Foundation

8.0123, DIGITAL OUTPUT SURVEY DEPTH SOUNDING
E.C. BUTT, Raytheon Company, South San Francisco, California

Technical Description: The purpose of this project is to develop a high precision survey depth sounder with a range of 2 to 250 feet and 2 to 250 fathoms with necessary signal processing so that the depth soundings can be read out in digital form as well as recorded on a conventional electro-sensitive paper. Logic circuitry is provided to give four bit parallel 1-2-4-8 BCD code output for recording on magnetic tape or feeding directly into a computer.

The equipment is designed in splash proof cast casings and suitable transducers are provided either for mounting in a small sounding launch or on a large survey type vessel.

The system is suitable for interfacing with such position finding systems as Decees Hi-Fix and Cubic Corporation Autotape.

SUPPORTED BY Raytheon Company

8.0124, OIL - WATER SEPARATOR
UNKNOWN, Cuno Engineering Corporation, Meriden, Connecticut 06453

PURPOSE: To develop an effective shipboard oil-water separation system as a means to prevent pollution of the seas by oil discharged with ballast water.

DESCRIPTION: A land-based pilot system has been built and tested at the contractor's seawater test laboratory. Results to date have been successful, but only at a significantly reduced throughput. The filters have since been further modified to increase separation efficiency at higher flow rates and additional tests will be conducted.

Further investigations and tests have examined effects of oil concentrations, oil viscosity, flow rates, differential pressure, temperature, and filter cleaning speed. It has been found that oil concentration, mixture, flow rate and differential pressure are the major considerations in the separator development. Tests are continuing to provide data for design of a practical shipboard separator.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8.0125, SELF-REGULATING STEAM GENERATOR
UNKNOWN, Combustion Engineering Inc., Windsor, Connecticut

PURPOSE: To develop an automatic Self-Regulating Marine Steam Generator having improved boiler control and performance characteristics and reduced complexity.

DESCRIPTION: The unit is an inherently self-regulating steam generator system with a series turbine mounted between the boiler drum and superheater providing combustion control based on steam demand. The boiler response time to meet changes in steam demand basis is reduced by use of welded water-walls and minimization of heat absorbing boiler brickwork. The unit has feedwater control integrated as part of the self-regulating steam generation process and will provide complete automatic response to single lever propulsion control. It has capacity for a 20,000 SHP turbine propulsion ship. The unit is fully erected at NAVSEC, Philadelphia, and is undergoing a series of preliminary tests to determine operating characteristics.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8.0126, BIO-ACOUSTIC AND BIOLOGICAL SAMPLING GEAR STUDIES
W.L. ARON, Smithsonian Institution, Washington, District of Columbia 20560

This task covers the laboratory analysis of sixty collections taken with the Hardy Continuous Recorder, the International Indian Ocean Expedition plankton net and the International Cooperative Investigations of the Tropical Atlantic (ICITA) plankton nets. These samples were taken in the Indian Ocean during the round-the-world voyage of the USC&GS Oceanographer. The catch data from the different samplers will be compared and related to acoustical data obtained from the ships EDO-PDR system and narrow-beam transducer sonar.

The volume reverberation of underwater sound in the oceans, caused by marine organisms, is of concern in marine operations. This study will provide new information on the sampling gear used to catch the organisms and will relate research equipment performance to the catches. Ultimately, this information is required for mapping or predicting areas of the oceans in terms of volume reverberation.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0127, STANDARDS FOR AUDIOMETRY

Maintenance and improvement of Sound Laboratory facilities for the calibration of audiometric devices, such as earphones, bone vibrators, artificial ears and artificial headboxes. Measurement of stability, distortion, and sound attenuation properties of circumaural earphones; accuracy of commercially available audiometer calibrators, and properties of artificial ears proposed as standards. Establishment of a cheaper, accurate and fast audiometric earphone calibration service. For new types of audiometric equipment, investigations of their properties and development of calibration procedures. Determination of the mechanical driving-point impedance and sensitivity of artificial headboxes proposed as standard devices for storing bone-conduction threshold data and for calibrating audiometric bone-conduction receivers. Participation in the work of USASI, IEC and ISO.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

8.0128, ENVIRONMENTAL TEST AND EVALUATION
J.G. LARSON, U.S. Navy, Research Laboratory, Washington, District of Columbia

Objective: 1. To perform acoustical and electrical tests, using pulse techniques, on transducer models, 2. To measure acoustic and electrical properties of transducers under hydrostatic pressure. 3. To determine the acoustic properties of acoustic linings for use in acoustic tank. 4. To determine effects on transducer materials under loaded and unloaded conditions.

Approach: The basic approach for all test work is to outline the program, provide necessary equipment, coordinate and perform the tests, and prepare and submit the required reports. The approach in providing facilities is to study and survey needs and requirements, formulate basic designs and specifications, initiate and coordinate design actions and construction and/or procurement.

SUPPORTED BY U.S. Dept. of Defense - Navy
8.0129, DESIGN AND DEVELOPMENT OF NEKTON
SAMPLER
Miami, Florida

Objectives: To design optimum gear for sampling tuna forage
nekton capable of: (a) capturing and retaining the desired com-
ponents of the nekton community, (b) sensing environmental
variables at the time of sampling, and (c) reporting the sample
certain data relating to the behavior of the device itself (e.g.,
speed through water, changes in sampling depth, amount of
water strained, etc.).

Through consultation with hydrodynamics design engineers,
new approaches to nekton sampling equipment will be sought. If
feasibility studies develop a promising design, a prototype will be
constructed and tested under controlled and field conditions.
Feasibility studies develop a promising design, a prototype will be
constructed and tested under controlled and field conditions.
A further use of production models will depend upon the outcome of the latter trials.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

8.0130, CHEMICAL EXPLOSIONS, PACKAGING AND
HANDLING AT SEA
D.W. KOS, 11 T Research Institute, Chicago, Illinois (DA49-083-
05A-3198)

Technical Objective: To develop containers and techniques
for detonating underwater chemical explosions in the size
range from 10-1000 tons. Provision to be made for controlled
sink rate and capability to detonate to depths of 4000 feet.

Approach: Design modular containers in three size ranges;
10-40 tons, 50-200 tons, and 250-1000 tons. Conduct theoretical
and laboratory studies to determine optimum explosive for use
with containers considering cost, safety, ease of handling and
minimum legal constraints, and compatibility with container
material. Construct prototype containers and sea testing including
detonation.

Progress: Container design completed. Steel shell with
designs that allow for compressibility and buoyancy chambers
with calibrated flooding to provide pre-determined sink rate.
Pressure fuse for detonation up to 4000 feet. Instrumented for
explosive time and depth. Aluminized ammonium nitrate slurry
selected for two 10-ton prototypes successfully detonated
off California coast in February 1968. A 250-ton container built,
sea tested, and detonated in deep water off Aleutians on 5 Sep-
tember 1968. The 250-ton container was 20 feet in diameter and
50 feet long, with a hemispherical nose and a skirted stern. It had
forward and aft buoyancy chambers and a 5,000 cubic foot explo-
sive chamber. Three 30-foot pontoons were located at equal
distances around the body for towing stability with the bottom
doono flotation for ballast. The explosive chamber contained
250 tons of a slurry which produced a seismic output equivalent
to the underwater detonation of about 340 tons of TNT. As-
solated instrumentation obtained detonation time and depth and
provided redundant systems for improved reliability of detona-
tion.


8.0131, INVESTIGATION OF METHODS TO REDUCE
SUCTION AND DISCHARGE LOSSES OF A PERIPHERAL
COMPRESSOR
F.D. DUFF, Mass. Inst. of Technology, School of Engineering,
Cambridge, Massachusetts 02139

Information concerning the improvement of performance of
peripheral compressors is very inadequate. The objectives of this
study are as follows: (1) to evaluate certain methods of suction
and discharge loss reduction in peripheral pumps; (2) to deter-
mine the streamline pattern from measurable machine parame-
ters and; (3) to determine the effectiveness of the stripper section
in controlling high pressure carry-over flow and its effect on the
through-flow rate at high Mach numbers.

Losses in the inlets and exit sections are a significant portion of
the overall compressor inefficiency and can be reduced by
proper design of these openings to conform to the machine
streamline pattern and thus offering resistance to the flow.

The loss-reduction methods are evaluated and found to in-
crease maximum efficiency by as much as 6 per cent. Streamline
directions can be calculated from specific machine variables and
conform closely with those observed. The stripper section
becomes less effective at higher Mach numbers and as much as 14
per cent of the through-flow is lost through flow carry over.

SUPPORTED BY Massachusetts Institute of Technology

8.0132, A DESIGN PROGRAM FOR SUPERCONDUCTING
ELECTRICAL MACHINES, PART II
D. GREENEISEN, Mass. Inst. of Technology, School of En-
gineering, Cambridge, Massachusetts 02139

This paper presents a procedure for the design of supercon-
donducting electrical machines. The magnetostatic field problem of a
cylindrical superconducting machine is solved. Equations for
the magnetic fields are developed, and from these, expressions for the
various machine parameters are obtained. These expressions are
adapted to a computer solution of the design problem. The com-
puter program obtains the design parameters for a minimum
volume machine design.

A design study for a typical marine electrical propulsion
system is conducted. The results of this study indicate quantita-
tively that the reduction in weight and space to be obtained in using
superconducting electrical machines vice conventional electrical
machinery. The study also presents some general characteristics of
superconducting machines.

SUPPORTED BY Massachusetts Institute of Technology

8.0133, TRAWL DESIGN, MATERIALS AND METHODS
Base, Gloucester, Massachusetts 01930

The primary purpose of this project is the development, test-
ing and introduction to industry of new and improved trawling
equipment. In the past, industry has been aided in its investigation
and trials of different types of trawl gear both by Base instigation
and industry-State-Federal cooperative activities under FL 88-
309. Current development activities now emphasize improving
the wing spread and headboard height for existing nets as well as
developing, testing and introducing an improved type of bottom
trawl net.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

8.0134, PELAGIC TRAWL
M.G. CORBETT, U.S. Dept. of Interior, Exptl. Fish & Gear Res.
Base, Gloucester, Massachusetts 01930

Research and development is to be continued to design a
trawl system capable of capturing fish at any desired depth inde-
dendent of vessel speed and warp length/depth ratio. Efforts are
oriented to microturbulent control of trawl door attitude to
effect depth changes and the development of an efficient high
lift/drag ratio trawl door.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

8.0135, MECHANIZATION OF TRAWL GEAR
M.G. CORBETT, U.S. Dept. of Interior, Exptl. Fish & Gear Res.
Base, Gloucester, Massachusetts 01930

Concurrent industry-Bureau interest in mechanization of
trawling gear is implemented by activities programmed under this
project. Basic objectives are improvement to the safety, economy
and efficiency of existing older trawl vessels. The overall ob-
jective of current activity is the development of a device to auto-
matically couple and uncouple the trawl doors from the towing
warps during the setout and haulback sequences of the trawl
operation.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

8.0136, GREAT LAKES GEAR RESEARCH
J. ELLIS, U.S. Dept. of Interior, Exptl. Fish & Gear Res. Base,
Ann Arbor, Michigan

The Region 4 Exploratory Fishing Base is responsible for the development of efficient and effective commercial fishing and
research fishing techniques through virtually all of the freshwater
commercial fish producing areas in the U.S. The fishing industry

333
8. ENGINEERING AND TECHNOLOGY

in this region is with few exceptions in an extremely depressed condition. A primary cause of this condition is the inadequacy of traditional fishing methods and equipment for meeting the present day situation from both resource and economic standpoint. Not only has the abundance of traditional commercial species changed markedly in most waters, but new outlets for low value species have been developing at a rapid pace in recent years. The paradox of having more fish than ever available for commercial use and an ailing fishing industry is explainable only the failure of the industry to progress technologically relative to the development and use of equipment, instruments, materials, and systems that are necessary to keep abreast of changes in fish populations and in potential uses of fish.

Objectives of the Great Lakes Gear Research Program are to improve fishing techniques, to develop more efficient harvesting devices, and to demonstrate the application of appropriate methods for meeting unique production conditions, often in waters supporting important sport fishing activities.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

8.0137, UNDERWATER ACOUSTIC HOLOGRAPHIC DISPLAY
R.K. MUELLER, Bendix Corporation, Southfield, Michigan (N00014-68-C-0338)

Objective: The Navy's interest in target classification, underwater observation, and the extension of underwater vision beyond the limits of range permitted by conventional light optics provides the incentive for this research. The application of lensless imaging (Holographic techniques) will be investigated using acoustic energy as the illuminant.

Approach: An investigation will be conducted in multiple element receiver arrays, multiplexing of signals electronically, and unique transduction techniques. Experimental hardware will be designed and constructed from which underwater acoustic holographic images will be obtained using photographic methods and a multi-element array.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0138, DEVELOPMENT OF UNDER-ICE HORIZONTAL SONAR SCANNING EQUIPMENT AND TECHNIQUES FOR LOCATING FISH SCHOOLS
C.R. BURROWS, State Dept. of Conserv., Saint Paul, Minnesota 55101

Objectives: 1. To adapt existing horizontal scanning sonar apparatus to under-the-ice commercial seining operations on inland lakes. 2. To demonstrate the gear and techniques to the local commercial roughfish seiners and promote its adoption in the industry.

Procedures: 1. Selection and acquisition of horizontal scanning sonar apparatus from among those currently offered to the industry by three different manufacturers. 2. Install this equipment on a sled or other snow vehicle for transportation to locations where fishing operations are being conducted. 3. Learn to interpret visual presentation of the equipment in terms of qualities of fish and species composition of the schools. This will be accomplished by scanning commercial haul areas before seine hauls are made, and comparing the actual catch of the seine with the prediction made from the equipment. 4. If and when results can be predicted with a high degree of reliability, a promotional program will be undertaken to establish this equipment in the industry. It will be demonstrated to all of the commercial seiners who may be in a financial position to afford this kind of refinement. It is expected that the first summer will be involved with the selection, acquisition and adaptation of the gear. The first winter will be involved with learning to use it and interpret the read-out. Further experimentation with gear and methods and promotional or extension work should occupy the second winter.


8.0139, DEPTH CONTROLLED STREAMER DEVELOPMENT
R. BRODING, Seismograph Service Corp., Tulsa, Oklahoma

NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY Seismograph Service Corporation

8.0140, DEEP-SEA CORE MAGNETOMETER AND A CORE ORIENTATION SYSTEM
D.E. HEINRICHT, Oregon State University, Graduate School, Corvallis, Oregon 97331

A device will be obtained for determining the orientation of ocean sediment cores and a sensitive spinner magnetometer procured to study directions of movement of core material. The equipment will be assembled from commercially available parts.

SUPPORTED BY U.S. National Science Foundation

8.0141, DEEP SEA PHOTOGRAPHIC SYSTEM AND A BOX CORER
L.D. KLUM, Oregon State University, Graduate School, Corvallis, Oregon 97331

Support is provided to construct a box corer and to purchase a stereo camera. The camera assembly and box corer may be used as separate systems or combined into a single camera corer. A mutual need for the gear has arisen among the marine geologists and the benthic ecologists at Oregon State University, Department of Oceanography. This equipment would augment and broaden the scope of present research programs.

SUPPORTED BY U.S. National Science Foundation

8.0142, MANAGEMENT OF THE OCEAN SALMON FISHERY WITH EMPHASIS ON THE BARBLESS HOOKS AS A MANAGEMENT TOOL
R. LOEFFEL, State Fish Commission, Portland, Oregon 97201

The hook and line (troll) fishery for chinook and coho salmon in the ocean uses gear that will catch salmon that for reasons of size limit and season cannot be kept. However, the effects of hooking results in mortalities to fish number into the hundreds of thousands annually. Part of this mortality is due to damage done when the barbed hook employed is removed from the fish. Such loss could be avoided if a "barbless" hook were used. The objective of the program is to measure the difference in survival of fish released from each kind of gear and to obtain information on the efficiency of barbless hooks for catching legal-sized salmon. Further information on salmon origin and migration will also be obtained. The work will be done along the north Oregon coast. Barbless and barbed hooks will be fished in paired fashion. Data on hook efficiency will be collected immediately. Survival information will be gleaned from the returns of tagged fish. Field work will commence in April 1967 and continue through June 1967. A second year of field work is anticipated. Project conclusion will be in 1970.


8.0143, PRELIMINARY TESTING OF PELAGIC TRAWLS ON SMALL DRAAGERS
R.W. BURTON, State Dept. of Nat. Resources, Providence, Rhode Island

Initial testing of available trawls is necessary to determine the type of trawl best suited for small draggers and to learn the most efficient and effective methods of handling the gear. It is also more economical to eliminate one trawl appearing less efficient or more difficult to handle, or a combination of two appearing best.1. A 220 HP vessel will test: the Boris trawl (British), Herman Engel trawl (German), and a Cobb trawl (American). 2. A 350 HP vessel will test: the Boris trawl, Herman Engel trawl, and the Cobb trawl. 3. Operating characteristics will be measured and recorded, including (but not limited to) the following a. Opening at mouth of trawl: height and width, determined by transducers on headrope and trawl doors. b. Speed of towing (constant tide or current) during given rpm over a measured course. c. Characteristics of handling, operating gear, including ease and accuracy of depth adjustment.

Part I of 2.

334
8. ENGINEERING AND TECHNOLOGY

This work seeks measurement of the equivalent fixed intensities of incandescent flashing lights of various flash duration. Hypotheses concerning brightness matching and/or magnitude estimation techniques will be used. With the former technique, a succession of reference flash lengths may be necessary at each supra-threshold level until a steady source is approximated.

The Coast Guard is primarily interested in a quantitative determination of the equivalent fixed intensities of flashing lights as a function of their intensity time distribution for each of the following observer conditions: When the equivalent fixed light illumination at the observer is 0.2, 2 or 20 microlux, then the background brightness is 0.1, 1.0, or 31 nits respectively. From this information, the validity of the Blondel-Ray absolute threshold relation for use at these levels will be studied.

The Coast Guard is secondarily interested in a quantitative determination of the supra-threshold advantages to be gained by means of flashing lights as a function of observer background. Thirdly, it is interested in the variation of the equivalent fixed intensity of a signal light as a function of the supra-threshold level at which it is observed.

SUPPORTED BY U.S. Dept. of Transportation - Coast Guard

8.0148. TAG DETECTION
E.D. JEWELL, State Dept. of Fisheries, Olympia, Washington

Project staff will acquire tag detection equipment, using the same to detect tags in the Puget Sound coho fishery where fish with previously applied color coded, magnetic wire tags will be caught and landed. These field tests will reveal a range of short comings of the equipment as now constructed, as relates to the variety of conditions under which it will need to operate in order to be most useful in furthering fisheries research and management objectives. Equipment will undergo continual and necessary adjustments and adaptations of technique as experience in its use may direct. Several detectors and spares will be available for use at one time, to provide broadest coverage during the limited season when tagged fish will be present in the fishery for testing. Tests will be centered chiefly on coho in the Hood Canal and Admiralty Inlet areas, where tagged fish will occur in greatest density by reason of proximity to their home streams. Tests will cover the commercial coho fishery, as well as sports caught coho, and finally home streams of release at spawning time. The period for coverage of the commercial net catch will be restricted to the September-November fishing season as prescribed by law. The sports catch will be examined through the period when significant numbers of coho occur in this fishery. Stream coverage will extend from November through December.

Support vessels required for contacting the fishing fleet on the grounds will be supplied by the Department of Fisheries.

Part 1 of 2.


8.0149. TAG EXTRACTION
E.D. JEWELL, State Dept. of Fisheries, Olympia, Washington

Under this phase effort will be directed toward: (1) removal of portions of the head of coho salmon, detected as having been tagged, and the final removal and identification of the tag. (2) develop a tool and associated techniques for removing head portions with a minimum but acceptable level of damage to either the market value of the fish, or its trophy value if sports caught.

Further work under this phase will involve personnel training in the complete extraction, identification and recording of tags recovered. These procedures are presently in their infancy and will require considerable refinement as part of the total program of coded wire tag development, directed toward a full realization of the potential of the device. The laboratory site utilized for tag recovery work will be selected later. In addition to tag removal and identification, coming from Sub-project 1, prior training of tag removal personnel (June-August) will occur with the use of fresh fish and fresh tissue will ar-
8. ENGINEERING AND TECHNOLOGY

rived, allowing also for concentrated efforts by other personnel on problems of field detection.

Part 2 of 2


8.0150, UPGRAADING CONVENTIONAL FISHING TECHNIQUES

A study of conventional methods of capturing marine animals is being conducted in an effort to apply the benefits of modern industrial technology to the commercial fishing industry of the Pacific Northwest.

Principal experiments include the application of electronics, instrumentation, telemetry, hydraulics, echo ranging, echo sounding, streamlining techniques, more efficient deck layout, modern shipboard machinery, improved geometry of fish nets, better ratio of horsepower to gear size, safety, and synthetic materials.

Initial experiments are concerned with determining the effectiveness of midwater trawling and its possible application in the commercial fisheries. As part of the midwater trawling investigations, experiments are also conducted utilizing electrical towing cables and remote instrumentation such as depth and temperature telemetry, catch indicators, bottom contact indicators, load indicators, underwater lighting, high frequency echo sounding, electrical shocking gear, and remote actuation devices.

Improvements in the geometric configuration and general performance of midwater trawls are attempted through the use of sea sled mounted scuba divers who observe the gear in action and make recommendations for design changes. Current investigations involve use of internal fykes, intermediate and cod end liners, maximum efficiency of webbing, incremental hang-in techniques for better load distribution, and determination of minimal speed requirements.

Work schedules in the near future include: automation of towing vessels, near bottom trawling over rough round, and deep-water demersal fish traps.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

8.0151, DEVELOPMENT OF NEW FISHING TECHNIQUES

Utilizing modern methods of underwater observations such as SCUBA, television, still and motion photography, and electronic and acoustic telemetry, information is collected on the behavior of fishes, performance characteristics of fishing gear, effect of bottom topography on active fishing gears, and other factors influencing the capture of marine animals.

Data is collected on the physical factors involved in the various parameters of fishing gear performance such as load shock, shear, stress, vibration, speed, drag and pressure.

Experiments are conducted utilizing light, sound, electricity and chemicals to determine their effectiveness in facilitating the capture of marine animals.

Information thus gained is used in the design, construction, test, and evaluation of experimental devices and methods which might be used by commercial fishermen to capture marine animals.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

8.0152, OCEAN ENGINEERING

The objective of this program is to upgrade commercial fishing techniques by incorporating modern engineering technology into new gear designs and methods.

Experiments will be conducted with a special polyurethane coating for nylon netting to reduce chafing during fishing operations.

Improvements will be made to an electrical depth telemetry system. A digital readout to improve accuracy and improved underwater connectors to improve reliability will be tested.

Electronic devices to monitor vertical and horizontal mouth opening and strains that develop in the trawl during fishing operations will be tested. Nylon rope with stretchable electrical conductors will be used to monitor devices placed on the trawl.

An electrical shocking system for improving the catching efficiency of trawls is being examined.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

8.0153, FISHING GEAR RESEARCH AND DEVELOPMENT

The objective of this program is to upgrade commercial fishing techniques by improving existing fishing methods and developing new gear designs.

Seminar for fishermen will be scheduled. New gear, construction techniques and handling methods will be presented and discussed. This will be supplemented with still and motion picture photography of operational fishing gear.

Tests and modification to the Universal trawl will be continued. The objective is to design a commercially acceptable trawl that can be fished at any level in the water column.

Design and construction of a trawl net to incorporate a third towing warp operated from the trawl net reel will be completed. Sea trials are scheduled for late FY 1969.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

8.0154, UNDERWATER CAMERA SYSTEM
L.C. BENNETT, Univ. of Washington, Graduate School, Seattle, Washington 98122

The purpose of the purchase of an underwater camera system is to replace a system lost during a recent oceanographic cruise. This camera system will permit the continuation of investigations in the Northeast Pacific Ocean and regional inshore waters, and will provide invaluable photographs of bottom sediments and structures to supplement data obtained by other geological and geophysical methods.

SUPPORTED BY U.S. National Science Foundation

8.0155, INVESTIGATION OF NUCLEAR THERMIONIC POWER SOURCES
J.E. GINGRICH, General Electric Company, Pleasanton, California

This project is investigating the application of nuclear thermionic power to the marine environment.

The utilization of nuclear reactors which can generate electricity directly is of interest to marine systems because of several attractive features: namely, compactness, long life, silence, reliability, etc. Major research programs are currently underway in this country and abroad to develop components for thermionic reactors which are intended primarily for space applications.

While much of this technology is directly applicable to marine systems, there are also major differences that must be considered. This project is utilizing the results from other thermionic reactor R & D Programs and applying it to systems for the marine environment. The work is being accomplished primarily through the formulation of preliminary designs for thermionic reactors suitable for underwater use.

This work began in 1961 and will be continued indefinitely in pace with other thermionic power development programs.

SUPPORTED BY General Electric Company

8.0156, POWER SOURCES
UNKNOWN, U.S. Navy, Civil Engineering Lab., Point Mugu, California

336
Objective: Adapt electronic power sources to ocean bottom and subbottom installations. Installations on or in the ocean floor will require electric power to perform missions and for station support. Power sources are available for ocean application are conventional, nuclear reactor, isotope generator and storage battery. These sources with the exception of conventional can be either in-situ, surface tendered or shore based. However, each of these sources will require that their system characteristics be matched to the operational requirements of the installation. Associated problems such as safety, waste heat removal, power transmission, and incompatibility of equipment to size of pressure hull exist and must be solved before placement of the power source can be completed. Information on submarine cables is available for use in power transmission systems, however, suitable power connectors have not been developed. The goal which will be achieved under this task area will be to develop the technology (excluding the development of power source) to adapt power sources in ocean areas.

Approach: Achievement of the objective involves work in the following areas: Area 1: Develop the safety criteria for use with ocean power sources. Results of current studies will indicate problem areas in safety design which must be solved. Area 2: Develop power connectors for use in power transmission systems for ocean installations down to 5000 feet. These power connectors will have to be compatible with existing submarine cables. Area 3: Investigate the problems encountered in incompatibility of equipment size to pressure hull feasibility in emplacement of large power sources down to 6000 feet. Area 4: Develop criteria to solve the waste heat problems encountered in placing power source in-situ.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0157, HYDROGEN PROPERTIES

Most of the refractive index of fluid hydrogen and the dielectric constant of solid hydrogen have been completed. They have been analyzed in terms of the density and temperature dependence of the Lorentz-Lorenz function and the Clausius-Mossotti function. The results find application in the densitometry of fluid and slush hydrogen by the aerospace industry. Their scientific value lies in providing new information on the interactions between molecules.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

8.0158, UNDERSEA PROPULSION AND POWER SOURCES

Objective: Develop power sources for application to undersea propulsion. These sources, either as chemical heat generators or as electrical energy generators must provide power at rates significantly exceeding those of present sources. The combustion of some metals or inorganic materials specific energies far greater than the combustion of the usual organic fuels. To develop superior high energy-density batteries, electrolytic systems based on liquids other than water are being explored.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0159, PROPULSION FOR SWIMMER VEHICLES

Objective: Develop propulsion of closed cycle power systems for use in swimmer delivery vehicles (SDV).

The power system under investigation includes a closed exhaust heat engine, utilizing chemical fuels which will provide mechanical power for SDV propulsion, electrical power for vehicle electronic equipment, and heat energy for swimmer heating. Approach: A contract was let to industry to establish state-of-the-art of the thermoelectrical power field and to establish the optimum type closed cycle power system to meet specific SDV propulsion requirements. Based on the results of this study an experimental model of the closed cycle propulsion system, as recommended by the study, will be developed. Development of the experimental model of the system will demonstrate feasibility of the closed cycle concept and will provide the design parameters and operating characteristics necessary for development of a developmental system.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0160, HYDROGEN-OXYGEN FUEL CELLS

Objective: Develop laboratory breadboard modules of fuel cells operating on hydrogen (H2) and liquid oxygen (LOX) for ultimate encapsulated advanced development of a family of 5 to 30 KW systems for undersea operation. Operational aims: power density (exclusive of fuel and oxidant), 50 lbs per KW; operating life, 5000 hrs (before 30% loss in power); electrode precious metal load, 20 GM per KW (max). Dis-covered to use for both continental shelf (gaseous H2 and LOX) and deep submergence (liquid H2 and LOX) operations. Ancillary objectives include: generation of hydrogen from liquidly fuelable fuels (EG, JP5, methanol) for shallow operation; delivery and storage handling of liquid H2 and LOX for deep submergence. Power plants of this type will permit a ten-fold increase in energy capability over secondary battery systems.

Approach: Development and evaluation through industry and Navy labs of a 5 KW cryogenic H2-02 fuel cell module designed, from the standpoint of heat rejection and purge gas handling; for encapsulation and testing under simulated ocean environment conditions. This approach will be closely integrated with a 5 KW encapsulated system to be operated in an outer space environment. Evaluation of latest state-of-the-art 2.5 KW circulating electrolyte H2-02 fuel cell module under submarine attitude conditions (pitch, roll, yaw, ascent, descent). Development of hydrogen generators operating on JP 5 or methanol for use in conjunction with 10 to 30 KW fuel cell system. Establishment of safe method of delivering and handling cryogens (H2 and O2) for deep submergence fuel cell use. Solution of problems of voltage regulation, off-design performance, etc., fuel cells.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0161, COLLATION OF POWER PLANT STUDIES
UNKNOWN, Illinois Institute of Technol., Graduate School, Chicago, Illinois 60616

The five power plant studies sponsored by the Maritime Administration during the period 1961 through 1964 dealing with the design of economical integrated power plants for the propulsion of future American merchant ships were reviewed and combined.


ITIRI extracted sufficient information from the above reports to permit a direct technical and economic comparison of the respective power plants, with the information condensed into one concise volume. The report gives brief descriptions of the plants and their auxiliary systems, and compares the economic factors on a common basis with respect to estimated initial costs and operating costs.

The study concludes that the diesel powered ship seems to be the most economical, and steam powered vessels have an economic advantage over those powered by gas turbines. It also concluded that with anticipated improvement in construction materials the gas turbine power plants will show greater promise. The report PB No. 175-612 is available from the Federal Clearinghouse for Scientific and Technical Information, Springfield, Virginia, 22151.

337
8. ENGINEERING AND TECHNOLOGY

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8.0162, THERMO-ELECTRIC GENERATORS
A.B. NEILD, U.S. Navy, Marine Engineering Lab., Annapolis, Maryland 21402

The work under this task is to complete the evaluation of a thermo-electric generator developed for use in the ONR/Convair oceanographic buoy. Bench tests will be conducted to verify the performance and verify the system for extended operation at sea. The installation will be beneficial to buoy development programs and to other similar requirements of the Navy's operations.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0163, LOADING CHARACTERISTICS OF A CHARGE-CONSTRAINED SYNCHRONOUS GENERATOR
J.P. REGAN, Mass. Inst. of Technology, School of Engineering, Cambridge, Massachusetts 02139

Previous electric-field-type electromechanical energy converters have relied on a variable capacitance, with terminal voltage constrained. An electrostatic generator is studied which employs a spatially varying charge distribution with the potential unconstrained. Energy is converted from mechanical to electrical form by means of a synchronous interaction between the excitation charge wave on the moving medium and the fixed load. Power output characteristics for both a continuum and discrete loading arrangements are derived and analyzed. A study of the effects of discrete loading is essential to understanding operation with a finite number of phases.

It is shown that such generators may be modeled by an equivalent circuit containing a current source in parallel with a characteristic internal capacitance and a load impedance. The values of these circuit elements are determined by the excitation charge wave and geometrical factors such as load-to-charge wave spacing, charge-to-ground potential distance, and interelectrode spacing and number of phases in the discrete loading case.

For the discretely loaded generator, the output theory is derived by assuming the form of the potential distribution along the loading electrodes. The discreteness requires that Fourier techniques be used and that the distribution be treated as an infinite sum of spatial harmonics of the fundamental wavenumber of the exciting charge wave. A six-phase, discretely loaded generator with an electrode-to-interelectrode width ratio equal to 1.54 is analyzed in detail. It is shown that this generator can deliver 75% of the power available from a continuously loaded generator having the same excitation and physical parameters. Data are presented to predict output power for discrete loadings, the range of which varies from five to 42. A six-phase laboratory generator is used to determine the equivalent circuit element values.

The theory predicts the current source magnitude to within 6%. With the stray capacitance due to electrode geometry constrained, the characteristic internal capacitance is predicted to within 5% by the theory.

SUPPORTED BY Massachusetts Institute of Technology

8.0164, AUTOMATIC BOILER CONTROLS
UNKNOWN, Cleveland Cliffs Iron Co., Cleveland, Ohio

Purpose: To install, test and evaluate automatic marine boiler control system capable of safe and economic operation without human intervention over the entire range of ship operations.

Description: The system provides automatic start-up, purging, restarting, and operation of feedwater, fuel, and air control for a marine boiler to enable it to respond to turbine throttle steam demand for maneuvering and steady ship operations. As installed on a single boiler ship in Great Lakes service, the control operation is continuous from soring start-up until winter shutdown.

The Steamer WILLIAM G. MATHER is currently in its fifth operating season with these automatic boiler controls installed. The controls have required only normal routine maintenance and, once the system was debugged, no operating casualties have occurred.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8.0165, HIGH-POWER HYDROACOUSTIC VIBRATOR DEVELOPMENT
R.A. BRODING, Seismograph Service Corp., Tulsa, Oklahoma

Summary: Previous hydroacoustic vibrators for marine "VIBROSEIS" operation were power limited to approximately 94 db ref. 1 yard. An improved vibrator was evolved that was capable of 104 db output over a greater frequency spectrum. This vibrator made use of a hydraulic power source of over twice the power output in a prime mover, a hydraulic pump of twice the flow capability and a servo control valve of over six times the flow capability. The vibrator proper makes use of a four foot diameter water piston compared to a 30-inch piston previously used. The ram area and stroke were increased to give essentially a full power capability from 10 to 120 Hz. Extensive testing of this vibrator has verified its power capability and reliability under extended operations with the vibrator under tow at 6 knots and at depths of 35-40 feet.

SUPPORTED BY Seismograph Service Corporation

8.0166, AN IMPROVED MARINE VIBROSEIS INSTALLATION
R.A. BRODING, Seismograph Service Corp., Tulsa, Oklahoma

Summary: Four high-powered hydroacoustic sources with four power units, hoists, hydraulicFW and tow arms were installed on the Motor Vessel King Tide. The 703 computer-controlled data acquisition system was also installed, along with a 1 or 1/2 mile 24-channel streamer cable, streamer depth depressors and storage reel for the streamer. The system was designed for continuous tow as 6 knots with the vibrators and streamer depressed at 30-40 foot depth. In a typical working day 50 miles of data are collected. If navigation control permits, this coverage can be doubled with a second shift. Redundancy in equipment as well as alternate modes of operation permit little loss of time in case of any failures in the system. The greatest deterrent is the limitation in working in seas of not greater than sea state 4 due to noise on the cable and ability to work on deck.

SUPPORTED BY Seismograph Service Corporation

8.0167, MERCHANT SHIP REACTOR PRELIMINARY SAFETY ANALYSIS
UNKNOWN, Westinghouse Electric Corp., Pittsburgh, Pennsylvania

Purpose: To prepare a Preliminary Safety Analysis of the proposed Westinghouse Maritime Reactor Plant installed in a merchant ship to determine acceptability of the design from a safety viewpoint, and necessity for further related research and development work.

Description: The government and Westinghouse jointly funded the preparation of a Preliminary, Safety Analysis of the advanced Westinghouse maritime reactor design, installed in a representative ship. The special design safety features include omission of the secondary reactor space containment, and containment vessel blowdown to the innerbottom in case of primary system rupture. Compared to the SAVANNAH, the reactor features higher power density, smaller containment vessel with much higher design pressure, close coupled primary coolant system components, and a five-year core requiring soluble neutron poison in the coolant at beginning of core life as well as burnable poison in the fuel.

The Safety analysis will be furnished to the Atomic Energy Commission for their review.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.
8.0168. **A Pilot Plant Study of Low Excess Air Combustion - Its Effect on Fireside Problems in Oil Fired Boilers**

**UNKNOWN, Babcock & Wilcox Co., Lynchburg, Virginia 24505**

High temperature ash deposition and fireside corrosion are considered the principle causes of decreased efficiency and availability of boilers, and often result in increased maintenance and repair costs. These problems are associated with increasing amounts of impurities, such as vanadium, sodium, and sulfur, which are present in the low cost residual oil that is used for marine fuel.

The report covers a review and technical evaluation of the information available on fuel oil combustion and allied fields to determine what benefits can be expected by operating marine boilers with controlled, low excess air combustion, and how such a combustion process can be designed and controlled. It also presents the results obtained from a pilot plant investigation of the effect of low excess air operation on the fireside problems in oil-fired boilers.

Among the significant conclusions reached as a result of this test program were the following: Low excess air combustion of residual fuels that contain sulfur is an effective method for controlling low temperature corrosion caused by condensed fuel trioxide. Much of the beneficial effect of low excess air combustion is lost if excess air at the burner fluctuates even for short periods of time to a level of about 5%. It appears that condensed SO3 from the flue gases is the primary if not the sole cause of low temperature corrosion when firing residual oils containing sulfur. Low melting compounds associated with oil-ash deposition problems when operating with normal excess air are not formed in large amounts when operating with low excess air combustion. Deposits from normal excess air tests are about twice as dense as those formed during low excess air combustion. The report PB No. 175-805 is available from the Federal Clearinghouse for Scientific and Technical Information, Springfield, Virginia, 22151.

**SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.**

**81. HYDRODYNAMICS**

*(see Chapter 2 on Water Motion)*

8.0169. **PRELIMINARY STUDIES TO CORRELATE SELECTED MINERALOGIC AND GEOLOGIC PROPERTIES WITH ENGINEERING PROPERTIES**


The practicality of a shipboard mineral identification and analysis laboratory for on-site placer deposit characterization and relation of generated physical/chemical data to drill performance and shipboard sample processing operations was clearly demonstrated during the 1967 Alaska field operations off Nome. During the two months on station, approximately 1200 mineralogic, petrologic, and qualitative chemical examinations were performed utilizing spectroscopic, mercury detection, ultra-violet, radiometric, and other laboratory equipt.-nt, including stereo and polarizing-petrographic microscopes. In short, the shipboard laboratory was demonstrated to have the same functional capability as similarly equipped laboratories on shore. Also, during the Alaska operations, original investigations were conducted on geochemical trace element correlations and development of an in situ pH/temperature measuring device.

**SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines**

**8.0170. HYDRODYNAMIC FLOW FIELD STUDY**

**J.R. RADDILL, North Amer. Rockwell Corp., Long Beach, California 90803**

Ocean Systems Operations adapted a computer program to calculate the flow and the associated pressure, viscous and wave drag, about advanced vehicle designs and stauionary structures. The computer program used in this study was written for the IBM 360. The inviscid flow field about a sunarmed body of arbitrary shape. It incorporates smoothing procedures which rendered computed flow velocities insensitive to small perturbations in the body coordinates. Computed velocities were compared with analytical results for an ellipsoid to assess the accuracy of the program. Computer programs were constructed for use in the study and design of subsurface manned and unmanned systems. The computer programs can calculate flow fields and dynamic coefficients for hulls of very generic shape.

**SUPPORTED BY North American Rockwell Corporation**

**8.0171. PARTIAL DIFFERENTIAL EQUATIONS AND CONTINUUM MECHANICS**

**G.B. WHITHAM, Calif. Inst. of Technology, Graduate School, Pasadena, California 91109**

Research will be continued in the areas of continuum mechanics, partial differential equations, and related topics. Whitam will continue research on non-linear wave propagation using variational principles and perturbation methods. Work will be continued on the behavior of long water waves, applying analytic and numerical methods to integro-differential equations which include effects more general than those of the usual theory. Study of the non-linear boundary value problem whose differential equation is Lu equals lambda f(x,u), where L is a Sturm-Liouville operator, f is monotone increasing in u with f(x,phi) is not equal to phi) and the interval is finite. The stable solution will carry over to the case where L is uniformly elliptic.

Certain linear boundary value problems for partial differential equations will be considered. By making use of the spectral representations associated with the ordinary differential system arising from separation of variables, alternative representations of the solution of the original problem can be found. This technique will be used to investigate the formation of underwater acoustic wave guides when the velocity profile is not a constant function of ocean depth.

**SUPPORTED BY U.S. National Science Foundation**

**8.0172. STUDY OF FISH MUCUS BIOCHEMISTRY**

**J.W. HOYT, U.S. Navy, Ordnance Test Station, Pasadena, California**

The investigator will study the mucuses produced by fishes to determine their chemical and physical properties and to determine how they operate to reduce frictional resistance in the water and to damp turbulence. These mucal secretions will then be compared for drag reduction efficiency. The demonstration of turbulence damping and friction reducing properties of linear, high molecular weight soluble polymers is a realistic development in fluid mechanics and is not yet completely understood. Viscoelastic effects are probably involved and will be studied.

Locomotory mechanisms of animals in the sea are of interest on several counts. Most directly, it relates to the design of vessels and equipment where speed or water resistance is important. The acoustics of movement is an area for study and one in which biological mechanisms may provide guidance. In addition, surface coverings of fishes may affect the echo characteristics of fishes and may serve as a stimulus to other animals which may be attracted or repelled by it. Such information could lead to knowledge about animal behavior, including pest repellents.

**SUPPORTED BY U.S. Dept. of Defense - Navy**

**8.0173. REALISTIC FREE SURFACE BOUNDARY CONDITIONS IN NUMERICAL HYDRODYNAMICS COMPUTATIONS**

**F. MACINTYRE, Univ. of California, Graduate School, San Diego - La Jolla, California 92038**

It is proposed to develop a general code for including realistic free-surface boundary conditions in numerical hydrodynamics. The programming necessary to produce such a code falls into three parts: (1) Orientation. The location, curvature, and orientation of the free surface must be sensed. The surface configuration may be approximated by a series of circular arcs passing through adjacent triples of points in the surface. (2) Surface metric. In general, in the surface coordinate system best
8. ENGINEERING AND TECHNOLOGY

suited to a given problem will not match the coordinate system chosen for the bulk liquid. Thus, in a study of linear capillary waves on an otherwise flat surface, it is logical to cast the bulk liquid into curvilinear coordinates, yet the surface of the waves is best approximated by series of cylindrical segments. Similarly, in a study of an axisymmetric problem such as a breaking bubble, the bulk fluid wants cylindrical coordinates, but the surface itself is composed of toroidal segments. Aris gives the fundamental tensorial hydrodynamic equations connecting a Riemannian surface to a Euclidean bulk fluid, complete with surface tension and the two surface viscosities.

The rectangular computation grid, so that it is necessary to treat the resulting odd-shaped grid-segments in a special manner.

SUPPORTED BY U.S. National Science Foundation

8.0174, OXYGEN PROPERTIES

Objective is to determine the equation-of-state and specific heat of liquid and gaseous oxygen and to calculated derived thermofunctions. Applications are to the use of liquid oxygen as a rocket propellant oxidizer. Work falls under data on the Properties of Matter.

Measurements of the specific heat of saturated liquid oxygen have been completed. Measurements of the specific heat at constant density on fluid oxygen are about 80% complete. The specific heat and density measurements are being checked for internal consistency. Methods have been developed for computing the derived thermodynamic functions. Applications are to the use of liquid oxygen as a rocket propellant oxidizer. The measurements provide new and/or more accurate properties data which are useful in designing more efficient missile propulsion systems.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

8.0175, WAVE ACTION ON STRUCTURES

The action of all types of waves on various types of structures will be studied in the laboratory using experimental models, in the field making prototype measurements, and by analytic theoretical approach. In particular such things as wave run-up, wave overtopping, wave forces, and structure stability are planned for investigation.

SUPPORTED BY U.S. Dept. of Defense - Army

8.0176, FLUID MECHANICS RESEARCH

To conduct exploratory investigations into problems such as (1) Hydrodynamic effects of hy-ophobic surfaces; (2) Effect of turbulence on damping of progressive water waves; and (3) Effect of compliant walls on turbulent shear flows. Problem (3) is related to drug reduction, which is a matter of considerable economic and technical potential. Problem (1) has important applications in industrial processes and in hydraulic model studies, while problem (2) is related to wave forecasting. This project continues NBS work on the development and application of various measurement techniques to the solution of important hydrodynamic problems.

All of these investigations are primarily experimental. In problem (1) wettable and non-wettable plates are oscillated vertically through an air-liquid interface and the damping was observed. In problem (2) measurements were made on heights of waves propagating through water made turbulent by a series of upward-directed water jets. In problem (3) the pressure drop was measured in turbulent flow of water and water-glycerol mixtures through tubes having compliant (soft rubber) walls. Experiments have been completed for all problems.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

8.0177, HYDRAULIC BULLETIN

To collect information on current research projects in hydraulics, conducted at about 175 Federal, State and private laboratories in the United States and Canada; and to make these project summaries available in useful form to the scientific and engineering community. A similar publication, compiled by the International Association for Hydraulic Research (Delft, Netherlands) covers hydraulic research in all countries other than the United States and Canada. The NBS publication thus forms part of a team which provides world-wide coverage of current hydraulic research.

Through 1966, research summaries were annually solicited from appropriate laboratories and their contributions were edited and placed in a format suitable for publication. However, publication is now biennial, and the 1967 issue was omitted, with the next issue to appear in 1968.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

8.0178, FLUID DYNAMICS CENTER
R.L. PFIEFFER, Florida State University, Graduate School, Tallahassee, Florida 32306

A new university center in Geophysical Fluid Dynamics involving advanced graduate training and research in applied mathematics, continuum mechanics, fluid dynamics, meteorology and oceanography is to be inaugurated. Anticipated research activities include (a) laboratory simulation of the formation of offshore shoals and the transformation of shorelines, (b) theoretical and experimental simulation of convection and hurricane formation by latent heat release, (c) experimental and observational studies of ocean wave energy transformations, (d) cellular convection studies and interpretation of satellite photos, (e) theoretical, experimental and observational studies of the global atmospheric jet stream, (f) simulation of planetary atmospheric circulations and (g) application of applied mathematics and computer technology to hydrodynamical phenomena and solving the Navier Stokes equations of fluid dynamics.

Critical fleet requirements are not now adequately under study by the Naval scientific community. For example, optimal interpretation of satellite meteorological data is not possible nor will it be until basic processes of cloud formation are understood. Advanced techniques now under development at Florida State University will permit modelling of clouds in its entire complexity and acceleration of work in this area will lead to greater effectiveness in fleet meteorology.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0179, HYDRODYNAMIC EFFECTS OF SUBMERGED BODY
M.P. TULIN, Hydronautics Incorporated, Laurel, Maryland

Objective: To gain quantitative knowledge of the hydrodynamic effects generated by a submerged body.

Approach: Conduct theoretical analyses and model tank experiments to predict the hydrodynamic effects of submerged bodies, with emphasis on the micro-structure of the air-sea interface.

SUPPORTED BY U.S. Dept. of Defense - Navy

340


8.0189. COMPUTATION OF PERIODIC PROPELLER FORCES IN NON-UNIFORM FLOWS USING A LIFTING SURFACE MODEL

F.R. BJORKLUND, Mass. Inst. of Technology, School of Engineering, Cambridge, Massachusetts 02139

A computational method is presented based on theory of the lifting surface model of a propeller blade in non-uniform flow. Unsteady expressions, previously derived by Dr. Neal A Brown, are adapted to a numerical solution of the three-dimensional Biot–Savart integral equation for the vorticity distribution given the downwash boundary condition. Since a computational method already exists for the solution using a lifting line representation of the blade, the analysis presented adds a correction to the results of that method. The correction is due to the effects of the radial and streamwise vorticity of the blade on itself. This has hitherto been neglected in the lifting line model, but has been shown to be very significant, especially for the higher harmonics of the wake. A computer program was developed and tested for correctness of results. Program listings and flow diagrams are included in the Appendices.

SUPPORTED BY Massachusetts Institute of Technology

8.0181. AN ANALYSIS OF THE RESPONSE OF CYLINDRICAL DUCTS TO INTERNAL, ZERO MEAN FLOW, AIR-CARRIED ACOUSTIC EXCITATION

W.T. ELLISON, Mass. Inst. of Technology, School of Engineering, Cambridge, Massachusetts 02139

Significant structural response of an internal pure tone sound field resulting from an external pure tone source, located approximately on the duct centerline, will arise only when coincidence occurs between the natural modes of propagation of acoustic waves within the duct and the natural modes of structural vibration of the duct itself. The coupling mechanism giving rise to such coincidence lies with an assumption of small variations of the source location from the duct centerline. This result which arose from a theoretical analysis based on a solution for the velocity potential within a semi-infinite cylinder in the presence of a non-axial incident plane wave and an equivalent modal resonator model of the cylinder undergoing principally radial vibrations in a lobar axially varying pattern was borne out by the experimental results.

SUPPORTED BY Massachusetts Institute of Technology

8.0182. MEASUREMENT OF WATER VELOCITY BY OPTICAL METHODS IN THE MIT PROPELLER TUNNEL

G.W. FANG, Mass. Inst. of Technology, School of Engineering, Cambridge, Massachusetts 02139

An optical system to detect and measure the flow velocity in the MIT propeller tunnel was built, based on the theory proposed by M.J. Bloch and J.H. Milgram in a paper to the Optical Society of America. The method involved the detection of reflected light radiation off air bubbles in the water. This radiation, after being spatially filtered by a reticle, is collected by a photomultiplier and temporarily filtered by a bandpass filter. The frequency of the resultant signal is a function of the flow velocity. Results of the investigation show a general agreement to within 3% between the velocities obtained by this method and that obtained by means of the pitot-static tube. Difficulties encountered in the investigation are enumerated, and recommendations are made for possible future investigations.

SUPPORTED BY Massachusetts Institute of Technology

8.0183. VARIABLE PRESSURE WATER TUNNEL RESEARCH

I.E. KERWIN, Mass. Inst. of Technology, School of Engineering, Cambridge, Massachusetts 02139

Funds from this grant will provide assistance in converting the MIT variable pressure water tunnel in initiating a number of research problems. The MIT tunnel was originally constructed in 1938-39 and has not been modified since. The original design of the tunnel was to solve one type of problem - the steady-state thrust and torque of a marine propeller under various flow conditions. Since this type of experiment has now become routine, the tunnel is not very useful for thesis research in its present form. Changes to the tunnel will include the removal of the present open-jet test section and replacement with a 20 inch diameter stainless steel closed-jet section. A storage tank will be added to facilitate rapid access to the test section, modern instrumentation and controls will be installed, and quieter measures will be applied to the tunnel. After the tunnel is converted to a more useful research tool, the following research problems will be pursued; propeller performance in irregular flow fields, cavitation noise, cavity dynamics, mechanisms of cavitation inception, hydroelasticity and singing, supercavitating hydrofoils and propellers, propeller induced vibration, hydrodynamic performance of various deep-sea devices, and experimental verification of propeller design theory.

SUPPORTED BY U.S. National Science Foundation

8.0184. INVESTIGATION OF THE NON-LINEAR CHARACTERISTICS OF FLUID-SUSPENDED VEHICLES

R.J. KIESSEL, Mass. Inst. of Technology, School of Engineering, Cambridge, Massachusetts 02139

Using present linear theory results for a rigid simple plenum fluid-suspension system, it was possible to determine the accuracy of a non-linear model and of analog computer simulation when using small perturbation amplitudes. By increasing the perturbation amplitudes it was possible to show that the range of validity of the linear theory solution increased as the lead time constant increased and also as the lead-to-lag time constant ratio increased. Further increasing of the perturbation amplitude showed that the maximum allowable perturbation amplitude increased as the lead time constant increased and also as the lead-to-lag time constant ratio increased. Increasing the perturbation amplitude beyond the range of validity of the linear theory showed that the peak dimensionless acceleration and the peak dimensionless change in vehicle-suspension-guideway clearance decreased.

SUPPORTED BY Massachusetts Institute of Technology

8.0185. EXPERIMENTAL INVESTIGATION OF VENTILATED CAVITIES

R.J. KINNEAR, Mass. Inst. of Technology, School of Engineering, Cambridge, Massachusetts 02139

A wedge with a 3.5 inch chord and a half-angle of 4.1 degrees is tested in the MIT Propeller Tunnel. No pulsations were observed on the cavity. Thus, the attempt to verify the theory that pulsations are possible in an infinite medium (without a free surface) is inconclusive. Although there exists a variance in the cavitation number between theory and experiment, the data plotted show that the general shape of the curve for a 4.1 degree wedge is correct. The primary discrepancy is in the pressure recording methods. Visual observations become difficult when ventilated cavities are generated in the test section. It takes only about 5 to 10 seconds for the air introduced into the cavity to recirculate through the tunnel.

SUPPORTED BY Massachusetts Institute of Technology

8.0186. UNSTEADY TWO-DIMENSIONAL CAVITY FLOWS

P.C. LEONE, Mass. Inst. of Technology, School of Engineering, Cambridge, Massachusetts 02139

A flow model for unsteady, two-dimensional cavity flows with finite cavities is established by examining the cases of finite aspect ratio foil and of a two-dimensional foil under a free surface in the limiting cases of high aspect ratio and large depth. Using the method of matched asymptotic expansions, the boundary conditions of the two-dimensional flow are determined and the perturbation pressure produced by the variations of cavity area is calculated as a function of aspect ratio or depth. The case of a flat plate foil with a natural cavity and executing harmonic oscilla-
8. ENGINEERING AND TECHNOLOGY

sections were steam heated copper tubes with integral fins ranging in size from 0.625 in. to 1.060 in. outside diameter with both straight and spiral fins. Heat-transfer coefficients and friction factors were determined for non-boiling forced convection heating.

Improvements in heat transfer for finned tubes compared to conventional tubes of the same internal diameter of up to 200 percent were found in some of the cases tested. The major portion of the improvement in heat transfer results from additional heat-transfer area added on the water side of the tube. Swirl flow was also found to contribute significantly to improved heat-transfer performance.

This investigation represents a start toward the development of a general prediction method for internally finned tubes. Further investigations are recommended to determine the effects of tightness of twist, number of fins, fin height, and fin profile on heat-transfer improvement and the value of internal fins as an augmentative technique.

SUPPORTED BY Massachusetts Institute of Technology

8.0187, DETERMINATION OF FLOW IN AN AXIAL-TO-RADIAL DIFFUSER WITH SWIRL
R.A. MAJOR, Mass. Inst. of Technology, School of Engineering, Cambridge, Massachusetts 02139

The parameters affecting the efficient design of axial-to-radial diffusers are discussed and a selection made of those to be investigated. A model diffuser was constructed based on the geometry of a jet impinging on a flat plate without internal vanes. Various amounts of swirl were introduced on a constant flow rate and the recovery of the diffuser for these conditions noted. The internal flow was mapped photographically and with pressure probes.

The results are given in the form of static pressure plots along the diffuser walls, velocity profiles, and calculated diffuser efficiency. The maximum efficiency of 91.7% occurred at just under the maximum swirl used, based on calculated inlet pressure.

A detailed program for additional testing is given.

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8.0188, VISCO-ELASTIC DYNAMIC VIBRATION ABSORBER
G.L. MORROW, Mass. Inst. of Technology, School of Engineering, Cambridge, Massachusetts 02139

Objective. The objective of this thesis work was the design, construction, and instrumentation of an apparatus to determine the dynamic properties of visco-elastic fluids for application in damped dynamic vibration absorbers.

Method: The result of the design was a set of parallel plates tailored to fit a Calidyne 01500 shaker. The shaker was used to provide the driving force. The lower plate was held stationary and the upper plant constrained to move in one dimensional translation. The dynamic variables measured were the magnitude of the applied force and phase angle between force and displacement. The force was measured via a strain gauge transducer, constructed for the thesis, and phase angle was measured by a phase detector using displacement as a reference. Force and phase were plotted automatically against frequency by an X-Y recorder.

The results are given in the form of static pressure plots along the diffuser walls, velocity profiles, and calculated diffuser efficiency. The maximum efficiency of 91.7% occurred at just under the maximum swirl used, based on calculated inlet pressure.

A detailed program for additional testing is given.

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8.0190, HETERODYNE MEASUREMENTS OF ATMOSPHERIC PHASE TURBULENCE AT 6328A
R.G. WALSH, Mass. Inst. of Technology, School of Engineering, Cambridge, Massachusetts 02139

This thesis investigates the effects of atmospheric turbulence on the spatial properties of the phase of transmitted beams. Experimental measurements in the form of a series of photographs of interference patterns between two beams were made using a modified optical heterodyne system. The two beams of the heterodyne system were mixed in a very small, controllable angular difference between their directions of approach to the detector. The resulting fringe patterns were affected by the atmosphere as differences between succeeding photographs show. The first order effect of the atmosphere was found to be a tilt relative to the direction of travel. Tilt differences as small as 5 seconds of an arc can be measured using this system with assurance; smaller values could be confused with systematic effects.

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8.0191, VORTEX WAKE SHEDDING OF A HEAVING CIRCULAR CYLINDER
R.G. WALSH, Mass. Inst. of Technology, School of Engineering, Cambridge, Massachusetts 02139

The periodic vortex wake shedding from a circular cylinder heaving perpendicular to the free-stream has been experimentally photographed in water using streaming air bub'les for flow visualization. The Reynolds number was greater than 10,000. The flow is a three dimensional instability problem, with spanwise vorticities being formed when the cylinder is stationary. For a specific range of heave amplitude and frequency, called the 'lock-in region', it is possible to have two-dimensional flow with spanwise correlation. There is an affect of free-stream turbulence and turbulence due to wake formation at high Reynolds number flow upon the 'lock-in region'. After a discussion of the past and present investigations of this flow phenomenon, it is modelled as a fluid oscillator. A discussion of the analogy between the flow and the oscillator characteristics is presented.

SUPPORTED BY Massachusetts Institute of Technology

8.0192, EXPERIMENTAL HYDRODYNAMICS
A.C. VASTANO, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543 (N00014-66-C0241)

This study is a continuing attempt to elucidate details of the hydrodynamics of flow regimes on a rotating earth that are pertinent to the understanding of oceanic phenomena. Part of the work is theoretical but it is supplemented by fluid dynamics laboratory studies of flow regimes in realistic models and by field measurements from ALVIN. A numerical model of western boundary currents is being developed. Laboratory experiments study the physical processes occurring at density interfaces and measure the fluxes of heat and salt through them. Small scale structure in the oceans also is to be observed with the use of ALVIN in the region of the main thermocline.
Results from this task should further the development of numerical models of physical processes in the oceans from which operational prediction methodology may be developed to meet the Navy's broad needs for environmental forecasts of the oceans.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0193, FLUIDIC CONTROL SYSTEM COMPENSATOR
C.K. TAFT, Univ. of New Hampshire, Graduate School, Durham, New Hampshire 03824

Fluidics is the technology wherein sensing, logic manipulation, amplification, information processing, control and/or actuation functions are performed solely by controlling fluid dynamic phenomena within fluidic devices or systems. To perform these functions using no-moving-part elements and appear to offer the advantages of reliability, low cost, and simplicity, these advantages are especially true in control strategies which utilize the unique properties of fluidic devices is being made at the University of New Hampshire.

It is the object of this research to investigate the following: 1. Periodic modulating signal waveform effects and freedom from limitation on fluid components. 2. The number of delays that can be used in a compensator and their duration. 3. Fluid switching device characteristics will affect pulse-width modulator performance. Hysteresis and non zero operating time will all contribute to the effective characteristics of this portion of the system. The effects of these nonideal characteristics will be described analytically. 4. The types of compensators which can be mechanized will be classified and the design specification simplified. 5. An experimental model using fluidic elements will be used to demonstrate the feasibility of the approach and verify the design strategies developed.

SUPPORTED BY U.S. Dept. of Defense - Army

8.0194, MODEL STUDIES OF REFRACTION OF SHOALING OCEAN WAVES
W.J. PIERSON, New York University, School of Engineering, New York, New York 10003 (NONR)

Objective: The laboratory wave-tank experiments on the behavior of refracted waves at caustics are to contribute to development and improvement of Navy wave forecasting methodology required to predict sea surface conditions in support of naval operations. Research on refraction effects particularly aids in the prediction of surf conditions.

Approach: A laboratory wave tank with various shaped, modeled shoals is being used to study the behavior of gravity waves at caustics produced by refraction effects as waves progress over these shoals. Emphasis is upon determining the transfer of energy at caustics.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0195, AZORES VOLCANIC STUDY
G.M. BOONE, Syracuse University, Graduate School, Syracuse, New York 13210 (NONR)

Investigations are made on the structure, sequence of eruptions, and chemical analyses of volcanic (lusitic) rocks that comprise the eastern part of San Miguel Island, Azores. Chemical analyses are made of the rock samples obtained during a field mapping program to determine the age of the rocks, the times of eruption, and magma depth from which the flows originated. As the Azores are along the Mid-Atlantic Ridge, this study bears on volcanic and tectonic problems associated with mid-ocean rises.

As the task concerns the volcanic and tectonic processes along one part of the Mid-Atlantic Ridge, it provides information that affects bottom topography, bottom roughness, and sedimentary layering associated with this mid-oceanic ridge.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0196, MARINE HYDRODYNAMICS
M. RAITTAR, Univ. of Washington, Graduate School, Seattle, Washington 98122

It is proposed to carry out the following studies: (1) Investigate a theoretical model for the combined wind-driven and thermohaline circulation of a zonal ocean, which is expected to demonstrate the essential physics of the Antarctic Ocean circulation. Results of this investigation will lead to refined models for the Antarctic Ocean and serve also as a preliminary step in the investigation of the circulations in oceans with meridional boundaries. (2) Include the effects of friction and nonrectangular geometry in an extended theoretical model of internal wave generation. This work is based on our recent results for the internal waves generated in a continuously stratified ocean by bathymetric coupling, at a steep continental slope, to long surface waves. Laboratory experiments will be continued to test the above theoretical results. (3) Laboratory studies will be performed to investigate the generation of internal waves by free oscillations of neutrally buoyant bodies. (4) Laboratory experiments will be performed to test the range of validity of theoretical averaging techniques for the study of non-linear wave behavior. (5) Solutions will be sought for the quasi-geostrophic free oscillations in a B-plane ocean that are intermediate in frequency range to those presently known etc.

SUPPORTED BY U.S. National Science Foundation

8J. MATERIALS

(8J. Design, Fabrication, Testing, and Environmental Effects. See Chapter 5g For Microorganism Causing Degradation.)

8.0197, CHEMICAL WOOD PRESERVATIVE TREATMENTS
H. HOCHMAN, U.S. Navy, Civil Engineering Lab., Port Hueneme - Point Mugu, California

Objective: To improve methods and materials for the treatment of timbers to prolong resistance to marine borers in a marine environment.

Approach: A number of approaches have been used, including a study of naturally resistant woods, analysis of creosotes, development of toxicity tests and harbor screening tests. A number of treating systems are receiving final evaluation in 20-foot piles at Pearl Harbor.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0158, EVALUATION OF EFFECTS OF SATURATED HYDROCARBONS ON PRESERVATIVE QUALITY OF CREOSOTE
H.P. VIND, U.S. Navy, Civil Engineering Lab., Port Hueneme - Point Mugu, California

Objective: To evaluate paraffinic waxes and other saturated hydrocarbons as agents for preventing bleeding and leaching of wood preservatives from marine timbers.

Approach: Small specimens of wood impregnated with various mixtures of creosote and paraffinic hydrocarbons are placed in sea water aquaria well stocked with marine borers of the species Limnoria tripunctata. The times required for the marine borers to sever the specimens of wood are employed as measures of the effectiveness of the preservative mixtures.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0199, CORROSION RESEARCH
P.H. BENSON, Lockheed Aircraft Corporation, San Diego, California 92101

Marine Corrosion and its prevention - Cathodic Protection, Electro-chemistry (COR)

SUPPORTED BY Lockheed Aircraft Corporation

8.0200, ANTIFOULING RESEARCH
P.H. BENSON, Lockheed Aircraft Corporation, San Diego, California 92101

Marine Biological Research - Marine Fouling and its prevention (AFR-2)

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8. ENGINEERING AND TECHNOLOGY

8.0201, HELIUM - HEAT TRANSFER
- Data on heat transport and on properties directly related to heat transport (viscosity, conductivity, and specific heat) will be produced for liquid and supercritical helium, and for superfluid helium. The systems and properties data so obtained will contribute significantly to the use of superconductors and cooled high purity conductors in industry and research, e.g., power transmission and generation systems, superconducting magnets and superconducting particle accelerators all of which must be cooled by helium.

For both Helium I and Helium II studies, compilation and critical correlation of existing data will outline specific areas of subsequent experimental measurement. For Helium I studies much of these data have not been determined and those data which do exist are not sufficiently accurate to permit optimal system design. For Helium II the parameters which correctly characterize the heat transfer of superfluid helium in large engineering systems will have first to be identified.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

8.0202, NEW APPROACHES TO BIOFOULING ASSAY
R.J. BENOIT, General Dynamics Corporation, Groton, Connecticut
- Tests indicate that a simple, quick, laboratory bio-assay procedure can be developed for use in marine fouling research. B. The evaluation of anti-fouling coatings in granular form (a new approach) appears to be feasible. C. Three test organisms were evaluated as candidates for a laboratory bio-assay procedure. D. Leaching rates obtained in granular, copper base paints was in the order of 0.1 to 0.3 mg Cu per day from 0.5 gm of powder in 100 ml sea water. The rates were consistently higher in granular paints of small particle size, and increased slightly daily for three days. These leaching rates are comparable to about 100 micrograms Cu/cm2/day and are greater than rates reported in the literature for several copper paints evaluated as coated panels.

SUPPORTED BY General Dynamics Corporation

8.0203, MICROBIAL CORROSION AND DETERIORATION OF NAVAL MATERIALS
R.R. COLWELL, Georgetown University, Graduate School, Washington, District of Columbia 20007
- Marine bacteria are being isolated from sea water to determine whether these microorganisms differ significantly from terrestrial forms. Electron microscopy and DNA base composition as well as conventional morphological and physiological characteristics are being determined. Computer analysis of the accumulated data will be employed to identify taxonomic groups.

The effective use of the ocean as a working environment requires thorough knowledge of its microbial activities. The role of marine microorganisms in corrosion and deterioration of materials, and as disease producing agents will contribute to this knowledge. Studies of the unique physiology of true marine microorganisms will provide basic information of effective use of the sea by other biological systems.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0204, CORRELATION OF BEACH PROPERTIES AND INCIDENT WAVES
- Study is being made, in both field and laboratory, of the relationship between beach properties (including profile as well as sediment properties) with incident wave and water level conditions. Study also involves the effect of structures in affecting changes in these characteristics.

SUPPORTED BY U.S. Dept. of Defense - Army

8.0205, CORROSION MITIGATION
- The investigation is to involve the collection and presentation of data showing the corrosion rate in sea water of various shapes of steel piling and of the stressing steel in pre-stressed and post stressed concrete piling. The corrosion rates are to be determined from piling installed at locations having various climatic, tidal and contamination conditions. The objective is to furnish information to aid in determining the life expectancy of steel used in piling installations.

SUPPORTED BY U.S. Dept. of Defense - Army

8.0206, STRENGTH OF GLASS
- Technical Objective: To develop improved methods for testing mechanical strength of glass and other brittle materials, to attempt to evaluate the influence of various types of defects on the strength of glass and to assist sponsor in developing specifications for strengthening glass for use in DSSV (Deep Submersible Systems Vehicle).

Approach: Devise test fixtures and gather breaking strength data on commercially available and special composition glasses to modify modulus of rupture formulas to account for large deflections; to collect strength data on glass specimens containing various types and amounts of defects encountered in commercial products; to allow appraisal of the influence of the defects on the strength of the glass products, and to assist the sponsor in developing specifications for strengthened glass products for deep ocean use by means of consultation and testing.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

8.0207, MICROBIAL CORROSION
- To investigate the role of microorganisms in the corrosion of metals in a marine environment. To perform basic studies on the mechanisms of microbial corrosion in the marine environment. To relate the results of these studies to current concepts on the significance of microorganisms in causing marine corrosion.

The corrosion rates of metals and alloys in sea water, natural and microorganism free, will be compared. In cases where the corrosion rates are greater in the presence of microorganisms, isolation of the microorganism at the corroding surface will be undertaken. The effect of such microorganism (pure or mixed culture) to again produce corrosion will be studied. Identification of organisms found to be important in causing corrosion will be done, time permitting. Isolation of and study of previously known organisms (viz. sulfate reducers) reported to have been involved with corrosion will be studied to ascertain their importance in marine corrosion and to determine their mechanism of action.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

8.0208, STEEL PILING
- Significance: To investigate the extent and causes of corrosion that occur on steel piling in underground and marine environments and to determine the effectiveness of projective methods where corrosion is a problem. Results from this investigation are of benefit to all engineers in industry and government who are concerned with design, construction and maintenance of all types of structures using piling.

Progress: Polarization and electrical measurement were made to determine the rate of corrosion on the pile specimens exposed in the extensive test sites at Dam Neck, VA (off-shore site) and Montreal, Quebec (underground site). Data obtained from previous inspections of steel piling in underground service were evaluated.

Future Objectives: (1) Perform additional inspections at the offshore marine and underground test sites. (2) Evaluate data ac-
cumulated over the past 7 years at 4 test sites in Mississippi and Louisiana, in cooperation with the U.S. Corps of continued investigation of (1) isolation, growth, and nutrition of blue-green algae, especially with marine forms. (2) Further investigation of phenomenon associated with single-cell growth of cocccoid and filamentous blue-greens, (3) Investigation of induced mutation in blue-green algae: effective mutagens and optimum conditions for their use, possible development of selected auxotrophic or pigment mutants for approach to specific problems.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

8.0209. METALS FOR DEFENSE

Significance - (1) To obtain information on the performance of metals and other materials in underground, marine and fresh water environments and to investigate and develop methods to provide protection to such materials when required. (2) Provide consultation services to the sponsors (Prince Project) and investigate special problems, often of an emergency nature, involving the use of metals and other materials in various environments. Priority is given to these problems over other work.

Progress - A large amount of time has been devoted to special corrosion problems of a classified nature of long and short term investigations. Goals sought by the sponsors have been achieved with considerable benefit. Work has been continued on the evaluation of specimens of monel, Cupro-Nickel, ductile iron and titanium for exposures up to 8 years at 6 underground test sites. Reports for publication on these materials are in various stages of progress.

Future Objectives - Completion of the reports for publication mentioned above. Evaluation and preparation of reports on the corrosion behavior in soils of aluminum and aluminum alloys, and stainless steels. Annual inspections to be made at 6 soil sites and 2 water sites.


SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

8.0210. MECHANICAL PROPERTIES

Work on the mechanical properties of matter and materials includes the development of methods of measurement applicable to liquids and solids under a variety of environmental conditions involving variations in method and rate of loading, the influence of temperature, pressure, etc. The work is important to extend our knowledge of the behavior of materials to cover new materials with unusual properties which characterize the material in a meaningful way, and to develop methods for evaluating the performance of important engineering combinations of materials ranging from composites of plastics and metals, to joints involving high strength aircraft fasteners, would include types required for underwater exploration vessels, to heavy built-up structural elements of buildings and bridges. Rate of change of load varies from zero for creep tests to ultrasonic frequencies. Temperatures of interest range from cryogenic nearly to the melting temperatures.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

8.0211. EFFECT OF PRESSURE ON MATERIALS

To develop and exploit techniques for determining crystal structures of high pressure (and simultaneously, if possible, high temperature) polymorphs in the range of 50 kbar and 1000 degrees C. Structure data are needed for innumerable polymorphs for general understanding of properties of condensed phases.

Diamond anvil cell is being utilized in single crystal diffraction studies using precession techniques. At present a beryllium unit is in operation and has proved useful in unit cell and space group determinations. Suitable absorption corrections have been worked out and the method is presently being applied to actual determination of atomic positions of a material stable only above 12 kbar. The major problem arises from a high background on the films produced by incoherent scattering by the beryllium cell. The background limits the quantity of data obtainable.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

8.0212. REINFORCED PLASTIC STRUCTURES

Objective: Develop high performance/high strength and modulus (lightweight) ship and submarine structures for advanced applications employing fiber reinforced plastics. Deck houses, masts, railings, etc for large ships where weight and microwave transmission problems are indicated; and deep submergence hull and appurtenance applications. Metallic materials are limited in depth capability unless augmented with considerable quantities of supplemental buoyancy.

Approach: While strength weight ratio of glass fiber and other fiber reinforced laminates are very attractive when small-scale tests are performed many problems such as fatigue, impact resistance, water absorption, long term stability, creep, closures, fabrication, etc need to be solved before their use can be specified for critical applications. These problems will be explored. For large boat hulls and structural components by tests of scale models. A survey of the state-of-the-art and latent progress will be made. Applicable design and production criteria will be assessed along with the cost effectiveness as compared with wood and aluminum. For deep submergence applications the approach will be as follows: Design, fabricate and test small-scale models including typical structural details to determine the material response to realistic loads and environment including short-term hydrostatic loading; creep, fatigue, aging, and dynamic loads. Compare results with those obtained in tests of models using other candidate materials and determine relative merit. If warranted, fabricate and test models of sufficient size to positively demonstrate potential of fiber-reinforced hulls for 20,000 ft operations. Effort is through industry and Navy Labs.

SUPPORTED BY U.S. Dept of Defense - Navy

8.0213. STRUCTURAL PLASTICS-DEEP SUBMERGENCE

Objective: Develop fiber reinforced plastic composite materials, particularly glass reinforced plastics (GRP) and the fabrication technique quality assurance and inspection criteria to provide designers with reliable design data to employ such materials for deep submergence structures in vehicles for use where the weight displacement ratios of metals are unsuitable or less promising. The potential economic factors of cost, reliability and maintainability are additional stimulants for the use of the technology with these materials as compared to steel, titanium and aluminum alloys. The technology of GRP and the fundamental understanding of properties are further advanced than such materials as massive glass and ceramics which are competitors for such materials application.

Approach: The following efforts are underway and planned through industry and at Navy labs in conjunction with the studies on models and structures: interface problems of fiber, finish and matrix from the surface chemical, bonding and microstructure standpoint. Higher compression strengths, strength along with water permeation effects and methods to control same.

SUPPORTED BY U.S. Dept of Defense - Navy

8.0214. BUOYANCY MATERIALS
8. ENGINEERING AND TECHNOLOGY

Objective: Low density materials with bulk modulus equivalent of higher than sea water is required for use in filling voids of submarines and surface ships to provide buoyancy for deep submergence vehicles, buoys and other structures whose weight displacement ratio is greater than water at the depth of interest and in addition, those materials provide shock protection for high-speed surface ships. Currently, syntactic foam (glass microspheres dispersed in a resin matrix) is available at a density of 43 to 44 LBS/cu ft for use at 20,000 ft depth. Densities as low as 25 lbs/cu ft are required for future vehicles. It is planned to develop material system with the following densities: 30 and 25 PCF in the next five years, coordination will be maintained on these developments with those going in conjunction with the DSSP (PM 1) program for the development of the DSSV.

Approach: The development of lower density syntactic foam modules will involve the incorporation of larger glass ceramic spheres with the matrix in some predetermined mix. Improved resin matrices and spheres of varying diameters will be included in these studies. The major limitations involve reliability under cyclic loading sympathetic implosion of glass or ceramic spheres. Modular design and nondestructive test methods and standards which will be studied. Techniques of measuring and assuring uniformity of low density foam used in large voids of surface ships will be undertaken. This effort will be undertaken through industry & at Navy labs.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0215. DIELECTRIC MATERIALS


Objective: With respect to dielectric materials, the task area will result in the following: develop a short term accurate method of classifying dielectric materials in terms of thermal endurance (time and temperature), 2 years and 300 dec C. Develop embedding materials for dielectric materials particularly varnishes, sleeving, resins and capacitors to reflect the current state-of-the-art and improve same as in the case of the studies related to the carborane polymer studies.

Approach: Temperature classification studies are being made employing thermal gravimetric analysis (TGA) and differential thermal analysis (DTA) studies and relating same to long term tests. Other methods to assess thermal endurance of dielectrics will be satisfied as well for surface materials such as diallyl phthalate (DAP) compounds. Navy developed embedding materials will be evaluated for induction motor stators for deep submergence. Designs and materials will be modified as test results dictate. Actual deep ocean exposures will be made on sample stators. Improved thermally conductive compounds will be employed using impregnating techniques developed by a Navy laboratory previously, with alumina in an epoxy matrix. Evaluate new and improved dielectric materials, including magnet wire and devise test methods necessary to upgrade materials and specifications. Effort is through industry and at Navy labs.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0216. PRESERVATION OF WOODS IN THE MARINE ENVIRONMENT


Objective: This effort will lead to a better understanding of fungal processes and wood boring animal action which each year account for approximately $50,000,000 in wood destruction in the marine environment. Data are necessary to establish a baseline for surface and submerged wood surfaces and the interrelationships between wood destroying animals and associated microorganisms.

Approach: Six large and 36 small pine test blocks have been submerged at each of 20 worldwide test sites. These blocks will be periodically examined and estimations made of marine borer and fungal activity. Three of the test sites are in the United States territorial waters, but from these test sites will be coordinated with data from the other test sites.
8.0220, STRUCTURAL TITANIUM ALLOYS -120/150 KSI YIELD STRENGTH


Objective: Develop a titanium alloy of 120,000 to 150,000 PSI yield strength for deep submersibles and high speed surface craft such as hydrofoils where high strength-weight ratio is needed. It must have minimum drop-weight tear test toughness of 200 ft-lbs at -30°F (in 9" thick). Northwest Aluminum Company (in Annapolis) coordinates this task area and is responsible for alloy development and mechanical and physical metallurgy investigation. NREL determines full-thickness fracture toughness characteristics and toughness criteria; also, stress-corrosion cracking susceptibility and fatigue characteristics. NASL is developing techniques for forming, welding, and non-destructive testing of heavy sections. Fabrication and quality control procedures developed in the laboratory will be applied in the construction of prototype structures and models which will be evaluated for marine use.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0221, HY 130-150 STRUCTURAL STEELS


Objective: Develop and evaluate a structural steel in the 130,000 to 150,000 PSI yield strength range (HY 130/150), weldable for shipyard conditions sections up to 4" in thickness. It must have adequate toughness (Charpy V-notch, transverse of 50 ft-lbs minimum at 0 degrees F), resistance to low-cycle, high-strain fatigue and minimum susceptibility to degradation under stress in sea water.

Approach: The major effort carried out by industry and Navy labs has resulted in the development of a family of Sr, Ni-Cr-Mo-V low carbon steels as optimum base metal compositions; the effect of residual elements (P, S, Al, O) has been established; weld wire compositions to permit weld metal properties equal or better than base metal are being developed; optimum melting, deoxidation practices are being established for producing commercial quality, weldable wire; producing weldable plates (up to 3" in thickness). Full section testing is being performed under NavShips contract NOB5 94464. (B) Develop improved electrodes of 115 ksi yield strength, with consistently reproducible weldment properties. Greatest effort is required in covered electrodes; metal-inert gas (MIG) electrodes will probably result from existing contracts. (C) determine characteristics of new electrodes, and weldments therefrom, with regard to fracture toughness, fatigue, shock, and corrosion.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0222, HY 80-110 STRUCTURAL STEELS


Objective: Develop and fully evaluate structural steel in the 80,000 to 115,000 psi yield strength range (HY 80/110), meeting the toughness requirements of current HY80 structural steel. The HY110 base metal will be an upgrading of the HY80 type alloy.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0223, ENERGY CONVERSION MATERIALS AND COMPONENTS


Objective: Develop materials for specialized application in direct energy conversion (DEC). Materials limitations are a major restriction to successful development of promising DEC technologies for Navy requirements. Major objective is development and evaluation of materials and components for fuel cell power plants; particularly for ambient pressure (free flooded) cells capable of operating for long periods. Under test conditions, between sea level and 20,000 ft submergence. Components must be compatible with hydrazine fuel, hydrogen peroxide oxidant, and alkaline electrolytes (KOH) in anticipated ambient ocean environment. Also, the kinetics of reactions of various fuels with various electrode materials must be quantified. The developments are applicable to plants for deep submergence vehicles, swimmer delivery vehicles, and stationary underwater power plants. A long term objective is development of thin-film oxide (solid) electrolytes for ultimate use in high temperature direct hydrocarbon fuel cells.

Approach. Hydroxide-hydrogen peroxide fuel cells. Phase I-determine stability and electrochemical behavior of single cells and cell stacks in high pressure oxygen, hydrogen peroxide, hydrazine, potassium hydroxide seawater environment. Evaluate thermal and electrical insulating materials. Phase II-investigate long term effects of high pressure conditions on electrode kinetics and stability and on cell performance. Phase III-study nitrogen solubility in KOH electrolyte and effects of temperature and pressure changes on gas evolution (posibility of bonds during ascent from deep ocean). Phase IV-stability characteristics; handling and dissociating hydrogen peroxide under deep ocean conditions; Effect of impurities and friction on hydrogen peroxide dissociation. Thin film oxide electrolytes-phase I-develop acceptable techniques for producing thin film and single crystals of promising semiconductor electrolytes and quantities establishing their electrical and cryotextographic properties. Phase II-characterization of polarization, effects of field gradients on electrical and electronic properties, and effect of time and temperature on cryotextography and properties. Phase III-construct and evaluate small experimental test cells. Effort is carried out through industry and Navy labs.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0224, HY 180/210 STRUCTURAL STEELS


Objective: Develop and evaluate a structural steel in the 180,000 to 210,000 psi yield strength range (HY 180/210) with adequate notch toughness, fatigue strength, and general corrosion and stress-corrosion resistance.

Approach: Investigate work through industry and Navy labs includes concurrent efforts in base metal development, heat treatment, joining, and structural evaluation. Base metal and weld filler metal development includes precipitation hardening maraging steels, the proprietary Hp 9Ni-4Co family of quenched heating steels, and most promising, a compositional dual-strengthened group combining both hardening phenomena. Heat treatment includes a consideration of the proprietary rapid multi-quenching technique for grain refinement. Basic studies include strengthening mechanisms, embrittlement phenomena, and effects of residual elements. Suitable weld filler metals which do not require
8. ENGINEERING AND TECHNOLOGY

post heat treatment must be developed and advanced joining techniques will be explored. Fracture toughness criteria will be established, and fatigue, corrosion, stress corrosion evaluated. Fabricated models will be tested under simulated service conditions in appropriate Navy facilities.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0225, MARINE FUNGI DEGRADATION
S.P. MEYERS, Univ. of Miami, Graduate School, Miami - Coral Gables, Florida 33124

The objectives of this research are (1) investigations of early fungal infestation to establish the significance of this population in wood degradation and its contribution to the biology of associated marine organisms, and (2) analysis of specific fungal destruction of cellulose and other higher molecular weight substances.

Data are necessary to establish a baseline for understanding the composite ecology of wood surface, and the interactions between wood destroying animals and associated microorganisms. This project will lead to a more accurate picture of fungal processes, and indirectly, to the mechanisms whereby wood boring animals modify the activities of associated fungi. A clear understanding of the role of fungi in biodeterioration processes could lead to better methods for protecting pilings and other wooden objects placed in the sea. The yearly wood destruction loss in the United States marine environment is estimated at $50,000,000.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0226, COMBUSTION OF RESIDUAL FUEL WITH MASIVE RECIRCULATION
UNKNOWN, Illinois Institute of Technol., Graduate School, Chicago, Illinois 60616

This research provided quantitative data on the external recirculation rates required to reduce deposition and corrosion of metal exposed to combustion products from low grade residual fuel. Measurements of the effect of massive recirculation on combustion noise were made that showed that combustion noise was reduced to that of the background equipment, a reduction of 17 db. Conclusion was that massive recirculation of combustion gases back into the flame area produces: (1) substantial reductions in deposition and corrosion rate. With sufficient recirculation, the corrosion rate with residual fuels can be brought down to that of distillate fuel; (2) high vanadium accumulation in the recirculating zone; (3) flame changes from an overventilated, vaporized flame with very low flame luminosity; and (4) combustion noise reduction by a substantial amount (15 db. in the tests).

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8.0227, FRICTIONAL RESISTANCE HULL SCALE AND COATINGS
UNKNOWN, U.S. Navy, Ship Research & Dev. Center, Cadronock-washington, Maryland 20007

To determine the effect on frictional resistance from the normal build-up of paint, rust scale and localized peeling on a ship's hull, and the relative resistance characteristics of Maritime and Navy paints.

DESCRIPTION: In a joint project with SNANE Panel a 21-ft. friction plane first painted with Navy paints MIL-P-54929A Undercoat, MIL-P-59328B Primer, and then with the Navy primer and MarAd paints 52-MA-403C Topcoat, 52-MA-401B (3) Undercoats, has had run at 3 feet immersion in the towing tank. The results of these tests are being analyzed to determine the relative resistance of the coatings.

Tests are under way with the same friction plane covered with plastic molds made from master molds which were taken on a commercial vessel while in dry dock under the three following conditions: a. Ship's bottom 'as is' when drydocked. b. After normal treatment for annual drydocking; i.e. hand wire brushing and scraping followed by application of one coat of anti-corrosive and one coat of anti-fouling paints. c. Anti-fouling plate to clean metal and applying complete five coat anti-fouling system.

When completed, these tests will be analyzed to determine the relative effect of procedures a., b., and c. above, on ship resistance.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8.0228, MICHOSES AND CORROSION
W.D. IVERSON, U.S. Dept. of Commerce, Natl. Bureau of Standards, Gaithersburg, Maryland (NAONR-14-67)

This research will consider anaerobic corrosion of metal and the part played by microorganisms in depolarizing cathodes. This includes the role of iron in metabolism of microorganisms, the role of substrate and electron donors in possible extracellular enzyme action in a corrosive environment, and the role of metal in the physiology of microorganisms.

Corrosion is a serious problem in sea structures exposed to the bottom mud zone. Very little is known about the fundamental biological, chemical, and physical processes whereby microorganisms contribute to corrosion. A combined biological metallurgical approach to the problem is essential.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0229, EFFECT OF INTERFIBER SPACING ON THE HIGH TEMPERATURE DEFORMATION OF AI-AIN1 COMPOSITES
H.C. LEWIS, Maas. Inst. of Technology, School of Engineering, Cambridge, Massachusetts 02139

To investigate the formability and high temperature tensile strength of AI-A13Ni fiber composites, directionally solidified tensile specimens were grown at four growth rates ranging from 3.5 to 9.4 cm/hr. and two nickel weight fractions, 6.13 and 6.2 wt. per cent. Tensile strengths ranged from room temperature to 500 degrees Centigrade. Test results showed a steep decrease in tensile strength with increasing temperature. Above 250 degrees Centigrade, however, the tensile strengths leveled off. The 6.2 wt % Ni composite showed better strength than the 6.13 wt % Ni composite. The tensile strengths increased with increasing growth rate from 3.5 to 5.2 cm/hr. At yet higher growth rates, it was found that microstructural defects were more prevalent than at the lower rates and the strengths decreased. The defects encountered were fiber depleted grain boundaries and banded areas of misaligned fibers. When both defects occurred simultaneously, the specimen failed in matrix shear with a low ultimate tensile strength. The percent elongation of the samples was generally from 1 to 2% before the ultimate strength was reached. For those samples that had a sufficiently defective microstructure, elongation was extensive after yield and occurred uniformly over the gage length. Multiple shear planes were aligned parallel to the eventual failure plane. Strain rate sensitivity tests on specimens that showed unusual elongation after yield resulted in a low strain rate sensitivity index that decreased with increasing % elongation.

SUPPORTED BY Massachusetts Institute of Technology

8.0230, PRODUCTION OF PLATES OF FIBER COMPOSITES BY SOLIDIFICATION, FORMING AND A COMBINATION OF BOTH
W.L. MARSH, Maas. Inst. of Technology, School of Engineering, Cambridge, Massachusetts 02139

The purpose of this investigation was to determine the feasibility of unidirectionally solidifying the Al3Ni eutectic in plate form. Theplates solidified displayed good fiber formation but only half of strengths achieved in cylindrical specimens. Plates with thickness to width ratios of 2, 25, and 75 were grown and tested. The hot pressing of Al3Ni plates was found to increase the strength to more than twice that of the as cast alloy. However, it was found that the bond between
the plates was weak to the extent that the layers could be peeled apart.

SUPPORTED BY Massachusetts Institute of Technology

8.0231, TEMPERATURE AND STRAIN RATE DEPENDENCE OF DEFORMATION IN AL-3Ni-AL COMPOSITES
R.W. RENDER, Mass. Inst. of Technology, School of Engineering, Cambridge, Massachusetts 02139

Objective: To determine the elevated temperature properties of the Al3Ni-Al eutectic fiber composite. Specimens were grown from a 6.13 weight percent nickel eutectic alloy. Tensile tests were conducted over a temperature range from room temperature to ninety-seven percent of the absolute eutectic temperature. The maximum strength of the fiber composite decreased linearly from 44,000 psi at 25 degrees Centigrade to 40,000 psi at 600 degrees Centigrade. These strengths are superior to 2024 T6 and 7075 T6 high strength aluminum alloys at temperatures above 300 degree Centigrade. The room temperature strength of the as cast alloy is approximately 13,000 psi.

The fiber morphology remained stable and did not appear to coarsen throughout the range of test temperatures. Deformation of the composite showed a low dependence on temperature and strain rate.

SUPPORTED BY Massachusetts Institute of Technology

8.0232, PILING PRESERVATIVES THRESHOLD STUDIES
B.R. RICHARDS, William F. Clapp Laboratories, Duxbury, Massachusetts 02331

Objective: To determine what changes occur in woods (treated with various preservatives and exposed in coastal waters) to cause these treated woods to lose their resistance to attack by marine borers and fouling organisms.

Panels of several woods were treated with various preservatives and amounts of preservatives. Panels of 18 different treating systems were placed under exposure in Boston Harbor, Mass. in July 1969. In the same month 27 systems were exposed in the waters of Whightsville Beach, N. C. Sufficient samples were prepared to remove 3 samples of each treatment system plus one control panel from each location every 6 months for 5 years plus additional samples for subsequent removal annually. When removed the test panels are chemically and biologically analyzed for changes.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0233, DEEP-WATER FOULING
H. TURNER, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543 (NONR)

Analysis of data will be concluded on research undertaken to determine the quantity and kinds of sedentary marine organisms that attach and grow on installations set at a series of depths in the open ocean and form a fouling community that may affect the performance of instruments. Studies were also conducted to devise simple, reliable moorings that could be set from relatively small vessels at a reasonable cost. The phenomenon of damage to deep-water moorings and submerged installations by predaceous fishes was investigated.

As more activities are being planned for deep ocean localities, it is essential that the ecological characteristics of this environment be better understood. The little information available makes it clear that assumptions based on extrapolation from shallow water conditions are invalid in most cases. Whether or not biological fouling plays an important role at great depths and what its nature may be, needs to be determined. The nature and severity of attack by abyssal fishes on moorings and other artifacts in the deep ocean must be known as well as the identification of the animals involved.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0234, WAVE FORCES ON BREAKWATERS
A.M. KAMEL, U.S. Army, Waterways Experiment Sta., Vicksburg, Mississippi

8. ENGINEERING AND TECHNOLOGY

The objective of this project is to develop a theory and obtain experimental data on wave pressures from which the magnitude, duration, and location of wave pressures and impact forces on full-scale breakwaters of the vertical wall and composition types can be predicted.

SUPPORTED BY U.S. Dept. of Defense - Army

8.0235, BIOLOGICAL OCEANOGRAPHY AND DETERIORATION, POLYMER STUDIES

Objective: To determine the role of deep sea microorganisms in the corrosion and deterioration of deep submergence structures and instruments placed on the ocean floor, and deep research vehicles. To develop suitable corrosion preventive methods and provide consultation on problems involving biological oceanography.

Approach: Chemical and physical studies will be made on the isolated polymers followed by the characterization and correlation of polymeric substances with plankton species. A broad based theory of occurrence, use and importance will then be formulated.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0236, BIOLOGICAL OCEANOGRAPHY AND DETERIORATION, DEEP OCEAN-HIGH PRESSURE BACTERIA

Objective: To determine the role of deep sea microorganisms in the corrosion and deterioration of deep submergence structures and instruments placed on the ocean floor, and deep research vehicles. To develop suitable corrosion preventive methods and provide consultation on problems involving biological oceanography.

Approach: Obtain specimens of world wide ocean bottom sediments and determine chemical and biological content. Isolate, identify and determine corosive influence of microorganisms in laboratory simulated deep sea environments. Determine the relation of ecology to the bottom zone influence in accelerating corrosion rates. Determine the mechanism of microorganism attack on metals and organic materials. Correlate lab results with natural deep sea immersions. Determine influence of galvanic metal couples and organic materials on microorganism activity, the effect of environment on this influence.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0237, EVALUATION OF BOOTTOP PAINT SYSTEMS FOR OCEANOGRAPHIC SHIPS IN A BOOTTOP PAINT TESTING MACHINE
UNKNOWN, Battelle Memorial Institute, Columbus, Ohio 43201

This project evaluated the use of ship bottom paints under conditions which partially simulated the water flow conditions to which a paint film is subjected on a ship at sea. Thirty-three coating systems were tested and evaluated by applying the paint films to a cylindrical surface which is rotated constantly in a water tank.

The studies showed the importance of proper application, surface preparation, and drying between coats. The paints were separated into groups rated as best, intermediate, and poorest performance. Both conventional and high-build vinyls were included in the group, and all systems used a poly-vinly butyral wash primer.

Excellent performance of high quality catalyzed epoxy coatings was noted. The report discusses this performance with respect to application over inorganic zinc silicate coatings. Factors which may have contributed to the various types of failures were noted in several of the films. One of these factors was that the lack of sandblasting contributed to poor paint performance.

Each film is identified by source, coating type and color, number of coats, method of application, drying time, and thickness. Certain of the test drums were photographed on black and white film to illustrate condition after certain numbers of days of continuous rotation in seawater at speeds simulating a ship moving within the range of 18.8 to 20 knots. The report PB No. is available at the Federal Clearinghouse for Scientific and Technical Information, Springfield, Virginia, 22151.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.
8. ENGINEERING AND TECHNOLOGY

8.0238, MOBILITY OF OIL-TYPE PRESERVATIVES IN IMMERSED WOOD
D.J. MILLER, Oregon State University, Agricultural Experiment Sta., Corvallis, Oregon 97331

Objectives: To describe the movement of oil-type preservatives in treated wood immersed in water.

Abstract of Procedures: Laboratory tests will examine the effects of water temperature and flow on migration of creosote along radial and longitudinal axes of treated specimens of Douglas fir and southern pine sapwood. Marine exposure to determine and describe patterns of creosote migration in small piling immersed in marine waters.

SUPPORTED BY Oregon State Government

8.0239, FOULING OF SENSORS
W.E. PEQUEGNAT, Texas A & M University System, Graduate School, College Station, Texas 77843 (NONR)

The principal objectives of this task are to discern the nature of the accumulation of fouling organisms upon artificial substrates, some of which are partially protected by equatorial attachment of a teflon band impregnated with organotin, to observe the impact of various parameters on the nature and rate of growth of the accumulation; to evaluate the effectiveness of organotin as an inhibitor; and to suggest means of providing functional integrity of sensors during relatively long periods of immersion in the sea.

This task is expected to provide a better understanding of the parameters affecting oceanographic sensors which might be employed by environmental systems implanted for prolonged periods.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0240, ANTI-FOULING MEANS FOR MARINE PROPELLERS
S. HAWKINS, Robert Taggart Incorporated, Fairfax, Virginia 22030

The serious effects upon ship performance of fouling from occurring.

SUPPORTED BY Robert Taggart Incorporated

8.0241, THE ROLE OF MARINE ORGANISMS IN THE DEGRADATION OF NAVAL MATERIALS
J. LISTON, Univ. of Washington, Graduate School, Seattle, Washington 98195

This research within the Task Area of Marine Microbiology is concerned with rates and mechanisms of degradation, solubilization, and mineralization of organic residues from marine plants and animals by marine bacteria. Experiments are being conducted in a series of model sea bed systems which provide conditions similar to those actually occurring in the sea. These models are dynamic flowing sea water systems which permit observations to be made throughout the complete cycle of microbial enzyme-catalyzed transformations.

This investigation relates to microbial transformations as they effect functioning and maintenance of Navy hardware.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0242, MARINE PILING ANALYSIS
T.C. SCHEFFER, U.S. Dept. of Agriculture, Forest Service, Madison, Wisconsin

To evaluate wood treated with waterborne copper compounds; conduct follow-up studies on piling that have given either unusually good or very poor service; and improve methods for assaying treated piling and analyzing for creosote. Samples of piling having authentic histories are obtained and analyzed in the laboratory. Short fence post sections of both Southern pine and Douglas fir were treated with a variety of preservatives using two treatment methods and were exposed at Key West and San Diego. Wood specimens examined in connection with this Work Unit also undergo a microbiological study.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0243, MICROBIOLOGICAL INVESTIGATIONS OF THRESHOLD PANELS
R.L. YOUNGS, U.S. Dept. of Agriculture, Forest Service, Madison, Wisconsin

To determine if marine fungi and bacteria are significant factors in the degradation of marine timber preservatives or in the initiation of attack by marine borders.

Marine exposed panels used in connection with other existing investigations are being sent to the Forest Products Laboratory for examination. The examinations include identifications of the principal marine fungi and bacteria and determination of the relationship between species of microorganisms and kind of preservative, kind of wood, or locality of exposure. Cultures of isolated organisms will be maintained for possible continuation of study in order to determine quantitatively the capacities of the organisms for degrading preservatives.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0244, LABORATORY STUDIES TO CORRELATE ENGINEERING PROPERTIES OF MARINE PLACER MATERIALS WITH SAMPLING TOOL PERFORMANCE

Extensive background work has been done to become familiar with the current state-of-the-art in submarine geotechnique. Based on this work, a tentative classification system has been devised for marine placer deposit so that samples obtained at sea and soils used in MMTD lab can be adequately described. The test equipment required for measuring these classification parameters has been procured and is currently in storage awaiting completion of the environmental mechanics laboratory to house it. This laboratory is expected to be in operation following the two summer offshore campaigns.

Initial utilization of the laboratory will be for additional engineering properties tests on the offshore samples and for conducting a series of tests to evaluate the effects of gold migration during sampling. In addition, engineering properties testing will be done to assist the work of other projects.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

8.0245, LABORATORY MODEL STUDIES OF PENETRATION INTO A SIMULATED COHESIONLESS DETRITUS

Previous work by Colp (1965) on "An experimental investigation of the continuous penetration of a blunt body into a simulated cohesionless soil" has shown the value of using a roller bearing matrix to simulate a detritus and photographing the pressure distributions and particle displacements resulting from penetration of the matrix by a solid body.

The results of such tests using shapes of varying geometry and using different methods of application of the penetrating force could be of significance in the development of undersea sampling and excavation techniques. The major part of the experimental setup necessary to conduct the tests has been obtained, but actual testing has been postponed until laboratory facilities are available.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

8.0246, ENGINEERING EVALUATION OF EXISTING DREDGE SYSTEMS AND OPERATIONS

This is a continuing study of dredging operations which will allow maximum knowledge to be acquired of past and present systems in industrial use. Analysis of these systems will permit sound decisions to be made in planning future areas for research and development and will permit realistic projections to be made for proposed marine mining operations requiring dredging.

350
SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

8.0247. DEVELOPMENT OF AN ELECTRONIC METHOD FOR THE AUTOMATIC SHIPBOARD RECORDING OF DRILL PERFORMANCE DATA


In order to be able to better analyze the performance of the delineation devices aboard the ship an electronic data acquisition system has been designed and assembled for recording on strip chart and magnetic tape, 15 parameters that affect the operation. The following data will be recorded: 1. Time 2. Drill operator's voice, giving depth of hole, sample interval, and any problems encountered. 3. Ship's roll and pitch. 4. Velocity and direction of wind. 5. Velocity and direction of ocean currents. 6. Speeds of electric motors driving hydraulic water pumps. 7. Hydraulic pressure (2). 8. Air or water pressure and flow to drill pipe. 9. Impact force applied to drill pipe. 10. Penetration rate of drill bit into sediment.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

8.0248. DEVELOPMENT OF DIAMOND DRILLING TECHNIQUES, FOR PHOSPHORITE DEPOSITS, USING STANDARD TOOLS PLUS BUOYANCY TANKS


Initial phases of drilling operations conducted by MMTC with rotary equipment have demonstrated poor capabilities for coring in anything but solid bedrock. Drilling operations in unconsolidated sediments utilizing percussive or vibratory driving and water or air flushing improved the volume of sample recovered but the sample poorly represented the physical nature of the sediment penetrated. Recent emphasis has been devoted to the development of equipment which will provide a relatively undisturbed core of even loosely consolidated sediments in shallow ocean depths. These parameters of research have not been expanded to include extremely broad ranges of sediment consolidation and water contents. Arrangements are proceeding with E. J. Longyear Company of Minneapolis to test their recently patented, rotary, controlled buoyancy drilling system.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

8.0249. DEVELOPMENT OF WIRE-LINE CORING TECHNIQUE FOR SAMPLING UNCONSOLIDATED DEPOSITS


During the summer of 1967, MMTC conducted an offshore heavy metals research project off the southern coast of Seward Peninsula in the vicinity of Nome, Alaska. Results indicated that relatively rapid penetrations of shallow ocean-floor sediments could be accomplished from surface craft but only inconsistently yielding characteristics samples of the quality and quantity necessary for accurate delineation studies. Though the Becker Hammer drill had been successfully adapted to ship-board operation, it produced samples reliable only for mineral content and identification analyses, not for studies of engineering properties. Therefore, the Becker drill system is being adapted to a wire-line coring technique capable of producing an essentially undisturbed sample of ocean-floor sediments. Initial tests will be made on the Oregon-California Marine Heavy Metals Project.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

8.0250. DEVELOPMENT OF MARINE CHURN DRILL FOR SAMPLING UNCONSOLIDATED DEPOSITS


A single wall drill pipe that will take a wire-line core barrel, will be driven by a 1,000-pound hammer encircling the pipe. Other innovations will be a conical topped buoyancy tank to maintain verticality when drilling starts and to guide the core barrel on re-entry to the device. The re-entering core barrel will be lowered on a sand line guided along the hammer hoist line by a small vanned trolley.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

8.0251. LITERATURE SEARCH AND PRELIMINARY ENGINEERING STUDIES OF ENVIRONMENTAL PROBLEMS ASSOCIATED WITH MARINE DEPOSIT Delineation Techniques


This will involve a search of the literature to acquire data generated by offshore oil drilling companies, JOIDES, or others regarding the effect on drill pipe of lateral loading caused by ocean currents as well as data on materials corrosion in sea water.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

8.0252. LABORATORY MODEL STUDIES ON DISTURBANCE OF DETRITUS BY PENETRATION


One of the major problems of obtaining representative samples from marine deposits and meaningful data as to engineering properties is the amount of disturbance caused by the technique used. A quantitative study of this disturbance on a laboratory scale will give much insight into methods of penetration which can be used at sea to obtain a time representative sample.

The study will be done using a granular material submerged in hydro-carbon solution which will simulate water but will not disturb the material when it freezes. Models will be 6-inch diameter by 12-inch high cylinders of uniform sediments with known properties. The drill rod will be simulated by a 1-1/2' diameter pipe capable of being fitted with various bit configurations and capable of being driven by different method of energy application. After penetration is completed the model will be placed in a freezer until solid and then sectioned for study.

A three-dimensional observation of the disturbance in the core and surrounding sediments will be possible in the area of the drilled hole.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

8.0253. LABORATORY MODEL STUDIES ON PRESSURE DISTRIBUTION IN DETRITUS DURING PENETRATION


Much work has been done on the response of soil and rock to large scale dynamic loading in the past few years, but as yet little is known of the behavior of marine material in dynamic loading. The work on this project is concerned with small scale loading and the effects it has on the placer-type deposits.

The project is designed around the use of unique pressure transducers and their ability to give meaningful results. If it is determined that useful data can be obtained with them several series of tests will be performed in the laboratory.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

8.0254. FINITE ELEMENT TECHNIQUES


Mathematical models based on the finite element method of stress analysis is becoming one of the main tools in rock and soil mechanics for determining reaction of the stresses and displacements. In the finite element method of analysis, a continuous solid is modeled by an assemblage of a finite number of interconnected elements. The method's versatility is in the fact that each element can have completely different material properties and, in addition, linear relationships may be used. Any geometry or slope can be modeled for used in the method. The method will be applied to various problems of marine mining technology where it will be advantageous to know the response of the seafloor to load phenomena.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

351
8. ENGINEERING AND TECHNOLOGY

8.0255. ACOUSTIC HOLOGRAPHY
Technol. Ctr., Belvedere - Tiburon, California 94920

Recently the principle of reconstructed wave fronts has been extended to the formation of visual pictures of acoustical waves. This method yields better results than conventional acoustical lens systems especially in the presence of turbidity thereby making it a useful method for control of systems underwater. The method is based on the process in which the diffraction patterns of an object irradiated by sound waves is biased by a coherent reference wave and recorded; the record is then the acoustical hologram. A three-dimensional visual image can be created when the acoustical hologram is interrogated with a suitable coherent light source.

This will allow for the inspection and control of mining operations at depth in the ocean without the need for direct observation by divers or persons in submersibles.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

8.0256. DEVELOPMENT, TESTING AND EVALUATION OF MODIFICATIONS REQUIRED TO ADAPT DRILLING SAMPLING SYSTEMS TO THE PLATFORM

To develop, design, test and evaluate the modifications and changes required to accommodate the various different types of drilling equipment presently planned for use on board the R/V VIRGINIA CITY, and any future requirements which might result from further research and development of drill systems.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

8.0257. LABORATORY MODEL STUDIES OF COMPARATIVE METHODS OF PENETRATION OF DETRITUS

A survey of mining fragmentation technology has disclosed the existence of various methods available for in situ disintegration of marine deposits. The methods of penetration are conveniently classified by the type of energy applied to the working tool.

Mechanical energy which was the first to be investigated showed certain interdependence between the rate of energy application and the resistance to penetration of granular media. Static penetration tests of a tubular body into sand have yielded an understanding of the granular deposit response to static loading. Dynamic loading to determine the penetration characteristics, at high to very high velocities of the tube, are planned.

Sampling reliability has been tentatively evaluated in conjunction with information on relative disturbance of the sample, using data from the 1967 Alaskan field work.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

8.0258. BACKGROUND AND EXPLORATORY STUDIES OF MATERIALS HANDLING IN THE MARINE ENVIRONMENT

This project has multiple aspects which can be conveniently divided into 3 major areas:

1. Investigation of the energy requirements to remove mineral particles hydraulically from an unconsolidated granular deposit. This requires study of kinetic energy distribution of a submerged water jet to disrupt cohesion of particles. Other methods will be tested.
2. The development of certain marine mining systems may depend upon excavating equipment operating remotely on the seafloor. The process of mechanical cutting of the seafloor deposit by rotary process is relatively complex. Its efficiency depends on many external and environmental conditions. A test tank is present, and sole dependence is on the experimental approach. The proposed investigation will provide information in the areas which are now entirely uninvestigated or are obscure.
3. Related to the above is the study of methods for transporting materials from the seafloor. The transportation process is the continuation of the first step of underwater mining. The scope of the investigation will include determination of parameters which affect vertical or horizontal pipeline transportation of mineral particles or ore material to the surface for further processing.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

8.0259. DEEP SEA MINING PROJECT
J.L. MERO, Ocean Resources Incorporated, San Diego, California 92121

Ocean Resources, Inc., an ocean exploration and mining consulting firm, was engaged to design a mining system and to test the system in about 1,000 feet of water for the mining of mineral containing rocks from the ocean floor. The equipment was designed and tested on an industrial production scale with hundreds of tons of rock being successfully dredged from the design depth. The test was highly successful in that the rock was recovered at a production cost well within that to be considered economic for the commercial mining of this type of material. The test was carried out in the Pacific Ocean.

SUPPORTED BY No Formal Support Reported

8.0260. VISCOSITY AND VISCOELASTICITY OF LIQUIDS AND GLASSES

To develop and improve techniques for the measurement of rheological properties of liquids and glasses (both low molecular weight and polymeric as functions of temperature and pressure, in the pressure range from 1 to 2,000 atmospheres). Viscosities of liquids in this pressure range are needed for both technological and scientific purposes (design of hydraulic systems, checking concepts in theories of transport phenomena), but validity of usual measurements has not been established. In the glassy range, where the approach to equilibrium is slow, the manner in which properties depend on both thermal and mechanical histories is not established.

Increase the frequency range of our dynamic bulk modulus measurements of polymeric liquids and glasses, needed to check current theoretical concepts. Establish the limits of validity of the torsion crystal viscometer, which seems to offer the best prospects of increasing the accuracy of viscosity measurements in the above pressure range. Examine the influence of both thermal and mechanical histories of PVT relations in the glassy and transition regions.

Progress: March through December 1967. A digital phasometer, capable of measuring phase angles to 0.01 degrees from 10 kHz to arbitrarily low frequencies was completed and tested. This is a significant improvement over anything previously available. In addition to our use with the bulk modulus apparatus, it is likely to find other applications. (The Navy Underwater Sound Laboratory at New London is already using it to check the performance of special amplifiers in sonar systems.) A companion instrument to measure range ratios at low frequencies was designed and constructed, and is being tested. The other needed modifications to operate the bulk modulus apparatus down to well under 1 Hz have been planned and should be constructed and assembled within a few months.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

8L. PLATFORM DESIGN AND MAINTENANCE

8.0261. SHIP STRUCTURE LABORATORY TESTING AND ANALYSES
UNKNOWN, Univ. of California, Graduate School, Berkeley, California 94720

Purpose: To develop lower cost basic hull design by structure simplification and by upgrading material/structural effectiveness.

352
8. ENGINEERING AND TECHNOLOGY

SUPPORTED BY North American Rockwell Corporation

8.0264. DEEP SUBMERGENCE VEHICLES - DYNAMIC ANALYSES
A.D. NEWSHAM, North Amer. Rockwell Corp., Long Beach, California 90803

This research project concerned the definition and development of the testing and data acquisition techniques necessary to obtain accurate hydrodynamic data on marine class bodies - as well as the subsequent incorporation of these results into dynamic analyses of vehicle motion. Experimental air/water tests were conducted to define hydrodynamic parameters, and the resulting data was combined with theoretical analysis to define vehicle characteristics. This data was prepared in format suitable for guide retrieval and use with a analytical tool for research design. Project milestones included vehicle mathematical models, synthesis of hydrodynamic data, rotation testing, superposition testing, free surface operation, added mass estimation and hull-interference on hull surfaces. A significant portion of relevant data was acquired from test programs concerning North American Rockwell's Beaver MK IV submersible work/research boat.

SUPPORTED BY North American Rockwell Corporation

8.0265. RESEARCH SUBMARINE BEAVER MK IV
G. TUTTLE, North Amer. Rockwell Corp., Long Beach, California 90803

A program of applied research was conducted in support of the development of North American Rockwell's Beaver MK IV Submersible Work/Research Boat. The research work was focused at achieving advances in a number of specific technological and operational areas, which included: Integrated Control and Display System; Manipulator Systems; Underwater Construction Tools; Components and Subsystems.

The results of this research were directly applied to the development of advanced, high performance systems for utilization in a high pressure marine environment. Experimental laboratory and field tests were conducted on samples and prototypes of candidate units to establish high degrees of reliability and confidence in those systems and components being incorporated into the Beaver IV. Beaver MK IV, a manned work research submarine is to be launched in September 1968. Beaver is an on-site vehicle designed to perform a wide variety of underwater work assignments. Vehicle capabilities include diver lock-out potential down to 1000 feet and dry test bed in undersea systems development experimental and test programs.

SUPPORTED BY North American Rockwell Corporation

8.0266. WAVE UPLIFT FORCES ON HORIZONTAL PLATFORMS
F. RAICHLE, Calif. Inst. of Technology, Graduate School, Pasadena, California 91109

The underside of a platform intersecting the crests of a train of water waves is exposed to high transient pressures. The specific objective of this research is to study theoretically and experimentally the pressure distribution and resultant forces associated with these transient pressures.

A more detailed fundamental approach is necessary in order to gain a better understanding of the relationship between the characteristics of the incident wave and the resulting pressure distribution when a finite plane surface intersects the wave crests. It is the primary objective of this research to deal with this basic problem with attention being given to the relation between the detailed structure of the pressure distribution and the details of the caustic waves.

SUPPORTED BY U.S. National Science Foundation

8.0267. DEEP RECOVERY SYSTEM
R.K. HELLER, U.S. Navy, Undersea Warfare Center, Pasadena, California 91107

Objective: Provide a capability for unmanned underwater location and recovery of objects from the sea floor. Recovery is important in studying performance and in the case of malfunction for determining requirements for design modifications and/or
8. ENGINEERING AND TECHNOLOGY

8.0268. TELEMETRERING BUOY SYSTEM FOR OCEANOGRAPHIC RESEARCH AND ENVIRONMENTAL PREDICTION
R.F. DEVEREUX, General Dynamics Corporation, San Diego, California (NONR)

This task covers the development and deployment of a long range telemetering oceanographic buoy system for use in the Navy's basic oceanographic research program. The development of this buoy system is important to the ongoing construction of our national buoy system. The approach involves further engineering development and field operation of these long range buoys. The work includes continued evaluation of the buoy system, including meteorological and oceanographic sensors, mooring lines, buoy electronics, mobile data center, and buoy-to-shore radio communication. Convair will coordinate with SIO in exploratory deployment of buoys in the North Pacific. This task will provide for buoy handling and servicing at sea. During the year's deployment, a mobile data center will be operated by Convair to receive data by telemetry from buoys, record and scale data, perform limited data processing and disseminate these data to agreed research and operational users.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0269. OCEANOGRAPHIC ENGINEERING
J.D. FRAUTSCHY, Univ. of California, Scripps Inst. of Oceanography, San Diego - La Jolla, California 92038 (NONR)

The objective is to develop designs as well as advise on and supervise construction and testing of oceanographic ships, devices and techniques to meet the advancing needs for oceanographic platforms and equipment. During the coming year, representation will be provided for the Navy during construction of AGOR-14 and AGOR-15. Studies on oceanographic vessel design will continue with emphasis upon the development of the boat truck concept. Results from this task are expected to significantly contribute to the design of oceanographic research ships in the Navy Ship Construction Program, including those used by Navy in-house and contractor laboratories. The bathythermograph digitizer will accelerate the handling of BT slide and should reduce the backlog of unprocessed slides.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0270. DEEP OCEAN ENGINEERING TECHNOLOGY
F.N. SPIESS, Univ. of California, Graduate School, San Diego - La Jolla, California 92038 (NONR-0014-67-A-1009-0008)

Increased national and Navy interest in the ocean from military scientific and economic considerations has stimulated investigations toward development of technological and engineering capabilities to work in the deep ocean environment. The objective of this work unit is to contribute toward development of such technology as it is applicable to Navy-oriented efforts. The Benthic Laboratory will be installed in approximately 1200 feet of water 3 miles offshore in La Jolla Canyon, and used in conjunction with precisely positioned sensor fields to be installed on the ocean floor. Development of the new high-strength sensor manipulator for use in the Benthic Laboratory will continue. RUM experiments will be conducted from the new Ocean Research Buoy (ORB).

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0271. SHIPBUILDING COST ESTIMATING METHODOLOGY
UNKNOWN, Engineering & Mgt. Sci. Corp., Woodland Hills, California

PURPOSE: To develop techniques that will enable more accurate forecasts to be made of the economic effects of introducing innovations in shipyard facilities, ship design, and quantity procurement.

DESCRIPTION: This study will identify significant differences between past practice and improved shipbuilding methods, and their effect on shipbuilding costs. It will show where, and to what degree, conventional "system oriented" cost estimating records and methods do not fully reflect these differences. A "product oriented" method of recording costs and analyzing data will be developed to more effectively take into account the effects of innovations.

The approach treats all structure, piping, ducts, and wiring located in a given compartment or module in La Jolla Canyon, and makes specific allowance for the working environment. The innovations considered are the facilities, design techniques, etc., which permit fabrication and outfitting to be done under convenient and efficient shop conditions as contrasted to conditions on the ship.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8.0272. HUMAN FACTORS IN SHIP CONTROL
UNKNOWN, General Dynamics Corporation, Groton, Connecticut

Purpose: To develop guidelines for determining human factors involved in bridge control for use in improving bridge equipment and arrangement.

Description: Guidelines are being developed for use by ship bridge designers to achieve an effective application of space and equipment to the deck officer's tasks in ship coming and control. Emphasis is placed upon the frequency and criticality of tasks, information requirements, human capabilities and stresses encountered by the bridge watch in arriving at and executing decisions.

Controls, displays and layouts resulting from analysis of these factors have been described as a means of assisting human performance. Criteria for equipment and layout design which would minimize human error have been developed and demonstrated in three alternative bridge designs, two of which were selected for tests and evaluation. Full scale models of these designs are presently under construction after which measures of operational and cost effectiveness will be obtained.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8.0273. CATAMARAN CONTAINERSHIP FEASIBILITY
UNKNOWN, General Dynamics Corporation, Groton, Connecticut

PURPOSE: To determine the technical and economic feasibility of utilizing twin-hulled ships for transocean shipment of unitized cargo.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

354
improvements have been made in shield design since SAVANNAH which utilize concrete to a large extent and reduce both shielding weight and cost. The report PB No. 178-964 is available from the Federal Clearinghouse for Scientific and Technical Information, Springfield, Virginia, 22151.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8.0276, WATER-TO-AIR RETRIEVAL
J.R. SMITH, All American Engineering Co., Wilmington, Delaware

This project was a preliminary study of a method using fixed wing aircraft to recover packages from a water surface. It involved study of the design, analysis, fabrication, and testing of a balloon type water pick-up station for use with 1,000 pound recoverable objects. As envisioned by All American, the pick-up station consisted of a recoverable package, floating on the surface of the water, connected by rope to a balloon. The aircraft was to fly by, engage the rope at a point just below the balloon, and winch the package aboard. The basic recovery system, including the winch, has been developed and tested by All American, and could be adapted for over the water recovery.

A mathematical model was used to establish the basic parameters on the 1,000 pound recovery station. The input parameters included a load limit on the package, rate of climb of the package and speed of the aircraft. From the model, the minimum length and strength of the rope for the pick-up station were found.

In this type of recovery system it is important that the balloon keep the pick-up lines as nearly vertical as possible. Various balloon shapes were studied to determine the one which would function best in winds of 15 to 20 knots.

SUPPORTED BY All American Engineering Company

8.0277, A STUDY OF A TRANSITIONAL CONTAINER-SHIP CONCEPT
A.R. GOOBECK, U.S. Dept. of Commerce, Maritime Administration, Washington, District of Columbia 20235

This research study developed a ship design that features a hold module and cargo handling system arranged to facilitate ready changeover from a highly flexible (100%) breakbulk operation to efficient all container storage via cellular stacking without the need for extensive structural modifications, guide installations, or additional handling equipment. Such ships can be used in the 'uncertain' trades to help smooth the transition from breakbulk cargos to containerized cargo.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8.0278, PRELIMINARY CALCULATION OF THE LIFT AND DRAG AND ANGLE OF ATTACK FOR SUBMERGED HYDROFOILS
J.G. GROSS, U.S. Dept. of Commerce, Maritime Administration, Washington, District of Columbia 20235

A hydrofoil lift and drag calculation procedure has been computerized in such a way as to minimize data input requirements. The goal was to develop a relatively simple method for determining hydrofoil lift, drag and foil angular motion at various speeds. The twenty-nine model input items include foil physical characteristics such as span, area, chord, dihedral, sweep, end plate height and distance, thickness, and camber; nacelle characteristics such as length, location on strut, diameter, projected area; and system characteristics such as craft weight, submergeance, design speed, and flap or incidence control indicator. Model output includes downwash drag, included drag, parasite drag, total drag, foil angle, nose lift angle and flap angle.

All of the output is varied from the take off speed (foilborne transition) to the maximum design speed in small speed increments.

The model is written in FORTRAN IV for H200. As yet, no model operating documentation exists.
8. ENGINEERING AND TECHNOLOGY

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8.0279. MODEL FOR THE PRELIMINARY DESIGN OF SURFACE EFFECT SHIPS
J.G. GROSS, U.S. Dept. of Commerce, Maritime Administration, Washington, District of Columbia 20235

This computerized model performs a preliminary analysis of surface effect ships. The goal was to determine major characteristics of surface effect ships for further analysis in a commercial environment. The model input includes such variables as vehicle gross weight, vehicle surface clearance, cushion loading parameter, number of compressors, significant wave height in a seaway, vehicle design range, design speed, beam/length ratio, vehicle body aero lift coefficient, and body aero drag coefficient.

Consideration is given to the various drag components, propulsion efficiency by various devices, compressor requirements, sea wave height effects, and vehicle weight components. Model output is presented as vehicle physical configuration, normalized drag components variation with vehicle speed, normalized propulsion and cushion power requirements with speed, cushion and propulsion power weight variations with speed, maximum power and design, structural weight, propulsion and cushion machinery weight, equipment weight, fuel requirements, and payload capacity.

The model is written in FORTRAN IV for H200. As yet, no model operating documentation exists.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8.0280. ADVANCED RESEARCH - SATELLITE INTERROGATED ENVIRONMENTAL BUOY

Objective - Design, develop and test low cost buoy systems for sea keeping and satellite interrogation characteristics.


Preliminary studies, designs, and testing of half scale models completed as in-house efforts. Three full scale buoys to be fabricated in accordance with detail design specifications. Tests to be conducted in coordination with interested ESSA divisions.

Progress (to June 30, 1967): Program funds became available in July 1966 and specifications for development of three prototype buoys were completed. The contract was issued in December 1966 and proposals evaluated which resulted in selection of Ocean Research Equipment, Inc. of Falmouth, Massachusetts, as the contractor. The contract was signed in April 1967.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

8.0281. NATIONAL DATA BUOY STUDY
R.W. GOEHRING, U.S. Dept. of Transportation, Coast Guard, Washington, District of Columbia 20591

This amount represents the National Science Foundations portion for the support of the National Data Buoy Study conducted by the U.S. Coast Guard as per agreement between Dr. Leland J. Haworth, Director, National Science Foundation and Dr. Robert A. Frosch, Assistant Secretary of the Navy, dated August 17, 1967.

SUPPORTED BY U.S. National Science Foundation

8.0282. ADVANCED DEEP OCEAN TECHNOLOGY

Objective: Acquire through systems analysis, studies and testing the operational depth limitations of present systems and to develop realistic programs and plans for advancing these present systems to meet the ever increasing fleet demands.

Approach: Develop detailed working plans for the development of such deep submergence machinery and equipment as speed reducers, submersible electric drive systems, hydraulic systems, high pressure sea water pump systems and tandem propulsion systems. To develop a detailed working plan requires: precise determination of the state-of-the-art of components which will be required to make up the system, analysis of the requirements of the system as compared to the state-of-the-art, identification of problems of potential problems, and the assembly of a program which includes the above.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0283. STRUCTURAL DESIGN CRITERIA
UNKNOWN, U.S. Ship Structure Committee, Washington, District of Columbia

Purpose: To develop means to obtain greater safety without adversely effecting economy.

Description: This program is a joint venture between the Maritime Administration, Navy, Coast Guard, and the American Bureau of shipping.

It has resulted in ship structure improvement which include: finding the cure for brittle fracture problems; elimination of the need for riveted crack arrestors; development of better welding techniques; a better understanding of notch effects; and development of improved radiographic and ultrasonic testing methods. Research is now being performed under the broad headings of Structural Response, Structural Design, and Materials which is expected to lead to further significant improvements by acquisition and analyses of new data; refinement of design and fabrication tools, and establishment of improved design criteria. Significant areas under these headings are: accumulation of data on ship response to seaway conditions (including slamming); statistical analyses of seaway and ship response data; expansion of the use of computers in design; development of hull girder models; determination of the characteristics of high strength steel structures in a marine environment; development of improved acceptance tests for joined materials, and improvement of fabrication methods.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8.0284. DESIGN AND CONSTRUCTION OF BARGE AND CLAM DREDGE FOR SURVEY OF FLORIDA'S COMMERCIAL CLAMS
H.W. SIMS, State Board of Conservation, Saint Petersburg, Florida

Phase 1. During phase one the principal investigator will work with a designer and boat builder to draw plans and construct the barge needed to begin the survey. The actual building of the barge will be done by the ship yard, but will require supervision and communication with the principal investigator. It will be the duty of the principal investigator to find and purchase equipment needed to outfit the boat and to see that this equipment is delivered to the builder in time to meet the work schedule.

Phase 2. The deeper waters 5-10 feet, along the shore line will be surveyed for hard clam beds. Samples will be taken by running the shore line to the extreme depth, then parallel to the shore at this depth for approximately 100 feet, return to the shore (water depth 3-5 feet), run parallel for 100 feet, turn and run out to extreme depth. At the end of each run, before turning offshore again, measurements of the clams will be made and data recorded. In most cases the clams will be returned to the water in the same area where they were found. Certain areas may be re-sampled to gather growth information.

Phase 3. Past studies indicate that populations of the surf clam may be found in large numbers in the mouths of large inlets into the bays. The dredge will be run over these areas to learn the extent of these clam beds. If this clam appears to be available in sufficient numbers, samples collected will be passed on to interested persons in the hope that a market for them may be created. Data, similar to that collected for Mercenaria will be recorded.

Phase 4. Before dredging the area a check of the bottom will be made and data on the abundance, size and condition of both plant and animal species found will be recorded. Samples of the sediments will also be taken and separated for particle size.
dredging the area, data will be recorded on the species collected. At some locations checks of the bottom will be made monthly. In other locations checks will be made at 3, 6 and 12 month intervals. These subsequent checks will be made by hand, without the re-use of the dredge. Other areas will be redredged monthly for as long as it is convenient for the dredge to return to the site. Yearly checks will be made of all sites, with the dredge. The data collected should show the immediate effects of the dredge as well as the long range results.

**SUPPORTED BY** U.S. Dept. of Interior - Bu. Comm. Fish. Florida State Government

8.0285, **MARINE METEOROLOGY UNTENDED STATION DEVELOPMENT**

M. GARSTANG, Florida State University, Graduate School, Tallahassee, Florida 32306

Development of a buoy stable enough to perform as a platform for measurements of wind profile in the open sea and development of an instrumentation system for five days of untended operation to measure, digitize and record wind and air temperature profiles, humidity, rainfall, and water temperature.

**SUPPORTED BY** U.S. Dept. of Commerce - E.S.S.A.

8.0286, **EXPLORE FISHERY AND RESEARCH APPLICATIONS OF SUBMARINES**

R.S. SHOMURA, U.S. Dept. of Interior, Biological Laboratory, Honolulu, Hawaii 96812

By correspondence, interviews, etc., the research applications of a submarine are being explored, and the several possible research missions are being related to a variety of broad design possibilities. With the submarine's missions clearly established and ranked in order of importance, a contract will be awarded for feasibility and conceptual design studies. These studies involve optimization of vessel design with respect to size, shape, power, speed and maneuverability; preparation of layout drawings; estimation of costs and schedules for ensuing design, construction, and operating phases; and a personnel analysis for the operating vessel.

**SUPPORTED BY** U.S. Dept. of Interior - Bu. Comm. Fish.

8.0287, **STABLE OCEANIC STATION**

R.J. PIERCE, Hydro Space Systems Corp., Cedar Rapids, Iowa 52402

Theoretical and experimental work has been conducted for the past five years on a concept of a large stable submerged oceanic station (100-20,000 tons displacement). The concept under study is based on the principle that a high degree of pitch stability and heave stability can be achieved if the sea station is, for the most part, submerged unaffected by surface conditions of winds and waves. The buoyancy and mass of the submerged portion is made very large. The superstructure protruding above the surface is made very small so that it has minimum coupling to the forces of winds and waves. The magnitude of the lateral forces of winds and waves is very small compared to the vertical forces of the large submerged mass, thus achieving a high degree of pitch stability. Pitch stability is further enhanced concentrating the buoyancy and mass structures laterally and widely separating the center of buoyancy and the center of mass. The buoyancy chamber and mass structures are discus-shaped to minimize drag due to ocean currents. Since dynamic station keeping is contemplated, low drag is important to minimize propulsive power. Analysis and scale model testing of large ocean stations of the order of 20,000 tons indicates that pitch stability of less than plus or minus 1 degree in 60-foot waves and 100-knot winds can be achieved. Analytical and scale model testing under simulated ocean conditions are being continued by Hydro-Space and the Hydraulics Institute of the University of Iowa. It is anticipated that when developed, the station could be used for many applications, such as deep ocean radio data stations, deep ocean communication and navigation stations, offshore oil production rigs, and general ocean base station other applications. One specific application is shown in the SEACOM brochure attached.

**SUPPORTED BY** Hydro - Space Systems Corporation

8.0288, **DESIGN STUDY - AN OPTIMUM FISHING VESSEL FOR THE GEORGES BANK GROUND FISH FISHERY**

C. HOMLIN, Ocean Research Corporation, Kennebunk, Maine 04043

This study was initiated to devise a method of optimizing fishing vessel design and operation for any fishery. Optimality was defined as maximum Return on Investment (ROI), and the Boston, Mass., fishing fleet was selected as the foundation. A generalized functional model of fishery resource exploitation was constructed. From this, a mathematical model was prepared, based on the Georges Bank groundfish, and programmed for an IBM 1130 computer, the output being ranked according to ROI. The model related vessel characteristics, crew size, and fishing operations, to the basic elements of the fish harvesting system, i.e., the net/engine/propeller subsystem. Descriptive plants were prepared for the resulting optimum vessel: LOA - 125', shaft HP - 1030, crew size - 16. Predicted maximum return on investment for the optimum vessel was 26.7%. The study demonstrates the feasibility of using a suitable computer program to examine the highly complex fishing operation, and to optimize any desired subsystem.

**SUPPORTED BY** U.S. Dept. of Interior - Bu. Comm. Fish.

8.0289, **PROPELLON EFFICIENCY 'U' VERSUS 'V' STERNs**

UNKNOWN, U.S. Navy, Ship Research & Dev. Center, Caderock-washington, Maryland 20007

**DESCRIPTION:** Using a Series 60 - .60 block coefficient model with normal stern configuration as parent for the tests, two mathematical forms were derived maintaining the same sectional area curve as the parent, such that one was more 'V' and the other more 'U'.

Wake survey tests were made with all three hulls at the 21.3' draft. In addition tests were made with the parent model at 80% design draft at both level keel and trim by the stern - the trim by the stern being such that propellar immersion was equal to that at design draft. The tests were made at the equivalent full scale speed of 19.5 knots and 6.0 knots for the parent form and at 19.5 knots only for the other two.

The next stage will be to perform vibration tests and make comparison with existing NSRDC propulsive data to determine the relative roles of wake distribution and vibration on overall propulsive efficiency.

**SUPPORTED BY** U.S. Dept. of Commerce - Maritime Admin.

8.0290, **CONTRAROTATING PROPELLER IN JUMBOIZED MARINER**

UNKNOWN, U.S. Navy, Ship Research & Dev. Center, Caderock-washingtorn, Maryland 20007

**Purpose:** To investigate the feasibility of converting existing mariners into containerships by jumboizing and in addition utilizing contrarotating propellers.

Description: An existing mariner model was lengthened by adding parallel midbody, representing 95 feet full scale, and fitted with a stock contrarotating propeller; in order to fit the propeller, the aft end of the existing shaft bossing was cut off an amount corresponding to two feet full scale.

The model was run for EHP and SHP at a displacement of 18,840 tons at 21.38 mean draft. These tests will be compared with tests of the original shorter model running at 18,610 tons at 29.96 feet draft with normal single screw propeller.

**SUPPORTED BY** U.S. Dept. of Commerce - Maritime Admin.

8.0291, **SHIP DESIGN WAVE RESEARCH**

R. ZARNICK, U.S. Navy, Ship Research & Dev. Center, Caderock-washingtorn, Maryland 20007

**Objective:** To conduct oceanographic research in those areas specifically affecting the design, development and operations of ships. Provide a centralized source of oceanographic knowledge and improve existing oceanographic data used in ship design.

**SUPPORTED BY** Hydro - Space Systems Corporation
8. ENGINEERING AND TECHNOLOGY

Approach: To simulate true sea state in model hull test facilities. A continuing study will be made of oceanographic literature to keep abreast of the most recent theories as to the most suitable representation of the seaway and all significant advances will be immediately applied to the ship design problem. Techniques will be developed for the generation of directional wave spectra in the Model Basin's Seakeeping Facility (MASK) to provide for a more meaningful model of oceanographic environmental conditions. The Model Basin will use its technical abilities to assist the oceanographer in obtaining reliable measurements of ocean environmental conditions.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0292, DEEP SEA SUBMERSIBLES
K.G. PICHA, Univ. of Massachusetts, School of Engineering, Amherst, Massachusetts 01003 (N00014-67-A-0158-0005)

Objective: The objective of this program is to develop, through a center of excellence, a body of knowledge in the field of deep sea engineering, particularly for exploration and exploitation devices. The interdisciplinary research program is broken into the following areas of immediate technological concern: energy conversion, environment, guidance and control, hydrodynamics, materials, propulsion, and structures.

Applicability: The investigators will continue theoretical and experimental work on (a) streaming of water by interaction with magnetically accelerated colloids, (b) composite materials (c) deep submergence vehicle system design (d) nonlinear behavior of hull structures (a) impact leading of submarine hulls (f) effects of pneumatic and hydraulic breakwater devices (g) design criteria for underwater anchorages (h) kinetics of ebullient bed catalytic reactions (i) aerodynamic simulation tests for marine vehicle components (j) propeller and wake noise in deep sea submersibles.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0293, STEP RESPONSE METHOD FOR DETERMINING HORIZONTAL COEFFICIENT FOR DEEP SUBMERSIBLES
M.A. ABKOWITZ, Mass. Inst. of Technology, School of Engineering, Cambridge, Massachusetts 02139

Objective: The objective of this program is to develop a comparative analysis of various combinations of column configurations for a mobile column stabilized platform. The platform is a deep draft vessel consisting of two longitudinally oriented, cylindrical hulls. To each hull two vertical columns are attached which pierce the surface of the water. The upper ends of the columns are attached to a platform well above the waterline. The platform may provide additional performance capabilities in comparison with a standard displacement vessel. The mobile column stabilized platform is not without its problems, however, and this experimental and analytical study provides an analysis of some of these problems.

The resistance characteristics of the model are compared with a standard hull form. The constraints imposed by stability and strength requirements on the column shape and size are theoretically calculated.

SUPPORTED BY Massachusetts Institute of Technology

8.0294, A STUDY OF THE INTERFACE LOCATIONS BETWEEN DISSIMILAR MATERIALS AND OTHER ASPECTS OF A COMPOSITE MIDSHIP SECTION
L. AFANASIEFF, Mass. Inst. of Technology, School of Engineering, Cambridge, Massachusetts 02139

The following aspects of midship section design, with employment of different component materials, are analysed: the stress schedule and optimum neutral axis position, the interface locations between dissimilar materials, the relation between frame and longitudinal spacing and their influence on the hull plating thickness, the ultimate strength of the composite hull girder and some aspects of a computer approach to composite midship section design.

SUPPORTED BY Massachusetts Institute of Technology

8.0295, WEIGHT ANALYSIS IN FISHING BOATS
R.W. CANAR, Mass. Inst. of Technology, School of Engineering, Cambridge, Massachusetts 02139

The purpose of this study is to determine a method for estimating the hull steel weight in the early stages of the design.

Hull steel weight refers only to the underdeck weight less the weight of bulkheads, deckhouses, and foundations. Since the hull steel weight is a direct function of the ship's full length scantlings and at the same time these are a direct function of the midship section scantlings, most of the work was devoted to find a relationship, if any, between the weight of the midship section and the hull steel weight. The weight of the midship section used is the 'weight per foot' which is the weight per foot of the longitudinal members plus the weight of the transverse members in one frame space divided by the frame spacing. A dimensionless coefficient results from the relationship among the hull steel weight, the weight per foot of the midship section and the ship's length. The weight per foot of the midship section and the ship's length equal to the hull steel weight (lbs/ft) divided by (lbs/ft); L equals length (ft).

To take care of the variation of scantlings toward the ends, this coefficient was related to the form prismatic coefficient C sub p.

Since the scantlings are proportional to the local radius in each station, the value of the 'Weight prismatic coefficient' alpha sub p and C sub p was expected to be the same. The results showed that it is not so for the following reasons: 1. There is much hull steel which is not shown in the midship section. 2. Both the block and prismatic coefficients used in this analysis were those calculated up to the design water line and these always less than the ones calculated up to the full depth.

The way chosen to include the effect of the vessel's size is the cubic number of times the block coefficient (L,B,D,C sub b/100) which is a rough measure of the underdeck volume.

SUPPORTED BY Massachusetts Institute of Technology

8.0296, AN INVESTIGATION OF THE PERFORMANCE OF A COLUMN STABILIZED PLATFORM
K.A. GUSTAFSON, Mass. Inst. of Technology, School of Engineering, Cambridge, Massachusetts 02139

The objective of this thesis is to obtain a comparative analysis of the performance of a mobile column stabilized platform. The platform is a deep draft vessel consisting of two longitudinally oriented, cylindrical hulls. To each hull two vertical columns are attached which pierce the surface of the water. The upper ends of the columns are attached to a platform well above the waterline. The platform may provide additional performance capabilities in comparison with a standard displacement vessel. The mobile column stabilized platform is not without its problems, however, and this experimental and analytical study provides an analysis of some of these problems.

The resistance characteristics of the model are compared with a standard hull form. The constraints imposed by stability and strength requirements on the column shape and size are theoretically calculated.

SUPPORTED BY Massachusetts Institute of Technology

8.0297, OPTIMIZATION METHODS APPLIED TO THE PRELIMINARY DESIGN OF A NAVAL AUXILIARY
F.C. HOLMES, Mass. Inst. of Technology, School of Engineering, Cambridge, Massachusetts 02139

The technique for optimizing multidimensional functions developed in Refs. (7), (10), and (13) has been applied in this report to the preliminary design of a multimission naval auxiliary. The algorithm computes a number of effectiveness factors for each design which reflect the ship's ability to meet its specified mission requirements. Factors are then combined with the ship's twenty-five year life cycle costs in an optimization criterion which permits selection of an optimum design. Sample results obtained from the algorithm described in this report are tabulated in Tables III, IV, V, and VI.

Unfortunately, the optimization technique utilized in this report did not permit examination of results in terms of the effect on cost of each individual effectiveness factor. For this reason, the recommendation is made that for future studies of this kind, an entirely new approach should be taken as described in Section IV.

SUPPORTED BY Massachusetts Institute of Technology
the suitability of other materials, such as titanium. Also, materials transverse members of a ship's midship section. Any framing J.F. INCE, COMPUTERIZED DESIGN OF PRIMARY HULL STRUCTURE J.F. INCE, Mass. Inst. of Technology, Graduate School, Cambridge, Massachusetts 02139.

The fifth of a series of computer programs has been developed to design the longitudinally continuous and primary transverse members of a ship's midship section. Any framing system and material distribution may be chosen for a given geometry and a normalized weight and cost will be determined. Using three types of steels, optimum combinations are found by a parametric study and a 'performance norm' solution of weight vs. cost obtained.

This curve is then used as a reference against which to test the suitability of other materials, such as titanium. Also, materials with hypothetical strength properties are investigated to show under what circumstances, i.e. for what unit weight and cost, they might excel the three commonly used steels used in optimum combinations.

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A computational method is presented by which the performance of a propeller operating at conditions different than the design conditions, can be determined. The analysis presented makes use of existing computational methods for the solution of the direct or design problem.

A computer program is developed and the results compared with experimental data. This comparison is considered favorable.

SUPPORTED BY Massachusetts Institute of Technology

8.0300, INVESTIGATION OF NAVAL SHIP FORMS P. MANDEL, Massachusetts Institute of Technology, School of Engineering, Cambridge, Massachusetts 02139.

NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY Massachusetts Institute of Technology


It is known that superconducting machines of capacity large enough to power ships of a destroyer's size are within the capability of present technology. Given this fact, the control of these machines must be examined to the extent of determining ship performance realizable with such a drive system.

A mathematical model for ship-propulsion plant performance is derived using the propeller characteristics of Nordstrom (14). From the model, a set of ideal performance characteristics in the form of plots of stop to full ahead and crash astern transients is obtained. These do not account for any equipment, prime mover, or machine limitations.

A conceptual design of a control system is presented. The system accounts for limitations on ideal performance that are discussed. Feasibility of the system is demonstrated.

Finally, incorporating the limitations to ideal performance, the model and control system are used to predict realistic ship performance characteristics, assuming power plants of gas turbines and conventional steam.

The principal results are that the gas turbine plant provides faster response to demands for increasing speed and that neither plant provides an advantage in a crash astern maneuver.

The characteristic plots for the transient maneuvers provide a basis of comparison for the observer familiar with capabilities of other power plant, control, and drive system combinations.

SUPPORTED BY Massachusetts Institute of Technology


The Deep Submergence Rescue Vehicle is being built with an activated roll stabilization system. The effectiveness of this system is limited by pump saturation. This investigation is concerned with improving the roll stabilization of the DSRV through the use of a passive tank stabilizer. A mathematical model for the tank system is developed and adapted to the DSRV model. The passive system is extended to include two modes of operation, each representing a separate tank frequency, which may be selected by the operation of a valve. The passive system and the dual mode system are simulated on an analog computer to determine their response to transient disturbances.

The results show that a passive stabilizer of reasonable design could improve the roll stabilization of the vehicle. Furthermore, it is concluded that stabilization of transient disturbances can be improved by dual mode operation if a tank frequency at least three times greater than the natural frequency of the vehicle can be obtained for one of the two tank modes.

SUPPORTED BY Massachusetts Institute of Technology

8.0303, ESTIMATION OF HULL STEEL WEIGHTS FROM MIDSHIP SECTION CHARACTERISTICS J.W. ROYCE, Massachusetts Institute of Technology, School of Engineering, Cambridge, Massachusetts 02139.

The purpose of this thesis is to develop a refined method of estimating the hull steel weights of naval auxiliaries. The approach utilized is based on the primary structure exhibited amidships, with modifications to account for partial substructures.

The primary structure includes the shell and framing, and decks, inner bottom, and longitudinal bulkheads whenever they are continuous for substantially the full length of the ship. Based on this primary structure at amidships, a "normalized weight," or weight per foot of longitudinally continuous material, plus the weight of transverse members divided by their spacings in feet is determined.

On the basis of the research discussed in Part II of this thesis, there is a strong indication that the normalized weight may be predicted by considering various properties of the midship section in longitudinal bending and specifying the allowable bending stress.

The normalized weight is used to predict a 'standardized underdeck weight' by means of an 'adjusted weight coefficient.' The standardized underdeck weight includes the weight of those items which are included in the normalized weight plus some smaller items (see Part I, section B) which are felt to be related to ship size. The adjusted weight coefficient relates the normalized and standardized underdeck weights.

Weights of partial substructures and special features must be added to the standardized underdeck weight to obtain the total underdeck weight. The special features are items which are not expected to show any trends in relation to ship parameters or which are unique to a particular design or ship class. These must be handled separately and individually. The partial substructures of greatest concern are transverse and local longitudinal bulkheads and platforms, flats, and discontinuous decks. Suggested approaches to developing estimation techniques for these items are discussed in Part III, sections A through D. The most interesting indication shown is probably that the curves of sectional areas between the design water line and the uppermost longitudinally continuous deck may be fairly well approximated by 3 straight lines for hulls with vertical sides above the DWL at amidships.

SUPPORTED BY Massachusetts Institute of Technology

8.0304, STRESSES DEVELOPED ON THE SURFACE OF CYLINDRICAL JOINTS SUBJECTED TO MULTIPLE LOADS J.C. SACCHINI, Mass. Inst. of Technology, School of Engineering, Cambridge, Massachusetts 02139.

This paper deals with the stresses developed at the intersection of two circular members of different diameters. Both members carried axial loads, with the larger member being continuous.
8. ENGINEERING AND TECHNOLOGY

through the connection and the smaller terminating at the con-
nection. The method for determination of the stress was by coat-
ing the larger member with photoelastic plastic and observing the
stresses that developed at the connection. Stress concentration
factors were determined by loading the larger member prior to
the connecting of the smaller members.

Analytical results, obtained from attempting to predict the
moment in the larger member generated by the load on the
smaller member, were calculated by using Hoygaard's Continu-
ous Ring Frame Analysis and Hardy Cross's Column Analysis.
The formulation of stress from this moment was combined with the
axial stress from the large member's end load, and the result
modified by the stress concentration factor determined earlier.

When the model tests were compared to the analytical results, it
was found that the moment or stress predicted was 2.5 to 3.2
times higher than that which would be expected from the model
tests. A great deal more investigation must be done with this type
of joint before a clear understanding of what is happening within
both members will be reached.

SUPPORTED BY Massachusetts Institute of Technology

8.0305, AN EXPERIMENTAL INVESTIGATION OF PAR-
TIAL LIMIT SHROUDED POPPELLERS
P.T. TARMERánd, Mass. Inst. of Technology, School of En-
gineering, Cambridge, Massachusetts 02139

Results are reported for a series of experiments in which
forces associated with a propeller fitted with a partial shroud are
measured. The shroud is partial in the sense that it subtends only
180 degrees of the propeller circumference rather than the full
circumference, as is commonly the case. S. J. Gordin in 1966
proposed that such a shroud could be used as a rudder if mounted
so that it can be moved from one side to another on the propeller
circumference. A difference in velocity between the water mov-
ing on each side of the shroud produces a radial force which can
be directed to either side by moving the shroud.

The quantities measured were the radial and axial force on
the shroud, termed 'lift' and 'drag', and the thrust and torque on
the propeller. Measurements were made in a propeller tunnel
using a series of four different half-shrouds with a single propeller.
Variations were made in the geometric properties of the shrouds
and in the orientation of the shrouds to the incoming flow with the
object of determining the effect of these properties on the
behavior of the propeller-shroud combination. Graphs of shrouds
and propeller performance characteristics are presented and
methods of interpreting and comparing them are suggested.

It is found that rather large radial forces can be obtained with
partial shrouds while getting very little accompanying drag.
Under many operating conditions a thrust will be developed for
the shroud. The forces on the shroud were found to be very sensi-
tive to the angle of attack of the shroud and to a lesser extent on
the camber of the shroud crosssection. The shroud has a marked
effect on the propeller characteristics and the results indicate that
a higher pitch propeller than would be chosen otherwise might be
desirable when using a partial shroud.

The partial shroud as a steering system seems to offer par-
ticularly good characteristics for applications where good maneu-
verability at low speeds is desired such as in tugs or salvage ves-
sels. With more research and design development it might prove
superior in a more general range of applications.

SUPPORTED BY Massachusetts Institute of Technology

8.0306, SEAKEEPING QUALITIES - MOTIONS AND
POWERING PREDICTIONS
UNKNOWN, Mass. Inst. of Technology, Graduate School, Cam-
bride, Massachusetts 02139

Purpose: To devise means to predict the over-all seakeeping
qualities of modern merchant vessels during the design stage in
order to improve their performance in rough weather.

Description: Computer programs developed by M.I.T.
for determining different displacement ship responses to wave ac-
tions (i.e., pitching, bending moment, added resistance in waves,
etc.) have been consolidated into one master program. 'Still water'
resistance data for the Taylor and Series 60 Families have been
added to the program. The end product will be a design
manual that will enable the naval architect to base his design, not
only on still water powering performance, but on powering in a
seaway and seakeeping capabilities.

The research also includes a computer program to predict the
motions of, and the vertical and horizontal forces in connec-
tions between, single line ahead push barge tows. Model tests in
head seas with three barges have been made to check the barge
computer program. This phase of research is an integral part of an
overall barge investigation being conducted both at M.I.T. and
Stevens Institute.

SUPPORTED BY U.S. Dept. of Commerce - Maritime
Admin.

8.0307, OPTIMIZATION METHOD APPLIED TO THE
PRELIMINARY DESIGN OF A NAVAL SALVAGE TUG
G.F. Wagner, Mass. Inst. of Technology, School of En-
gineering, Cambridge, Massachusetts 02139

A non-economic optimization criterion is developed for a
multi-mission naval salvage tug in this report. The optimization is
carried out on a digital computer by the use of the exponential
random search procedure in a multi-dimensional design space.
The algorithm minimizes the quotient formed by dividing the life
cycle cost of each design by the sum of a number of non-
economic effectiveness measures of the design. The effectiveness
measures chosen reflect the ability of the tug to meet its required
pier mission and salvage mission. Sample results of the pro-
gram are contained in section III of the paper.

The optimization criterion proved satisfactory, but, the
method of computing individual requirement effectivenesses was
not satisfactory in all cases. An improved method for computing
the effectiveness of a design is recommended in Section V.

SUPPORTED BY Massachusetts Institute of Technology

8.0308, SATELLITE INTERROGATE ENVIRONMENTAL
BUOY DEVELOPMENT
D. Franttz, Ocean Research Equipment Corp., Falmouth, Mas-
sachusetts

TECHNICAL OBJECTIVE: The ocean buoys to be
fabricated under this contract are part of a system to measure
oceanographic and meteorological parameters at remote sites and
transmit the information to a central analysis location through
satellite communication relay of data.

Approach: Develop and fabricate three prototype buoys.
One buoy will be used to test long life mooring configurations and
seakeeping characteristics. Two buoys will be used to test deep
ocean moored characteristics, survivability and communication
with satellites. The basic contract is amended to include emplace-
ment and testing of Buoy 01.

SUPPORTED BY U.S. Dept. of Commerce - E.S.S.A.

8.0309, BUOY ENGINEERING
R.G. Walden, Woods Hole Oceanographic Inst., Woods Hole,
Massachusetts 02543

The objective of this task is to improve the instrumentation
necessary to the moored experiments being conducted at Woods
Hole. These engineering efforts will include a theoretical and ex-
perimental study of the performance of deep ocean mooring lines
in the ocean; comparative testing and evaluation of mooring
materials, hardware, and fabrication techniques; design and
development of surface and subsurface prototype buoys to meet
the research requirements; and development and testing of spe-
cial engineering telemetry system for use in the program.

This work is a necessary adjunct to the efforts of the WHOI
scientists to determine the scales of oceanic motion using moored
oceanographic buoys. The technology will benefit the Navy, both
in its contributions to understanding the physics of motion in the
sea and to other buoy systems required by the Navy.

SUPPORTED BY U.S. Dept. of Defense - Navy

360
8.0310, PERSISTANCE AND PROPELLION HUL CON-
FIGURATION

Transom Sterns: It is the objective of this study to carry out
research that will provide design information which will allow
transom sterns to be utilized by high-speed vessels without power
loss.

Additional tests have been made with 0.65 and 0.55 block
coefficient models, developed from the initial form by a geomet-
ric method also developed at the University to determine the
trend of bulbous bow performance with block coefficient change.

Transom Sterns: It is the objective of this study to carry out
research that will provide design information which will allow
transom sterns to be utilized by high-speed vessels without power
loss.

Resistance and propulsion tests have been completed with
seven after body variations, the fore end remaining the same in
each case.

Parameters used in the test are: Length - 700', beam - 100',
draft - 22'-35', block coefficient - 0.50. Stern width has varied
from 75' to 45' and stern immersion from 1' to 11.5' over a speed
range of 13 to 27 knots.

It is also intended to investigate stepped transom sterns for
vessels that at times may have to operate at a much deeper draft
than normal load draft.

SUPPORTED BY U.S. Dept. of Commerce - Maritime
Admin.

8.0311, SATURATED DIVING FACILITIES FOR DIVER-
SCIENTIST AND RELATED RESEARCH

G.H. SAVAGE, Univ. of New Hampshire, Graduate School, Dur-
ham, New Hampshire 03824 (N00014-67-A-0158-0005)

Currently, the feasibility study and model test program for the
OSCLAB and SEADOPOD saturated diving facilities are being
done. The EDALHAB will be tested in a lake very soon. Work has started on a compact underwater monitoring and
control system for saturated diving habitats. Investigation is
proceeding of the feasibility of using fluidic controls in underwater
vehicles, mobile habitats, and free operating oceanographic in-
struments.

The work under this contract is directly beneficial to Navy
diving, salvage and underwater construction tasks which require
saturated diving. Indirectly, it will provide marine scientists with
new and improved techniques and tools to procure oceanogra-
graphic and related data that is of direct Navy concern.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0312, FORCES AND MOTIONS INDUCED BY WAVES
ON OCEAN PLATFORMS

J.P. BRESLIN, Stevens Institute of Technol, School of Engineer-
ing, Hoboken, New Jersey 07030

Stevens Institute of Technology will use the facilities of the
Davidson Laboratory for research into the forces and motions in-
duced by waves on ocean platforms with the objective of develop-
ing design criteria that will improve design and construction of ex-
ploration, trial drilling, and production drilling platforms. Research
will be directed to three principal elements: (a) a more precise specification of wave-induced loads on both submerged
and grounding surfaces; (b) means of reducing motions induced by
the seaway for both moored and dynamically positioned plat-
forms; and (c) determination of wind-induced loads for predic-
tion of overturning moments. The project personnel will adapt to
the use of laboratory platforms the well-proved Davidson Laboratory
program for computing ship motions, supplementing existing in-
formation through the use of model elements in the laboratory
research tank facilities. A wing tunnel will produce the necessary
wind loadings on model elements. Configurations will then be stu-
died to determine how motions can best be reduced at critical
frequencies. Results will be presented in a form suitable for use by
designers.

SUPPORTED BY U.S. National Science Foundation

8.0313, SHIP MANEUVERING AND CONTROL

UNKNOWN, Stevens Institute of Technol, Graduate School, Hob-
oken, New Jersey 07030

Purpose: To develop a design manual on ship controllability
covering determination of rudder shape and area for efficient
operation at sea, and improved control during docking and
stopping.

Description: Straight run model tests have been made in the
regular towing tank; and turning tests conducted under the rotat-
ing arm with three series 60 degrees. They have been checked
at coefficients 0.70 and 0.80, and one mariner model to obtain hull
hydrodynamic forces and moments.

Similar tests were made using three different rudder areas.
With the aid of the test data, formulae are being developed for
estimating the directional stability and controllability of single-
screw merchant vessels. Stopping performance tests have also
been made and a mathematical model developed to simulate ship
stopping maneuvers. This model was checked with available full
scale data obtained for an Esso Suez Class tanker. These data will
be useful for predicting ship stopping capabilities, and will be put
in a form which is useable in ship design.

SUPPORTED BY U.S. Dept. of Commerce - Maritime
Admin.

8.0314, 40,000 HORSEPOWER PLANETARY REDU-
CTION GEAR SYSTEM

R. HETTENBACH, Curtiss Wright Corporation, Rutherford-
Wood Ridge, New Jersey

With the advent of hydrofoil craft and fast deployment lo-
gistic ships a need arose for a lightweight transmission system. In
one such application, a 40,000 HP gear box was to be installed in a
34 inch pod diameter. Curtiss-Wright through its experience in
aircraft planetary designs, built and has been testing 4 to 1
planet planetary system satisfying those requirements. The gear units
have an outside diameter of 34 inches, are 5 feet long, weigh
4,000 lbs each and show an efficiency of 99.0 percent. The plane-
tary gear box utilizes double helical gears, journal bearings, air-
craft type materials with carburized and ground surfaces. The ac-
curacy of the gear tooth ends falls within the precision clas-
sification.

A significant departure from normal planetary design has been
in the load distribution among the planets. Here, material
deflection characteristics and geometric shapes were calculated to
arrive at a uniform load distribution.

The criterion for the gear box was to design for an unlimited
life all the gear box elements at power ratings of 50,000 HP and
4,000 RPM input speed.

This program has been sponsored by the Navy since 1962. To
date, over 300 hours of locked torque rig testing has been accu-
imated at powers ranging from 22,000 HP to 50,000 HP with an
input speed of 4,000 RPM. Additional testing is planned at the
higher HP ranges with lower input RPM tp match the current high
HP gas turbine engines. Final reports are issued at the completion
of a given work statement phase.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0315, HIGH SPEED SHIP PROPULSION

R.B. LEWIS, Curtiss Wright Corporation, Rutherford - Wood
Ridge, New Jersey

Study high speed ship propulsion. Compute the range per-
formance and thrust power ratio for optimized propulsor configu-
rations and show the sensitivity of installed performance to
changes in the important component performance parameters for
various propulsion system/high speed craft types.
8. ENGINEERING AND TECHNOLOGY

The equations for performance will be developed for all the various combinations, using with identification of terms to show the commonality. Types of craft will include hydrofoil, captured air bubble, planing hulls, and displacement hulls. Types of propulsors will include, propellers, waterjets, and mistjet.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0316, MOORING IMPROVEMENT SYSTEM
UNKNOWN, Frederick R. Harris Inc. - New York, New York

PURPOSE: To develop an improved ship mooring system that will permit ships to be secured more rapidly, safely, and economically.

DESCRIPTION: An advanced mooring system is being developed which consists of two major parts; a set of constant tension mooring winches (with controls) and a telescopic mooring arm. The system is designed to permit two 120 foot mooring arms to place ship's hawsers on pier mooring bollards, and dock the ship alongside a pier from a distance off between two already moored ships, with only one man handling each mooring arm and without the assistance of tugs. The complete system will provide constant tension control, and simplified mooring and handling of lines. Construction of the constant tension mooring winches for the telescopic arm has been substantially completed. Fabrication of the mooring arm and assembly and shop test of the completed system are soon to be undertaken.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8.0317, TRANSITIONAL CONTAINERSHIP CONCEPT
UNKNOWN, George G. Sharp Incorporated - New York, New York

Purpose: To determine the means for ready changeover of a ship's cargo hold from a 100 percent break-bulk operation to an efficient all container handling operation as cargo demand dictates.

Description: This research study will examine the problems of designing a ship's cargo handling arrangements and equipment to permit 'instant' conversion from a 100 percent break-bulk cargo ship to a pallet carrier or to a cellular containership, without sacrifice in operating efficiency, and without the need for extensive structural modifications to the ship.

The ship selected for study and comparison is comparable to the 'standard' mariner that is in use for general cargo today - length-565 ft., beam-76 ft., break-bulk capacity-812,000 cu. ft., speed-20-22 knots.

A basic hold module was developed to satisfy all functional requirements, and from this three conceptual designs were prepared. The last of the three is being developed in more detail with emphasis given to special structural features for container operations. Cost estimates of the transitional ship will be included.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8.0318, HULL DESIGN - MODULAR DECKHOUSE
UNKNOWN, J.J. Henry Company Inc. - New York, New York

Purpose: To develop means for reducing ship construction costs by applying modular concepts to the design, fabrication, and outfitting of deckhouses.

Description: The most suitable distribution and amount of space needed to accommodate a 35-man crew was investigated to determine the manner in which an efficient functional layout could be arranged that would be simple and inexpensive to install. The layout was required to be expandable or retractable to accommodate crew sizes at variance with the base model. A vertically oriented sub-division of the house separated into two major subassemblies around the machinery trunk, with the pilot house as a separate assembly on top, was selected as the best means to minimize field connections made aboard ship.

A fabrication concept was investigated in conjunction with a shipyard and a joiner contractor by which outfit could be prepositioned at appropriate levels and in predetermined sequence for direct insertion into the open face of each structural subassembly.

Each fabrication and installation process was analyzed to determine the manhours which could be saved by permitting wider use of bench work in place of field work, reduction of trade interference, and maximum use of modular construction. Economic analysis included the cost of all special facilities materials and jigs.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8.0319, ROLL DISTRIBUTION OF A NUCLEAR CARGO SHIP WITH AND WITHOUT FLUME STABILIZATION
UNKNOWN, J.J. McMullen Associates Inc. - New York, New York

Purpose: To determine the effects of flume stabilization on the motions of large nuclear powered cargo vessels under severe sea conditions and zero speed.

Description: Analysis was made of the predicted rolling motions of a large nuclear powered containership, at zero speed and lying in the trough of the waves, to provide design criteria for the reactor plant and to evaluate the effectiveness of the flume stabilization system in reducing rolling under these conditions. The probable sea states on Trade Route 12 were used in predicting rolling.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8.0320, FULL SCALE STRESS MEASUREMENT TESTS OF GREAT LAKES ORE CARRIER

Purpose: To obtain statistical data on wave induced stresses in a typical modern ore carrier operating on the Great Lakes, and to relate these stresses to measured wave and weather data, in order that design criteria appropriate to super size ore carriers of up to 1,000 feet in length can be developed.

Description: This project is a joint cooperative venture initially supported by the Maritime Administration, Lake Carriers Association, American Bureau of Shipping, and the Society of Naval Architects and Marine Engineers who are coordinating the project. Instrumentation to measure hull stresses consists of transducers located amidships on the underside of the port and starboard main deck plating of the RYERSON, and at the forward and aft quarter points.

Data is recorded periodically on tape which monitors all points simultaneously. The wave data is derived from the ship's logs, and from wave buoys launched from the RYERSON under storm and high wave periods.

The third season of data collection is under way. This third season is being devoted largely to evaluation of course changes as a means to minimize springing. Two instrumented ship models are being tested at Davidson Laboratory to provide a means to improve predicting capability. One model is of the 730 foot EDWARD L. RYERSON, and the other is of 1,000 foot future ore carrier. The results of these investigations will also generate useful information on techniques for developing more accurate scanning criteria for all types of supertankers.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8.0321, DYNAMICS OF MOORED BUOY SYSTEMS USED IN OCEANOGRAPHY R&D AND SURVEILLANCE
J.H. NATH, Oregon State University, Graduate School, Corvallis, Oregon 97331

Objective: Effective use of moored buoy systems for research or operations will require a knowledge of the noise generated in various buoy-mounted instruments by motions of the anchored buoy.

In support of this requirement, this research will develop a capability for predicting statistically the motion at any point on the anchored buoy system given information on the ocean currents, ocean waves, and wind force on the surface buoy.

362
Approach: This is a laboratory effort involving the preparation of a computer program to simulate the motions of an anchored buoy, of medium size, along with its mooring cable. The complete set of dynamic equations, which relate this computed-simulated anchored buoy to the forces acting on it, will then be solved to give the motions resulting from any given set of forces.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0322, MARINE ATMOSPHERIC RESEARCH FACILITY
S.I. NESHYBA, Oregon State University, Graduate School, Corvallis, Oregon 97331

Support is provided for the construction of a moored offshore, marine meteorological platform, including a basic set of sensors, a data telemetry system, and sufficient power and safety equipment. The platform will be used to support research in: 1) marine meteorological phenomena, 2) coastal air processes as related to weather modification, 3) air-sea exchange processes, and 4) meteorological turbulence near the ocean interface.

SUPPORTED BY U.S. National Science Foundation

8.0323, SHAFT HORSEPOWER SERVICE ALLOWANCE FOR SHIPS
G.H. LEVINE, Robert Taggart Incorporated, Fairfax, Virginia 22030

A study has been undertaken to establish a more rational method of determining the shaft horsepower service margins for ships. The end results are to be an analytical procedure for determining the service margin and a delineation of the types of data necessary to solve the problem and the methods necessary to obtain this data.

SUPPORTED BY Society of Naval Architects & Marine Engrs.

8.0324, FUNCTIONAL AND ECONOMIC ANALYSIS OF SHIP MANEUVERING SYSTEMS
UNKNOWN, Robert Taggart Incorporated, Fairfax, Virginia 22030

Purpose: To devise modifications to merchant ship maneuvering and control systems which will upgrade operating efficiency and improve economy.

Description: This investigation includes analysis of maneuvering and control systems currently in use and the study of new concepts. A detailed analysis has been made of the effectiveness of rudder operation in the propeller race of a high-speed, single-screw merchant ship, and the analytical results confirmed by shipboard measurements and observations.

A new concept for steering configuration which shows great promise for improved performance both at low ship speeds and during ocean transit is under study. This steering unit is expected to require much less power and be less complex than existing steering machinery. Automatic steering control, which has been found to induce undesired ship motions, is being investigated more thoroughly.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

8M. SANITARY ENGINEERING
(see Chapter 6e on Water Quality and Pollution.)

8.0325, OCEANOGRAPHIC FACTORS IN THE FUNCTIONAL DESIGN OF WASTE DISPOSAL SYSTEMS
J.W. JOHNSON, Univ. of California, Water Resources Center, Los Angeles - U.C.L.A., California, 90024

In the design of waste disposal systems, such as ocean sewer outfalls, cooling water waste lines from nuclear power plants, etc., a large variety of technical problems remain to be solved to place such design on a sound scientific basis. The three major areas of studies have been: 1. The mixing of a buoyant jet being discharged horizontally at the water surface. 2. The mixing of a series of buoyant jets being discharged horizontally from both sides of a manifold placed at the bottom of a tank. 3. The mixing caused by the mass transport associated with surface waves having a circular normal directional spectra.

The laboratory work done previously at UCB in regard to Item 1 was re-examined, and compared with the results of work done subsequently by other institutions. These results were then compared with the two sets of prototype data with which the investigators were aware: The Pacific Gas & Electric Plant at Morro Bay California, and the discharge of the Columbia River into the North Pacific Ocean. The data compared favorably, on a gross basis. It became evident that the laboratory work should be extended to much smaller values of Froude number and that the statistical fluctuations of temperature and salinity in the mixing jet should be studied in detail.

In regard to Item 2, the results of the studies of single jets by a number of investigators were compared, and a preliminary report written on the findings. It was evident that no additional work need be done on the portion of a single jet between the bottom and surface, but that there is essentially no information on the interaction of multiple jets from a manifold. The laboratory equipment has been designed, constructed and tested, with preliminary tests made.

The results of a theoretical study of Item 3 have been negative, in the sense that there appears to be no mixing caused by the mass transport of waves with a circular normal distribution. However, the theoretical study was linear, and there may be some nonlinear mechanism that exists.

SUPPORTED BY University of California

8.0326, MODEL ADVANCED WASTE-TREATMENT PLANT
A. MACHIS, Washington Suburban San. Comm., Hyattsville, Maryland

The objective of this project is to design and construct a 5 mgd advanced waste treatment plant at the Commission's Piscataway Wastewater Treatment Plant to demonstrate the high efficiency removal of phosphorus, BOD, suspended solids and refractory organics. The AWT plant is planned to consist of lime precipitation, re-precipitation, re-carbonation, filtration, activated carbon adsorption, and activated carbon regeneration.

Research by the Federal Water Pollution Control Administration and others has shown the feasibility of attaining improved removals of carbon and phosphorus from municipal waste discharges. The work has been primarily in the laboratory and small pilot plants; now it is ready for larger pilot scale or full-scale operation. The Piscataway Plant is a particularly appropriate site because of joint FWCPCA-WSSC cooperation in AWT and because of the interest in water pollution problems in the Potomac Estuary.


8.0327, SYSTEMS ANALYSIS FOR SHIPBORNE MUNICIPAL INCINERATION
M.W. FIRST, Harvard University, School of Public Health, Boston, Massachusetts

This work is concerned with: (1) fundamental studies of the atmosphere 10-30 miles off-shore and its capacity to absorb gaseous wastes without polluting the coastal areas; (2) analysis of the effects of large scale dumping of incinerator residues on the marine life in the vicinity and on the bottom; (3) an investigation of the deposition and distribution of solid residues on the ocean floor; (4) applications of the methods of systems analysis and high speed computers to optimize collection networks oriented towards waterfront ship loading points, location of dockside transfer stations, and scheduling of ship movements with respect to the distribution of loading and burning times, load size, crew shifts, etc. (5) use of operations research methods to investigate the relative merits of all applicable solid waste management systems on the basis of urban configuration, geographical location, pollution control practices, etc.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - P.H.S.
This research program was undertaken to further develop the capabilities to support sea bottom installations and operations through the effective selection and preparation of ocean floor construction sites. Two primary areas were considered: (1) the foundation emplacement associated with the installation of an above-bottom habitat, and (2) the modification of the surrounding bottom terrain to enhance the capability for performing mission tasks. Foundations for manned habitats, such as stands, mats, piles and anchors, were assessed in terms of habitat configuration and bottom conditions. Site modification for the purposes of accommodating the foundations and structures encompassed such tasks as overburden removal, leveling, rock drilling/blasting, and sediment stabilization. Third, the techniques of bottom conditions were considered in the investigations. The experience and state-of-the-art of the offshore development industry (oil drilling and mining) was a factor in assessing currently available procedures and equipment. Two internal technical reports have been prepared documenting results of the study: 'Site Selection and Site Preparation Analysis for Manned Underwater Structures', TS-1219/020 May 1968; and 'Operational Considerations of Site Selection and Site Preparation for Manned Bottom Installation', TS-2247/020.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0333. DESIGN AND CONSTRUCTION
UNKNOWN, U.S. Navy, Civil Engineering Lab., Port Hueneme - Point Mugu, California

Objective: To acquire engineering data on the behavior of materials used in ocean construction and to develop engineering criteria for the design of ocean structures. The effects of the ocean environment on ocean structures is one of the primary factors which must be considered before the design of an on- or in-bottom installation can be completed. Information is available on the behavior of materials at 2500 feet and 6000 feet. However, the knowledge of the effects of protective coatings, biological degradation and shallow water corrosion is limited. Various structural...
shapes can be adapted to the ocean environment, however, at present detailed engineering criteria are only available for the design of cylinders and spheres. Other structural shapes must be investigated and data on the behavior of standard construction materials such as concrete must be obtained. Work undertaken in this task area will provide the technological foundation to accomplish future requirements in the design and construction of ocean installations.

Approach: Achievement of this objective involves work in the following areas: Area 1: Development of fundamental information on the effects of deep ocean environment on materials and designs in the ocean environment. Area 2: Development of engineering data on the structural behavior of materials and designs in the ocean environment. Area 3: Development of specialized safety techniques and warning devices to warn of impending structural and atmospheric failures in undersea construction.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0334, ANCHORS AND MOORINGS
UNKNOW, U.S. Navy, Civil Engineering Lab., Port Hueneme-Point Magu, California

Objective: Develop the anchors and mooring systems required for surface, subbottom, and bottom installations in the oceans. The goals to be achieved under this task area are as follows: Maximum depth: 6,000 ft; holding power: 300,000 lb vertical and horizontal loads; performance: 5 years unattended. The requirement for strength, rigidity, and integrity in ocean areas imposes new and stringent demands on anchors and mooring technology. The present state-of-the-art for deep ocean anchorage consists of dead-weight anchors and standard drug-type anchors. These anchors are massive, have low holding-power-to-weight ratio, require considerable horizontal distance to set and are difficult to handle and transport. Achievement of this task area will provide ocean capability to meet most anticipated future requirements in deep ocean anchorages.

Approach: Achievement of this objective involves the following three phases: Phase I: Development and testing of anchor designs and procedures for their rapid and efficient placement in the deep ocean. Embedment anchors offer a potentially fruitful avenue for investigation. However, drilled-in and driven type piles of various designs and configurations may well be adapted to deep ocean anchorage functions and will warrant investigations. Phase II: Development of anchor designs with the capability to resist not only uplift forces but also bearing loads. This work would fulfill the requirements of the bottom- test type constructions required in the near future. Phase III: Development and testing of deep ocean mooring systems to meet most anticipated future needs. When Phase I and II are well underway, sufficient information will be available to proceed with mooring complexes. These complexes may involve multiple, taut line systems where packages will be anchored at depths down to 6,000 ft and they may involve combinations of systems for anchoring of large installations on the ocean floor.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0335, RELATIONSHIPS BETWEEN RATES OF SEDIMENT ACCUMULATION & CHANGES WITH DEPTH OF CERTAIN MASS PHYSICAL PROPERTIES IN MARINE SEDIMENTS
D.L. TINDERBITZEN, Lockheed Aircraft Corporation, San Diego, California 92101

The purpose of the study is to determine the mathematical relationship between rates of sediment accumulation and changes in shear strength and water content with depth in marine sediments. Cores obtained from four geological provinces of Southern California are being utilized. The environments are began flanks, basin slopes, inner shelf and Los Angeles Bay. Each core is analyzed for grain size, water content and shear strength at various depths in the core. Data is then processed through various statistical and curve fit programs to determine the relationships of these parameters to the different rates of accumulation for these environments.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0336, HIGH PRESSURE ROCK STUDIES
R.B. GORGON, Yale University, School of Engineering, New Haven, Connecticut 06520 (NONR)

This task is a continuing program on laboratory experiments to investigate the non-elastic properties of minerals and rocks at temperatures and pressures that occur in the earth's crust and upper mantle. Studies of internal friction in crystalline rocks with and without a fluid phase will continue. These experiments are being carried out at low frequencies, characteristic of seismic waves. Plastic deformation of single mineral crystals will be studied using etching techniques.

While this research is concerned primarily with these properties as they relate to the physical state of the earth's interior, the results obtained and experimental techniques developed will contribute to our knowledge of the behavior under stress of rocks beneath the ocean floor.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0337, GEOLOGICAL OCEANOGRAPHY - PHYSICAL PROPERTIES

Objective: To determine those environmental factors affecting the underssea uses of the ocean; to investigate and define the physical properties of ocean sediment; determine the critical properties of sediments which affect the stability of structures and equipment placed on the sea floor.

Approach: Develop a shear strength and plate loading device for use of DRVs. Investigate the effects of chemical bonding on shear strength. Study bio-chemical properties of marine sediments and generally improve measurement and analysis techniques of the mass physical properties of sediments through a contract with the University of Rhode Island. Develop controlled photographic techniques for bottom roughness.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0338, SUPPORTING SYSTEMS

Objective: Provide, maintain and operate the supporting systems required for in-situ and laboratory tests of ocean soils, materials, components and models. All construction work in the ocean requires preliminary work or studies in a laboratory or in-situ to prevent costly failures of equipment in the ocean. For this purpose, simulated hydrostatic facilities and in-situ testing equipment must be built, maintained and operated. By the end of FY 68 there will exist at NCEL a deep ocean simulation laboratory consisting of six 9-in vessels; and one 6-ft vessel. Also there will exist a 6000-ft deep ocean test, instrument, placement and observation system (OTIPOS) for making in-situ tests. During the past year the deep ocean simulation laboratory has been used extensively in support of in-house laboratory projects such as studying the spheres, and short and long term critical pressure test on acrylic windows. In addition, pressure testing of material and equipment for other naval activities such as the pressure testing of buoyancy spheres for CURV; lights and cameras for Sealab; and proof testing of polaris junction box have been conducted. Achievement of the objective of this task will allow the navy to continue to meet requirements for: pressure and in-situ testing in support of research and development; and proof test required before equipment can be used in the ocean.

Approach: Achievement of this objective involves work at the Naval Civil Engineering Lab and in industry in the following areas: Area I: maintain and operate the deep ocean simulation laboratory and the deep ocean test instrument placement and observation system. Area II: improve existing systems and formulate the new systems so that the adequate facilities exists when the need for conducting studies in them arises.

SUPPORTED BY U.S. Dept. of Defense - Navy
8. ENGINEERING AND TECHNOLOGY

8.0339. DEEP OCEAN SYSTEMS
D.C. PAULI, U.S. Navy, Office of Naval Research, Washington, District of Columbia

Objective: To develop new techniques and equipments to enhance the performance of useful underwater work and the technology of underwater installations.

Three programs are being pursued, primarily through industry. Advanced diver equipment is being studied and developed to enable a free-swimmer to go much deeper and do much more work than is now possible. For utilization on DRV's, underwater robot mechanisms, etc., a new manipulator concept employing tensor elements is being pursued. This manipulator will be light, less bulky, and far more flexible than any equivalent equipment now in use. The problem of efficient measurement of ocean-floor programs are all aimed at improving navy capability of underwater construction, salvage, rescue, and recovery. Time-wise results from all three programs would be beneficial today and for many years to come. In respect to general objective (3) above, two programs are underway. Solutions are being sought for heating and breathing problems in the manned underwater installations which are currently required for the Navy man-in-the-sea effort.

Approach: All the above programs are proceeding in general through following phases (1) establish requirements; (2) study possible solutions; (3) select trial solutions; (4) design and analyze; (5) model and/or component parts fabricate and test; (6) prototype test and evaluation. The order can change and there are often overlaps or concurrent efforts in these phases, but each of the programs fits this general outline.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0340. CIVIL ENGINEERING STRUCTURES IN THE OCEANS
P.G. MAYER, Georgia Inst. of Technology, School of Engineering, Atlanta, Georgia 30332

Engineering structures in the ocean involve forces and constraints which demand attention to the interrelationships between the soil dynamics of the ocean floor, the hydrodynamics of wave action and of the viscous damping, and the structural response characteristics. These interrelationships must be understood as random phenomena and must be treated by probabilistic methods.

The present study involves the formulation of a structural model based on continuous mass distribution, an analysis of the wave force spectrum using the theory of random processes as applied to structure and the ocean, and an analysis of foundation conditions. The synthesis of the above will be attempted by numerical methods.

Ph.D. thesis on this project by Billy L. Edge completed in June 1968.

SUPPORTED BY Georgia Institute of Technology

8.0341. DEEP SEA SEDIMENT STUDIES
A.F. RICHARDS, Univ. of Illinois, Graduate School, Urbana, Illinois

Research on the mass physical and engineering properties of deep-sea sediments and development of instruments and techniques for measuring these properties will be continued. The vane shear and gamma-ray densitometer in situ probes will be modified for use in deep water and will be field tested. A laboratory study to determine means for obtaining valid shear strength data from sediment cores, will be undertaken. The development of a computer capability for reduction, analysis, and storage of soil-mechanical data will be initiated.

Information concerning the interaction of both acoustic waves and man-made structures with marine sediments is important in naval operations. Such information requires an understanding of the physical and acoustical properties of marine sediments, their interrelationships, and the techniques necessary for properly measuring them. This program will help provide the required understanding.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0342. ELECTROKINETIC SOIL STUDY
M.I. ESRIG, Cornell University, School of Engineering, Ithaca, New York (NONR)

This investigation, dealing with electrically induced relaxation of the breakout forces required to free metallic objects buried in soils, will be completed. The results of laboratory experiments will be analyzed and the theoretical basis for the observations will be considered.

Electrical techniques for the reduction of breakout forces and conversely for localized soil stabilization may have widespread applications in salvage operations and in ocean-bottom construction.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0343. OCEANOGRAPHIC RESEARCH
R.F. HILL, Univ. of Rhode Island, School of Engineering, Kingston, Rhode Island 02881

Objective: Identify those environmental parameters near the ocean/bottom interface that have engineering significance; develop a detailed technical description of these parameters as a function of global position, and document the detailed descriptions so as to be of maximum benefit to deep ocean system planners and designers. The pertinent parameters include current magnitude, turbidity, dissolved corrosive agents, bottom bearing strength, bottom roughness, soil adhesion, etc.

Approach: Develop a list of and describe the technical scope for those environmental parameters which are pertinent to the engineering of deep ocean systems. Conduct a survey of technical information resources, such as the published literature, unpublished reports, interrogation of experts, etc. Analyze and evaluate this information to determine the present state-of-knowledge of pertinent oceanographic environment. Develop a detailed description of those environmental parameters that should be observed in situ to close the gap between the present state-of-knowledge and the desired understanding of the pertinent oceanographic parameters resulting in a detailed catalogue of the pertinent parameters, the necessary special and temporal sampling required to measure these parameters, the necessary accuracy of those parameters, and the preferable format of the data. A detailed technical report will result from this contract.

SUPPORTED BY U.S. Dept. of Defense - Navy

8.0344. UNDERWATER WELDING
F.J. PILIA, Ocean Systems Incorporated, Reston, Virginia

Dry Welding - Experiments have been conducted and operational tests have proven techniques for Argon shielded TIG welding to depths down to 165 feet. Work is underway to perfect a Helium shielded TIG technique and to verify the technique at depths down to 600 feet. Helium must be employed as shield gas due to the narcotic effect of Argon under pressure.

Wet Welding - OSI is attempting to develop a wet welding machine employing the MIG process which will provide faster and cleaner welds than wet stick welding.

Dry MIG tests have been conducted at depths down to 100 feet. Dry tests will be continued down to 200 feet and then wet tests will be attempted.

SUPPORTED BY Ocean Systems Incorporated

9. COASTAL ZONE MANAGEMENT AND USE

(recreation, Conservation, Planning, and Management)

9.0001. ECONOMIC EVALUATION OF PRIMARY BENEFITS FOR FISHING AND HUNTING BASED ON THE NATIONAL SURVEYS OF FISHING AND HUNTING
S.V. CIRIACYWANTRUP, Univ. of California, Water Resources Center, Berkeley, California 94720

The primary objective is to appraise and analyze the data collected in the 1960 National Survey of Fishing and Hunting with view to improving the projections of 'demand' for saltwater and freshwater fishing, small game, big game, and waterfowl hunting.

366
Relevant and reliable projections of the future consumption of fishing and hunting are valuable guides to future investment programs in land, water, and facilities development. Good projections constitute valuable checks as to the adequacy of water development programs, both at the activities and the regional level.

The nature and extent of the relationships between participation in the respective sports and other variables which might influence participation; for example, trip costs, distance of trip, expenditure on equipment, and the characteristics of the sportsman’s family income, age, and profession are being ascertained by multiple regression analysis.

SUPPORTED BY University of California

9.0002, EARTHQUAKE HAZARD - A PUBLIC POLICY PROBLEM IN THE SAN FRANCISCO BAY AREA

K. STEINBRUGGE, Univ. of California, Inst. of Governmental Studies, Berkeley, California

This will be a study covering the inevitability of future earthquakes, earthquake history in the Bay area and the significance of the public of the Bay area faults. The civil and structural engineering problems and the geological problems will be discussed, also such special problems as seismic sea waves and earthquake prediction. The governmental role and public policy will include relationships between federal, state, regional and local agencies involved, and will stress the great need for a planning agency to coordinate public action.

SUPPORTED BY University of California

9.0003, A SURVEY OF THE MARINE ENVIRONMENT FROM FORT ROSS, SONOMA COUNTY, TO POINT LOBOS, MONTEREY COUNTY

M.W. ODEMAR, State Dept. of Fish & Game, Sacramento, California

The primary purposes of the study were (1) determine whether there were any acceptable ocean areas which may receive wastes from the proposed California Central Valley Drain; and (2) determine areas (if any) where the least damage to the biota would result from the waste discharge.

Other purposes of the study were (1) to evaluate beneficial uses of the marine environment between Bodega Bay and Point Lobos; (2) collate biological data pertaining to organisms in the study area; (3) survey the benthic biota at each candidate discharge site; and (4) collect limited oceanographic data at each candidate discharge site. Data from the various sub-studies were used to develop the recommendations presented in the final report July, 1968.

SUPPORTED BY California State Government

9.0004, USE OF THE COASTAL ZONE FOR THE U. S. COASTLINE OF LAKE ERIE AND LAKE SUPERIOR

A.B. BIGLER, Natl. Planning Association, Washington, District of Columbia

The contractor will conduct investigations and analyses on the use of the coastal zone for the U.S. coastline of Lake Superior and Lake Erie intended to aid in future policy planning for these areas. Specific tasks include: (1) Review of background studies of factual data about the two lakes and their utilization and the areas. Specific tasks include: (1) Review of background studies of factual data about the two lakes and their utilization and the economic and social ends served; (2) Analysis of the effectiveness of measures employed in the past for determining utilization of coastal zone resources, including case studies of selected conflicts; (3) Assessment of the potentials for applying marine science and technology to achieving greater multiple use, or more optimal use of coastal zone resources; (4) Identification and evaluation of new or different measures to protect higher-level utilization of coastal zone resources; (5) Analysis of international problems and opportunities in achieving optimal use of lake waters, lake-shore, and lake-bed resources, and recommendations of desirable new measures.


9. COASTAL ZONE MANAGEMENT AND USE

9.0005, ISLAND STUDY


This survey and planning study has three major objectives: (1) Inventory all 10-acre or larger islands in the U.S., Puerto Rico, and the Virgin Islands by size, ownership, and development status. (2) Identify and evaluate those islands which have significant wilderness, historical, or other recreational values. (3) Develop a program for island conservation.

The Island Study was started during fiscal year 1967. The inventory phase and the detailed studies of those islands with significant recreational values have been completed. The final report, outlining a program for island conservation, should be released during fiscal year 1969.

SUPPORTED BY U.S. Dept. of Interior - Bu. Outdoor Rec.

9.0006, INVENTORY AND ATLAS OF GULF COAST SPORT FISHING FACILITIES

N.G. VICK, U.S. Dept. of Interior, Bureau of Sport Fish. & Wife., Panama City, Florida

A complete inventory of fishing facilities and fishing areas for the coast of the Gulf of Mexico from Brownsville, Texas to Key West, Florida will be made. All available reports and brochures on salt water sport fishing will be obtained through the circulation of a facilities checklist to recreational and fishing committees of chambers of commerce in coastal communities. Field trips will be made to confirm and add to the data obtained through correspondence. The results will be reviewed by State Conservation agencies for accuracy and completeness. The information will be published as a single atlas consisting of unit maps which together will cover the whole coast.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

9.0007, HYDROLOGY OF COASTAL AREA IN THE VICINITY OF RICEBORO, GEORGIA

A.N. CAMERON, U.S. Dept. of Interior, Water Resources Division, Atlanta, Georgia

This research is part of the program of water resources investigations conducted by the U.S. Geological Survey in cooperation with the State of Georgia.

Purpose - To determine the hydraulic and chemical characteristics of surface waters in the North Newport River Drainage Basin and the piezometric surface and quality of water in the principal artesian aquifer in the vicinity of Riceboro prior to the beginning of operations of a large industry as well as after the plant is in operation.

Methods - The tidal behavior of the Newport River estuary will be studied and the amount of interchange between salt and fresh water, the time of travel through the estuary, and the dispersion patterns will be determined. Discharge measurements will be made. Chemical analyses will be made on water samples collected periodically and water quality monitors will be installed. Wind direction and velocity component data will be recorded at one station. Continuous water level recorders will be installed on four wells. Electric and gamma-radiation logs will be made of selected wells within 30 miles of Riceboro to determine the amount of casing and depth of the well and aid in interpretation of the geology and identification of the aquifer. Aquifer tests will be made at the plant site after completion of the plant wells.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

9.0008, SEA SLED AND SCUBA RECONNAISSANCE OF INSHORE AND STUDIES ON EFFECT OF ARTIFICIAL SHELTERS ON STANDING CROP OF FISHES


Objectives: 1. To compile a qualitative and quantitative inventory of physical and biological factors of the coastal waters of the State. 2. To evaluate the effectiveness of artificial shoals as a fishery management tool. 3. To compile fishery management data from marine sanctuaries. 4. To construct artificial shoals in areas selected for habitat improvement.

SUPPORTED BY Georgia State Government
9. COASTAL ZONE MANAGEMENT AND USE

Procedure: 1. With the use of SCUBA gear, the standard underwater transecting procedure developed during previous segments will be utilized to gather information on bottom topography and estimates of standing crop of fish. Resulting information will be applied in the selection of sites for future construction of artificial fish shoals. 2. The shoals constructed during the past segments will be examined from time to time and transects will be made to evaluate the effectiveness of the shoals in increasing fish life. 3. In an attempt to gather information on the effects of fishing pressure on standing crops of fishes, selected areas will be set aside as sanctuaries. Transecting will be conducted prior to and during the use of such areas as sanctuaries for purposes of comparing standing crops of fishes. 4. Construction of artificial shoals will be continued, utilizing damaged concrete pipes or other suitable materials.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish. Hawaii State Government

9.0009, HAWAII STATE COMPREHENSIVE OUTDOOR RECREATION PLAN

S.M. MARK, State Dept. of Plan. & Econ., Honolulu, Hawaii

This project will investigate all phases of existing and proposed outdoor recreation, both urban and non-urban, of the State, its political subdivisions, the federal government, and private interests, including but not limited to, forests, reservoirs, lakes, rivers, sea shorelines, multiple-use areas, farms, hunting preserves, refuges, parks, natural areas, historic and cultural sites, and other significant outdoor recreation areas. It will consider such activities as hunting, fishing, skiing, hiking, camping, picnicking, pleasure driving, boating, swimming, golfing, and other forms of outdoor recreation in which people of the State, including handicapped and underprivileged, may participate. It will serve as a guide for enhancing and preserving the natural beauty of the islands and its recreational areas. It also will consider and take into account the coordination of the activities of all agencies of the State, federal, and county governments relating to outdoor recreation.

The Plan will attempt to project estimated general recreation information for the State to 1985, based both on an analysis of present use of areas and facilities and on trends in population, income, leisure time, mobility, recreation habits, and interests. More detailed and specific demand and programmed facilities data will be provided for the next five-year period. Assuming the Plan's execution to begin in early 1968, this will cover the period to 1972.

In accomplishing the above efforts, the Plan will be made towards investigating the feasibility and possible methodology for utilizing automated data processing system following or adapted to that utilized in the national surveys in maintaining recreation inventory and investigating and analyzing methodologies, concepts and alternatives for accommodating and integrating national concerns in programs for highway beautification, preservation and enhancement of natural beauty, and the handicapped and underprivileged in Hawaii's outdoor recreation areas and facilities.

SUPPORTED BY U.S. Dept. of Interior - Bu. Outdoor Rec.

9.0010, BAYOU LAFOURCHE SEDIMENTATION STUDY, LOUISIANA

W.H. BOYLE, U.S. Dept. of Interior, Water Resources Division, Baton Rouge, Louisiana

This research is part of the program of water resources investigations conducted by the U.S. Geological Survey in cooperation with the State of Louisiana.

Purpose: To determine the rate of sedimentation and the resulting channel characteristics such as size, shape, and slope.

Methods: A quantitative analysis of data collected by the U.S. Geological Survey and other agencies since 1955 will be utilized to compile an estimate of the amount of sediment coming into the bayou that can be made available as sediments to the bayou. This estimate will be compared to an amount derived by means of a gamma probe at 18 cross-sections within the study reach.

Findings: The density of the sediment at selected areas will be determined and the accuracy of these data will be assessed. Finally, a prediction of the stabilized channel will be made for the bayou within the study reach.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

9.0011, 1965 SALT-WATER ANGLING SURVEY

J. CLARK, U.S. Dept. of Interior, Sandy Hook Marine Lab., Highlands, New Jersey

Description of Work: Supply information and plan layout for interview forms to be used by the Bureau of Census for nationwide survey of information on species, numbers, weights, areas, and methods of fishing for salt water game fishes. Provide a list of primary and secondary game species for each sampling area. Assist the Bureau of Census in solving taxonomic problems in field canvass data. From compilations furnished by the Bureau of Census, prepare a complete data report for publication. Discuss results with appropriate fish and game officials where necessary.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

9.0012, INVENTORY AND ATLAS OF MARINE SPORT-FISHING FACILITIES

B. FREEMAN, U.S. Dept. of Interior, Sandy Hook Marine Lab., Highlands, New Jersey

A series of line maps will be prepared as an atlas and will summarize marine sportfishing facilities and fishing grounds of the Atlantic coast from Maine to Florida. Intended as both a comprehensive guide for sportmen and an inventory of facilities, each map will show locations of boating facilities, supplies, and services, as well as principal roads and towns. Water depths, fishing grounds, and common game fish will be indicated to a distance of ca. 30 miles offshore. The atlas will include location of natural and artificial reefs as well as principal wrecks. Tabular summaries accompanying each map will list fishing piers and public shore fishing areas, State and Federal parks, wildlife areas, and associated recreational facilities.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

9.0013, DESIGN, CONSTRUCTION AND LONGEVITY OF ARTIFICIAL FISHING REEFS

R.B. STONE, U.S. Dept. of Interior, Sandy Hook Marine Lab., Highlands, New Jersey

Design and install artificial fishing reefs of junk cars, concrete materials and scrap tires on approved reef sites off Monmouth Beach, N.J., Atlantic Highlands, N.J., Charleston, S.C., Jacksonville, Fla., Palm Beach, Fla. and in Biscayne Bay, Miami, Fla. Arrange these to provide comparative data on the design and type of materials used in relation to the effectiveness and longevity of fishing reefs. Make periodic underwater observations on condition of materials, encrusting organisms and population of fish attracted to reefs. Conduct laboratory tests on reef models of fish in the current of effluents, tides and other environmental factors.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

9.0014, SURFACE AND GROUND WATER POTENTIALITIES OF THE MULLICA RIVER BASIN

M.L. GRANSTROM, Rutgers The State University, School of Engineering, New Brunswick, New Jersey 08903

The proposed research project involves a systems analysis study and an ecological field investigation of an aquatic system of water transfer from the Mullica River basin (containing a large amount of water reserves) to several New Jersey cities. This study will determine the: 1) cities which will have future demands for Mullica River water 2) optimum conjunctive surface and ground water development 3) economic effects of water withdrawal on shellfish, other biota, recreation, and waste assimilation capacity of the river and estuary.

The systems analysis approach will involve applications of extremal mathematics, such as linear programming, or simulation and stochastic processes. Fish spawning and nursery grounds studies and plankton dredging surveys will determine the distribution of these biota with respect to the existing and projected hydrodynamics of the river-estuary system. Dissolved oxygen, salinity, and other water quality parameters will also be measured for the mathematical model. Project results will be applicable to other river basins which have conjunctive surface and ground water potentialities which affect the estuarine ecology.
9.0015, CRITERIA FOR EVALUATING THE QUALITY OF WATER BASED RECREATION FACILITIES

C.C. STON, North Carolina, School of Education, Raleigh, North Carolina 27609

Statement of Problem - On the basis of opinions of users of water based recreation facilities and the opinions of professional recreation experts, rating standards will be established for quality of swimming, boating, and fishing. These standards will be used in evaluating the adequacy of facilities for at least one geographical area.

Objectives - To establish criteria of a practical nature that would aid in determining the quality of water based recreation facilities; to develop standards for evaluation purposes; to develop standards that would serve as guidelines for the operators of water based facilities.

Procedures - To determine existing practices relative to current standards; to determine from the user of water based recreation facilities data essential to the adoption of criteria; to determine acceptable practices as performed by practitioners of good professional reputation. Major Subjects - Marinas: boat docks, boat ramps, boat hoist, marine repair and services, boat mooring, boat anchoring, boat wet storage (boat slips), boat dry storage, floats, docks, piers, tackle shop and supplies, refreshment services, fishing bait, toilet, buoy safety markers. Swimming Areas: bathhouses, beaches, lifeguard staffing patterns, swimmer lifeguard ratio, swimmer loads. Fishing Facilities: fishing piers, boat rentals, rescue squads. The data will be collected over an area of several states in the East during June, July, and August, 1965. Such data will be processed at North Carolina State University at Raleigh.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rch
North Carolina State University

9.0016, PUBLIC INVESTMENT CRITERIA FOR WATER-ORIENTED RECREATION IN THE LAKE ERIE BASIN

R.A. TYBOUT, Ohio State University, Graduate School, Columbus, Ohio 43210

The project has three parts: 1) The measurement of demand for water-oriented recreation at numerous sites. 2) Analysis of costs of pollution abatement and recreation facilities at the same sites. 3) Evaluation of the relative merits of alternative public investment for recreation enhancement and of selected financial policies.

Each part is assigned a year of research time. Demand will be measured by a simultaneous-origin adaptation of the Hotelling-Clawson method. Shifts in demand due to pollution and income changes will be measured and, in fact, play an important part in the determination of benefits from abatement. The analysis of costs of pollution will seek to relate marginal pollution contributions at recreation sites to costs of abatement. The third, or final part of the analysis will explore the implications of combining the results of the first two parts in a cost-benefit framework with various methods of financing, including pollution taxes, user charges and other revenue sources.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rch
Ohio State University

9.0017, TECHNIQUES OF PLANNING

B.A. TICHENOR, U.S. Dept. of Interior, Pacific Northwest Water Laboratory, Corvallis, Oregon 97330

This project has two objectives: 1. To provide consultation and assistance to projects in the Research Branch of the Pacific Northwest Water Laboratory with respect to the design of experiments, setting up a mathematical models, statistical analysis of data, use of electronic computers for data processing, and application of engineering principles and techniques; 2. To apply the techniques of operations research and systems analysis to problems in water resources management and development, giving special emphasis to those problems occurring in the Pacific Northwest.

SUPPORTED BY U.S. Dept. of Interior - O. Water Res. Rch
Rutgers The State University

9.0018, ECONOMICS OF WATER QUALITY FOR A REGIONAL SYSTEM


To develop workable methods for the integration of empirical materials on possible supply, demand and quality conditions for the development of an efficient water basin investment and management program. These methods would be generally applicable to water basin investment and management in various regions of the world. More specifically, our objective would be to interrelate (1) quality conditions simulated by the diffusion model for the Delaware estuary, (2) supply conditions as derived from the current simulation model for the Delaware River basin and (3) probable demand conditions projected with the use of Philadelphia Regional economic base studies, to guide investment and quality management policy on the Delaware estuary.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl

9.0019, SOCI-ECONOMIC STUDY OF NARRAGANSETT BAY, RHODE ISLAND

R. RORHOLM, Univ. of Rhode Island, Agricultural Experiment Sta., Kingston, Rhode Island 02881

To identify, measure and evaluate the economic and social values of the marine resources of the Bay to the State of Rhode Island. The project will be based on secondary source information currently available to the University of Rhode Island with additional surveys or interviews being made as necessary to supplement existing data. To identify, measure and analyze economic and social trends in Rhode Island which would be significant in terms of water pollution control or land use regulation of the Bay and that portion of the watershed which is significant in determining the quality of the estuarine water resources.

To explore how benefit cost analysis techniques may be best applied to determine the effects of various combinations of beneficial uses on the estuarine resources. To identify and recommend needs for future studies or basic data systems which would be useful in obtaining optimum public benefits from use of the Bay resources.

SUPPORTED BY Rhode Island State Government

9.0020, EVALUATION OF ATLANTIC COAST ESTUARIES

G.P. SPINNER, Univ. of South Carolina, Graduate School, Columbia, South Carolina 29208

The project is administered by the University of South Carolina but the technical aspects are under the direction of the Marine Resources Committee, a sub Committee of the Atlantic Waterfowl Council.

The purpose of the study is to determine which of the estuarine zone ecosystems are of high priority in the life cycle of waterfowl and other marine resources. This determination will be based on the mapping of marine resources based on data supplied by cooperating agencies and will also include ownership of salt marshes and associated shoal water by conservation agencies. The needs for the resources will be determined and a plan to preserve the essential habitat will be formulated based on present plans and programs of conservation and other land use agencies.

SUPPORTED BY Belle W. Baruch Foundation

9.0021, COASTAL ZONE MANAGEMENT AND USE

The Laboratory will be conducting research on a broad range of water oriented problems, utilizing personnel with experience in a myriad of scientific disciplines, including chemistry, biology, forestry, oceanography, etc. The application of sound mathematical, statistical and engineering principles by this project will complement the various research groups and will result in effective utilization of the full range of techniques which can be applied to the solution of problems in water resources.

SUPPORTED BY U.S. Dept. of Interior - F. Water Pol. Ctl
9. COASTAL ZONE MANAGEMENT AND USE

9.0021. EVALUATION OF ENGINEERING PROJECTS AND ESTUARINE DATA (ESTUARINE PROGRAM)
R.F. HOOGLAND, U.S. Dep. of Interior, Biological Laboratory, Fort Crockett - Galveston, Texas
Estuarine-dependent species of the Gulf of Mexico coast comprise over 90% of the nation's most valuable fishery resources. If the nursery grounds of these species are to be preserved, it is essential that the estuarine habitat of these species be protected during and following construction of water development projects in upland basins, saltwater systems, and coastal marshes. The increasing number, as well as complexity, of construction projects require a detailed understanding of estuaries.

It is the purpose of this project to (1) assist the Branch of River Basin Studies (BSFW) by reviewing all proposed construction and water-development projects affecting western Gulf estuaries and, when warranted, recommend remedial measures to reduce adverse project effects; (2) where practical, recommend changes in water-development projects whereby the habitat would be enhanced for the fishery resources; (3) inventory, organize, and keep current all published and unpublished data related to western Gulf estuaries, and (4) recommend basic research needed for protecting estuarine fishery resources.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

10. LEGAL STUDIES

10.0001. PRELIMINARY STUDIES OF INTERNATIONAL REGIMES FOR MARINE RESOURCES
F.T. CHRISTY, Resources For The Future Inc., Washington, District of Columbia
The basic objective is to make some preliminary analyses of the social science aspects of international marine resources and to identify and describe the kinds of problems facing ocean regimes and the kinds of research (economic, political science, and legal) that should be undertaken to help resolve the problems. The results are being used as a guide for the development of a program of studies by Resources for the Future, Inc.

SUPPORTED BY Resources For The Future Incorporated

10.0002. SURVEY OF MAINE LAW AFFECTING MARINE DEVELOPMENT
D.J. HALPERIN, Univ. of Maine, Graduate School, Orono, Maine 04473
The University of Maine Law School will make a complete survey of all statutes, court decisions, administrative regulations, and policies of the State of Maine which affect marine resource development, and will examine their scientific validity and economic impact. The study will be directed from the Law School, but will involve experts in the sciences and economics from other institutions, including the State Department of Sea and Shore Fisheries. The inter-disciplinary team will relate the laws and regulations to conservation, health, and the economic well-being of the state, will determine the extent to which the laws and regulations are observed, and will determine what major gaps exist in the legal structure insofar as the state's ability to utilize its resources is concerned. The initial step will be to survey the legal structure in detail. This is a prototype legal study which should produce a methodology as well as results useful in Maine.

SUPPORTED BY U.S. National Science Foundation

L.F. GOLDIE, Rutgers The State University, Graduate School, New Brunswick, N. Jersey 08903
The law of the sea is undergoing increasingly intense scrutiny as a growing technology expands the possibility for developing undersea minerals. On the Continental Shelf, oil and gas exploitation is taking place in deeper and deeper waters. Beyond the edge of the Shelf, increasing attention is being paid to the possibilities for the commercial development of mineral resources of the sea floor. Current law, however, does not define the edge of the Continental Shelf nor the limits to which a coastal state can claim exclusive rights. Nor are there any rules at present that would govern the acquisition of exclusive rights to the sea floor and the exploitation of deep sea minerals. Considerable debate is underway in both national and international forums, but there has been extremely little scholarly study of alternative rules and legal regimes which might be adopted for the orderly development of marine resources.

The study will survey international law in the light of the emerging problems associated with the development of minerals in the continental shelf and deep seabed. The study will bring together to, (1) legal doctrines and concepts; analyze the economic, technological, and social changes that are occurring; and suggest and evaluate alternative regimes that can accommodate these changes within the framework of international law.

SUPPORTED BY Resources For The Future Incorporated

10.0004. LAW OF THE SEA
L.M. ALEXANDER, Univ. of Rhode Island, Graduate School, Kingston, Rhode Island 02881
Study conferences on the law of the sea are being held to clarify concepts underlying national and international laws and agreements, to identify problems which require scientific research, to explore relationships between existing or future laws and the development and use of ocean resources, and to examine the implications of various other aspects of the laws.

SUPPORTED BY U.S. Dept. of Defense - Navy

10.0005. INSTITUTIONAL ARRANGEMENTS FOR THE MARINE SCIENCES
A. BARBER, Inst. For Politics & Planning, Arlington, Virginia 22209
The study will focus on the question of what changes or innovations in national and international institutions, public and private, are needed to conduct research; develop resources; promote investment; and manage the marine environment in the public interest. Specific tasks include (a) analysis of the effectiveness of existing institutional arrangements for financing and managing multi-national investments in oceanic endeavors; (b) development and analysis of alternative institutional arrangements which might evolve for further encouraging such investments during the 1970's; and (c) recommendation for practical steps for encouraging such investments which may improve existing institutional arrangements, develop new institutions, and modify existing institutions in the context of U.S. national policy objectives.

Specific areas to be considered are fishing; environmental observation, prediction and reporting; and a conceptual basis for multi-national marine investment and management.


10.0006. PACIFIC SALMON FISHERIES - ECONOMICS OF MANAGEMENT
J. CRUTCHFIELD, Univ. of Washington, Graduate School, Seattle, Washington 98122
The law of the sea is undergoing increasingly intense scrutiny as a growing technology expands the possibility for developing undersea minerals. On the Continental Shelf, oil and gas exploitation is taking place in deeper and deeper waters. Beyond the edge of the shelf, increasing attention is being paid to the possibilities for the commercial development of minerals resources of the sea floor. Current law, however, does not define the edge of the continental shelf nor the limits to which a coastal state can claim exclusive rights. Nor are there any rules at present that would govern the acquisition of exclusive rights to the sea floor and the exploitation of deep sea minerals. Considerable debate is underway in both national and international forums, but there has been extremely little scholarly study of alternative rules and legal regimes which might be adopted for the orderly development of marine resources.

370
The specific aims of the proposed study are to survey international law in the light of emerging problems associated with the development of minerals in the continental shelf and deep-seabed. The study will bring together the pertinent legal doctrines and concepts; analyze the economic, technological, and social changes that are occurring; and suggest and evaluate alternative regimes that can accommodate these changes within the framework of international law. The study will require library research, consultation with social scientists, and research on various international organizations, particularly the International Telecommunications Union and the International Atomic Energy Agency. The results of the study will be reported and published in a suitable form.

SUPPORTED BY Resources For The Future Incorporated

11. EDUCATION AND TRAINING

(educational Programs and Courses; Manpower Training; CommitteeSupport; Publications)

11.0001, A SYMPOSIUM ENTITLED ORGANIC CHEMISTRY OF NATURAL WATERS
D.W. HOOD, Univ. of Alaska, Inst. of Marine Sciences, College, Alaska 99735

A symposium entitled 'Organic Chemistry of Natural Waters' was held at the University of Alaska in College, Alaska, September 4-6, 1967. The program included a keynote address by Dr. T. Parsons on Importance and General Implications of Organic Matter in Aquatic Environments; a session on Dissolved Organic Matter Distribution in Natural Waters and Sediments chaired by Dr. E. K. Duursma; a session on Biological Production and Utilization of Organic Matter in Natural Waters chaired by Dr. Mary Belle Allen; a session on Organic Matter and Water Quality chaired by Dr. Douglas Worf; a session on Inorganic-Organic Associations in Natural Waters chaired by Dr. Francis Richards; and a panel discussion on special problems with organic matter in Polar and Sub-Polar waters. In all, 27 of the world's outstanding experts on organic matter will present papers and a total of about 100 participants in the symposium are expected. The proceedings will be published as a monograph from the Institute of Marine Science, University of Alaska.

SUPPORTED BY U.S. National Science Foundation

11.0002, GRADUATE SUMMER RESEARCH PROGRAMS IN EXPERIMENTAL EMBRYOLOGY
H.E. LEHMAN, Bermuda Biolog. Sta. For Res., Saint George, Bermuda

The program is approximately seven weeks duration during the summer, beginning the second week of June and extending through the third week of July. The first four weeks are spent in the introduction of standard embryological methods for handling a wide variety of marine embryonic materials. Emphasis is upon experimental methods and techniques for the study of fertilization, hybridization, nucleo-cytoplasmic interactions, mechanics of cleavage, embryonic determination, chemo-differentiation, morphogenesis, regeneration and growth. The remaining weeks are spent in carrying out original research on problems of the participants' own choosing. In this period the student is given as complete freedom as possible to design experiments within the limitations of time, materials and equipment available at the laboratory.

The Bermuda Biological Station is exceptionally well situated for such a program since a large number of marine embryonic materials, some of which are not available elsewhere, may be collected readily in the surrounding waters. The program will be permitted to use one of the Station's boats and items of underwater swimming equipment in order to carry out its own collection activities. The student will, therefore, receive some additional experience in general marine biology via their observations of reef communities from which experimental materials will be derived.

SUPPORTED BY U.S. National Science Foundation

11.0003, RESEARCH TRAINING IN MARINE BIOLOGY, PALEONTOLOGY AND SYSTEMATIC ZOOLOGY
E.H. SMITH, Univ. of The Pacific, Graduate School, Dillon Beach, California 94929

For the past seventeen years, the University of the Pacific has conducted a summer program in marine biology at Dillon Beach, Tomales Bay, California. Although the kinds of courses offered over the years have included marine paleontology, oceanography, marine ecology, ichthyology, etc., the prime focus has been directed to invertebrate zoology. Of the 248 students who have participated in the invertebrate course since 1951, more than 55 are now in the advanced stages of their doctoral programs, and at least 15 hold academic appointments.

Courses now run for a seven-week period with the latter part of the program devoted to individual research projects. Grant provided ten doctoral stipends for summer of 1968. The students selected came from widely separated geographical areas. The requirement for a summer of resident study or research at the marine station is being applied at many inland universities to candidates for advanced degrees in Biology, Paleontology, and Zoology.

SUPPORTED BY U.S. National Science Foundation

11.0004, SHIPBOARD WORK ABOARD THE OCEANOGRAPHER
O.L. BANDY, Univ. of Southern California, Graduate School, Los Angeles, California 90007

This support is for funds for travel from Los Angeles, California to Wellington, New Zealand, via Hong Kong, and from Valparaiso, Chile to Los Angeles. This funding is needed primarily for Robert L. Fleisher, graduate student in micropaleontology, to participate in the Wellington-Valparaiso leg of the current cruise of the OCEANOGRAPHER. By arranging to go to Wellington via Hong Kong, it will be possible for Mr. Fleisher, who is a graduate student of the principal investigator, to cooperate in some shipboard work with the staff of Dr. Eggleston of the Fisheries Research Station, Aberdeen, Hong Kong.

SUPPORTED BY U.S. National Science Foundation

11.0005, STANFORD BIOLOGICAL OCEANOGRAPHY
M. GILMARTIN, Stanford University, Hopkins Marine Laboratory, Pacific Grove, California 93950

The Stanford Program in Biological Oceanography represents an educational/research approach to: 2) the development of broadly trained biological oceanographers, and, b) the introduction of students in marine biology to biological oceanographic research and techniques, combined with an active research program in biological oceanography.

The program is based on four 12-week cruises per year, with the scientific party for each cruise composed of three senior scientists (faculty) and ten junior scientists (graduate students) form nation wide universities. The senior scientists give lectures, lead seminars, and supervise the field and laboratory activities of the junior scientists. Both the senior and junior scientists pursue their own research interests concurrently with the basic program. Student participation represents registration in Biology 222H, a 15-unit graduate level course offered by the Hopkins Marine Station.

During fiscal 1968, one cruise was conducted in the Gulf of California, two cruises in the equatorial current system and the Galapagos Islands, and one cruise in the in-shore waters of northern South America and Central America. During these cruises research was conducted on various aspects of: the ecology of zooplankton and phytoplankton communities including primary productivity, the physiological ecology and distributional aspects of shallow water benthic communities, the physiology of deep water zooplankton, the community structure and distribution of certain mid-water fishes.

SUPPORTED BY U.S. National Science Foundation

371
11.0006. APPLIED MARINE ENGINEERING PROGRAM AT SCRIPPS INSTITUTION OF OCEANOGRAPHY

W. A. MURENBERG, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

Scripps Institution of Oceanography will initiate a graduate research and education program in applied marine science and engineering. The new applied program will involve the Departments of Earth Sciences, Marine Biology and Oceanography, with engineering support from the Departments of Engineering, University of California at San Diego. The program will initiate activities in such fields as support of ocean industry in the concept, research and design of transport, harbors, mining production, recreational facilities, beach control, fisheries and disposal, and development of the technological base in delineation and appraisal of marine resources; analysis of limiting conditions, current effects of organisms on man-made structures, etc.

SUPPORTED BY U.S. National Science Foundation

11.0007. OCEANOGRAPHY STUDY ACTIVITIES

F.N. SPIESS, Univ. of California, Graduate School, San Diego - La Jolla, California 92038 (N00014-67-A-0109-0009)

This work unit provides the scientific expertise of the Marine Physical Laboratory staff to various scientific and technical committees.

The aims of these activities is to make available to the Navy and other appropriate agencies the knowledge and imagination of the members of the MPL staff. This is done through membership on committees of various types. Actual work other than attendance at meetings includes writing of special studies and reports and occasional conduct of some initial probing experiments.

SUPPORTED BY U.S. Dept. of Defense - Navy

11.0008. AMERICAN TABLES COMMITTEE FOR THE NAPLES ZOOLOGICAL STATION


The Naples Zoological Station, Naples, Italy, has a uniquely distinguished past in its contribution to the progress of the life sciences. To scientists from many lands, subsidized by their own countries, the Station has become a focus for the practice and display of an international cooperative spirit. Outstanding biologists are afforded a conducive climate in which the exchange of ideas and information may occur through unrestricted research in general and experimental biology. The program is administered through a series of 'working tables,' which is operationally defined as a working space for scientists from a given country for varying lengths of time; each table providing for all costs of actual research work at the Laboratory, including services and materials.

The American Tables Committee is now reviewing applicants for laboratory space at the Station. As it is supported in large measure by various institutions throughout the world, the United States (NSF) has supported the Station in recent years by buying the 'tables.' The Committee of the American Institute of Biological Sciences, sponsored by a grant from the National Science Foundation, accepts and reviews applications and makes selections of scientists.

SUPPORTED BY U.S. National Science Foundation

11.0009. RESEARCH PANELS IN MARINE BIOLOGY


The American Institute of Biological Sciences is providing the Navy with essential services.

A cadre of biologists has been developed over the years, who are not only experts in their own specialties, but who are knowledgeable in related matters of concern to the Navy. These biologists are providing information on the state-of-the-art of specific problem areas, pointing out gaps in our knowledge, and suggesting effective approaches to solutions.

SUPPORTED BY U.S. Dept. of Defense - Navy

11.0010. ARCTIC FIELD RESEARCH

R.A. FAYLOR, Arctic Inst of North America, Washington, District of Columbia

The contractor submits annually to the Office of Naval Research a broad, diverse program of scientific research to be carried out in the Arctic, especially at the Naval Arctic Research Laboratory, and is responsible for execution of such laboratory and field tasks as are approved by ONR. The contractor also organizes symposia, advisory panels and prepares necessary reference work such as the Arctic Bibliography. Irresolvable liaison is maintained between the available pool of national and international scientific talent and the facilities and opportunities of the Naval Arctic Research Laboratory. The development and coordination of the research program provides basic information in the fields of glaciology, geomorphology, physiology, ecology, geology, oceanography, micrometeorology, geophysics, marine biology, botany and paleontology within the Arctic environment.

Investigations supported by this task provide the Navy with new and accurate information on arctic and subarctic environments and their effects on man, material and operations. It is clearly advantageous to the Navy and others to acquire all possible information on Arctic environment and its effect on physical and biological processes, especially on human activities.

SUPPORTED BY U.S. Dept. of Defense - Navy

11.0011. ARCTIC FIELD RESEARCH

R.C. FAYLOR, Arctic Inst of North America, Washington, District of Columbia (NONR-3996011)

The contract will provide continued effort in research, advisory panels, reference work and publication of the Arctic Bibliography. This work commenced in 1947. Funding is provided by U.S. and Canadian government agencies and private sources.

This publication has provided abstracts of publications prior to 1964. In the last few volumes, Russian publications are most numerous, amounting to about 40% of the material. A substantial amount of the material concerns oceanography and geophysics. The bibliography is one valuable source of Soviet research in The Arctic Ocean Basin. It is clearly advantageous to the Navy and other branches of DoD to acquire all possible information on the Arctic environment and its effect on physical and biological processes.

SUPPORTED BY U.S. Dept. of Defense - Navy

11.0012. ARCTIC ADVISORY SERVICE

R.C. FAYLOR, Arctic Inst of North America, Washington, District of Columbia (NONR)

Reference work, including compilation of special purpose bibliographies and literature reviews is being accomplished and the product combined with expert knowledge and advice of a large number of consultants, in furnished to NOL as background and guidance in arctic investigations and operations. In addition, NOL has subcontracted to the University of Kansas and McGill University for discrete studies in Sea Ice Physics and Thickness Measurements.

This Work Unit assists NOL with the planning of Arctic research and its applications. Through its available manpower and library resources the contractor is able to provide historical as well as current knowledge of considerable importance and relevance to the Navy with special reference to (a) sea ice physics, (b) sea ice thickness measurements and (c) safety of low-flying aircraft over snow and ice surfaces.

SUPPORTED BY U.S. Dept. of Defense - Navy

11.0013. ARCTIC BIBLIOGRAPHY PROJECT

M. MARTHA, Arctic Inst of North America, Washington, District of Columbia (AT(30-1)-2797)

The Arctic Bibliography provides a key to scientific publications available in the principal libraries throughout the world, relating to the Arctic and Subarctic and to low temperature conditions. Volume 14 assembles over 8,500 abstracts of scientific publications mostly of the period 1962 to 1965 and makes this
large compilation available to all who are concerned with the problems of northern research development. Subjects covered include geology, meteorology, oceanography, geophysics, and the basic biological sciences, as well as the social sciences and humanities, engineering, mining, fisheries, etc. Administration, native populations, economic conditions, public health and welfare have special attention. All parts of northern Eurasia and North America are represented. Publications are listed by author, the foreign titles with an English translation; all abstracts are in English, and a detailed subject-geographic index is added. The Bibliography is compiled by the Arctic Institute of North America. Volumes 1-12 in this series were published by the United States Government Printing Office, Vol. 13-14 by the McGill University Press, Montreal.

The Arctic Bibliography has become over the years a standard reference work and continues to be required by major libraries and research institutions as well as individual scholars investigating the Arctic and other underdeveloped areas.

SUPPORTED BY U.S. Atomic Energy Commission

11.0014, HANDBOOK OF MARINE TECHNOLOGY

The Editorial Board and Technical Review Teams are presently reviewing material for inclusion in the Handbook of Marine Technology. The handbook will include standardized reference tables, graphs, constants, monograms, etc. covering the fields of physical oceanography, chemical oceanography, biological oceanography, geological oceanography, marine meteorology, ocean engineering and diving.

This handbook will be pertinent to the design of oceanographic acquisition systems, deep submergence systems, and man-in-the-sea programs.

SUPPORTED BY U.S. Dept. of Defense - Navy

11.0015, WORKSHOP ON EFFECTS OF ATOMIC RADIATION ON OCEANOGRAPHY

The purpose of the Workshop is to update NAS Pub. 551 concerning the effects of atomic radiation on oceanography and fisheries by bringing together approximately 35 scientists from many different fields to resolve apparent divergencies in the publication and identify and fill in missing elements.

Outline prepared. Participants selected and assignments made for preliminary work.

SUPPORTED BY U.S. Atomic Energy Commission

11.0016, COMMITTEE ON OCEANOGRAPHY

The Committee on Oceanography was organized in 1957 to assist government agencies on a multitude of problems, ranging from the effects of radioactivity on the marine environment to the training of long range scientific studies of the oceans. The Committee has recently been reorganized under the chairmanship of Dr. John C. Calhoun, Jr. During the year ahead, the Committee expects to focus on the attack of scientific problems as well as management problems that effect our ability to conduct oceanographic research. The scientific problems to be emphasized are expected to include: scales of motion in the oceans, geotectonics, matter in the ocean, models of marine ecological systems, and air-sea interrelationships. Attention also will be given to development of the National Oceanographic Program.

SUPPORTED BY U.S. Dept. of Defense - Navy

11.0017, UNDERGRADUATE RESEARCH PARTICIPATION

It is proposed that the Smithsonian Institution provide training in the biological sciences for 25 undergraduates from colleges and universities in the United States during the summer of 1967 and the academic year 1967-68. Within the Institution's Museum of Natural History, Oceanographic Sorting Center, the National Zoological Park, Radiation Biology Laboratory, and Tropical Research Institute, students will spend either ten weeks during the summer or, in the case of students at colleges and universities having work-study programs or quarter systems, ten weeks during the academic year carrying out research projects under the supervision of senior scientific staff members.

SUPPORTED BY U.S. National Science Foundation

11.0018, MARINE SCIENCE STUDIES

The purpose of this task is to provide for the planning, organizing, and conduct of scientific conferences as requested by the scientific officer. Written reports shall be furnished at the conclusion of each study.

SUPPORTED BY U.S. Dept. of Defense - Navy

11.0019, SECOND AND FOURTH ANNUAL EDWIN A. LINK LECTURES

Funds were requested for the Second (1965), the Fourth (1967), and the Sixth (1969) Edwin A. Link Lectures. Alternately in Oceanography and in Space Sciences these lectures are given in honor of Mr. Link, Inventor, Industrialist, and Philanthropist.

SUPPORTED BY Link Foundation

11.0020, PUBLICATION OF OPPORTUNITIES IN OCEANOGRAPHY

Originally published with funds from the Link Foundation and the Naval Oceanographic Office, the money from sales of the booklet are retained for use in publishing revised manuscripts.

SUPPORTED BY Smithsonian Institution

11.0021, CONSULTATIVE AND ADVISORY SERVICES - BATTERY PROBLEMS

The purpose of this task is to provide for the planning, organizing, and conduct of scientific conferences as requested by the scientific officer. Written reports shall be furnished at the conclusion of each study.

February 1967 - December 1967: Advice on battery problems was given during the year to United Aircraft, USASI, International Nickel, General Services Administration, Battelle Memorial Institute, Federal Trade Commission, Union Carbide, Securities and Exchange Commission, K & W Batteries, Patent Office, Naval Research Laboratory, and Senator Hart. Advice on measurements and data related to standard cells was given during the year to the editor of Measurements and Data, to ITT of Florida, to Department of Chemistry of Purdue University, Industrial Research Institute, Irvin P. Stern Associates, BIPM, Dr. Froelich of PTB, L & N, Nortronics, Sandia, Lawrence Radiation Laboratory, Boston College, Dr. Hetzel of PTB. Lectures were given to various groups touring the standard cell laboratory.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.

11.0022, INCREASE EFFICIENCY OF HAWAIIAN LONGLINE FISHERY

The Hawaiian longline fishery contributes a substantial part of the needs of the fresh fish market in Hawaii. Although the prices received at the wholesale and retail levels are one of the highest in the State, the fishery, in recent years, has declined in the number of boats active in the fishery and the total catch. Part of the decline is related to the labor-intensive nature of this
11. EDUCATION AND TRAINING

fishery. The relatively low efficiency of fishing, plus the need for long hours of "soaking" the gear contributes to a long fishing day. The present project is designed to seek means of increasing the efficiency of this method of fishing. The financial returns to the fishermen could be increased by (1) mechanizing parts of the longline fishing operation, thus permitting more units of gear to be fished, (2) locating new areas of good fishing, and (3) seeking alternate fishery resources to harvest during periods of low availability of the large-size tunas in Hawaiian waters. Much of the effort in this project will be devoted to keeping industry informed of foreign developments in gear research and fishing success in waters within range of the Hawaiian fishing fleet.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

11.0023, STATUS OF OCEANOGRAPHIC EDUCATION AT PRE-COLLEGE LEVEL
R.H. CHARLIER, Northeastern III. State Coll., Graduate School, Chicago, Illinois 60625

Follow-up Work: Prepare a "unit" teacher and students manual for use in pre-college situations. Originally support interest was shown by National Youth Science Foundation but no further word received since March '68.

Study place of Marine Sciences in pre-college science curriculum. Prepare teachers, not planning for oceanography, to familiarize themselves with oceanology. Investigate interest and reactions of students to marine sciences. Articulate a high school/collage/graduate school program.

SUPPORTED BY No Formal Support Reported

11.0024, MARINE LABORATORY
J.G. BROOM, State Wildlife & Fish Comm., New Orleans, Louisiana

This project area incorporates all six of the previous described phase areas, namely coastal Louisiana. Here, the project leader will compile, analyze and interpret the data. It is proposed that different types of nets and sampling devices will be developed and evaluated for use in these situations as the need arises as determined by the project leader. Additionally methods and gear used successfully in other areas will be evaluated for application here.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish. Louisiana State Government

11.0025, BIOLOGICAL INVESTIGATIONS WITH ISOTOPES
J.A. HELLEBUST, Harvard University, Graduate School, Cambridge, Massachusetts 02138

This grant will be used to maintain and improve the usefulness of the central isotope facilities shared by the faculty and students of the Biological Laboratories. The utilization of instruments and isotope facilities, under the direction of Mr. Edward Lenhoff, avoids unnecessary duplication of expensive equipment and provides greater safety. A large number of current and proposed research projects of departmental professors and staff members vitally depend upon our centralized isotope facilities. These projects range from investigations in molecular biology to ecological studies on marine algae.

SUPPORTED BY U.S. Dept. of Hith. Ed. & Wel. - P.H.S.

11.0026, TECHNICAL ASSISTANCE AND LIAISON WITH FISHING INDUSTRIES
R.A. BRUCE, U.S. Dept. of Interior, Expl. Fish & Gear Res. Base, Gloucester, Massachusetts 01930

The primary purpose of this project is to benefit the fishing industry through increasing and maintaining Bureau-Industry contact. In part, to achieve this objective, Base personnel use specialized instrumentation devices aboard commercial fishing vessels to improve the effectiveness of fishing gear being used. Other commonly used devices to achieve this end are (1) Bureau super-vision of the use of new or unfamiliar gear, (2) personal attention to inquiries on gear or fishing problems by the individual industry member, and (3) timely reporting and/or relay of useful information gathered from sources outside of the Bureau.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

11.0027, INVESTIGATIONS IN MARINE BIOLOGY
P.B. ARMSTRONG, Marine Biolog. Laboratory, Woods Hole, Massachusetts 02543

This grant supported general research activities of the instructional associated with the summer courses in marine biology staff at the Marine Biological Laboratory.

SUPPORTED BY U.S. National Science Foundation

11.0028, SUPPORT OF TRAINING PROGRAMS IN INVERTEBRATE ZOOLOGY AND MARINE BOTANY
H.B. STEINBACH, Marine Biolog. Laboratory, Woods Hole, Massachusetts 02543

The Marine Botany course, now designated Experimental Biology, has been reorganized to stimulate an informed interest in some of the most recent concepts and techniques in the botanical sciences and at the same time to direct student interest in the biological sciences and at the same time to direct that interest to a single group of invertebrates and thus it provides a depth of experience and knowledge of that particular group. The purpose of these courses, as well as all research training courses at MBL, are to produce research investigators as well as initiate investigations into the marine environment.

The courses are made up of outstanding students from many universities. Opportunities are provided to meet active investigators in various fields of research from all parts of the country as well as participating in seminars, formal discussions and meetings. The number of highly qualified applicants has been nearly two to three times the available space for the students. First consideration has been given to persons who appear likely to contribute to the advancement of biology. Past experience has justified this mode of selection.

SUPPORTED BY U.S. National Science Foundation

11.0029, RADIOBIOLOGICAL RESEARCH ON MARINE ORGANISMS
H.B. STEINBACH, Marine Biolog. Laboratory, Woods Hole, Massachusetts 02543

This grant will provide support for the radiobiological facilities used by about one hundred and twenty investigators in the conduct of their research projects during the summer of 1968. These investigators will be selected on the basis of their projects and their requirements for the facilities and biological materials available at the Marine Biological Laboratory.

SUPPORTED BY U.S. Dept. of Hith. Ed. & Wel. - P.H.S.

11.0030, SUPPORT FOR THE OPERATION OF OCEANOGRAPHIC RESEARCH VESSELS
P.M. FYE, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543

This project provides approximately 50% of the costs of operating the WHOI vessels ATLANTIS II, CHAIN, CRAWFORD AND GOSNOLD. One time, request for NSF supported research is thus provided in a ratio of 43% for biological work and 57% for physical sciences. The biological portion also includes $51,242 for travel of biologists to and from research vessels. The total for DES is $616,380 and for BMS $522,600.

The above mentioned research vessels will be engaged in a broad multi-disciplinary program of oceanographic research during the fall of 1967 and during 1968. Program includes studies of the Gulf Stream: biological studies in the North Atlantic, the tropical Atlantic, and the South Atlantic: heat-flow, gravity and mag-
netic investigations in the Caribbean; sound transmission and geographical studies in the northeastern Atlantic; and other programs.

SUPPORTED BY U.S. National Science Foundation

11.0031, WOODS HOLE STUDY ACTIVITIES

E.E. HAYS, Woods Hole Oceanographic Inst., Woods Hole, Massachusetts 02543 (NONR)

Objective: Provide services on acoustic propagation and oceanography to Naval technical committees seeking answers to operational problems or attempting to define the state of the art of equipment design, and to provide similar services to the oceanographic scientific community by participating in meetings, symposia, and working groups.

Approach: Provide the Navy with specific answers from available oceanographic data in response to specific requests; serve on committees and working groups on oceanographic and marine engineering problems for the Navy; maintain a liaison between the oceanographic scientific community and the seagoing forces of the Navy so that full use can be made of the oceanographic information.

SUPPORTED BY U.S. Dept. of Defense - Navy

11.0032, SPECTRAL ANALYSIS

W. MARKS, Oceanics Incorporated, Hicksville - Plainview, New York 11019 (NONR)

A handbook on the application of spectral techniques to the study of oceanographic and other geophysical phenomena is being developed. A series of prescribed parameters have been derived and are being analyzed to determine the effects of various analysis parameters, such as spectral windows, length of records, etc.

The results of this effort should contribute to the design of environmental data collection systems which may be used to provide information for operational oceanographic forecasts.

SUPPORTED BY U.S. Dept. of Defense - Navy

11.0033, SUPPORT OF THE MARINE BIOLOGY PROGRAM AT THE LAMONT GEOLOGICAL OBSERVATORY

P.R. BURKHOLDER, Columbia University, Graduate School, New York, New York 10027

NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY G. Unger Vetlesen Foundation

11.0034, CONFERENCE REPORTS

F. FREMONTSITH, New York Academy of Sciences, New York, New York

The New York Academy of Sciences will provide this Office with publications of the biology conferences which were held under Contract Nonr 4592(00), NR 104-838. The proceedings are in book form and are being distributed in accordance with the directives of this Office. These conferences are part of a series presented by the Academy and follow the pattern of the well-known interdisciplinary conferences sponsored by the Josiah Macy, Jr. Foundation. The volumes will consist of an approximately verbal record of the discussions of a small selected group of recognized experts on the problem which is the topic of the conference - no formal papers are presented. The controversial tone and the informal expression of opinion are essential to the achievement of a thorough and well-rounded review of the subject and usually bring out unorthodox insights and approaches. The use of this method has in the past been particularly effective in developing mutual understanding and basis for planned topics, which include ecological, as well as cellular studies.

The distribution of these proceedings, among current and potential ONR investigators and among program managers and scientists in ONR and the Navy bureaus, will aid tremendously in coordination of research and of research programs, especially where background and viewpoints impinge on such others as engineering, physics, and geophysics.

SUPPORTED BY U.S. Dept. of Defense - Navy

11.0035, BIOLOGY CONFERENCE SERIES

F. FREMONTSITH, New York Academy of Sciences, New York, New York

The New York Academy of Sciences through its Interdisciplinary Communications Program, is conducting a series of conferences in a variety of biological disciplines of special interest to the Navy. The conferences will be devoted to subjects directly or indirectly contributing to the Hydrobiology, Ecology, and Biological Orientation Programs of this Office. A diversity of conference subjects has been selected for the series in order to focus attention on aspects of the various research studies where true advances are being made, where promising trends appear to be developing, and where disciplines of the Biological Sciences are involved.

During the proposed conferences, the state-of-the-art in a wide spectrum of biological research and Naval relevance will be discussed by a selected group of internationally prominent scientists. The resulting published proceedings of the conferences will be made available to appropriate addresses on the ONR distribution list and to appropriate program managers and scientists within and also outside the Department of the Navy. These publications will aid, not only the scientific community per se, but in addition will aid in the coordination of research and of research programs, especially where life sciences knowledge and viewpoints impinge on those of the physical sciences.

SUPPORTED BY U.S. Dept. of Defense - Navy

11.0036, AN ENLARGED PROGRAM OF RESEARCH IN NEW LABORATORIES OF MAINE SCIENCES

UNKNOWN, New York Zoological Society, New York, New York

NO SUMMARY HAS BEEN PROVIDED TO THE SCIENCE INFORMATION EXCHANGE

SUPPORTED BY Rockefeller Foundation

11.0037, COOPERATIVE RESEARCH AND TRAINING PROGRAM IN BIOLOGICAL OCEANOGRAPHY

C.G. BOOKHOUT, Duke University, Graduate School, Beaufort, North Carolina 28516

This grant will support a program of training and research in biological oceanography associated with the R/V EASTWARD at Duke University Marine Laboratory. Major aspects of this program include graduate traineeships and postdoctoral awards in biological oceanography, advanced seminars in oceanography, and training and research projects aboard the R/V EASTWARD. In March of each year a five-man Project and Program Review Committee composed of nationally recognized oceanographers meets to review research projects, and to select graduate trainees and post doctoral recipients.

This year the Committee approved a shipboard program of 279 days for the R/V EASTWARD. When these days were combined into programs of similar research, a schedule of 237 planned days at sea evolved. Twenty-three institutions are involved in the research and training programs during FY 69. Also included in the program is a 90-day cruise into the Caribbean Sea in which 11 institutions are participating.

The success of this program is measured not only by the improved caliber of application and substantially increased requests for shiptime, but especially by the large number of resultant publications and the fine, well trained graduates.

SUPPORTED BY U.S. National Science Foundation

11.0038, RESEARCH AND TRAINING IN MARINE BIOLOGY

C.G. BOOKHOUT, Duke University, Graduate School, Beaufort, North Carolina 28516

This grant provides support for predoctoral and postdoctoral awards in marine biology at the Duke University Marine Laboratory.

The purpose of the predoctoral award is to make it financially feasible for a qualified graduate student from any university in the U. S. to receive training and do research in marine biology at the Duke University Marine Laboratory. All applications for the award are reviewed independently by 5 referees, only on of
11. EDUCATION AND TRAINING

whom is from Duke University. Twenty-one awards are given to graduate students who received the highest ratings. The award is for a period of five weeks in the summer.

The program also includes two predoctoral awards. These are available on a competitive basis. A faculty member from any college or university, exclusive of Duke University, may apply. Selections are made on the basis of the quality of the research proposal and whether the facilities of a marine laboratory are actually needed to do the research. The award is for a period of 12 weeks, and can be held at any time during the year.

SUPPORTED BY U.S. National Science Foundation

11.0039, STUDENT RESEARCH AT THE MARINE SCIENCE CENTER

This project provides for support of students primarily during the summer, but also during other times of the year to undertake small research projects as part of their training experience in marine biology. Emphasis in the individual projects is on ecology and physiology of intertidal and near shore invertebrates of the Oregon coast. Principal Investigator is Joel W. Heddeth assisted by resident and visiting staff.

SUPPORTED BY U.S. National Science Foundation

11.0046, SYMPOSIUM ON RESEARCH NEEDS AND PRIORITIES FOR MARINE GEOLOGY OF THE GULF OF MEXICO

It is planned to hold a 3-1/2 day symposium to determine research needs and priorities for marine geology, with particular reference to the Gulf of Mexico. There is considerable need for analysis and program planning in marine geology not only with respect to geological research in general but also with respect to oceanographic research and to the development of marine resources. The Gulf of Mexico is one of the world's best examples of a nearshore oceanic environment wherein present-day processes provide a model for past marine geologic events, and, in addition, is one of the more extensive shelf areas surrounding U. S. shores making it particularly attractive geologically because of its high potential mineral resource value. The Gulf therefore is an especially logical area of focus for the proposed symposium.

Suggested topics of symposium discussion include: sedimentation and sedimentation processes; relationships between marine geology and marine ecology; geophysics and geologic structure of the Gulf; facilities for serving marine geology research; engineering properties of ocean sediments; and instrumentation. Approximately 30 participants will be brought together for the planned symposium. It is expected that there will be a report of findings including the identification of key scientific efforts that are needed, the approach to achieving solutions to the problems identified, magnitudes of effort required, priorities, and identification of those efforts of current opportunity in the Gulf of Mexico.

SUPPORTED BY U.S. National Science Foundation

11.0041, REPORT DISTRIBUTION

The objective of this phase is to record all data in usable form and distribute timely information about the time and intensities of impeding oyster spatfalls to local members of the industry for their use in preparing to clutch for spatfalls. This will be done by means of a weekly bulletin distributed to industry and other interested laboratories. Results of research in oyster seed investigations and oyster fatness experiments will be reported to the contracting agency.

Part 3 of 3.


11.0042, A TRAINING PROGRAM FOR GRADUATE STUDENTS IN MARINE SCIENCES AT THE FRIDAY HARBOR LABORATORIES

R.L. FERNALD, Univ. of Washington, Friday Harbor Laboratories, Seattle, Washington 98105

The grants were requested and have been used to provide limited financial assistance to qualified graduate students for training in all areas of marine sciences represented by formal courses of instruction and by research activity and supervision at the Friday Harbor Laboratories, the marine biological laboratory of the University of Washington. Facilities for year round investigation and study have been developed at the Laboratories and efforts have been made to increase the use of these facilities at times other than summer. Advanced graduate students from a number of different universities have taken advantage of the opportunity to remove seasonal limitation from marine investigations and have been able to carry out year round studies. Formal courses offering research training are offered in the Spring and Summer Quarters of the year. No geographic restrictions have been imposed in the award of these grants-in-aid to qualified graduate students. The merit of their individual program has been the important criterion for determining the question of support.

SUPPORTED BY U.S. National Science Foundation

12. FACILITIES

12.0001, RESEARCH-TRAINING COURSE IN OCEANOGRAPHY IN SOUTHEAST ALASKA

D.W. HOOD, Univ. of Alaska, Inst. of Marine Sciences, College, Alaska 99735

The course was divided into two sessions. The first included courses in General Oceanography (Geology 411, 3 credits) and Chemical Oceanography (Chemistry 641, 3 credits). The second session consisted of student research projects in Chemical Oceanography (Chemistry 642, 3 credits) or Marine Microbiology (Biology 641, 3 credits).

Students attended both courses during the first session, and each student completed a research project and attended conferences in his area of interest during the second. At the beginning of the program, each student selected a research project in conference with the appropriate staff member. During the first session, the student made a research plan, did preliminary field work and formulated plans for accomplishing his research project. The entire group was spent gathering laboratory and field data to complete this project. A research report was prepared and presented to the entire group during the last week of the program.

SUPPORTED BY U.S. National Science Foundation

12.0002, LENGTHENING AND INCREASING OCEANOGRAPHIC CAPABILITIES OF R/V ACONA

D.W. HOOD, Univ. of Alaska, Inst. of Marine Sciences, College, Alaska 99735

The 80-foot R/V ACONA will be lengthened to 100 feet (L.o.a.) in order to (1) permit increase of her scientific complement from eight to eighteen; (2) increase deck working space and (3) more than double existing laboratory space. This modification will require addition of only one crew member and will increase operating costs by less than 10%. Concomitant modifications to improve the research capabilities of the vessel will include increase of power output capacity by replacement of two 15 kw generators with two 40 kw, replace existing winch with less than 2,000 meter-depth capability; installation of a 510 h.p. marine engine to replace the existing 300 h.p. engine; and installation of a ventilated hood in the dry laboratory. Lengthening will be achieved by cutting the vessel in half amidships and adding a 15-foot section and by extending the fantail five feet.

In its present configuration the R/V ACONA will not accommodate scientific parties of sufficient size to conduct 24-hour work on the continental shelf in Gulf of Alaska and along the Aleutian chain. Hence, its operations have been confined to inshore waters and inter- waterway work. Conversion will permit
more extended operations during the non-winter months thus extending also the research and training capabilities of the Institute of Marine Science of University of Alaska, the only U. S. oceanographic institution now concerned entirely with the far northern waters of the west coast.

SUPPORTED BY U.S. National Science Foundation

12.0003, ARCTIC RESEARCH LABORATORY
W.R. WOOD, Univ. of Alaska, Graduate School, College, Alaska 99705 (NONR-4009(01))

Naval Arctic Research Laboratory (NARL), Barrow, Alaska, provides a base of operations, a laboratory and logistic support in the arctic environment for scientists of government, university and private institutions working under contracts with ONR and other government agencies. Basic research in physical and biological sciences, as well as naval sciences are conducted on the Arctic Slope and in the Arctic Seas through NARL and its 20 field stations, including drifting ice stations in the arctic pack.

Operations and investigations at NARL supply the Navy with new and accurate information on Arctic and sub-Arctic environments and their effects on human activities. Studies include arctic oceanography, geophysics, hydroacoustics and terrain analysis. Personnel trained provide the Navy a pool of manpower with first-hand experience in an area which is unique among oceans where the Navy must operate.

SUPPORTED BY U.S. Dept. of Defense - Navy

12.0004, AQUISITION OF A SUITABLE PROTOTYPE FISHING VESSEL AND GEAR
J.R. HOLLOWAY, Amer. Samoa Dept. of Agric., Pago Pago - Tutuila, American Samoa

Objectives: Obtain a fishing vessel of convenient size and maximum flexibility for utilization in exploratory fishing and initial fisheries development phases.

Procedures: The small Hawaiian sampan (40 degrees plus or minus) would seem the ideal vessel for the needs of American Samoa, since these boats are regularly used for bottom fishing, setting of crab and lobster nets and live-bait pole-and-line fishing for tunas.

A competent and experienced captain-fisherman will be recruited and with his aid a suitable second hand vessel will be purchased, or chartered in Hawaii readied, and shipped to American Samoa.

Additional gear such as seines, floats, line etc. not available with the vessel will be purchased and shipped with the vessel. Some gear such as fish traps and lobster pots will be fabricated in Samoa by fishery trainees.


12.0005, HUMAN PERFORMANCE IN UNUSUAL ENVIRONMENTS
A.J. BACHRACH, Arizona State University, Graduate School, Tempe, Arizona 85287

Objective: The objectives of this group are to establish and operate a facility to investigate man's performance in unusually stressful environments, with emphasis on the underwater environment. This is the environment in which the Navy is tending more and more to operate, with free swimmers and divers.

Approach: Contractor will design, construct, and operate a facility for studying man's performance in controlled underwater environment in which relevant variables are programmed and monitored by means of small computers. Variables to be controlled include depth (to 33 ft), composition of breathing mixture, complexity of work assignment, and degree of subjects isolation.

SUPPORTED BY U.S. Dept. of Defense - Navy

12.0006, MARINE BIOLOGY RESEARCH AT THE BERMUDA BIOLOGICAL STATION
W.H. SUTCLIFFE, Bermuda Biol. Sta. For Res., Saint George, Bermuda

12. FACILITIES

The grant provides support for general research activities of visiting investigators at the Bermuda Biological Station.

SUPPORTED BY U.S. National Science Foundation

12.0007, FEASIBILITY STUDY ON HORIZONTAL TEST TANK FOR MODEL STUDIES AND COMPONENT TESTING

The need for an experimental test facility for the investigation of mining problems has been shown during the analysis of drilled systems operations. A contract for an architectural and engineering study for such a facility has been let to Tetra Tech Inc., an ocean technology firm, of Pasadena.

The first phase of the program will be to determine configurations for the water tank, test carriage, instrumentation system and adjustable model of beaches and ocean bottoms. The planned facility will be used for a variety of tests including model testing of total systems for wire line dredging, towed hydraulic systems, submerged mining systems, problems related to surf and bottom currents and testing of diver and remote operated equipment.

SUPPORTED BY U.S. Dept. of Interior - Bureau of Mines

12.0008, SUPPORT OF THE RESEARCH VESSEL AHOYOHA III
J. SAVAGE, Univ. of Southern California, Graduate School, Los Angeles, California 90007

The R/V AHOYOHA III is a 30 ft. Drake style power cruiser constructed of wood with fiberglass coating. At the present time, she is powered with 221-crib inch interceptor gasoline engines with twin of Southern California plans to reengine with diesel engines. Nautical equipment includes a Bendix 42 radiotelephone and a Raytheon A-20 echo sounder.

The R/V AHOYOHA III is being used as a vehicle for the in situ measurements and observation of environmental factors by marine biologists and geologists. Because of the nature of this type of research work all investigators are qualified scuba divers. At the present time 14 geology graduate students and faculty, and 20 biological science graduate students and faculty are qualified divers.

The presently recommended grant provides for a year’s support of the R/V AHOYOHA. The budget includes the cost of new diesel engines, installation costs of the engines will be borne by the University of Southern California.

SUPPORTED BY U.S. National Science Foundation

12.0009, SUPPORT OF THE VERMILION SEA FIELD STATION AT BAJA CALIFORNIA
R.P. PHILLIPS, San Diego Natural History Mus., San Diego, California 92134

This modest biological field station is 340 miles southeast of San Diego, in one of the most remarkable desert environments of western America. It is on the west shore of the Gulf of California, in an exceptionally interesting marine area of islands and bays, with varied rocky and sandy habitats to depths of 600 fathoms. The surface waters are subject to great temperature range and tidal amplitude. The diversified flora and fauna are largely of tropical character and have prominent endemic elements. The surrounding terrain is an equally interesting desert, with unusual xerophytes and associated animals.

The station is a 9-room building, just above the high tide line. It has fresh water and electric power. An International Travelall and a 17-foot outboard motorboat are kept there; and other boats, up to an 85-foot motor vessel, are available locally for charter. Good food and accommodations are available at $7.00 per day in the village.

The station is reached in two hours by scheduled flights from Tijuana (round trip approximately $49). The overland route takes three days by truck.

Visiting investigators are invited to use the station. They should be qualified workers with legitimate research projects, and they should be provided with proper collecting permits and other credentials for work in Mexico. Formal request should be made to the Director.
12. FACILITIES

SUPPORTED BY U.S. National Science Foundation

12.0010. PARTIAL SUPPORT OF SHIP OPERATIONS FOR RESEARCH AT SEA ON OCEANOGRAPHY

W.A. NIERENBERG, Univ. of California, Scripps Inst. of Oceanography, San Diego - La Jolla, California 92038

This project will provide approximately 38% of the operating costs for the coming year of the following Scripps vessels: R/V AGASSIZ, ARGO, HORIZON, OCONOSTOTA, SCRIPPS, and WASHINGTON. It will also provide funds for purchase of a computer system to be installed aboard the R/V WASHINGTON. It will support virtually all the ship time for Foundation sponsored research. Research to be carried out will cover a wide range of scientific objectives, one-third biological and two-thirds in the other marine sciences. The geographical area covered will be between the North and South American continents and the central Pacific. The longest expedition will be a combination of physical, chemical, geological and biological oceanography. This cruise will center most of its activities between Hawaii, Samoa, and Kwajalein. Currents, various water properties and sediments at abyssal depths and in relation to sea-floor structure are to be collected. Also sampling of the fauna will be carried out throughout the cruise ranging from the near surface, to tops of seamounts and guyots and into the abyssal depths. Other cruises will study ocean currents at the sea-floor and their spatial correlation; marine biota of the California Peninsula and Gulf; Pleistocene oceanography and biology of the Eastern North Pacific; heat budget of the sea surface; taxonomy, zoogeography and ecology of Pacific zooplankton; tectonic and geological history of the Southwest Pacific Region; and development of deep-sea autonomous instruments.

SUPPORTED BY U.S. National Science Foundation

12.0011. SUPPORT FOR THE PHYSIOLOGICAL RESEARCH SHIP, R/V ALPHA HELIX

P.T. SCHOLANDER, Univ. of California, Graduate School, San Diego - La Jolla, California 92038

On July 1, 1967, the floating laboratory 'Alpha Helix' was anchored in Brazil's Rio Negro with Dr. Carroll Williams of Harvard as senior scientist. Fifteen scientific reports ensued. Striking findings were the high content of hormonal insecticides dissolved in the Rio Negro as a result of leaching from the vast, flooded rain forests. Hallucinogens were extracted and preserved from plant material of the genus Virola, used by Amazon Indians, which will form the basis for further studies of its chemical composition. On August 15, 1967, Dr. Jacob Barle of UCLA took over as senior scientist, with an agronomically, weighted program. Twenty-five reports ensued. Important studies were made on ripening of tropical fruits. It was discovered that root fungi (mycorrhizae) are a general occurrence in the jungle trees. This probably explains how such lush forests can thrive on such mineral-poor soil.

SUPPORTED BY U.S. National Science Foundation

12.0012. PARTICIPATION IN USARP EXPEDITIONS

I.E. WALLEN, Smithsonian Institution, Washington, District of Columbia 20560

A cooperative project to continue participation of biological workers from the Smithsonian Institution on Antarctic cruises and expeditions on an opportunity basis within existing logistic arrangements. Participants' salaries will be borne by the sponsoring institution. Transportation from the United States to the port of embarkation will be coordinated through the Smithsonian Institution from funds provided by this proposal. In this way, biological specialists from cooperating United States Antarctic Research Programs aboard USNS Eltanin trans-Pac and South Pacific cruises and the USNS Eastwind Oceanographic Cruise to the Antarctic Peninsula, 1966. Professional personnel from the Smithsonian Oceanographic Sorting Center have helped in shipboard sorting, cataloging, and preservation of biological collections when University participation was lacking. The SOSC has contributed to improvements in handling of collections and data records aboard ship and in the development of techniques for processing zooplankton, fragile specimens and other biological materials requiring special handling. Support has also been possible for field work in unique areas where the logistic opportunity afforded an extension of biological research without the additional costs for analysis of data and specimens. The Juan Fernandez Island Expedition is a case in point. The plan presented by the Smithsonian Institution in this proposal includes only travel cost for five participants who will cooperate in research aboard USARP ships and on land expeditions.

SUPPORTED BY U.S. National Science Foundation

12.0013. METEOROLOGICAL SUPPORT OF DEEP-SEA DRILLING OPERATIONS


The proposed work consists of the providing of meteorological advice in support of the Ocean Sediment Coring Program. In particular, the Prisc is to provide a meteorologist aboard the drilling vessel for which the University of California has planned under the terms of Contract NSF-C-482. It is drilling operations from a floating vessel in the deep oceans it is regarded as imperative that the master of the vessel and the drilling operations manager on board be provided with meteorological advice. The proposed work will assure both the safety of the vessel, which will operate at times in very remote areas, and wave-forecasting services in order to optimize the several aspects of the drilling operation which are limited by vessel motions. All communications and facsimile reception equipment will be supplied by the University, so the subject Proposal is only for the furnishing of the meteorological personnel.

SUPPORTED BY U.S. National Science Foundation

12.0014. RESEARCH ADVISORY SERVICES


Description: The Board, and its predecessor, Maritime Cargo Transportation Conference, undertakes investigations of maritime problems in areas where the National Research Council can best provide guidance on means and techniques to improve maritime systems. Co-operative government-industry panel efforts are utilized where such advisory services can best serve the national interests of maritime transportation.

The Maritime Cargo Transportation Conference did extensive exploration and research of cargo handling in the port of San Francisco; unitized cargo techniques for inland and overseas transportation; cargo handling by cranes; buttoming gear, and roll-on/roll-off vessels; and origin to destination systems.

More recent work of the Board has been a functional analysis of work performed aboard ship; development of a stepboard system to collect data for management information; and a statistical study of the U.S. Merchant Marine work force including employment qualifications, union-company affiliations, age, length of service, attrition work opportunity, and retirement trends.

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

12.0015. SYSTEMS ANALYSIS ASSISTANCE TO HEADQUARTERS U.S. COAST GUARD

E.E. HOWE, U.S. Dept. of Transportation, Coast Guard, Washington, District of Columbia 20591

The objective of this project is to provide a systems analysis capability for the Coast Guard Headquarters in establishing their position relative to icebreakers and their use in the decade ahead. The approach is to assist in problem structuring drawing on such techniques as cost-benefit analysis, mission definition and analysis, use of relevance tree and economic modelling.

SUPPORTED BY U.S. Dept. of Commerce - N.B.S.
12.0016, SUPPORT OF THE NATIONAL OCEANOGRAPHIC DATA CENTER


This grant will support the administration and operation of World Data Center A, Oceanography, required by international commitments; which have not been provided for in the regular NODC budget or elsewhere. The functions of this center include: acquisition of data; exchange of data; compilation, preparation, printing and distribution of semiannual catalogues of data, track charts and photographs of publications, special data lists, related charts, information for international commissions, committees and expeditions and development of improved methods to prepare and issue up-to-date catalogues of data and related information.

SUPPORTED BY U.S. National Science Foundation

12.0017, SUPPORT OF THE NATIONAL OCEANOGRAPHIC DATA CENTER


This grant will support the administration and operation of World Data Center A, Oceanography, required by international commitments, which have not been provided for in the regular NODC budget or elsewhere. The functions of this center include: acquisition of data; exchange of data; compilation, preparation, printing and distribution of semiannual catalogues of data, track charts and photographs of publications, special data lists, related charts, information for international commissions, committees and expeditions and development of improved methods to prepare and issue up-to-date catalogues of data and related information.

SUPPORTED BY U.S. National Science Foundation

12.0018, SUPPORT OF WORLD DATA CENTER - A (OCEANOGRAPHY)


This grant will support the administration and operation of World Data Center A, Oceanography, required by international commitments, which have not been provided for in the regular NODC budget or elsewhere. The functions of this center include: acquisition of data; exchange of data; compilation, preparation, printing and distribution of semiannual catalogues of data, track charts and photographs of publications, special data lists, related charts, information for international commissions, committees and expeditions and development of improved methods to prepare and issue up-to-date catalogues of data and related information.

SUPPORTED BY U.S. National Science Foundation

12.0019, UNDERWATER ACOUSTICS MEASUREMENTS FACILITY


Objective: To develop an acoustic facility at USL for the purpose of performing underwater acoustic measurements under controlled conditions.

Approach: It is clear that certain aspects of acoustic propagation are not entirely understood. To aid in the construction of analytic models to completely represent propagation effects, it is necessary to perform definitive experiments under carefully controlled conditions. This is not always possible under actual sea conditions. It is necessary that a facility be developed at USL where key experiments can be performed which will go a long way to improving understanding of certain propagation phenomena. It is intended, also, that such a facility containing one or more carefully designed tanks, would support other investigative programs such as array configuration studies and system model studies. In the latter case, for instance, through direct linkage with USL's planned computer facility, various acoustic systems could be modeled and their performance could be evaluated.

SUPPORTED BY U.S. Dept. of Defense - Navy

12.0020, SYSTEM OPERATIONS AND ACOUSTIC PHYSICS

J.C. MUNSON, U.S. Navy, Research Laboratory, Washington, District of Columbia

12. FACILITIES

Conduct a program which will lead to the specifications for underwater systems. The spectrum of work will include theoretical acoustics, systems concepts, validation of operational concepts, and systems analysis. Attention will be given to the Navy needs for systems in deep ocean and in shallow water areas. The work will be carried through to the development of experimental research systems which will be used both for research and to demonstrate conceptual and operational feasibility.

SUPPORTED BY U.S. Dept. of Defense - Navy

12.0021, HUDSON LABORATORIES SHIP SUPPORT


The emphasis on underwater sound propagation has necessitated an accelerated oceanographic research program. This effort together with the increasing use of larger and heavier research tools towed at greater depths has generated the requirements for an improved sea going research platform. At the request of ONR, the reserve fleet ship, USS SÀN CARLOS was converted to meet these requirements and was recommissioned the USNS JOSEIAH W. GIBBS (T-AGOR 1). It has been substantially modified in a progressive manner to continue to meet the ever changing requirements of the Hudson Laboratories at-sea phases.

MSTS will provide the services of USNS JOSEIAH W. GIBBS (T-AGOR 1) to support the sea going phases of the research program of HUDSON LABORATORIES. MSTS will operate the GIBBS throughout FY 69. The ship will be under the operational control of MSTS and under the technical control of ONR. Detailed procedures are described in the joint memorandum of agreement between the Chief of Naval Research and Commander, Military Sea Transportation Service. The technical control will be transferred on 1 October 1968 to the Naval Research Laboratory under a new memorandum of agreement.

SUPPORTED BY U.S. Dept. of Defense - Navy

12.0022, SUPPORT OF THE COMMITTEE ON OCEANOGRAPHY OF THE NATIONAL ACADEMY OF SCIENCES

H.E. VANNES, U.S. Navy, Office of Naval Research, Washington, District of Columbia

The Committee on Oceanography serves as advisor to the Federal Government on general as well as specific goals and problems associated with further development of national oceanographic programs. The Committee is sponsored jointly by the Office of Naval Research, the National Science Foundation, the Atomic Energy Commission, the Bureau of Commercial Fisheries, and the Environmental Science Service Administration.

The major accomplishment of the Committee on Oceanography during the past year was the completion of an extensive report, Oceanography 1966 - Achievements and Opportunities (NAS-NRC Publication 1492). The report contains a review of advances in oceanography during the past several years; a detailed analysis of the Committee's earlier report, Oceanography 1960 to 1970, that updates the Committee's previous recommendations and introduces some new topics; and a discussion of the problems of management, planning, and organization of the National Oceanographic Program.

During the year ahead, the Committee expects to focus its attention on several basic issues in ocean science. This will fall into two major categories: major scientific oceanographic problems and management problems affecting this nation's ability to conduct oceanographic research.

SUPPORTED BY U.S. National Science Foundation

12.0023, OPERATION OF THE R/V HERO AND PALMER STATION SUPPORT LABORATORY

S.T. CRAPO, Marine Acoustical Serv. Inc., Miami, Florida 33135

This contract provides for the operation of the new 125 Ft. Antarctic Research Ship Hero and associated shore scientific laboratories in Antarctica. In addition to the actual operation of the ship, the contractor will be responsible for the management and support services necessary to enable scientific investigators...
12. FACILITIES

and associated personnel to perform research aboard the Hero
and at the biological laboratory located at Palmer Station, An-
tarctica.

SUPPORTED BY U.S. National Science Foundation

12.0024. SUPPORT OF RESEARCH VESSELS JOHN EL-
LIOTT PILLSBURY, GERDA, TURSIOPS
F.G. SMITH, Univ. of Miami, Graduate School, Miami - Coral
Gables, Florida 33124

A. Geology and Geophysics: The oceanographic work in
geology and geophysics at the Institute of Marine Sciences,
University of Miami, covers a wide scope, including sedimentary
petrology, mineralogy, micro-paleontology, paleotemperature
determinations, absolute dating of sediments, and sedimentary
color, as well as seismic reflection and gravity investigations.
There were 18 professional geologists, geochemists, and
geophysicalists associated with the Institute involved in various
aspects of the research. In addition, approximately 12 graduate
students participated in the programs. B. Biological Oceanog-
raphy: The biological program at the Institute of Marine Sciences
encompassed investigations on the planktonic, nectonic and
ectoparasites. Also studies on

Deep ocean basins. Individual research efforts were directed
toward understanding the systematics and distribution of fishes,
crustaceans, echinoderms and cephalopods. Also studies on
zooplankton and phytoplankton ecology, larval development, and
marine bacteria and fungi were conducted. Approximately 20
scientists were associated with various phases of the work, and 28
graduate students also participated.

SUPPORTED BY U.S. National Science Foundation

12.0025. CURATING OF BLAKE PLATEAU CORES
F.G. SMITH, Univ. of Miami, Institute of Marine Science, Miami
— Coral Gables, Florida 33124

This grant will support a service function performed by the
Institute of Marine Science, University of Miami, on behalf of all
member institutions of the Ocean Sediment Coring Program and
other appropriately qualified scientists. The work will consist of
curatorial care and distribution of core samples. The University of
Miami will provide storage space for the cores and office and
laboratory space for visiting scientists who come to the Institute
to study the cores.

SUPPORTED BY U.S. National Science Foundation

12.0026. SUPPORT OF UNIVERSITY OF GEORGIA
MARINE INSTITUTE RESEARCH VESSEL OPERATION
V.J. HENRY, Univ. of Georgia Graduate School, Sapelo Island,
Georgia 31327

This grant provides support of the R/V Kit Jones, a 65 foot
diesel trawler outfitted with appropriate research equipment. The
area of operation includes the estuaries, shelf and upper continen-
tal slope of coastal Georgia and southeastern United States.
Cruises of several days duration can conveniently be made by 4 to
6 scientists and larger groups can be accommodated for one day.
Shipboard equipment includes Dega radar, dual Loran units,
ship-to-shore and CB radios, automatic pilot, recording fathome-
ter, salinometer, transmissometer, winches, nets, dredges and
cores.

The Kit Jones is used by the staff and visitors of the Marine
Institute for research and instructional purposes. Research in-
cludes a large spectrum of biological and geological problems.
Examples are pollution ecology, source and distribution of turb-
bidity, and primary productivity of estuarine and coastal waters;
and sediment distribution and structures, animal-sediment rela-
tionships, and topography and structure of the continental shelf
and slope. A large number of training and collection cruises by
Georgia and eastern universities and colleges are made each year
and serve to introduce students from several disciplines and levels
of instruction to the marine environment.

SUPPORTED BY U.S. National Science Foundation

12.0027. OPERATIONAL SUPPORT OF OCEANOGRAPHIC
RESEARCH VESSELS
R.G. BADER, Univ. of Hawaii, Graduate School, Honolulu,
Hawaii 96822

Support for approximately 60% of the operating cost for
University of Hawaii's R/V TERRIT AND charter costs for 118
days of use of the R/V SITKIN will be provided for a one year
period. This will amount to a total of 268 ship days. The require-
ment for the second vessel is due in part to the fact that several
projects concerned with seismic refraction work involve the use
of two vessels simultaneously. Also TERRIT is a small vessel (90
ft. l.o.a.) carrying a scientific party of 6 and therefore capable of
being scheduled only for single project cruises.
Projects to be carried out involving use of NSF supported
ship time include: studies of dissolved oxygen in sea water in rela-
tionship to water masses around Hawaii; studies of ocean turbu-
ulence; seismic refraction studies of crustal and upper mantle
structure in the vicinity of the Murray Fracture Zone and over
selected volcanic submarine ridges and seamount chains; a com-
prehensive geologic and geophysical study of the structural rela-
tionships between mid-Pacific volcanic ridges and fracture zones
involving magnetic surveys, seismic reflection studies, precision
echo-sounding surveys, gravimetric profiles, bottom sampling and
photography; studies of crystalline mineral colloids in marine
sediments; and analyses of tropical zooplankton.

SUPPORTED BY U.S. National Science Foundation

12.0028. MANAGEMENT OF THE ENIWETOK MARINE
BIOLOGICAL LABORATORY
R.W. HIATT, Univ. of Hawaii, Graduate School, Honolulu,
Hawaii 96822

This grant is for the management of the Eniwetok Marine
Biological Laboratory, a facility available to male citizens en-
gaged in marine biological research. A good laboratory, reason-
ably equipped, and with good logistic support is located on an
atoll lagoon containing excellent coral reefs and some relatively
undisturbed terrestrial environment. Inquiries for working
space and feasibility of research intended at Eniwetok are to be
sent to Dr. Robert W. Hiatt, Laboratory Manager, University of
Hawaii, 2444 Dole St., Honolulu, Hawaii 96822. Travel to and
from Eniwetok, subsistence at the site and laboratory facilities are
provided at no cost to investigators.

SUPPORTED BY U.S. Atomic Energy Commission

12.0029. LOGISTIC SUPPORT, MAINTENANCE AND
RENOVATION OF FACILITIES
C.E. WILDE, Mount Desert Island Biol. Lab, Salisbury Cove,
Maine

The Mount Desert Island Biological Laboratory is an inde-
pendent institution providing research facilities to qualified in-
vestigators whose programs in marine biology or local fauna and
flora can be accommodated. Approximately 30 research groups
are present each season (June 15 - Sept. 15) with investigators
from about two dozen institutions located in 14 - 18 states. Sum-
maries of the programs are published in the Bulletin of the Labora-
tory issued annually. Applications for research space and
housing facilities should be addressed to the Director.

SUPPORTED BY U.S. National Science Foundation

12.0030. LOGISTIC SUPPORT AND MAINTENANCE OF
FACILITIES
C.E. WILDE, Mount Desert Island Biol. Lab, Salisbury Cove,
Maine

The Mt. Desert Island Biological Laboratory is one of very
few independent marine biological research stations in the United
States. It was founded in 1898 at South Harpswell, Maine, incor-
porated in 1914, and has functioned as a seasonal field station at
Salisbury Cove, Maine. The laboratory has operated uniquely by
cooperative volunteer efforts of its investigators. At the present
time the yearly paid employees are in full time maintenance men
and part time assistant director. The officers serve without renu-
morization.
12. FACILITIES

Located on Frenchmen Bay, there is immediate access to organisms of the cold Atlantic waters as well as to environments of rocky shores, fresh water lakes, bogs, meadows and spruce forests. Acadia National Park is close by. The individual research programs carried out at the Laboratory represent a broad spectrum of marine biological research. The advantages of the later summer or spring months, with certain invertebrates, the greater availability of other organisms throughout the season and special ecological aspects of the location have led to emphasis on certain kinds of research: comparative physiology of fish (especially renal and respiratory physiology); various aspects of development using marine eggs; problems of ion transport, cell division, regeneration, botanical ecology, fine structure, organ biochemistry, hemodynamics and general comparative physiology.

SUPPORTED BY U.S. National Science Foundation

12.0031, STUDIES ON THE PHYSIOLOGY OF MARINE ORGANISMS USING RADIOISOTOPES
H.B. STEINBACH, Marine Biol. Laboratory, Woods Hole, Massachusetts 02543

This contract is in partial support of a continuing service facility maintained to provide a wide variety of requirements—radioisotopes, chemicals, equipment, research space—for the radiobiological research of about seventy-five senior scientists each summer. Assignments of space for next summer will be made early in 1967.

SUPPORTED BY U.S. Atomic Energy Commission

12.0032, RESEARCH TRAINING LABORATORY
H.B. STEINBACH, Marine Biol. Laboratory, Woods Hole, Massachusetts 02543

The Research Training Building to be supported under this grant will consist of 4 floors and a basement totaling 65,000 gross feet (44,200 Net). The new building has been carefully designed to ensure that each course will be operated as an integrated physical unit and that a close working relationship will be maintained between the staff and the students. The basic plan focuses on a central trainee area surrounded by individual staff research space and specialized purpose rooms.

The basic objective of the Marine Biological Laboratory has been the development of young scientists well-trained in the biological marine sciences. Almost from the beginning of MBL a series of advanced research-training courses in several substantive areas of marine biology have been conducted at the Laboratory. All of the buildings in which these courses are now given are antiquated wooden structures erected during the late 1890's. The need for a modern facility is urgent. The increased sophistication of research techniques in experimental biology require adequate space to conduct the courses. The core of the research-training program is vested in five formal summer courses: Invetebrate Zoology, Marine Botany, Physiology, Experimental Embryology, and Marine Ecology. With a senior staff of 40 and 12 staff assistants, the new building will house more than 240 individuals in the research-training programs. In addition to the summer programs, the new laboratory will house the year-round research project: the Systematics-Ecology Program. This group has a senior staff of 25 investigators who will occupy all of the first floor and a portion of the basement. Other expanded activities are planned for spring and fall courses when the new laboratory is completed.

SUPPORTED BY U.S. National Science Foundation

12.0033, PROVIDE RESEARCH FACILITIES AND SERVICES
UNKNOWN, Marine Biol. Laboratory, Woods Hole, Massachusetts 02543 (PH-43-67-1129)

Independent and not as an agent of the Government, the Contractor shall furnish approximately 1,422 square feet of space and supporting services to 25 staff of 25 investigators who will occupy all of the first floor and a portion of the basement. The program is vested in five formal summer courses: Invetebrate Zoology, Marine Botany, Physiology, Experimental Embryology, and Marine Ecology. With a senior staff of 40 and 12 staff assistants, the new building will house more than 240 individuals in the research-training programs. In addition to the summer programs, the new laboratory will house the year-round research project: the Systematics-Ecology Program. This group has a senior staff of 25 investigators who will occupy all of the first floor and a portion of the basement. Other expanded activities are planned for spring and fall courses when the new laboratory is completed.

SUPPORTED BY U.S. National Science Foundation

12.0034, SUPPORT OF TWO RESEARCH VESSELS
D.C. CHANDLER, Univ. of Michigan, Graduate School, Ann Arbor, Michigan

This project provides full support for the operation of two research vessels currently in use on the Great Lakes for program activities of the Great Lakes Research Division of University of Michigan's Institute of Science and Technology. Will provide funds for operating the 114-ft. INLAND SEAS and the 50-ft. MY-SIS. This project will be joint funded.

Research activities involving use of these vessels are concerned with specific problems in the Great Lakes and their tributaries, with emphasis on the physical, chemical and biological processes and phenomena of the waters within the lake basins and on the interactions between these waters and their atmospheric and geologic boundaries. In addition to being used to conduct the University of Michigan's research efforts, these vessels are made available to other midwestern universities for research and educational purposes.

SUPPORTED BY U.S. National Science Foundation

12.0035, EXPERIMENTAL COMMERCIAL OPERATION OF SAVANNAH
UNKNOWN, First Atomic Ship Transp. Inc., Hoboken, New Jersey

Purpose: To operate the SAVANNAH on an experimental commercial basis, and establish operational data as to the reliability, economics and safety of nuclear ships for use in future planning for advanced nuclear ship designs.

Description: The SAVANNAH has been operating in regularly scheduled commercial cargo liner service efficiently, reliably and on schedule for three years with no serious mechanical or operational problem. All security requirements of the Atomic Energy Commission and the Coast Guard have been met. Records and analyses of operational cost factors have been prepared to provide basis for improved future designs.

During the past year, deck Officers were licensed as Reactor Operators for the first time, annual outage time was reduced from 30 to 12 days, and initial visits were made to the following countries: Yugoslavia, Tunisia, Greece, Israel, Cyprus, Okinawa, Lebanon, Korea, Phillipines, and Taiwan. The original reactor core is still intact; the SAVANNAH is due for a shuttle refueling outage of about 2-3 months beginning in August, 1968. 0113

SUPPORTED BY U.S. Dept. of Commerce - Maritime Admin.

12.0036, RESEARCH VESSEL U.S.N.S ELTANIN
W. SMOLEN, Alpine Geophysical Associates, Norwood, New Jersey

This contract provides for the field party technical support on board the Antarctic research ship Eltanin, for the procurement of specialized scientific and oceanographic equipment used in the research project, and for the cargo handling and logistic processing related to the Eltanin scientific activities. This amendment provides for additional equipment, supplies, and personnel changes necessary for carrying out these functions.

SUPPORTED BY U.S. National Science Foundation

rate for space, plus supporting services hereafter designated as a 'Research Fee' shall be charged in accordance with the following schedule: (1) NINDB Biophysics Branch has rooms 121, 122, 123, 113A, each of which has a basic occupancy of up to two persons each; research fee is $1,560. (2) NINDB Ophthalmology Branch has room L315 (same basic occupancy); research fee is $480. (3) NIMH has room 216 (same basic occupancy); research fee is $2,160. (4) NIAMD has rooms L321-W221 (same basic occupancy); research fee is $840. (5) Twelve extra persons (NINDB Biophysics, 3; NINDB Ophthalmology, 1; NIMH, 4; NIAMD, 4); research fee is $1,440. Total research fee is $6,480.

SUPPORTED BY U.S. Dept. of Hth. Ed. & Wel. - P.H.S.
12. FACILITIES

12.0037, SUPPORT OF RESEARCH VESSEL AT LAMONT GEOLOGICAL OBSERVATORY
J.L. WORZEL, Columbia University, Graduate School, Palisades, New York 10964

This project supports approximately half the operating costs of two research vessels, VEMA and CONRAD, operated by Lamont Geological Observatory of Columbia University. This amounts to about $605,400 of which 15% or $90,800 is related to biological research and the remaining 85% or $514,600 for physical oceanography.

The main objective of oceanographic research to be carried out on R/V VEMA and CONRAD in the next year continues to be the assessment of the sedimentary distribution and the identification of three layers which are generally found in the oceans of the world. Another objective is the study of the magnetic seismic refraction program is presently underway with the Japanese and a similar one planned with the Australians. These cooperative programs have the advantage of providing a second ship for two-ship operations without additional ship operating costs for Lamont. In conjunction with these major objectives, an integrated program of geophysical-geological investigations is planned for the tracks en route and return from the main research areas.

SUPPORTED BY U.S. National Science Foundation

12.0038, TRANSPORTATION EXPENSES FOR PARTICIPATION IN USC/GSS OCEANOGRAPHER GLOBAL EXPEDITION
P.K. WEYL, State University of New York, Graduate School, Stony Brook, New York 11790

This grant is to cover travel expenses and $40,000 of equipment for personnel to join the USC & GSS OCEANOGRAPHER and carry out research in three projects to develop a research program in oceanography.

SUPPORTED BY U.S. National Science Foundation

12.0039, SUPPORT OF THE R/V EASTWARD
C.G. BOOKHOUT, Duke University, Graduate School, Beaufort, North Carolina 28516

This grant provides support for the operation of the R/V EASTWARD for approximately 11 months. The R/V EASTWARD is an 118-ft. steel hulled research vessel built with assistance from NSF for the purpose of furnishing an available facility for training, research and participation in international cooperative programs of biological oceanography. The program carried out by this research vessel includes both research and training projects.

Each year a National Project and Program Review committee reviews this program and upon their recommendation ship-time is made available. This year the Committee approved a total of 279 days of ship-time. By combining related research programs this was reduced to 237 days. Twenty-three institutions will participate in this Cooperative Program during 1968-69. Included in a 90 day cruise to the Caribbean in addition to her continuing program of research along the continental shelf of Cape Hatteras.

SUPPORTED BY U.S. National Science Foundation

12.0040, COOPERATIVE RESEARCH AND RESEARCH TRAINING PROGRAM IN BIOLOGICAL OCEANOGRAPHY
R.J. MENZIES, Duke University, Marine Laboratory, Beaufort, North Carolina 28516

This grant supported the operation of the Research Vessel EASTWARD and the cooperative research and research training program in biological oceanography. Participation in the program is open to all qualified individuals on a competitive basis.

SUPPORTED BY U.S. National Science Foundation

12.0041, RESEARCH VESSEL OPERATIONS
W.V. BURT, Oregon State University, Graduate School, Corvallis, Oregon 97331

These vessels will be used to conduct a wide spectrum of oceanographic research in the northwestern coastal waters and in the Northeast Pacific. Most cruises are multidisciplinary. Graduate students presently numbering 102 participate extensively in shipboard activities. Visiting investigators are also accommodated whenever possible.

SUPPORTED BY U.S. National Science Foundation

12.0042, OPERATION AND MAINTENANCE OF THE OREGON STATE UNIVERSITY SEAFOODS LABORATORY
D.L. CRAWFORD, Oregon State University, Agricultural Experiment Station, Corvallis, Oregon 97331

Objective: To provide for the operation and maintenance of the Oregon State University Seafoods Laboratory at Astoria, Oregon, which operates as an integral part of the Department of Food Science and Technology.

Description of Work: This laboratory provides a center at which applied basic research in the field of marine food science and technology can be conducted in close cooperation with and for the development of the fishing industry of Oregon. Its close proximity to the major fishing industry of Oregon facilitates and speeds the dissemination of knowledge obtained through research at the center and elsewhere necessary to bring about needed technological development.

SUPPORTED BY Oregon State Government

12.0043, THE INSTITUTE FOR THE DEVELOPMENT OF RIVERINE AND ESTUARINE SYSTEMS (IDRES)
J.R. FELDMEIER, Franklin Institute, Philadelphia, Pennsylvania

The Franklin Institute will establish, in cooperation with the Academy of Natural Sciences of the State of Pennsylvania, Lehigh University and Temple University, The Institute for the Development of Riverine and Estuarine Systems (IDRES). These institutions will conduct basic research programs focused on the long-term objectives of better utilization resources of the Delaware riverine-estuary complex including effects of thermal pollution in the Delaware River, effects of thermal effluent discharge, the mechanics and thermodynamics of the distribution and mixing of thermal effluence, and the development of a conceptual model of sedimentation of the Delaware riverine estuary complex. In addition, an information center to serve the principal investigators conducting this research and as a focal point of coordination with other Federal and private information centers related to estuarine problems will be established by the Franklin Institute. Study and design of an industrial wasteline for the Delaware estuary with a view toward study of an alternative method to that now available for the disposal of waste will be begun.

SUPPORTED BY U.S. National Science Foundation

12.0044, LABORATORY OF NEUROBIOLOGY
J. DELCASTILLO, Univ. of Puerto Rico, School of Medicine, San Juan - Rio Piedras, Puerto Rico 00931

The purpose of this application is to set up a laboratory devoted to the investigation of neurobiological problems primarily through the use of invertebrate organisms, thus taking advantage of the rich fauna which inhabits the littoral waters of Puerto Rico. The University of Puerto Rico Medical School could make a significant contribution to biomedical research by introducing scientists to new organisms, cells and preparations which, due to the restricted geographical distribution of existing marine biological laboratories, are so far have been unavailable for both physical and biochemical research. It could therefore, fill a national and even an international need. Initial work will probably deal with problems related to the conduction and spread of excitation within coral colonies; the chemistry and actions of neurotransins and pharmacologically active compounds produced by tropical fishes and invertebrates; physiology and molluscan nerve cells; excitation-inhibition mechanisms in invertebrate muscles; induction, nervous and mechanism of activation of chemoreceptors in nerve and muscle cells and the electrophysiology of neurosecretory cells. Actual results cannot be anticipated easily, since the immediate task of the laboratory will be an exploratory one. The laboratory
envisioned in this application will be open to graduate students and visiting scientists. It may, therefore, play an important role both in the development of the graduate divisions of the U.P.R. and the establishment of closer academic ties between the countries of the two large American Continents.

**SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel.- P.H.S.**

**12.0045. OPERATION OF R/V TRIDENT**

**J.A. KNAUSS, Univ. of Rhode Island, Graduate School, Kingston, Rhode Island 02881**

Support for approximately half the cost of operations at University of Rhode Island's research vessel TRIDENT will be provided for a one year period. R/V TRIDENT is a converted Army, FS freighter used to carry out a broad spectrum of scientific cruises in the Atlantic and Caribbean. Cruise participants include URI faculty and graduate students and guest investigators from other institutions. Cruises planned for the coming year will encompass the following areas of study: collection and analysis of rock samples from the Mid-Atlantic Ridge south of Iceland to test the seafloor spreading hypotheses; temporal aspects of vertical distribution of pelagic organisms; ecology and nutrient requirement of phytoplankton in the Gulf of Panama; bioacoustic investigation of cetacean and fish sounds; sub-bottom investigation of the post cretaceous drainage pattern in the approaches to Rhode Island and Block Island Sounds.

Total direct costs for the year beginning 9/1/67 for operation of R/V TRIDENT are $501,935. This project will fund $251,000 of which approximately 2/5 or $100,400 is for biologically oriented shipboard work and 3/5 or 150,600 for shiptime related to physical, chemical and geological oceanographic research.

**SUPPORTED BY U.S. National Science Foundation**

**12.0046. OPERATION OF R/V ALAMINOS**

**R.A. GEYER, Texas A & M University System, Graduate School, College Station, Texas 77843**

This project provides a continuation of partial support of R/V ALAMINOS, which is operated by the Department of Oceanography of Texas A & M University. Total costs for operating this vessel for the coming year (1 October 1968 to 30 September 1969) are estimated to be $461,400. The Foundation will contribute $230,900 toward this total and the remaining funds will be derived from other sources. This project will be joint funded in the following manner: DES, $148,500; BMS, $55,400.

Research projects requiring use of the ALAMINOS represent a broad spectrum of oceanographic effort, most of which is carried out in the Gulf of Mexico and the Caribbean. The coming year's schedule will also include work in the Eastern Equatorial Pacific in cooperation with another oceanographic institution. Examples of studies to be carried out in the coming year include the following: current measurements in the Gulf Loop and Yucatan Currents; characterization and distribution in space and time of particulate and soluble, inorganic and organic carbon species in sea water; geological and geophysical studies of sediment structures in various physiographic provinces of the Gulf and Caribbean; benthic collections and photographic observations in the western Gulf.

**SUPPORTED BY U.S. National Science Foundation**

**12.0047. OCEANOGRAPHIC VESSEL OPERATIONS**

**F. A. RICHARDS, Univ. of Washington, Graduate School, Seattle, Washington 98122**

This project provides approximately 40% of the total funds required for the coming year in support of ship operations at the University of Washington. The Oceanography Department operates the R/V THOMPSON, HOH and ONAR and supplements them with a charter vessel to be used for approximately 69 days. Total fleet funding also includes $1,000 for charter of a small aircraft for making a variety of water surface observations from the air. Total costs for ship operations and charter purposes will be $954,694, of which $538,687 is available from other sources. Foundation support will total $396,000, of which $230,900 is for shiptime for physical, geological and chemical oceanographic studies and $165,100 for biological oceanographic studies.

The oceanography program of the University of Washington is concerned primarily with the Northeast Pacific Ocean, Puget Sound and its approaches and the Arctic Sea; and secondarily with the eastern tropical Pacific Ocean and the Caribbean Sea. Current programs emphasize studies in: geology and geophysics dealing with analyses of sediments in the inshore regions and in the North Pacific Ocean; chemistry and geochemistry particularly concerned with nutrients and dissolved gases in the sea; physical oceanography concerned with the dynamics of discrete water parcels in the inshore regions and physical parameters of Arctic waters; biological oceanography dealing with plankton productivity studies in Puget Sound, off the Washington-Oregon coast, and in the Arctic.

**SUPPORTED BY U.S. National Science Foundation**
SUBJECT INDEX

Absorption Spectra
  OCEANOGRAPHIC RESEARCH ...Depth, Non Specific, Optical, Optical Devices, Optical Systems, ...1.0167

Abyssal Environment
  THE CYCLE OF ORGANIC MATTER IN THE DEEP SEA ...Adsoption, Biogenous, Distribution, Marine Bacteria, Origin, ...1.0112
  SEA FLOOR TOPOGRAPHY ...Acoustical, Geomorphology-topography, Seamounts-guyots, Sedimentation, Structural Studies, ...7.0294
  SYSTEMATICS OF THE ANTARCTIC AND SUBANTARCTIC GAMMARIDEAN AMPHIPODA ...Animal Taxonomy, Antarctic Ocean, Bathyal, Shrimp - Amphipoda, Vertical Distribution, ...5.0359
  REASSESSMENT OF TAXATION AND EVOLUTION OF ECHINODERMS ...Classification - Taxonomy, Internal Structure, Modern Organisms, Paleontology, Phylum Echinodermata, Pecambran, ...5.0613
  CYTOTAXONOMIC STUDIES OF TELEOST FISHES ...Animal Taxonomy, Blood Cells, Minnows, Sets of Chromosomes, ...5.0242
  DEEP-WATER ZOOPLANKTON OF THE SARGASSO SEA ...Bermuda, Sargasso Sea, Vertical Distribution, Zooplankton, ...5.0738
  ABYSSAL PLAIN SEDIMENTATION AND STRATIGRAPHY ...Bathyal, Borehole Geophysics, Core Temperature, Earth Interior, Geothermal, Heat Flow Measurements, Heat Flows, Sediments-general, Technique Development, ...7.0122
  DEEP FLOW, WATER CHARACTERISTICS, TOPOGRAPHY AND SEDIMENTS IN THE CENTRAL PACIFIC AREA ...Currents-bottom, Distribution, Geomorphology-topography, Pacific Ocean-general, Structural Studies, Water Motion Recorders, ...7.0083
  POTASSIUM/ARGON DATING OF DEEP-SEA SAMPLES ...Argon-potassium, Geologic Age Relations, Microfossils, Radioactive Dating, Sea Floor Spreading, Tectory Period, ...7.0086
  GEOCHEMICAL STUDIES OF DEEP-SEA DEPOSITS - THEIR SOURCES AND MODES OF DEPOSITION ...Atlantic Ocean-general, Biogenous, Biogeochemical Processes, Chemistry, Mineralogy, Ocean Bottom, ...7.0057
  DEEP SEA PHOTOGRAPHIC SYSTEM AND A BOX CORER ...Benthonic-bottom, Coring and Dredging, Photography, ...8.0141
  GEOTHERMAL STUDIES IN DEEP-SEA DRILL HOLES ...Bathyal, Borehole Geophysics, Core Temperature, Earth Interior, Geothermal, Heat Flow Measurements, Heat Flows, Sediments-general, Technique Development, ...7.0122
  PRESSURE EFFECTS ON MARINE ORGANISMS ...Environmental Physiology, Pressure, Vertical Distribution, Water Pressure, ...5.0243
  OCEANOGRAPHIC RESEARCH ...Benthonic-bottom, Fouling, Geomorphology-topography, Marine Soils, Tables, Compilations, Catalogs, ...8.0343
  BOTTOM CURRENTS AND DEEP SEA TIDES ...Acoustical, Benthonic-bottom, Currents-other, Finite Differences, Model Studies, Tides, ...2.0004
  DEEP OCEAN RESEARCH AND DEEP OCEAN ENGINEERING ...Engineering Studies-general, Geophysics-general, Marine Biology, Structural Studies, Submersibles, Textures-structures, ...4.0311

DEEP OCEAN ENGINEERING TECHNOLOGY ...Benthonic-bottom, Buoya, Experiments and Tests, Facilities, Platforms, Scientific-service-support, ...8.0270

ABYSSAL OSTRACODES OF THE WORLD ...Core Analysis, Shrimps - Seed Or Mussel, Vertical Distribution, World Wide, ...5.0356

ABYSSAL AND BATHYAL SYNOPSIS OF WORLD ...Animal Taxonomy, Bathyal, Crustacea -non-specific, Vertical Distribution, World Wide, ...5.0394

DEEP OCEAN ACOUSTIC RESEARCH ...Acoustical, Pressure, Submersibles, Textures-structures, Transmission, Velocity, ...1.0010

SUPPORTING TECHNOLOGY AT NAVAL RESEARCH LABORATORY ...Fouling, Microorganisms (non-specific), Organics, Submersibles, ...8.0217

STUDIES ON OPHIOID FISHES ...Animal Taxonomy, Benthic Fauna, Fish -other, Vertetbrate Anatomy, Vertical Distribution, ...5.0054

Acids
  RESEARCH ON THE PHYSICAL CHEMISTRY OF CHEMICAL REACTIONS IN SEA WATER ...Apatic-general, Carbonate, Bicarbonate, Chemical Reactions, Equilibrium - Chemical, High Pressure Research, Reaction-general, Solubility, Sr, State, Sulfite, ...1.0127

Acorn Worms
  BIOSYNTHESIS OF BROMOPHENOLS IN MARINE INVERTEBRATES ...Bioluminescence, Metabolism, Phenols, ...5.0961

Acoustics
  ACOUSTIC FIELD ...Acoustical, Reverberation, Transmission, Water Properties-general, ...1.0032
  ULTRASONICS ...Acoustical, Instrumentation-Non-specific, Transmission, Velocity, ...1.0036
  PREDICTION OF SOUND FIELDS BY NORMAL MODE AND OTHER THEORY ...Acoustical, Computer Applications, Transmission, ...1.0011
  UNDERWATER SOUND PROPAGATION STUDIES ...Acoustical, Liquids, Transmission, Water Properties-general, ...1.0029

Attenuation
  HF AUDIO ABSORPTION IN ICE ...Acoustical, Ice Acoustics, Reverberation, Salinity, Sea Ice, ...3.0073
  SEA FLOOR ROUGHNESS ...Acoustical, Benthonic-bottom, Bottom Sampling Device, Magnetic Studies, Propagation, Transmission, ...7.0033
  RELIABLE ACOUSTIC PATH ...Acoustical, Benthonic-bottom, Bermuda, Raging, Reverberation, Transmission, ...1.0032
  ULTRASONICS ...Acoustical, Instrumentation-Non-specific, Transmission, Velocity, ...1.0036
  PREDICTION OF SOUND FIELDS BY NORMAL MODE AND OTHER THEORY ...Acoustical, Computer Applications, Transmission, ...1.0011
  UNDERWATER SOUND PROPAGATION STUDIES ...Acoustical, Liquids, Transmission, Water Properties-general, ...1.0029

Coherence
  SHALLOW WATER PROPAGATION ...Acoustical, Reverberation, Sholls, Transmission, Water Properties-general, ...1.0035
  UNDERWATER ACOUSTIC SIGNAL COHERENCE ...Acoustical, Transmission, ...1.0012
  SIGNAL COHERENCE AND ARRAY DESIGN STUDIES ...Acoustical, Reflection, Signal Analysis-other, Spectra, Waveform, ...1.0024
## SUBJECT INDEX

**Acoustics**

**Diffraction**
- ACOUSTIC HOLOGRAPHY - Acoustical, Holography, Liquids, Ocean Mining, ...8.0255

**Dispersion**
- CIRCULATION STUDIES - Acoustical, Caribbean Sea, Ocean Currents- other, Transmission, Water Properties- general, ...1.0046

**Generation**
- HIGH-POWER HYDROACOUSTIC VIBRATOR DEVELOPMENT - Liquids, Seismic Studies, Sonar, ...8.0165

**Instrumentation**
- Detectors
  - UNDERWATER ACOUSTIC HOLOGRAPHIC DISPLAY - Acoustical, Holography, Instrumental Services, Photography, Recognition Systems, ...8.0137
- Instrumentation - Non-specific
  - ULTRASONICS - Acoustical, Attenuation, Transmission, Velocity, ...1.0040
- Instrumentation - other
  - SONIC UNDERWATER NAVIGATION FOR SHIPS - Equipment, Navigation, Ranging, Sonar, Sound Gear, ...4.0100

**Intensity**
- MEASUREMENT OF UNDERWATER ACOUSTIC PROPAGATION - Acoustical, Depth, Forecasting-prediction, Transmission, ...1.0014

**Interference**
- STUDY OF PROBABILITY OF DETECTION AND FALSE ALARM RATE OF FREQUENCY ACOUSTIC TLEMETERING SYSTEM - Acoustical, Oil and Natural Gas - Sulfur, ...8.0106

**Media**
- Interfaces
  - HONEYWELL ACOUSTIC RESEARCH PROGRAM - Acoustical, Data Acquisition, Data Analysis - General, Model Studies, Reverberation, Sonar, ...1.0071
  - ACOUSTIC SCATTERING - Acoustical, Model Studies, Reflection, Scattering, Surface Environments, ...1.0069
  - OCEAN ACOUSTIC ENVIRONMENT - Acoustical, Reverberation, Scattering, Transmission, ...1.0016
  - SOUND SCATTERING IN THE OCEAN - Liquids, Scattering, ...1.0040
  - ACOUSTIC SCATTERING STUDIES - Acoustical, Reflection, Scattering, ...1.0026
- Liquids
  - HIGH-POWER HYDROACOUSTIC VIBRATOR DEVELOPMENT - Generation, Seismic Studies, Sonar, ...8.0165
  - ACOUSTICS PHYSICS - Acoustical, Transmission, ...1.0058
  - ACOUSTIC AMBIENT NOISE - Acoustical, Arctic, Noise, Spectra, ...1.0053
  - BI-STATIC ECHO RANGING - Acoustical, Reverberation, ...1.0067
  - ACOUSTIC LUNEBERG LENS - Technique Development, ...8.0054
  - ENVIRONMENTAL REVERBERATION STUDIES - Acoustical, Bubble, Electron, Reverberation, Scattering, ...1.0039
  - SHALLOW WATER ACOUSTIC PROPAGATION STUDIES (SWAPS) - Acoustical, Geomorphology-topography, Subbottom, Thermal, Transmission, Turbulence - Sea Water, Water Motion, Waves, ...1.0065
  - SYSTEM OPERATIONS AND ACOUSTIC PHYSICS - Acoustical, Economic Theory, Instrumentation-general, Standards, Specifications, Systems Analysis, ...12.0020
  - SOUND SCATTERING IN THE OCEAN - Interfaces, Scattering, ...1.0040
  - UNDERWATER ACOUSTICS MEASUREMENTS FACILITY - Acoustical, Facilities, Transmission, ...12.0019
  - REVERBERATION RESEARCH STUDIES - Acoustical, Reverberation, Water Properties-general, ...1.0027

**ENVIRONMENTAL SUPPORT OF SONAR DESIGN** - Acoustical, Model Studies, Ships and Cruises, Transmission, Water Properties-general, ...1.0015

**UNDERWATER SOUND PROPAGATION STUDIES** - Acoustical, Attenuation, Transmission, Water Properties-general, ...1.0029

**ACOUSTIC HOLOGRAPHY** - Acoustical, Diffraction, Holography, Ocean Mining, ...8.0255

**Noise**
- ACOUSTIC AMBIENT NOISE - Acoustical, Arctic, Liquids, Spectra, ...1.0053
- AMBIENT SEA NOISE - Acoustical, Buoys, Sampling, Sound Production, ...1.0013
- ARCTIC ACOUSTIC RESEARCH - Applied Electronics, Arctic, Ice Acoustics, Transmission, ...1.0016
- AMBIENT NOISE RESEARCH STUDIES - Acoustical, Depth, Model Studies, Spectra, ...1.0023

**Nonlinear Acoustics**
- ULTRASONICS - Acoustical, Surface Environments, Ultrasonic Frequency, ...1.0019

**Phase Relationships**
- UNDERWATER ACOUSTIC ANALYSIS - Acoustical, Forecasting-prediction, Signal Analysis-other, Transmission, Water Properties-general, ...1.0030

**Ranging**
- RELIABLE ACOUSTIC PATH - Acoustical, Attenuation, Bermuda, Reverberation, Transmission, ...1.0032
- SONIC UNDERWATER NAVIGATION FOR SHIPS - Equipment, Instrumentation-other, Navigation, Sonar, Sound Gear, ...4.0100

**Reflection**
- ACOUSTIC IMAGE INVESTIGATION - Acoustical, Sonar, Technique Development, ...1.0018
- ACOUSTIC SCATTERING - Acoustical, Interfaces, Model Studies, Scattering, Surface Environments, ...1.0069
- MICROACOUSTICS - Acoustical, Scattering, Sound Gear, Water Tunnels Tables, ...1.0043
- MEASUREMENT AND THEORY OF SCATTERED UNDERWATER SOUND - Acoustical, Scattering, Transmission, ...1.0008
- SIGNAL COHERENCE AND ARRAY DESIGN STUDIES - Acoustical, Coherence, Signal Analysis-other, Spectra, Waveform, ...1.0024
- ACOUSTIC SCATTERING STUDIES - Acoustical, Interfaces, Scattering, ...1.0028

**Refraction**
- INTERNAL WAVE STUDIES - Acoustical, Model Studies, Scattering, Surface Environments, Waves-internal, ...1.0021

**Reverberation**
- HONEYWELL ACOUSTIC RESEARCH PROGRAM - Acoustical, Data Acquisition, Data Analysis - General, Interfaces, Model Studies, Sonar, ...1.0071
- HF AUDIO ABSORPTION IN ICE - Acoustical, Attenuation, Ice Acoustics, Salinity, Sea Ice, ...1.0073
- BIOLOGIC SOUND SCATTERING - Acoustical, Population Dynamics, Scattering, Vertical Distribution, Zooplankton, ...1.0060
- OCEAN ACOUSTIC ENVIRONMENT - Acoustical, Interfaces, Scattering, Transmission, ...1.0016
- WOODS HOLE ENVIRONMENTAL STUDIES OCEANIC ACOUSTICS - Acoustical, Atlantic Ocean-north, Benthonic-bottom, Data Analysis - General, Scattering, ...1.0057
- BI-STATIC ECHO RANGING - Acoustical, Liquids, ...1.0067
- RELIABLE ACOUSTIC PATH - Acoustical, Attenuation, Bermuda, Ranging, Transmission, ...1.0032
- ENVIRONMENTAL REVERBERATION STUDIES - Acoustical, Bubble, Electron, Liquids, Scattering, ...1.0059
- GLOBAL VOLUME REVERBERATION LIMITATION STUDIES - Acoustical, Atlantic Ocean-north, Scattering, Sound Production, ...1.0057
SUBJECT INDEX

Acoustics

ULTRASONICS ...Acoustical, Attenuation, Instrumentation-Non-specific, Velocity, ...1.0036

SHALLOW WATER ACOUSTIC PROPAGATION STUDIES (SWAPS) ...Acoustical, Geomorphology-topography, Liquids, Subbottom, Thermal, Turbulence, Sea Water, Water Motion, Waves, ...1.0065

OCEANOGRAPHIC RESEARCH ...Acoustical, Anti-submarine-warfare, California, Military Aspects, Temperature, ...1.0005

OCEANOGRAPHIC RESEARCH - INVESTIGATIONS WITH THERMISTOR CHAIN ...Acoustical, Forecasting-prediction, Temperature, Thermal, Water Properties-general, Waves-internal, ...1.0014

PHYSICAL OCEANOGRAPHY ...Surface Environments, Temperature, Velocity, Waves, ...1.0026

OCEANOMETRICS ...Acoustical, Forecasting-prediction, Statistics-general, Velocity, ...1.0006

SHALLOW WATER OCEANOGRAPHY ...Acoustical, Continental Shelf, Hydrodynamics, Rhode Island, Surface Environments, ...1.0030

DEEP OCEAN ACOUSTIC RESEARCH ...Abyssal, Geomorphology-topography, Noise, Velocity, ...1.0010

PREDICTIVE OCEAN ACOUSTICS ...Acoustical, Environmental Effects-geologic, Forecasting-prediction, Velocity, ...1.0034

SHALLOW WATER PROPAGATION ...Acoustical, Continental Shelf, Reflection, Transmission, Sound Production, ...1.0001

PREDICTION OF SOUND FIELDS BY NORMAL MODE AND PREDICTIVE OCEAN ACOUSTICS ...Acoustical, Environmental Effects-geologic, Forecasting-prediction, Velocity, ...1.0001

SHALLOW WATER ACOUSTIC SIGNAL COHERENCE ...Acoustical, Coherence, ...1.0012

MEASUREMENT OF UNDERWATER ACOUSTIC PROPAGATION ...Acoustical, Depth, Forecasting-prediction, Intensity, ...1.0014

PREDICTION OF SOUND FIELDS BY NORMAL MODE AND OTHER THEORY ...Acoustical, Attenuation, Computer Applications, ...1.0044

ACOUSTIC PROPAGATION STUDIES ...Acoustical, Instrumentation-general, Technique Development, ...1.0004

ARCTIC ACOUSTIC RESEARCH ...Applied Electronics, Arctic Ice Acoustics, Noise, ...1.0001

UNDERWATER ACOUSTIC MEASUREMENTS FACTORY ...Acoustical, Facilities, Liquids, ...1.0019

SONAR ACCURACY ...Acoustical, Geomorphology-topography, Noise, Velocity, ...1.0001

BOTTOM-REFLECTED SONAR STUDIES ...Acoustical, Scattering, Sonar, Surface Environments, ...1.0001

UNDERWATER SOUND PROPAGATION STUDIES ...Acoustical, Attenuation, Liquids, Water Properties-general, ...1.0029

Ultrasonic Frequency

ULTRASONICS ...Acoustical, Nonlinear Acoustics, Surface Environments, ...1.0019

PHYSICAL ACOUSTICS AND THE PROPERTIES OF MATTER ...Acoustical, Cavitation, Constants, Velocimeter, Velocity, Water, ...1.0031

Velocity

PRESSURE INSENSITIVE VELOCIMETER ...Acoustical, Instrumental Services, Pressure, Transducers, Velocimeter, ...1.0055

WOODS HOLE ENVIRONMENTAL STUDIES IN PHYSICAL OCEANOGRAPHY ...Acoustical, Bathythermographs, Oceanic Fronts, Salinity, Temperature, ...1.0005

PHYSICAL OCEANOGRAPHIC RESEARCH ...Acoustical, Attenuation, Instrumentation-Non-specific, Transmission, ...1.0036

PHYSICAL OCEANOGRAPHY ...Surface Environments, Temperature, Transmission, Waves, ...1.0026

OCEANOMETRICS ...Acoustical, Forecasting-prediction, Statistics-general, Transmission, ...1.0006
Subject Index

Acoustics

Deep Ocean Acoustic Research...
Acoustical, Pressure...
Submersibles, Textures-structures...
Transmission...

Predictive Ocean Acoustics...
Forecasting-prediction...

Predictive Ocean Acoustics...
Acoustical, Environmental...
Ecto-geologic...
Transmission...

Activation Analysis

Trace Elements in Sea Water...
Isotope Tracer-other...
Long Island Sound...
Radioactivity-general...
Trace Element Analysis...

Neutron Activation Analysis of Iron Meteorites...
Aluminum, Argon-potassium...
Carbon, Cosmogenious...
Iron, Neutron Activation...

Application of Nuclear Techniques to Marine...
Minerals Technology...
Geological Exploration...
Gold, Manganeese...
Ocean Mining, Properties...

Fallout Inventory of the Oceans and Related...
Mechanisms...
Radioactivity, Radioactivity-general...
Trace Elements...

Composition of Lead Halide Pollution Aerosols...
Aerosols, Air Pollution Sampling...
Air Pollution-chemistry...
Conformation, Oxidation-general...

Aero-space

Lighting

Visual Landing Aids Field...
Atmosphere Optical Phenomena...
Detectors, Electric Lighting Systems...
Fog-haze-mist, Infrared Radiation...

Navy Aircraft Lighting...
Aircraft...
Colorimetry, Equipment-instruments...
Standards, Specifications...

Meteorological Conditions

Visual Range Meters...
Distance-measuring-device...
Fog-haze-mist, Guidance...
Landing, Visibility...

Space

Seco 'D' and Fourth Annual Edwin A. Link Lectures...
Lecture Grants, Oceanography-general...

Africa

Migration of Atlantic Tunas...
Atlantic Ocean-general...
Migration, Tag....

Agglutination Tests

Immunology and SeroLOGY of Marine Animals...
Biochemical Analysis, Blood Plasma...
Immunology, Pathology...

Aging

Aging in Hydroids...
Cell Injury and Autolysis, Developmental...
Physiology, Environmental Physiology...
Hydra, Portuguese Man-of-war...

Agricultural Engineering

Farm Structures & Design

Buildings

Pacifc Biomedical Research...
Mycobacterium Leprae...
Pacific Ocean-general...
Pharmacognosy...

Air

Research and Computations on the Thermodynamic Properties of Air and Related Gas...
Critical, Free Energy...
Hydrogen, Virial Coefficient...

Helium - Heat Transfer...
Diving and Scuba, Heat Transfer...
Helium, Submersibles, Temperature Effects...

Air Motion

Advection

Development of Physical-Numerical Models for Studies of the Atmosphere-Ocean Planetary Boundary Layer...
Ming, Simulation Theory, Thermal...
Turbulence, Wind-water Interaction...

Air Motion-general

Dynamic Study of the Temporal...
Meteorologic Model Studies...
Satellites, Storms-general, Tropical, Tropical Cyclones...

Meso and Convective Scale Systems in the Maritime Tropical Atmosphere...
Convection, Heat Budget...
Islands, Meteorologic Model Studies, Tropical...

Three-Dimensional, Global Climatology...
Applied Climatology, General Movement...
Patterns, Spectral Analysis...
Tables, Compilations, Catalogs...

Air Motion-other

Experiments in Air-Sea Interaction Involving...
Surface Pressure Measurements...
Pressure-density...
Wind-other...
Wind-water Interaction...

Convection

Research on Dynamics of Low Latitude Circulations...
Heat Exchange, Meteorological Studies...
Shear, Tropical Cyclones...

Atmospheric Conditions Associated with Cumulus Convection...
Cumulus...
Meteorologic Model Studies...
Shear, Tropical Cyclones, Velocity...

Meso and Convective Scale Systems in the Maritime Tropical Atmosphere...
Air Motion-general...
Heat Budget...
Islands, Meteorologic Model Studies...

Research on Turbulent Convection...
Forced Convection, Labor story Analysis, Stratified...
Turbulence, Turbulent...

Diffusion

Hydrosphere-Atmosphere Radiochemical Measurements...
Carbon, Nuclear Explosions - Fallout...
Particle-gas Transfer...
Tracers, Velocity...

Argonne Micrometeorological Modeling Facility Proposal...
Meteorologic Model Studies...
Micrometeorology, Public Health...
Turbulence, Wind Tunnels...

Analysis of the Marine Layer - A Meso Meteorological Study...
Air-Sea Boundary-general...
California, Heat Exchange, Orographic Effects...
Turbulence...

Patterns

Cloud Patterns Related to Selected Circulation Systems in Eastern Pacific...
Meteorological Studies...
Photographic, Satellite...

Research on Dynamics of Low Latitude Circulations...
Convection, Heat Exchange...
Meteorological Studies...
Shear, Tropical Cyclones...

Troposphere Meteorology in the Tropical Atlantic Area...
Anticyclones-cyclones...
Atlantic Ocean-general...
Clouds-precipitation...
Meteorologic Model Studies...

Application of Meteorological Satellite Sensing to General Circulation Models...
Infrared Radiation...
Meteorologic Model Studies...
Particle-gas Transfer, Satellites...
Thermodynamics, Weather Forecasting...

Equatorial Circulations in the Straitsphere...
Atmospheric Divisions, Mass Transport...

Weather Program - Station T-3...
Arctic Ocean, Drift Stations, Energy Exchange Processes...
Heat Budget...
Physical Climatology...
Weather Forecasting...

Large-Scale Inertial Ocean-Atmosphere Relationships...
Air-sea Boundary-general...
Greenland Sea, Jet
<table>
<thead>
<tr>
<th>SUBJECT INDEX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Motion</td>
</tr>
<tr>
<td>Wave generation by the turbulent wind field over the sea... Platforms, Pressure-density, Turbulence, Waves, Wind-water interaction, 3.0008</td>
</tr>
<tr>
<td>Atmospheric turbulence field studies... Air motion instruments, Air-sea boundary general, Boundary layer studies, Heat exchange, Turbulence, 3.0020</td>
</tr>
<tr>
<td>Measurement and predictive statistics of reversion... Acoustical, Geomorphology-topography, Reversion, scattering, Surface environments, Textures-structures, 1.0007</td>
</tr>
<tr>
<td>Wind-general</td>
</tr>
<tr>
<td>Prediction of extreme environmental factors... Forecasting-prediction, Meteorological extremes, Statistics-general, Technique development, Waves, 4.0048</td>
</tr>
<tr>
<td>The propagation of acoustic waves in the stratified atmosphere... Acoustics, Temperature, Transmission, Waves, 1.0059</td>
</tr>
<tr>
<td>Eastern boundary currents... Mixing, Ocean currents other, Pressure-density, Wind-water interaction, 2.0026</td>
</tr>
<tr>
<td>The net effect of wind on recreational tidal streams in Florida... Air-sea boundary other, Estuaries, Florida, Tides, Water level fluctuation, 2.0082</td>
</tr>
<tr>
<td>Objective weather analysis... Research development, Technique development, Tropic, Weather forecasting, 4.0042</td>
</tr>
<tr>
<td>Wind-other</td>
</tr>
<tr>
<td>Experiments in air-sea interaction involving surface pressure measurements... Air motion other, Pressure-density, Wind-water interaction, 3.0017</td>
</tr>
<tr>
<td>Air motion instruments</td>
</tr>
<tr>
<td>Marine meteorology untended station development... Automatic stations, Buoy, Meteorological studies, Platforms, Profiles, 8.0285</td>
</tr>
<tr>
<td>Energy transfer near the earth's surface... Buoy, Heat and radiation transfer, Thermodynamics, Turbulence, 3.0044</td>
</tr>
<tr>
<td>Atmospheric turbulence field studies... Air-sea boundary general, Boundary layer studies, Heat exchange, Turbulence, Velocity, 3.0020</td>
</tr>
<tr>
<td>Survival craft drift and leeway... Buoy, Currents ocean, Equatorial, Operational aspect, Tables, Compilations, Catalogs, 6.0129</td>
</tr>
<tr>
<td>Tracers</td>
</tr>
<tr>
<td>Tritium in hurricanes... Aircraft, Heat and radiation transfer, Heat exchange, Particle-gas transfer, Tritium, Trop- ical cyclones, 3.0047</td>
</tr>
<tr>
<td>Hydrosphere-atmosphere radiocative measurement... Carbon, Diffusion, Nuclear Explosions, Fallout, Particle-gas transfer, Velocity, 3.0043</td>
</tr>
<tr>
<td>Wind tunnels</td>
</tr>
<tr>
<td>Argonne micrometeorological modeling facility proposal... Diffusion, Meteorologic model studies, Micrometeorology, Public health, Turbulence, 4.0071</td>
</tr>
<tr>
<td>Air pollution-chemistry</td>
</tr>
<tr>
<td>Composition of lead halide pollution aerosols... Activation analysis, Aerosols, Air pollution sampling, Condensation, Oxidation general, 6.0156</td>
</tr>
<tr>
<td>Air temperature instruments</td>
</tr>
<tr>
<td>Numerical code converter... Humidity instruments, 8.0076</td>
</tr>
<tr>
<td>Air-earth interface</td>
</tr>
<tr>
<td>Boundary layer studies... Air-sea interaction process, Buoy, Circulation general, Lakes, Profiles, Wind-water interaction, 3.0028</td>
</tr>
<tr>
<td>Line islands experiment... General synoptic observations, Line islands, Physical climatology, Satellites, Wind-water interaction, 3.0063</td>
</tr>
<tr>
<td>Atmospheric-oceanic-glaciologic interactions in the antarctic... Antarctica, Heat budget, Heat exchange, 3.0009</td>
</tr>
<tr>
<td>STRUCTURE OF TURBULENCE... Diffusion, Turbulence, 8.0075</td>
</tr>
<tr>
<td>Atmospheric turbulence field studies... Air motion instruments, Air-sea boundary general, Heat exchange, Turbulence, Velocity, 3.0020</td>
</tr>
<tr>
<td>Air-sea boundary studies</td>
</tr>
<tr>
<td>Development experimental system for air sea interactions... British west Indies, Buoy, Meteorological studies, 4.0008</td>
</tr>
<tr>
<td>Committee on oceanography... Committee-support, Marine environments general, Oceanography-general, Radioactivity-general, 11.0016</td>
</tr>
<tr>
<td>Air-sea interaction... Currents-ocean, Gulf of Mexico, Thermal, Tropical cyclones, Weather forecasting, 3.0042</td>
</tr>
<tr>
<td>Ocean-atmosphere studies with stable isotopes and dissolved gases... Equilibrium, Chemical, Gases, Mixing, Oceanic fronts, Particle-gas transfer, Tracers, 3.0005</td>
</tr>
<tr>
<td>Large-scale inertial ocean-atmosphere relationships... Greenlaw, Jet streams, Patterns, Sea Ice, Sea of okhtsk, Weather forecasting, 3.0024</td>
</tr>
<tr>
<td>Exchange meteorologist with japanese antarctic research expedition... Antarctic ocean, General Synoptic observations, Mixing, Radioactive, Sea ice, 3.0011</td>
</tr>
<tr>
<td>Support of two research vessels... General sea Water chemistry, Great Lakes general, Marine Biology, Ships, Oceanic Currents, 12.0034</td>
</tr>
<tr>
<td>Transport processes across an air-water interface... Model studies, Statistics-general, Wind-water interaction, 3.0003</td>
</tr>
<tr>
<td>Marine atmospheric research facility... Instrumental services, Meteorological studies, Platforms, Telemetry other, Turbulence, Weather modification general, 8.0322</td>
</tr>
<tr>
<td>The occurrence and effects of plankton in the sea... Marine biology, Plankton, 5.0781</td>
</tr>
<tr>
<td>Use of on-line computers for environmental research... Acoustical, Development of models, Hybrid computer applications, Meteorological studies, Water motion, 4.0081</td>
</tr>
<tr>
<td>Air oceanography... Atlantic ocean-north, Buoy, Gulf Stream, Satellites, Technique development, 4.0163</td>
</tr>
<tr>
<td>Radiant energy flux across the air-sea interface and heat budget of the oceans... Forecasting-prediction, Heat and radiation transfer, Heat exchange, Radiation general, Turbulence, 3.0032</td>
</tr>
<tr>
<td>Marine interface chemistry... General sea Water chemistry, Organics, Sampling, 1.0073</td>
</tr>
<tr>
<td>Large-scale interactions... Acoustical, Buoy, Pacific Ocean-north, Temperature, Thermal, 3.0006</td>
</tr>
<tr>
<td>Hydrodynamic effects of submerged body... Fluid dynamics, Model studies, Theoretical analysis, Water tunnels tables, 8.0179</td>
</tr>
<tr>
<td>Miscellaneous services for federal aviation agency (visual range)... Distance-measuring-device, Fog-haze-mist, Visibility, 3.0011</td>
</tr>
<tr>
<td>Atmospheric turbulence field studies... Air motion instruments, Boundary layer studies, Heat exchange, Turbu- lence, Velocity, 3.0020</td>
</tr>
<tr>
<td>Ocean dynamics - oceanographic analyses and forecasting models... Acoustical, Hydrodynamics, Model studies, Surface environments, Temperature, 1.0004</td>
</tr>
<tr>
<td>Historical charts and interpretation of changes in sea surface temperature in the north pacific ocean... Atlases-maps, Circulation-general, Commercial fishing, Pacific ocean-north, Temperature, 1.0179</td>
</tr>
<tr>
<td>Analysis of the marine layer - a meso meteorological study... California, Diffusion, Heat exchange, Orographic effects, Turbulence, 3.0001</td>
</tr>
<tr>
<td>Air-sea boundary-other</td>
</tr>
<tr>
<td>The net effect of wind on recreational tidal streams in Florida... Estuaries, Florida, Tides, Water level fluctuation, Wind general, 2.0002</td>
</tr>
</tbody>
</table>

390
SUBJECT INDEX

DRIFT-STATION BIOLOGY ...Animal Taxonomy, Arctic Ocean, Oceanic Fronts, Productivity - Food Chain, Sea Ice, ...5.0743
FIORD OCEANOGRAPHY ...Estuaries, Fjords, Hydrodynamics, Model Studies, Simulation Theory, ...4.0040
SEA OTTER ...Metamorphosis, Population Dynamics, Range Or Territorial Dist., ...5.0528
SEAL BIOLOGY AND HARVEST ...Environmental Ecology, Intertidal Relat.(non-specific), Life History Studies, Reproduction Studies (general), ...5.0622
ECOLOGICAL STUDIES OF THE COPPER RIVER DELTA ...Censusing, Maps-generic, Spawning & Nesting Sites, Waterfowl -non-specific, ...5.0855
POPULATION STUDIES OF ANADROMOUS FISH - UPPER COOK INLET DRAINAGES ...Captive Rearing, Censusing, Population Dynamics, Salmon -coho,chinook,sockeye..., Streams, ...5.0050
SILVER SALMON STUDIES IN THE RESURRECTION BAY AREA ...Aquatic Ecology, Bays, Environmental Ecology, Management-other, Salmon -coho,chinook,sockeye..., ...5.0189
INVESTIGATION OF ANADROMOUS DOLLARDYR VARNISH POPULATIONS IN HOO-HOO BAY DRAINAGES, SOUTHEASTERN ALASKA ...Lake Trout, Srool: Trout. Migration, Population Dynamics, Streams, ...5.0013
FISH POPULATIONS IN THE CHENA RIVER ...Pike's, Pickeral, Musselkullage, Population Dynamics, Salmon & Trout - Non-specific, Streams, ...5.0029
EXPANSION OF CURRENT AND DEVELOPMENT OF ADDITIONAL COMMERCIAL FISHERIES CATCH, PRODUCTION AND GEAR STATISTICS ...Censusing, Commercial Fishing, Fish -non-specific, Fish -other, Reliability Theory, ...5.0018
PRE-EMERGENT FRY PINK SALMON FORECAST - SOUTHEASTERN ALASKA ...Aquatic Ecology, Censusing, Number Or Density, Salmon -coho,chinook,sockeye..., Spawning & Nesting Sites, ...5.0019
KVICHAK RIVER TOTAL SMOLT CENSUS ...Censusing, Fish -non-specific, Migration, Mortality Rates, Nets, Population Dynamics, ...5.0002
KVICHAK RIVER TOTAL SMOLT ...Censusing, Fish -non-specific, Migration, Mortality Rates, Nets, Population Dynamics, ...5.0002
KING CRAB SAMPLING GEAR STUDY ...Censusing, Crab, Fishing Gear, Population Dynamics, Spawning & Nesting Sites, ...5.0113
DUNGENSEN CRAB POPULATION DYNAMICS STUDY ...Crabs, Life History Studies, Population Dynamics, Tags, ...5.0346
INVESTIGATION OF SPawning GROUND POTENTIALS AND GROWTH AND SURVIVAL OF JUVENILE SOCKEYE SALMON IN FRATER LAKE SYSTEM ...Censusing, Lakes, Nets, Salmon -coho,chinook,sockeye..., Spawning & Nesting Sites, Tags, ...5.0190
MONITORING THE EFFECTS OF LAND USE ON SALMON PRODUCTION ...Environmental Ecology, Land Use, Pulp, Paper, Logging, Salmon & Trout - Non-specific, Streams, ...5.0192
INVESTIGATION OF ECOLOGICAL FACTORS LIMITING PRODUCTION OF THE ALASKAN PANDALIB SHRIMP ...Commercial Fishing, Life History Studies, Nets, Shrimps - Common, Von Uexkull Distrib., ...5.0345
COOK INLET ESCAPEMENT ENUMERATION STUDY ...Censusing, Migration, Organism Sampling Devices, Salmon -coho,chinook,sockeye..., Sonar, Sonar and Echo Sounding, ...5.0112
IDENTIFICATION OF RED SALMON STOCKS TAKEN IN THE CAPE KULMLIK-AANIACHAK BAY FISHERY (CHIGNIK FISHERY) ...Commercial Fishing, Salmon -coho,chinook,sockeye..., ...5.0004
MARINE BIOLOGICAL ...Espigations ...Taxonomic Collection Of The Fresh And Saltwater Fishes Of Alaska ...Animal Taxonomy, Collections, Fish -non-specific, Fresh Water, ...5.0008
MARINE BIOLOGICAL INVESTIGATIONS ...Nektion Of Inside Waters Of Southwestern Alaska ...Plankton Sampling, Population Dynamics, Temporal Distribution, Zooplankton, ...5.0521
MARINE BIOLOGICAL INVESTIGATIONS - ANALYSIS OF HERRING FISHERY DATA ...Age, Bays, Commercial Fishing, Salmon -coho,chinook,sockeye..., ...5.0022

Alaska

SOCKEYE SALMON MIGRATORY BEHAVIOR AND BIOLOGICAL STATISTICS COLLECTION, SOUTHEASTERN ALASKA ...Behavioral Ecology, Censusing, Migration, Salmon -coho,chinook,sockeye..., Streams, ...5.0027
OFFSHORE SALMON ABUNDANCE INDEX ...Commercial Fishing, Number Or Density, Salmon -coho,chinook,sockeye..., Streams, ...5.0028
COPPER RIVER SOCKEYE SALMON INVESTIGATIONS ...Aquatic Ecology, Biological Rhythms, Migration, Population Dynamics, Salmon -coho,chinook,sockeye..., Stocking of Fish & Shellfish, ...5.0025
COPPER RIVER SOCKEYE SALMON INVESTIGATIONS ...Commercial Fishing, Migration, Neta, Salmon -coho,chinook,sockeye..., Streams, ...5.0026
BRISTOL BAY OFFSHORE TEST FISHING PROGRAM ...Age, Bays, Commercial Fishing, Neta, Salmon -coho,chinook,sockeye..., ...5.0023
SOCKEYE SALMON MIGRATORY BEHAVIOR AND BIOLOGICAL STATISTICS COLLECTION, SOUTHEASTERN ALASKA ...Aquatic Ecology, Behavioral Ecology, Censusing, Migration, Salmon -coho,chinook,sockeye..., ...5.0016
PRE-EMERGENT FRY PINK SALMON FORECAST (KODIAK, ALASKA) ...Maturity & Growth Stages, Number Or Density, Salmon -coho,chinook,sockeye..., Spawning & Nesting Sites, Streams, ...5.0017
KVICHAK RIVER SMOLT STUDY LITERATURE SURVEY ...Censusing, Fish -non-specific, Migration, Number Or Density, Survey Studies, ...5.0003
KODIAK KING CRAB ENVIRONMENTAL ZONE SURVEY ...Continental Shelf, Environmental Ecology, Horneshoe Or King Crabs, Reproductive System, ...5.0348
COOK INLET CATCH AND ESCAPEMENT AGE AND SEX COMPOSITION STUDIES ...Age, Migration, Nets, Salmon -coho,chinook,sockeye..., Sex -non-specific, Spawning & Nesting Sites, ...5.0014
COOK INLET SMOLT ENUMERATION STUDY ...Censusing, Productivity (agricultural), Salmon -coho,chinook,sockeye..., Spawning & Nesting Sites, ...5.0015
INTERSTITIAL WATER OF GLACIAL-MARINE SEDIMENT ...Estuaries, Glacial Clastic, Intertidal - Connee Water, Water, Water Supply-General, ...7.0188
FORECAST OF KODIAK ISLAND PINK SALMON RUNS FROM ABUNDANCE OF JUVENILES IN ESTUARIES ...Estuaries, Fishing Gear, Maturity & Growth Stages, Migration, Number Or Density, Salmon -coho,chinook,sockeye..., ...5.0179
STUDIES OF SOCKEYE SALMON, ONCORHYNCHUS NERKA, IN THE NUSHAGAK DISTRICT, ALASKA ...Commercial Fishing, Intertidal Relat.(non-specific), Lakes, Population Dynamics, Salmon -coho,chinook,sockeye..., Spawning & Nesting Sites, ...5.0228
ECOLOGY OF EELGRASS ...Bering Sea, Food Webs, Phytoplankton, Potamogeton, Ruppia, Zostera ...Primary Productivity, ...5.0677
DEVELOPMENT OF WIRE-LINE CORING TECHNIQUE FOR SAMPLING UNCONSOLIDATED DEPOSITS ...Bottom Sampling Device, Coring and Dredging, Mechanical Properties, Mineralogy, Technique Development, ...5.0249
PRELIMINARY STUDIES TO CORRELATE SELECTED MINERALOGIC AND GEOLOGIC PROPERTIES WITH ENGINEERING PROPERTIES ...Engineering Geology, Mineralogy, Petrology, Ships and Cuiuous, Trace Element Analysis, ...5.0169
BRISTOL BAY ESTUARINE ECOLOGY ...Estuaries, Fishing Gear, Life History Studies, Migration, Oceanic Fronts, Salmon -coho,chinook,sockeye..., ...5.0004
NAKnek SYSTEM RED SALMON STUDIES ...Growth Rate, Migration, Number Or Density, Salmon -coho,chinook,sockeye..., ...5.0021
ARCTIC-YUKON-KUSKOKWIM AREA ANADROMOUS FISH INVESTIGATIONS ...Commercial Fishing, Life History Studies, Population Dynamics, Salmon & Trout - Non-specific, Salmon -coho,chinook,sockeye..., ...5.0024
RESTORATION AND REHABILITATION OF EARTHQUAKE DAMAGED PINK AND CHUM SALMON STUDIES IN PRINCE WILLIAM SOUND ...Earthquakes, Flow Characteristics -water, Salmon -coho,chinook,sockeye..., Spawning & Nesting Sites, Stream Rehabilitation, Tectonics-general, ...5.0191
BRISTOL BAY INTERMEDIATE HIGH SEAS-INSHORE TEST FISHING ...Age, Bays, Commercial Fishing, Salmon -coho,chinook,sockeye..., ...5.0022
Alaska

COASTAL AND INSHORE OCEANOGRAPHY ....Estuaries, Marine Biology, Shoreline - Coastline, Water Analysis-general, Water Properties-general, ...5.0851

PINK SALMON INVESTIGATIONS - INTERTIDAL ECOCOLOGY ....Life History, Studies, Salmons - 8to.oho, chinoook, sockeye,... Spawning & Nesting Sites, Tidal Streams, Water Salinity, ...5.0186

PINK SALMON INVESTIGATIONS - FRESHWATER ECOLOGY ....Aquatic Ecology, Salmon - 8to.oho, chinoook, sockeye,... Spawning & Nesting Sites, Streams, Water Properties-general, ...5.0185

MARINE BIOLOGICAL INVESTIGATIONS STUDIES PROJECT (FISHES). ....Aquatic Ecology, Bays, Fish - non-specific, Population Dynamics, ...5.0011

MARINE BIOLOGICAL INVESTIGATIONS - SURFACE ZOOPLANKTON PROJECT ....Number Or Density, Plankton Sampling, Vertical Distribution, Zooplankton, ...5.0737

TECHNICAL ASSISTANCE TO INDUSTRY ....Commercial Fishing, Diffusion of Information, Fishing Gear, General Information Services, ...5.0031

OCEAN ENGINEERING ....Commercial Fishing, Design, Machin- ery, Equipment, Fishing Gear, Shrimp, ...5.0249

ADULT SHRIMP STUDIES ....Bays, Biological Rhythms, Habitat Studies, Life History Studies, Shrimp - Commod., ...5.0340

ESTUARINE STUDIES OF SOUTHEASTERN ALASKA ....Benthic Fauna, Environmental Ecology, Estuaries, Number Or Density, Vertical Distribution, ...5.0652

PINK SALMON INVESTIGATIONS - EARLY SEA LIFE OF SALMON ....Environmental Physiology, Life History Studies, Parasitology -other, Water Temperature-non-specific, ...5.0187

RELATIONSHIP BETWEEN GLACIAL FLOUR POLLUTION AND POLLUTANTS FROM OTHER SOURCES ....Adsorption, Adsorption Capacity, Estuaries, Glacial Clastics, Pollution - Effects of, Pulp, Paper, and Logging, Size, ...6.0134

ORGANISMS RESPONSIBLE FOR TOXICITY OF ALASKAN CLAMS ....Biological Pollutants -general, Clams, Food Spoilage Detection, Microbiological, Pollutants-general, ...5.0344

Algae- Blue-green

Aphanizomenon

CHEMISTRY OF ALGAL TOXINS ....Algal Toxins, Bioassays, Biochemical Analysis, Gymnodinium, Microbiological Analysis, ...5.0709

Cyanophyta (non-specific & Ot)

NUTRIENT REQUIREMENTS OF ALGAE ....Algal Culture, Nitrate, Nitrite, Nutrition Studies, Phosphate, Phosphite, ...5.0706

Algae- Brown

Fucus

DEVELOPMENT OF POLARITY IN THE FUCACEAN ZYGOTE ....Cellular Physiology, Differentiation Mechanism, Plant Developmental Biology, Polarity, Reproductive Physiolo- gy, ...5.0972

DETERMINATION OF THOSE MARINE SPECIES HAVING THE GREATEST KNOWN POTENTIAL FOR THE COMMERCIAL FISHERY ....Ag Uses of Nat. resource-other, Al- ginate, Commercial Fishing, Food Supply, Fucus, ...5.0098

Kelps

Laminariaeae (non-specific &Ot)

ENVIRONMENTAL EFFECTS ON THE METABOLISM OF MARINE ALGAE ....Enzymes, Glycine Acid, Light, Marine Plants, Phytoplankton, Responses to Growth, ...5.0702

RESTORATION, PROPAGATION, AND MANAGEMENT OF MARINE ALGAE ....Applied Ecology, Growth and Differentiation, Habitat Studies, Marine Plants, Pacific Ocean-east, ...5.0680

FILM PROJECT (KELP FORESTS) ....California, Cinematography, Fishery Development -other, Habitat Studies, ...5.0678

ECOLOGY OF THE KELP FORESTS ....Behavioral Ecology, California, Environmental Ecology, Fish - non-specific, Habitat Studies, ...5.0194

Phaeophyta (non-specific & Ot)

EFFECTS OF DEPTH ON GROWTH AND REPRODUCTION OF BENTHIC MARINE ALGAE ....Algal Culture, Depth, Growth and Differentiation, Reproductive Physiology, Rhodophyta (non-specific & Ot), ...5.0684

STUDIES OF THE PHAEOPHYCEAE ORDERS CHORDARI- ALES AND PUNCTARIALES ....Algal Culture, Atlantic Ocean-north, Range Or Territorial Distr., Temporal Distribution, ...5.0715

ALGAL SUBSTANCES IN THE MARINE FOOD WEB ....Food Chains, Food Webs, Humic Acid, Marine Plants, Phenols, Secretions and Products, ...5.0725

DETERMINATION OF THOSE MARINE SPECIES HAVING THE GREATEST KNOWN POTENTIAL FOR THE COMMERCIAL FISHERY ....Ag Uses of Nat. resource-other, Alginic, Commercial Fishing, Food Supply, Fucus, ...5.0098

PRIMARY PRODUCTION AND DECOMPOSITION IN ESTUARINE WATER ....Estuaries, Florida, Methane Bacteria (non-specific), Primary Productivity, Rhodophyta (non-specific & Ot), Turnover (metabolic), ...5.0954

PHYOCHIMISTRY OF NARCOTIC PRINCIPLES IN CAU- LERPA ....Caulerpa, Caulerpin, Rhodophyta (non-specific & Ot), Sterols, ...6.0111

Sargassum

RELATIONSHIPS BETWEEN PHYTOPLANKTON AND ZOOPLANKTON IN THE CARIBBEAN SEA ....Caribbean Sea, Intertrophic Relat.(non-specific), Phytoplankton, Vertical Dispersion, Zooplankton, ...5.0779

Algae- Cryptophyceae

Zoanthella

SYMBIOSIS BETWEEN MARINE ALGAE AND INVER- TEBRATES ....Gastropods - slugs,conch,snails, Photosynthetically Active, Symbiosis, ...5.0730

SYMBIOSIS OF TROPICAL ZOANTHIDEA AND ZOO- ANTHELLAE ....Anthozoa, Mesogonyogaen Rana , Metabolism, Symbiosis, Tropic, ...5.0642

FORMATION AND UTILIZATION OF TERPENES ....Anthozoa, Biosynthesis, Enzyme-substrate, Symbiosis, Terpenes, ...5.0957

Algae- Diatoms

MORPHOGENESIS OF THE DIATOM SHELL ....Cellular Mem- branes (non-spec.), Plant Developmental Biology, Silica, Structural Functions, ...5.0734

MORPHOGENESIS OF THE DIATOM SHELL ....Cellular Membranes (non-spec.), Intracellular Localization, Organelle & Membrane Formation, Plant Developmental Biology, Silica, ...5.0712

PHYSIOLOGY AND ECOLOGY OF MARINE DIATOMS ....Al- gal Culture, Habitat Studies, Marine Plants, Nutrition Studies, Physiological Ecology, Plant Taxonomy, ...5.0735

BIOCHEMICAL STUDIES ON SILICEOUS SKELETAL FORMATO- NATION ....Cell Wall, Gulgii Apparatus, Histochemistry - Cytotoxic, Plant Developmental Biology, Silica, ...5.0750

Algae- Dinoflagellates

Algae- Dinoflagellates

BIOLOGY AND PALEONTOLOGY OF MARINE DINOFLAGEL- LATES AND HYDROXOSPHERES ....Algal Culture, Cell Cycle, Plant Developmental Biology, Range Or Territorial Distr., Spores, Vertical Distribution, ...5.0799

COMPARATIVE STUDIES OF DINOFLAGELLATE TOXINS ....Algal Culture, Algal Toxins, Cellular Physiology, Toxicology, ...6.0121

Gonyaulax

CIRCADIAN RHYTHM IN PHOTOSYNTHESIS IN THE MARINE ALGAE GONYAULAX AND ACETABULARIA ....Acetabularia, Autotrophic, Biological Rhythms, Control and Regulation, Kinetics, ...5.0685

MOLECULAR MECHANISMS IN BIOLOGICAL CLOCKS ....Control and Regulation, Marine Plants, ...5.0963

LIGHT RECEPTOR CONTROL OF THE CULTURAL RHYTHM OF ENZYME SYNTHESIS IN THE BOLIMINOSCE	
SUBJECT INDEX

Algae- Green (charophyceae)

Nitella
GROWTH AND CELLULAR MORPHOGENESIS IN NITELLA...Elongation of Cell, Growth and Differentiation, Manometers, Plant Developmental Biology, Water Movement, ...5.0711

Algae- Red

Chondrus
ECOLOGICAL STUDIES OF THE MARINE ALGA CHONDRUS CRISPUS STACKHOUSE...Nat. resource-other, Algal Culture, Growth and Differentiation, Reproductive Physiology, ...5.0710

Rhodophyta (non-specific & Ot)

IMPROVEMENT AND APPLICATION OF BENTHIC ALGAL ISOPE PRODUCTIVITY MEASURING METHODS...Algae-General, Benthonic-bottom, Caulerpa, Pacific Ocean-general, Physiological Ecology, Plant Prod. (non-specific), ...5.0906

EFFECTS OF DEPTH ON GROWTH AND REPRODUCTION OF BENTHIC MARINE ALGAE...Algal Culture, Depth, Growth and Differentiation, Phaeophyta (non-specific & Ot), Reproductive Physiology, ...5.0801

INDUCTION AND CONTROL OF DIFFERENTIATION IN ALGAE...Control and Regulation, Differentiation Mechanism, Nutrition Studies, Photoperiodism, Plant Developmental Biology, ...5.0708

PRIMARY PRODUCTION AND DECOMPOSITION IN ESTUARINE WATER...Estuaries, Florida, Methane Bacteria (non-specific), Phaeophyta (non-specific & Ot), Primary Productivity, Turnover (metabolic), ...5.0954

INVESTIGATIONS ON THE CRUSTOSE CORALLINES OF THE NORTH ATLANTIC...Atlantic Ocean-north, Diving and Scuba, Marine Plants, Plant Taxonomy, Sedimentology-general, ...5.0172

PHYTOCHEMISTRY OF NARCOTIC PRINCIPLES IN CAULERPA...Caulerpa, Caulerpa, Phaeophyta (non-specific & Ot), Sterols, ...6.0111

Algal Physiology

Biological Rhythms

EXPERIMENTAL MANIPULATION OF MECHANICAL AND PHYSIOLOGICAL RHYTHMS - A DUAL APPROACH TO THE BIOLOGICAL CLOCK PROBLEM...Acetabularia, Behavioral Ecology, Crabs, Perching Birds - Songbirds, ...5.1002

Environment

Responses to Growth

BIOLOGICALESSENCE...Autotrophic, Bays, Bioluminescence, Jamaica, Phytoplankton, ...1.0165

ENVIRONMENTAL EFFECTS ON THE METABOLISM OF MARINE ALGAE...Enzymes, Glycolic Acid, Laminariaeaceae (non-specific & Ot), Light, Marine Plants, Phytoplankton, ...5.0801

THE ECOLOGIC IMPACT OF THE INTERACTIONS AMONG MICROORGANISMS AND AQUATIC CONTAMINANTS IN LAKE ERIE...Lake Erie, Pollution - Effects of, Primary Productivity, Sediments, Water Bacteria, ...5.0819

DETERMINATION OF SELECTED ENVIRONMENTAL REQUIREMENTS OF IMPORTANT MARINE PHYTOPLANKTON SPECIES...Axenic Culture, Growth and Differentiation, Marine Biology, Marine Plants, Phytoplankton, ...5.0833

INTEGRATED FIELD AND LABORATORY SYSTEM FOR ASSESSING THE EFFECTS OF POLLUTANTS AND TOXICANTS UPON WATER QUALITY...Algal Culture, Axenic Culture, Phytoplankton, Pollution - Effects of, ...5.0831

Growth and Differentiation

EFFECTS OF DEPTH ON GROWTH AND REPRODUCTION OF BENTHIC MARINE ALGAE...Algal Culture, Depth, Phaeophyta (non-specific & Ot), Reproductive Physiology, Rhodophyta (non-specific & Ot), ...5.0684

GROWTH AND CELLULAR MORPHOGENESIS IN NITELLA...Elongation of Cell, Manometers, Nitella, Plant Developmental Biology, Water Movement, ...5.0721

PRELIMINARY INVESTIGATION OF GROWTH AND DIFFERENTIATION IN MARINE COENOCYTIC ALGA CALDERPA PROLIFERA...Caulerpa, Differentiation Mechanism, Growth Rate, Plant Developmental Biology, ...5.0711

ARCTIC BIOLOGICAL OCEANOGRAPHY...Adaptation, Arctic Ocean, Phytoplankton, Potamogeton, Ruppia, Zoanth, ...Water - Light Qual. & Quant., Water Temperature-other, ...5.0853

RESTORATION, PROPAGATION, AND MANAGEMENT OF MARINE ALGAE...Applied Ecology, Habitat Studies, Laminariaceae (non-specific & Ot), Marine Plants, Pacific Ocean-east, ...5.0660

ECOLOGICAL STUDIES OF THE MARINE RED ALGA CHONDRUS CRISPUS STACKHOUSE...Ag Use of Nat. resource-other, Algal Culture, Chondrus, Reproductive Physiology, ...5.0710

EXPERIMENTAL CULTURE OF CALCAREOUS GREEN ALGAE OF CORAL REEFS...Algal Culture, Biology, Calcium, Chlorophyceae (non-specific & Ot), Plant Taxonomy, Reefs, ...5.0719

EUTROPHICATION OF TIDAL WATERS...Eutrophication, Model Studies, Nutrients, Photosynthesis, Tidal Water Areas, ...5.0909

DETERMINATION OF SELECTED ENVIRONMENTAL REQUIREMENTS OF IMPORTANT MARINE PHYTOPLANKTON SPECIES...Axenic Culture, Marine Biology, Marine Plants, Phytoplankton, Responses to Growth, ...5.0833

Metabolism

Algal Metab.(non-specific & Ot)

MARINE TOXINS OF THE TROPICAL PACIFIC...Fish - non-specific, Pacific Ocean-general, Polynesia, Toxinology, Toxins, ...6.0113

Chemicals (incl. algalicides)

EFFECT OF NITROLITRIC ACID (NTA) UPON THE TOXICITY OF METALS TO SELECTED SPECIES OF ESTUARINE PHYTOPLANKTON...Acids, Carbon, Estuaries, Isotope Tracer-other, Phytoplankton, ...5.0829

Enzymes

ENVIRONMENTAL EFFECTS ON THE METABOLISM OF MARINE ALGAE...Glycolic Acid, Laminariaeaceae (non-specific & Ot), Light, Marine Plants, Phytoplankton, Responses to Growth, ...5.0702

STUDY OF NITROGEN METABOLISM IN MARINE ALGAE...Bioindicators, Marine Plants, Microbiological Analysis, Pollution - Effects of, Quantitative & Qualitative, ...5.0727

Growth Substances

CONTROL OF PLANT PATHOGENS USING ACTIVE ANTIMICROBIAL SUBSTANCES ISOLATED FROM MARINE ALGAE...Bacteria, Endogenous Biological Extracts, Fungi - non-specific, Marine Plants, Nutrition in Disease, ...6.0127

Nitrogen Fixation

NUTRITION LIMITATION AND SOURCES OF NITROGEN FOR MARINE PRIMARY PRODUCTION...Marine Plants, Mathematical Biophysics, Other Models, Phytoplankton, Primary Productivity-other, ...5.0845

Nutrition Studies

MARINE PHYTOPLANKTON RESEARCH...Algal Culture, Indonesian Ocean-general, Pacific Ocean-general, Phytoplankton, SYMBIOSIS, ...5.0847

NUTRITIONAL STUDIES ON MARINE ORGANISMS...Crustacea - non-specific, Invertebrate Nutrition, Organics, Phytoplankton, ...5.1001

PHYSIOLOGY AND ECOLOGY OF MARINE DIATOMS...Algae-Diatoms, Algal Culture, Habitat Studies, Marine Plants, Physiological Ecology, Plant Taxonomy, ...5.0735

INDUCTION AND CONTROL OF DIFFERENTIATION IN ALGAE...Control and Regulation, Differentiation Mechanism, Photoperiodism, Plant Developmental Biology, Rhodophyta (non-specific & Ot), ...5.0708

PHYSIOLOGICAL AND BIOCHEMICAL REQUIREMENTS OF PHYTOPLANKTON SPECIES...Algal Culture, Marine Plants, Media, Phytoplankton, Planktomed - Floating, ...5.0996

SEASONAL VARIATIONS OF ALGAL POPULATIONS...Algae-General, Algal Culture, Temporal Distribution, ...5.0705
SUBJECT INDEX

NUTRIENT REQUIREMENTS OF ALGAE ...Algal Culture, Cyanophyta (non-specific & Ot). Nitrate, Nitrite, Phosphate, Phosphite, ...5.0706

SYMBIOSIS IN CONVOLUTA ...Algae- General, Eddyworms, Symbiosis, ...5.0711

Respiration

RELATIONSHIP OF PHOTOSYNTHESIS TO RESPIRATION OF OCEANIC MICROALGAE ...Light, Marine Plants, Mass Spectroscopy, Oxygen, Photosynthesis, ...5.0774

Photoperiodism

INDUCTION AND CONTROL OF DIFFERENTIATION IN ALGAE ...Control and Regulation, Differentiation Mechanism, Nutrition Studies, Plant Developmental Biology, Rhodophyta (non-specific & Ot), ...5.0608

Photosynthesis

RELATIONSHIP OF PHOTOSYNTHESIS TO RESPIRATION OF OCEANIC MICROALGAE ...Light, Marine Plants, Mass Spectroscopy, Oxygen, Respiration, ...5.0774

EUTROPHICATION OF TIDAL WATERS ...Eutrophication, Growth and Differentiation, Model Studies, Nutrients, Tide-water Areas, ...5.0099

Reproductive Physiology

EFFECTS OF DEPTH ON GROWTH AND REPRODUCTION OF BENTHIC MARINE ALGAE ...Algal Culture, Depth, Growth and Differentiation, Phaeophyta (non-specific & Ot), Rhodophyta (non-specific & Ot), ...5.0684

TAXONOMY OF CALCAREOUS GREEN ALGAE ...Chlorophyceae (non-specific & Ot), Indian Ocean-general, Plant Morphology, Plant Taxonomy, Range Or Territorial Distri, ...5.0718

DEVELOPMENT OF POLARITY IN THE FUCACEAN ZYGOTE ...Cellular Physiology, Differentiation Mechanism, Fucus, Plant Developmental Biology, Polarity, ...5.0972

ECOLOGICAL STUDIES OF THE MARINE RED ALGA CHONDRIUS CRISPUS STACKHOUSE ...Ag Uses of Nat. resource-other, Algal Culture, Chondrus, Growth and Differentiation, ...5.0710

Alginates

DETERMINATION OF THOSE MARINE SPECIES HAVING THE GREATEST KNOWN POTENTIAL FOR THE COMMERCIAL FISHERY ...Ag Uses of Nat. resource-other, Commercial Fishing, Food Supply, Fucus, Phaeophyta (non-specific & Ot), ...5.0098

Alkali Metals

ELECTROLYTE-NON-ELECTROLYTE INTERACTIONS IN SEA WATER AND RELATED SOLUTIONS ...Alkaline Earths, Complexes, Electrolytes, Saline Water Systems, Thermal Properties-other, Water Analysis-general, ...1.0107

Alkaline Earths

ELECTROLYTE-NON-ELECTROLYTE INTERACTIONS IN SEA WATER AND RELATED SOLUTIONS ...Alkali Metals, Complexes, Electrolytes, Saline Water Systems, Thermal Properties-other, Water Analysis-general, ...1.0107

Alloys

COMBUSTION OF RESIDUAL FUEL WITH MASSIVE RECIRCULATION ...Atmospheric, Gases, Combustion Products, Fuels, ...8.0226

OCEAN ENGINEERING RESEARCH ...Engineering Studies-general, Materials Used Undersea, Moorings, Water, Water Properties-general, ...8.0059

METALS FOR DEFENSE ...Corrosion Prevention-other, Soils, Water, ...8.0209

MICROBIAL CORROSION ...Biological, Fouling, Marine Bacteria, Sulfur Bacteria, Water, ...8.0207

Aluminum

INTERMETALLIC COMPOUND ...Effect of Interfiber Spacing on the High Temperature Deformation of Al-1Al3Ni Composites ...Aluminum, Metal Matrix, Nickel, Plasticity, Tensile, ...5.0081

Ammonia

PRODUCTION OF PLATES OF FIBER COMPOSITES BY SOLIDIFICATION, FORMING AND A COMBINATION OF BOTH ...Aluminum, Fiber, Filament, Metal Matrix, Nickel, Orientation, ...5.0230

TEMPERATURE AND STRAIN RATE DEPENDENCE OF DEFORMATION IN AL-1Ni AL COMPOSITES ...Aluminum, Deformation - General, Metal Matrix, Nickel, Strain Rate, ...5.0231

Titanium

STRUCTURAL TITANIUM ALLOYS ...100 KSI YIELD STRENGTH ...Materials Used Undersea, Strength - Weight Ratio, Stress Concentration-toughness, Submerisbles, ...8.0219

STRUCTURAL TITANIUM ALLOYS ...120/150 KSI YIELD STRENGTH ...Fatigue, Materials Used Undersea, Strength - Weight Ratio, Stress Concentration-toughness, Stress Corrosion, ...8.0220

Alternative Planning

THE INSTITUTE FOR THE DEVELOPMENT OF RIVERINE AND ESTUARY SYSTEMS (IDRES) ...Delaware River, Estuaries, Waste Disposal-general, ...12.0043

PUBLIC INVESTMENT CRITERIA FOR WATER-ORIENTED RECREATION IN THE LAKE ERIE BASIN ...Costs, Finance, Fiscal, Pollution Abatement, Projected Demand, Recreation Sites, ...5.0516

AN ECONOMIC EVALUATION OF WATER POLLUTION CONTROL, YAQUNA BAY, ORE ...Bays, Benefit-cost Analysis, Model Studies, Oregon, Systems Analysis, Water Quality Control-general, ...6.0173

Aluminum

NEUTRON ACTIVATION ANALYSIS OF IRON METEORITES ...Activation Analysis, Argon-potassium, Carbon, Cosmogenous, Iron, Neutron Activation, ...7.0092

EFFECT OF INTERFIBER SPACING ON THE HIGH TEMPERATURE DEFORMATION OF AL-1Al3Ni COMPOSITES ...Intermetallic Compound, Metal Matrix, Nickel, Plasticity, Tensile, ...8.0229

PRODUCTION OF PLATES OF FIBER COMPOSITES BY SOLIDIFICATION, FORMING AND A COMBINATION OF BOTH ...Fiber, Filament, Intermetallic Compound, Metal Matrix, Nickel, Orientation, ...8.0230

TEMPERATURE AND STRAIN RATE DEPENDENCE OF DEFORMATION IN AL-1Ni AL COMPOSITES ...Deformation - General, Intermetallic Compound, Metal Matrix, Nickel, Strain Rate, ...5.0231

American Samoa

ROCK SAMPLING AND GEOPHYSICAL STUDIES IN THE TONGA KERMADEC TRENCH SOUTHWEST PACIFIC ...Coring and Dredging, Equipment Purchase Operation, Pacific Ocean-west, Photography, Seismic Reflection, Trenches, ...7.0093

DEEP EARTHQUAKES AND ISLAND-ARC TECTONICS AND STRUCTURE ...Atmospheric, Earthquake Location, Earthquakes, Island-arcs, Seismic Studies, Velocity Variations, ...7.0140

AQUISITION OF A SUITABLE PROTOTYPE FISHING VESSEL AND GEAR ...Commercial Fishing, Equipment Purchase Operation, Nets, Tuna, Mackerel, Albacore, ...12.0004

FISH POPULATION OFF THE ISLAND OF TUTUILLA, AMERICAN SAMOA ...Animal Taxonomy, Commercial Fishing, Fish -non-specific, Fishing Gear, Number Or Density, ...5.0052

FISH POPULATIONS OF AMERICAN SAMOA ...Crustacea - non-specific, Fish -non-specific, Fishing Gear, Number Or Density, ...5.0033

GEAR EVALUATION ...Fish -non-specific, Fishing Gear, Nets, ...5.0214

INVESTIGATE POPULATION DYNAMICS OF ALBACORE ...Commercial Fishing, Population Dynamics, Tuna, Mackerel, Albacore, ...Water Environment -other, ...5.0081

Ammonia

CHEMICAL EXPLOSIONS, PACKAGING AND HANDLING AT SEA ...Durability, Deterioration, Explosions, Detonation, Packaging, Safety, ...5.0130

397
<table>
<thead>
<tr>
<th>Subject Index</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonium</td>
<td>398</td>
</tr>
<tr>
<td>Amphibians</td>
<td>398</td>
</tr>
<tr>
<td>Andaman Sea</td>
<td>398</td>
</tr>
<tr>
<td>Animal Characteristics</td>
<td>398</td>
</tr>
</tbody>
</table>

**Ammonium**
- Regulation of Ammonia Excretion in Fish and Aquatic Amphibia...Anura -other, Fish -other, Kidney and Urinary System, Metabolism, Water...5.0468
- Investigation of Decomposition in Shrimp...Food Spoilage Detection, Physical Decomposition, Shrimp...5.0011

**Amphibians**
- Amphibia -non-specific & Other...Morphologic Regulatory Mechanisms in Terrestrial and Marine Organisms...Collagen, Developmental Physiology, Fish -other, Metabolism, Porifera...5.0962

**Andaman Sea**
- Geologic Survey of Martaban Canyon, Northeastern Indian Ocean...River Delta, Sedimentary History, Submarine Canyons, Tectogenesis, Valleys...5.0039

**Animal Characteristics**
- Adaptation...Zoophysiology of Oceanic Benthic Animals off the North Carolina Coast...Atlantic Ocean-north, Benthic Fauna, Benthic-bottom, Environmental Physiology, Water Temperature-non-specific...5.1069
- Systematic and Distributional Study of Deep-Sea Ectoprocta (Bryozoa)...Animal Taxonomy, Bryozoa, Ecological, Vertical Distribution...5.0650
- Physical Studies in the Bottlenose Dolphin...Tursiops truncatus...Cardiovascular System, Central Nervous System, Mammals...5.0588
- Physiological Studies on Fishes Lacking Hemoglobin...Cardiovascular System, Fish, Fish -other, Hemoglobin, Metabolism, Polar...5.0241
- Deep Diving Antarctic Birds and Mammals...Antarctica, Locomotion -animal, Penguins, Seals, Water Pressure, Water Temperature...5.0555
- Light and Dark Adaptation in the Retinae of Young Bluefish...Bluefish, Photoperiod, Retina, Visual Organs...5.0263
- Rhythmic Activity of Bluefish Under Experimentally Varying Light Regimes...Biological Rhythms, Bluefish, Environmental Physiology, Photoperiod, Water Light Quality & Quantity...5.0286
- Growth, Condition, and Survival of Shellfish...Environmental Physiology, Maryland, Oysters, Water Quality-general, Water Salinity...5.0447
- Thermal Acclimation Patterns in Paratypes and Hosts...Host Resistance, Host Specificity, Life History Studies, Monogenea, Water Temperature-non-specific...5.0663
- Cardiovascular Adjustments in Diving Mammals...Cardiovascular System, Effects on Cardiovascular system, Locomotion-animal, Mammals...5.0674
- Cardiovascular Studies on Diving Mammals...Basic Hemodynamics, Cardiovascular System, Control and Regulation, Heart, Locomotion -animal, Seals...5.0639

**Age**
- Chonotrich Charities Protozoa...Animal Taxonomy, Ciliates, Invertebrate Anatomy, Life History Studies, Range Or Territorial Dist...5.0742
- Hair Seals...Dispersal -other, Metamorphosis, Population Dynamics, Seals, Spawning & Nesting Sites...5.0525
- Estimation of Parameters of Striped Bass Population and Description of the Fishery of Lower Chesapeake Bay...Basses -sea,white, White Perch, Consuming, Chesapeake Bay, Fishing Gear, Population Dynamics...5.0151
- Evaluate the Research Techniques Which Will Be Employed to Study the Basic Life History of the Red Crab (Geryon Quinquedens)...Crabs, Mark, Tag Or Capture -other, Maturity & Growth Stages, Site...5.0494
- Bristol Bay Intermediate High Seas-Inshore Test Fishing...Alaska, Bays, Commercial Fishing, Salmon -coho,chinook,sockeye...5.0673
- Bristol Bay Offshore Test Fishing Program...Alaska, Bays, Commercial Fishing, Nets, Salmon -coho,chinook,sockeye...5.0673
- Cook Inlet Catch and Escapement Age and Sex Composition Studies...Alaska, Migration, Nets, Salmon -coho,chinook,sockeye...Sex -non-specific, Spawning & Nesting Sites...5.0014
- Distribution, Age Growth, and Mortality Studies of Salt Water Fishes of Importance to Sport Fishermen...Chesapeake Bay, Growth Rate, Mortality Rates, Vertical Distribution...5.0155
- Age Determination of Large Atlantic Sharks...Atlantic Ocean-north, Growth Rate...5.1028
- The Biology of the Laysan and Black-footed Albatrosses...Albatrosses, Shearwaters...Age Dist (non-specific), Control of Nuisance Species, Mark, Tag Or Capture -other, Spawning & Nesting Sites...5.0077
- Evaluation of the Atlantic Flyway Sea Duck Kill...Animorphs -other, Hunting, Mortality Rates, Sex -non-specific, Species, Computation of...5.0606
- Age and Growth of Bluefish...Atlantic Ocean-north, Bluefish, Growth Rate, Population Dynamics, Scales...5.0287
- Surf Clam Population Dynamics...Clams, Commercial Fishing, Continental Shelf, Population Dynamics, Scales...5.0048
- Marine Biological Investigations - Analysis of Herring Fishery Data...Alaska, Alewife, menhaden,shad,herring, Data Analysis - General, Dispersion -other...5.0501
- Administration of Whaling Act, Commercially Utilized Whales...Food Supply, Growth Rate, Mammals, Parasitology -other, Reproduction Studies (general)...5.0668
- Fur Seal Research, Population Dynamics...Growth Rate, Life History Studies, Mark, Tag Or Capture -other, Populations, Species, Seals...5.0671
- Administration of Whaling Act - Development of Research Tools...Management -other, Mark, Tag Or Capture -other...5.0670
- Surf Clam Biology...Clams, Growth Rate, Life History Studies, Reproductive System, Tags...5.0448
- Fish Population Parameters...Biological Rhythms, Life History Studies, Population Dynamics, Scales...5.0039

**Fertility**
- Cryogenic Preservation of Viable Fish Sperm...Fish -non-specific, Freezing Techniques, Male Gametes, Rapid Freeze, Reproduction and Fecundity of Tuna...Behavior, Biological Rhythms, Female Gametes, Tuna, Mackerel, Albacore...5.0159

**Growth Rate**
- Dynamics of Oceanic Plankton...Number Or Density, Productivity (agricultural), Rotifer...5.0825
- Microstratification of Marine Zooplankton...Environmental Physiology, Thermal, Vertical Distribution, Zooplankton...5.0753
- Population Studies on Interstitial Invertebrates...Australia, Gastropods -slugs,conch,snails, Longevity, Oregon, Starfishes...5.1021
SUBJECT INDEX

ENDOPARASITES

Endoparasites - other

PARASITES OF ANTARCTIC VERTEBRATES AND INVERTEBRATES - Animal Taxonomy, Antarctic Ocean, Collections, Ectoparasites...

COMPARATIVE BIOCHEMICAL AND MORPHOLOGICAL CHARACTERISTICS OF MARINE FUNGI FROM SHELLFISH - Fungal Culture, Histochemistry - Cytochemistry, Histology and Cytology, Marine Fungi (non-specific), Plant Taxonomy, ...

BIOLOGICAL ACTIVITIES OF MARINE FUNGI - Host-parasite Interactions, Invertebrate Pathology, Marine Fungi (non-specific), Oysters, Pathological Physiology, Plant Developmental Biology...

Helminths

AMINO ACID & PROTEIN METABOLISM IN SCHISTOSOMES - Amino Acids non-specific, Flukes, Metabolism, Proteins - non-specific, ...

SYSTEMATICS OF DEEP SEA TROOMATES - Animal Taxonomy, Organic Evolution, Trematoda - other, Vertical Distribution, ...

SYSTEMATIC STUDIES OF CERTAIN MARINE PARASITIC WORMS - Animal Taxonomy, Life History Studies, Red Worms, Eye Works, Trematoda - other, ...

EPIDEMIOLOGY OF SALMON POISONING DISEASE - Epizootic, Infectious Conditions and Dis, Pathology, Salmon & Trout - Non-specific, Water Salinity, ...

NATURAL HISTORY OF SALMON POISONING RICKETTSIAE - Flukes, Invertebrates, Neorickettsiae Helmint, Reservoirs, ...

EPIDEMIOLOGY OF SALMON POISONING DISEASE - Flukes, Neorickettsiae Helmint, Pathology, Salmon & Trout - Non-specific, Virulence and Pathogenicity, ...

PARASITES OF PHILIPPINE FISHES - Animal Distr. (non-specific), Aquatic Ecology, Fish - non-specific, Philippines, ...

BLOOD PARASITES OF NORTHWEST FISHES - Blood Plasma and Serum, Codfishes, Hake, Proteozoa, Sculpins, Trematoda - other, ...

Protozoa

PARASITISM IN DEEPSEA FISHES - Fish - non-specific, Helmint, Proteozoa, Vertical Distribution, ...

OCCURRENCE OF THE PROTOZOA PARASITE CERATOMYXIA IN ADULT PACIFIC SALMON AND STEELHEAD TROUT - Infectious Conditions and Dis, Pathology, Proteozoa - other, Rainbow Trout, Steelhead Trout, Vertebrate Pathology, ...

ULTRASTRUCTURAL STUDIES OF PARASITIC AND SAPROPHYTIC FUNGI AND PROTOZOA ASSOCIATED WITH MARINE INVERTEBRATES - Cell Cycle, Electron Microscopy, Host-parasite Interactions, Myxomycetes, ...

PROTOZOOLOGY - Animal Taxonomy, Axenic Culture, Histology and Cytology, Invertebrate Nutrition, ...

PATHOLOGY - EPIZOOTOLOGY - Epizootiology, Mortality Rates, Oysters, Pathology, Proteozoa - other, ...

PARASITOLOGY - Ciliates, Crabs, Oysters, Pathology, Proteozoa - other, ...

BLOOD PARASITES OF NORTHWEST FISHES - Blood Plasma and Serum, Codfishes, Hake, Helmint, Sculpins, Trematoda - other, ...

HOST RESISTANCE

THERMAL ACCLIMATIZATION PATTERNS IN PARASITES AND HOSTS - Adaptation, Host Specificity, Life History Studies, Monogenea, Water Temperature-non-specific, ...

HOST SPECIFICITY

PARASITISM IN DEEPSEA FISHES - Fish - non-specific, Helmint, Proteozoa, Vertical Distribution, ...

BIOLOGY, MORPHOLOGY, AND EVOLUTION OF THE DISK-FISHES OR SHARKSUCKERS - Animal Taxonomy, Ethological, Fish - other, Vertebrate Anatomy, ...

RELATIONSHIP BETWEEN WATER TEMPERATURE AND SIZE OF PARASITIC COPEPODS - Collections, Copepods, Size, Temperature, Water Temperature-non-specific, ...

SYSTEMATICS OF CALIGOID COPEPODS - Animal Taxonomy, Copepods, Ectoparasites, Nomenclature, Classification, ...

THERMAL ACCLIMINATION PATTERNS IN PARASITES AND HOSTS - Adaptation, Host Resistance, Life History Studies, Monogenea, Water Temperature-non-specific, ...

PARASITOLOGY - other

ADMINISTRATION OF WHALING ACT, COMMERCIALLY UTILIZED WHALFS - Age, Food Supply, Growth Rate, Mammals, Reproduction Studies (general), ...

PINK SALMON INVESTIGATIONS - EARLY SEA LIFE OF SALMON - Alaska, Environmental Physiology, Life History Studies, Water Temperature-non-specific, ...

RESERVOIRS

NATURAL HISTORY OF SALMON POISONING RICKETTSIAE - Flukes, Helmint, Invertebrates, Neorickettsiae Helmint, ...

ANIMAL PHARMACOLOGY

DRUG EVALUATION

ELASMOBRANCH PHARMACOLOGY - Mechanism of Action, Neuroeffective, Sharks, ...

ELASMOBRANCH PHARMACOLOGY - Fish Repellents, Mechanism of Action, Sharks, ...

MECHANISM OF ACTION

ELASMOBRANCH PHARMACOLOGY - Drug Evaluation, Neuroeffective, Sharks, ...

ELASMO BRANCH PHARMACOLOGY - Drug Evaluation, Fish Repellents, Sharks, ...

MARINE ANIMAL TOXINS - Fish Repellents, Sharks, Toxins, ...

TOXINS

CHARACTERIZATION AND MODE OF ACTION OF PROTEIN VENOMS OF MARINE ANIMALS - Leich, Mechanism of Action, Sea Urchins & Other Echinoderm, Toxicology, Venom, ...

MARINE ANIMAL TOXINS - Fish Repellents, Mechanism of Action, Sharks, ...

MARINE TOXINS OF THE TROPICAL PACIFIC - Algal Metab. (non-specific &ot), Fish - non-specific, Pacific Ocean-genera, Polynesian Toxicology, ...

PLANT ORIGIN

LABORATORY STUDIES TOXIC DINOFLAGELLATES - Algal Culture, Algal Toxins, Gonoutaux, Gulf of Mexico, Gymnodinium, ...

TOXINS - non-specific

BIOCHEMISTRY AND PHYSIOLOGICAL ECOLOGY OF POISONED FISH - Enzymes - non-specific, Fish - non-specific, Metabolism, Muscle, Pathology, ...

TOXINS - other

HEMATOLOGICAL CHANGES IN F. HETEROCLOTS UPON EXPOSURE TO TOXIC METALS - Blood Cells, Blood Plasma and Serum, Cadmium, Killifish, Cyprinodon, Lead, ...

COMPARATIVE TOXICITIES OF METALS TO ESTUARINE FISHES - Biosuagest, Eutrophics, Industrial Wastes, Killifishs - Cyprinodon, Solid Waste, ...

403
SUBJECT INDEX

Animal Resistance to ....

Environment Resistance

TEMPERATURE AND SALINITY TOLERANCE OF THE SARD SHRIMP, CRANGON SEPTEMPINOSA ...Environmental Physiology, Estuaries, Salinity, Shrimps - Common, Temperature ...5.0407

EVOLUTIONARY DIVERGENCE OF ONUPHID POLYCHAETES ...Comparative Physiology, Environmental Physiology, Invertebrate Nutrition, Lugworms, Marine Segmented worm, Water Temperature-non-specific ...5.0563

ENDOCRINE REGULATED PROCESSES IN TELEOST FISHES ...Comparative Physiology, Fish - other, Hypophysectomy, Osmoregulation, Pituitary ...5.0288

MOVEMENTS OF FRESHWATER CATFISH IN THE ESTUARIES OF SOUTHWEST LOUISIANA ...Blue Catfish, White Catfish, Estuaries, Louisiana, Migration, Water Salinity ...5.0699

TEMPERATURE TOLERANCE OF MARINE ANIMALS THROUGH BEHAVIORAL RESPONSES ...Behavior, Mortality Rates, Thermal, Water Temperature-non-specific ...5.0118

FISH HOLDING AND LIFE STAGE SENSITIVITY STUDIES ...Contamination - Water, Fish, Fish - non-specific, Great Lakes, general, Maturity & Growth Stages ...5.0276

OPERANT OSMOTIC REGULATION IN A MARINE ANIMAL ...Learning and Retention, Octopus, Squid, Cislidelle, Osmoregulation, Water Salinity ...5.0564

Animal Taxonomy

SYSTEMATICS OF THE ANTARCTIC AND SUBANTARCTIC GANADAE AMPHIPODA ...Abyssal, Antarctic Ocean, Bathyl, Shrimp - Amphipods, Vertical Distribution ...5.0359

PARASITIC COPEPODA ...CRUSTACEA ROM INVERTEBRATES AND FISHES ...Copiforma, Ectoparasites, Indian Ocean-general, Invertebrate Anatomy ...5.0451

DISTRIBUTION AND BIOLOGY OF PACIFIC ZOOPLANKTEN ...Pacific Ocean-general, Productivity - Food Chain, Range Or Territorial Dist, Vertical Distribution, Zooplankton ...5.0745

RESEARCH ON INDO-WEST PACIFIC MARINE MOLLUSKS OF THE FAMILY CONIDAE ...Gastropods - slugs, conch, snails, Indian Ocean-General, Invertebrate Anatomy, Number Or Density ...5.0817

THE PORIFERA OF FANNING ISLAND, CENTRAL PACIFIC ...Dispersion - other, Environmental Effects-geologic, Line Islands, Porifera ...5.0539

CONTINUED STUDIES OF THE SYSTEMATICS AND ZOOGEOGRAPHY OF WESTERN ATLANTIC CAECIDAE ...Atlantic Ocean-general, Derivatives, Gastropods - slugs, conch, snails, Invertebrate Anatomy, Publications - other, Temperature, ...5.0414

THERMAL CHARACTERISTIC ...Basic Embryology, Porifera, Speciation, Structural Functions ...5.0587

A SYSTEMATIC STUDY OF ENTOCYTHID OSTRACODS ...Madagascar-nulagray Republic, New Zealand, Publications - other, Shrimps - Seed Or Mussel, South America ...5.0492

MONOGRAPH OF THE CEPHALOPODA OF THE NORTH ATLANTIC ...Atlantic Ocean-north, Depth, Nomenclature, Classification, Optical, Publications - other, Salinity, Temperature, ...5.0411

CYTOTOXIC CRUSTACEA ...Embryology, Porifera, Speciation, Structural Functions ...5.0587

A SYSTEMATIC STUDY OF ENTOCYTHID OSTRACODS ...Madagascar-nulagray Republic, New Zealand, Publications - other, Shrimps - Seed Or Mussel, South America ...5.0492

CHONOTRICH CIILATE PROTOZOA ...Age, Climates, Invertebrate Anatomy, Life History Studies, Range Or Territorial Dist ...5.0743

TAXONOMY AND ECOLOGY OF NEARSHORE MARINE OSTRACODA ...Biofacies, Class Ostracoda, Ecological, Environmental Ecology, Palcoenvironments, Shrimps - Seed Or Mussel ...5.0707

SYSTEMATIC STUDIES ON HERMIT CRABS AND OTHER DECAPOD CRUSTACEANS ...Atlantic Ocean-south, Crabs, Developmental Physiology, Life History Studies ...5.0438

A COMPARATIVE SYSTEMATIC INVESTIGATION OF MARINE CRUSTACEANS IN THE HOTOLICHROUS PROTOZOA ORDER HYMENOSTOMATIDA ...Cilia and Flagellae, Climates, Comparative Physiology, Invertebrate Anatomy, Temperature ...5.0569

CYTOTOXIC STUDIES OF TELEOST FISHES ...Abyssal, Blood Cells, Minnows, Sets of Chromosomes ...5.0242

ORGANIZATION OF THE ACADEMYS COLLECTION OF RECENT MARINE, TERRASTIAL, AND FRESHWATER INVERTEBRATES ...Collections, Invertebrates - non-specific, ...5.0752

YEAR-ROUND PROGRAM OF RESEARCH IN MARINE ECOLOGY ...Aquatic Ecology, Marine Biology (non-specific), Plant Ecology (non-specific), Plant Taxonomy, Training Grants, Fellowships ...5.0899

REVISION OF THE CLASSIFICATION AND PHYLOGENY OF THE SUBORDER BALANOMORPHA (CIARIPEDIA - THORACICA) ...Barnacles, Collections, Handbooks, Nomenclature, Classification, Vertical Distribution ...5.0704

ECOLOGY OF SKELETAL PLANKTON ...Collections, Flagellates, Gastropods - slugs, conch, snails, Paleoecvironments, Vertical Distribution, Vertical Distribution ...5.0997

MARINE VERTEBRATES OF THE CALIFORNIA PENINSULA ...California, Environmental Ecology, Range Or Territorial Dist, Temperature ...5.0554

RELATIONSHIPS AMONG POPULATIONS OF LIMNORIA TRIPUNCTATA ...Isopods, Population Dynamics, Reproductive System ...5.0407

RESEARCH TRAINING IN MARINE BIOLOGY, PALEONTOLOGY AND SYSTEMATIC ZOOLOGY ...Invertebrates - non-specific, Oceanography-general, Paleontology, Training Grants, Fellowships ...5.0118

THE SYSTEMATICS AND ZOOGEOGRAPHY OF THE BRYozoan FAUNA OF THE AUSTRALIAN ISLANDS ...Australian, Bryozoa, Collections, Hawaii, Range Or Territorial Dist, ...5.0542

SYSTEMS OF DEEP SEA TREMATODES ...Helminths, Organic Evolution, Trematoda - other, Vertical Distribution ...5.0646

CYTOTAXONY OF SPECIES OF RELATED PLECOYPod MOLLUSKS ...Clams, Derivatives, Invertebrate Anatomy, Oysters, Selection & Breeding ...5.0413

LARVAL DEVELOPMENT OF SCYLLARIDEAN LOBSTERS ...Developmental Physiology, Environmental Physiology, Invertebrate Nutrition, Laboratory, Lobsters ...5.0409

NORTH AMERICAN POST-OLIGOCENE CYTHERID OSPARACODS ...Invertebrate Anatomy, Life History Studies, Nearctic, Phylogeny, Shrimps - Seed Or Mussel ...5.0179

REPRODUCTIVE RELATIONSHIPS AMONG POPULATIONS OF A MARINE WOOD-BORING ISOPOD ...Invertebrate Anatomy, Isopods, Population Dynamics, Reproductive System ...5.0414

SYSTEMATICS AND DISTRIBUTION OF WORMFISHES (MICRODISHEDM) ...Bone, Collections, Fish - other, Invertebrate Anatomy, Vertical Distribution ...5.0515

MONOGRAPH OF THE FISHES OF THE ORDER PLECTOGRAFIDAE ...Bone, Comparative Anatomy, Fish - other, Publications - other, Invertebrate Anatomy, Range Or Territorial Dist, Sea Squirts - Tunicates, Vertical Distribution ...5.0609

SYSTEMATIC STUDIES OF CERTAIN MARINE PARASITIC WORMS ...Helminths, Life History Studies, Red Worms, Eye Works ...Trematoda - other ...5.0541

SYSTEMATIC AND DISTRIBUTIONAL STUDY OF DEEP-SEA ECTOPROCTA (BRYOZOA) ...Adaptation, Bryozoa, Ecological, Vertical Distribution ...5.0569

SYSTEMATIC STUDIES OF SPONGES OF THE JAMAICAN FORE-REEF SLOPE ...Habitat Studies, Invertebrate Anatomy, Jamaica, Porifera, Reefs ...5.0588

FAMILIAL RELATIONSHIPS IN TELEOST FISHES ...Comparative Anatomy, Fish - other, Genetic, Karyotypes, Nomenclature, Classification ...5.0148

SYSTEMATICS OF MARINE SYMBIOTIC CRUSTACEA ...Invertebrates - Barnacles, Copepods, Life History Studies, Symbiosis ...5.0516

REVISION OF GENERA AND SUBGENERA OF WATER MITES OF THE WORLD ...Growth, Mouling & Metamorph, Nomenclature, Classification, Publications - other, Ticks & Mites, World Wide ...5.0627

GENERAL SYSTEMATIC STUDIES OF THE OCTOCRALIA OF THE TROPICAL ATLANTIC ...Anthozoa, Tropica ...5.0589

GROWTH LAYERING IN BIVALVED MOLLUSKS - AN AID IN PALEOECOBOGEOGRAPHICAL INTERPRETATION ...Biological Rhythms, Environmental Physiology, Freshwater Mussels, Scallop, Growth Rate, Invertebrate Physiology ...5.0355
### Subject Index

#### Anthozoa

**Carbon Hill**

**Age Profile of a Hawaiian Reef**

**Carbon-14**, Coring and Dredge, Growth Rate, Hawaii, Reef, Sea Level Variations, ...7.005

**Coral Atoll Ecol:**

Atolls, Bibliography, Data Analysis, General, Productivity, Food Chain, ...5.007

**Symposium of Tropical Zoanthidae and Zoanthellae**

Message RNA, Metabolism, Symbiosis, Tropic, Zoanthellae, ...5.004

**Formation and Utilization of Terpenes**

Bio synthesis, Enzyme-substrate, Symbiosis, Terpenes, Zoanthellae, ...5.005

**Natural Compounds with Carbon-Phosphorus Bonds**

Bond Type, Decomposition-other, Natural Occurring, Phosphorous, ...5.013

#### Antibiotics

**New Drugs from the Sea, Especially Antibiotics**

Caribbean Sea, Marine Plants, Pacific Ocean, General, ...6.003

#### Antimetabolites - Non-specific

**Growth and Toxicogenesis of Clostridium Botulinum in Fishery Products**

Bacterial Exotoxins, Clostridium Botulinum, Fish, Non-specific, Growth (non-specific & Ot.), Medical Studies, Microbiological, ...6.004

#### Appalachian Highlands

**New England Province**

Estuarine Sedimentation Processes, Estuaries, General Deposition, Intertidal Areas, Morphology-general, Tidal Streams, Tides, ...7.005

**A Study of the Ecology of the Microfauna Living Between Intertidal Marine Sediments**

Beach, Copepods, Crustacea, Non-specific, Intertidal Areas, Salinity, ...5.004

**Trophic Relationships in Shoral Benthic Environments**

Benthic Flora, Biology, Estuaries, Habitat Studies, ...5.007

#### Applied Electronics

**Digitizing System for Oceanographic Data**

Analog-digital Converters, Bathymetry, Digital Computers, Instrumental Services, Seismic Studies, Spectral Analysis, ...4.004

**Studies of Earthquakes in the Cape Mendocino Area**

Data Transmission Systems, Earthquake Location, Earthquakes, Seismic Studies, Telemetry-other, ...5.005

**Ocean System Telemetry Study**

Booys, Data Acquisition, Data Transmission Systems, Moorings, Telemetry-other, ...4.005

**Ocean Engineering Studies**

Data Acquisition, Data Processing Services, Engineering Studies-general, Instrumental Services, Laboratory Analysis, Sonar, ...5.006

**Arctic Seismic Transducer Evaluation**

Ardtic, Evaluation Other, Ice Acoustics, Propagation, Transducers, ...5.007

**Arctic Acoustic Research**

Ardtic, Ice Acoustics, Noise, Transmission, ...5.008

#### Biological Sciences

**Biological Instrumentation**

Behavioral Ecology, Instrumental Services, Instrumentation-general, Navigation Systems-other, ...5.009

**Application of Biotelemetry to the Study of Marine Vertebtrates**

Central Nervous System, Fish, Non-specific, Locomotion-animal, Telemeters, Telemetry, ...5.009

#### Aquaculture & Fish-farming

**Development of Techniques for the Aquaculture of Pompano**

Environmental Physiology, Florida, Maturity & Growth Stages, Pathology, Tuna, Mackerel, Albacore, ...5.007

**Shrimp Production in Louisiana Salt-Marsh Ponds**

Under Existing and Managed Conditions, Captive Rearing, Lagoons, Louisiana, Shrimps - Common, Water Movement, Currents, ...5.008

**Systems Engineering and Development of Commercially Valuable Marine Resources in the Delaware Area**

Commercial Fishing, Delaware, Fish & Shellfish, Oysters, Quality - Non-specific, ...5.009

**The Status and Potential of Aquaculture**

Algal Culture, Fish - Non-specific, Food Supply, Survey Studies, ...6.003

**Oyster Fatness Study**

Fats, Lipids & Oils, Food Supply, Growth Rate, Invertebrate Nutrition, Oysters, ...5.004

**Bionomics of Fishes and Shellfishes**

Bays, Economics-general, Environmental Ecology, Oregon, Productivity - Food Chain, ...5.005

**Construction of a New Series of Small Replication Ponds and Research on the Factors Limiting Fish Production in Impounded Waters**

Ponds, Productivity (Agricultural), ...6.000

**Culture of Pompano in Brackish Water Ponds**

Brackish Water, Food Supply, Louisiana, Pompans, Scads, Jacks, Stocking of Fish & Shellfish, ...6.001

**Culture of Atlantic Croaker in Brackish Water Ponds**

Brackish Water, Captive Rearing, Drums, Management, Ponds, Productivity (Agricultural), ...5.005

**Culture of Red Swamp Crawfish, Procambarus Clarkii, in Brackish Water**

Bass, Captive Rearing, Crayfish, ...5.006

**Culture of Blue, Channel, and White Catfish in Brackish Water Ponds**

Blue Catfish, White Catfish, Brackish Water, Captive Rearing, Channel Catfish, Louisian, ...5.006

#### Aquatic Or Soil-aquatic Cycles

**The Development of Hatchery Techniques to Aid in the Production of Economic Mollusks**

Captive Rearing, Clams, Food Supply, Oysters, Spawning & Nesting Sites, ...5.006

**Life History of Clupea harengus pallasi**

Alev, menhaden, shad, herring, Artificial Incubation, Life History Studies, Water Salinity, Water Temperature - Non-specific, ...5.006

**Methods of Rearing Eggs and Larvae to Juvenile Stages**

Captive Rearing, Environmental Physiology, Fish - Non-specific, Maturity & Growth Stages, ...5.007

**131.116B - Larval Culture (Shrimp Aquaculture Program)**

Algal Culture, Captive Rearing, Environmental Physiology, Food Supply, Shrimps - Common, ...5.006

**Juvenile and Adult Culture (Shrimp Aquaculture Program)**

Captive Rearing, Digestive System, Food Supply, Shrimps - Common, Water Environment - Other, ...5.007

**Food and Experimental Environments (Shrimp Aquaculture Program)**

Captive Rearing, Growth Rate, Ponds, Shrimp - Common, ...5.006

**Pesticides**

Bioassay, Fish, Persistence of Residues, Pesticides - Non-specific, Pollution Effects, ...5.007

**Pesticide Kinetics**

Degradation, Estuaries, Insecticides - Non-specific, Marine Biology - Non-specific, Pollutants - Path, ...5.008

**Aridic Soils**

**Biochemical Effects of Microorganisms Upon the Salt Marsh Environment**

Core Analysis, Identification, Marine Bacteria, SHEP, Shrimp-marshes, Temperature, Water Level Fluctuation, ...5.009

**Relationships Between Phosphate and Other Chemicals at the Watersubstrate Interface in Western Lake Erie**

Chemical-general, Lake Erie, Phosphate, Phosphite, Sediments, ...5.009

**Hydrography, Sedimentation and Chemical Aspects of the Reef Environment**

Currents, Ocean, Environmental Ecology, Fish - Non-specific, Reefs, ...5.009

**Aqueducts**

**Surface and Ground Water Potentialities of the Mullica River Basin**

Conjunctive Use, Economic Impact, Estuaries, Systems Analysis, Water Quality-general, Water Transfer, ...5.010

---

408
SUBJECT INDEX

Aquilifers
HYDROLOGY OF COASTAL AREA IN THE VICINITY OF RICEBORO, GEORGIA ...Artesian Flow, Dispersion -water, Estuaries, Georgia, Saline Water Intrusion, Water Quality-general, ...9.007
REMOTE SENSING, GULF COASTAL AREA, CENTRAL FLORIDA ... Aircraft, Fresh Water, Saline Water Systems, Temperature, Tides, ...4.0160

Arachnids -spiders, ticks, mites
HORSESHOE OR KING CRABS
NEUROPHYSIOLOGICAL INVESTIGATIONS OF LIMULUS CENTRAL NERVOUS SYSTEM ...Brain, Cardiovascular, Nervous System, ...5.0469
THE EFFECT OF SOME NEUROTRANSMITTERS ON THE CENTRAL NERVOUS SYSTEM OF LIMULUS POLYPHEMUS ...Brain, Cardiovascular, Nerve Effects, Neuroeffective, ...5.0470
KODIAK KING CRAB ENVIRONMENTAL ZONE SURVEY ...Alaska, Continental Shelf, Environmental Ecology, Reproductive System, ...5.0348
A HISTOCHEMICAL STUDY OF THE CENTRAL NERVOUS SYSTEM OF LIMULUS POLYPHEMUS ...Cholinesterase, Histochecmistry - Cytochem, Nervous System, Organelle-enzyme Assn, ...5.1000
PHYSIOLOGY OF THE LIMULUS HEART ...Biological Rhythms, Cardiovascular, Heart, Nervous System, ...5.0463
NEUROPHYSIOLOGICAL MECHANISMS IN BEHAVIOR ...Gi-gant water Bug, Water Strider, Locomotion, Proprioeceptors, ...5.0490
ISOCHIMICAL CHARACTERIZATION OF CHOLINESTERASES IN THE BLOOD AND CENTRAL NERVOUS SYSTEM OF LIMULUS POLYPHEMUS ...Blood and Lymph, Cholicisterase, Enzyme-substrate, Nervous System, Reaction Rates, ...5.0468

Sea Spiders
PYCNOGONIDA OF THE ANTARCTIC REGIONS ...Animal Taxonomy, Antarctica, Benthic Fauna, Collections, ...5.0647

Ticks & Mites
REVISION OF GENERA AND SUBGENERA OF WATER MITES OF THE WORLD ...Animal Taxonomy, Growth, Moult- ing & Metamorph, Nomenclature, Classification, Publications - other, World Wide, ...5.0627

Arctic
ARCTIC BIBLIOGRAPHY PROJECT ...Bibliography, Geophysics-general, Meteorological Studies-general, Oceanography-general, ...11.0013
ARCTIC BASIN HEAT FLOW ...Coring and Dredging, Crust, Geotherm Gradient, Heat Flows, Physical Properties, ...7.0105
ARCTIC AIR, SEA AND ICE ...Climatology, Heat and Radiation Transfer, Heat Exchange, Micrometeorology, Sea Ice, Weather Forecasting, ...3.0038
ARCTIC FIELD RESEARCH ...Geology-general, Glaciology-general, Marine Biology, Micrometeorology, ...11.0010
RADIOLARIA IN PACIFIC SEDIMENTS ...Biogenous, Classification - Taxonomy, Order Radiolaria, Pacific Ocean-north, Population - Distribution, ...7.0286
CHEMICAL OCEANOGRAPHY ...Circulation-general, Isotop-e Tracer-other, Oceanic Fronts, Tracers, Water Analysis-general, ...11.0072
ARCTIC PLANKTON ECLOGY ...Acoustical, Marine Biology (non-specific), Oceanic Fronts, Plankton (non-specific), Popul-aton Dynamics, ...1.0017
BIOLOGICAL OCEANOGRAPHY ...Organics, Phytoplankton, Temporal Distribution, ...5.0386
ARCTIC SEISMIC TRANSDUCER EVALUATION ...Applied Electronics, Evaluation Other, Ice Acoustics, Propagation, Transducers, ...8.0118
ACOUSTIC AMBIENT NOISE ...Acoustical, Liquids, Noise, Ocean, ...1.0063
ARCTIC UNDERSEAS RESEARCH, JOINT USA-CANADIAN HEAT BUDGET STUDY ...Heat and Radiation Transfer, Instrumentation-general, Physical Climatology, Sea Ice, ...3.0071

Arctic Ocean
ARCTIC ACOUSTIC RESEARCH ...Applied Electronics, Ice Acoustics, Noise, Transmission, ...1.0001
ARCTIC SUPPORT ...Remote Sensing-general, Scientific-service-support, Sea Ice, Submerged Ships, ...3.0080
WESTERN ARCTIC OCEANOGRAPHIC INVESTIGATIONS ...Arctic Ocean, Basins, Circulation-general, Mixing, ...2.024

Arctic Ocean
SATELITE SEA ICE STUDIES USING HRIR ...Data Analysis - General, Infrared Radiation, Satellites, Sea Ice, Technique Development, ...3.0075
WEATHER PROGRAM - STATION T-3 ...Drift Stations, Energy Exchange Processes, Heat Budget, Patterns, Physical Climatol-ogy, Weather Forecasting, ...3.0060
ARCTIC RESEARCH ...Acoustical, Currents-ocean, Geomorphology-topography, Magnetic Studies, Sea Ice, ...4.0049
ARCTIC BIOLOGICAL OCEANOGRAPHY ...Adaptation, Growth and Differentiation, Phytoplankton, Potamogeton, Rup-pia, Zostera ...Water - Light Qual & Quant, Water Tempera-ture-other, ...5.0853
CLIMATE CHANGE OVER THE POLAR OCEAN ...Heat and Radiation Transfer, Heat Budget, Numerical Analysis-other, Physical Climatology, ...3.0058
DISTRIBUTIONS OF CURRENTS AND PHYSICAL PROPERT-IES WITHIN THE ARCTIC OCEAN ...Acoustical, Currents-ocean, Heat and Radiation Transfer, Sea Ice, Temperature, ...4.0051
ARCTIC SUB-ICE STUDY ...Acoustical, Marine Biology, Sea Ice, Submersibles, ...3.0074
ARCTIC RESEARCH LABORATORY ...Acoustical, Alaska, Drift Stations, Seismic Studies, Terrain Analysis, ...12.0003
DRIFT-STATION BIOLOGY ...Alaska, Animal Taxonomy, Oceanic Fronts, Productivity - Food Chain, Sea Ice, ...5.0743
ARCTIC FIELD RESEARCH ...Bibliography, Environmental Effects-geologic, Geophysics-general, Russia, ...11.0011
ARCTIC ADVISORY SERVICE ...Bibliography, Ice Properties-general, Library, Sea Ice, ...11.0012
ARCTIC UNDERSEAS RESEARCH, PHYSICAL AND CHEM-ICAL PROPERTIES OF SEA ICE ...Environmental Effects-geologic, Ice Properties-general, Model Studies, Sea Ice, ...5.0870
ISOTOPIC OCEANOGRAPHY ...Data Acquisition, Oceans - Sea Water, Radioactivity-general, Sampling, Trace Elements, ...1.0090
PREDICTION OF POLAR ICE BEHAVIOR AND DISTRIBUT-ION ...Data Acquisition, Forecasting-prediction, Hydrodynam-ics, Ice-general, Sea Ice, Weather Forecasting, ...3.0078
WESTERN ARCTIC OCEANOGRAPHIC INVESTIGATIONS ...Arctic, Basins, Circulation-general, Mixing, ...2.0014

Baffin Bay
SEDIMENTS IN BAFFIN BAY AND THE EFFECTS OF AN ARCTIC ENVIRONMENT ON MARINE SEDIMENTATION ...Benthonic-bottom Origin, Physical Properties, Polar, Sedi-mentation, ...7.0265
ARCTIC EAST OCEANOGRAPHIC PROJECT (OCEANO-GRAHY OF THE BAFFIN BAY REGION) ...Circulation-general, Marine Biology, Polar, Sea Water Chemistry-other, Water Properties-general, ...4.0125

Beaufort Sea
GRAVITY SURVEY ARCTIC OCEAN ...Bathymetry, Continent-al Shelf, Geodetic Surveys, Gravity Studies, Seismic Studies, Structural Studies, ...7.0154

Chuckchi Sea
STRATIGRAPHY OF UNCONSOLIDATED SEDIMENTS ON THE CONTINENTAL SHELVES OF THE CHUKCHI AND NORTHERN BERING SEAS ...Bering Sea, Continental Shelf, Core Analysis, Correlation, Oceanic Fronts, Sedimentary History, ...7.0286

Greenland Sea
LARGE-SCALE INERTIAL OCEAN-ATMOSPHERE RELA-TIONSHIPS ...Air-sea Boundary-general, Jet Streams, Patterns, Sea Ice, Sea of Okhotsk, Weather Forecasting, ...3.0024
Atlantic Ocean-north

STUDIES OF THE BENTHIC INVERTEBRATES OF THE ATLANTIC CONTINENTAL SHELF...Benthic Fauna, Continental Shelf, Population Dynamics, Productivity - Food Chain,...5.0023
NORTHERN SHRIMP EXPLORATIONS...Censusuing, Commercial Fishing, Fishing Gear, Shrimps - Common,...5.0457
TIME-SERIES OBSERVATIONS OF TEMPERATURE AND SALINITY...North Atlantic and North Pacific Ocean Stations...Depth, Pacific Ocean-north, Salinity, Sampling, Temperature,...4.0005
CIRCULATION ON THE CONTINENTAL SHELF...Circulation-general, Continental Shelf, Eastern, Water Motion Recorders,...5.0027

Atlantic Ocean-south

MARINE SEDIMENTS...Bathymetry, Magnetic Studies, Ridges, Sea Floor Spreading, Textures-structures,...7.0203
SYSTEMATIC STUDIES ON HERMIT CRABS AND OTHER DECAPOD CRUSTACEANS...Animal Taxonomy, Crabs, Developmental Physiology, Life History Studies,...5.0408
HETEROTROPHIC ACTIVITY AND PRIMARY REGENERATION IN THE OCEAN...Biogeochemistry, Carbon, Gulf of Mexico, Organisms, Organisms-general,...1.0114
OCEANIC FISHES OF THE TROPICAL ATLANTIC...Fish -non-specific, Survey Studies, Tropic, Vertical Distribution,...5.0408
RESEARCH IN OCEANIC PHYSICS...Convection, Mixing, Oceanic Fronts, Thermodynamics, Water-water Interaction,...2.0059
STABLE ISOTOPES...Atlantic Ocean-north, Carbon, Chemical Analysis (water), Sampling, Water Chemistry-other,...1.0108
FISHES TAKEN INCIDENTAL TO SHRIMP TRAWLING...Fish -non-specific, Nets, Number Or Density, Shrimps - Common,...5.0072
CONTRIBUTIONS TO THE BIOLOGY OF THE ROYAL RED SHRIMP, HYNEMOPENAEUS ROBUSTUS...Maturity & Growth Stages, Number Or Density, Shrimps - Common,...5.0421

Atlantic Plain

Continental Shelf

STUDIES WITH TROPICAL AND SUBTROPICAL MICROALGAE...Algal Culture, Benthic Flora, Primary Productivity, Sah - Tropic, Tropic,...5.0093
SUPPORT OF THE R/V EASTWARD...Caribbean Sea, Cooperative-studies, Facilitiies, Marine Biology (non-specific), Ships and Cruises, Training Grants, Fellowships,...12.0039
INTERVIEW AND OBSERVATION...Censusuing, Commercial Fishing, Fish -non-specific, Range Or Territorial Dist.,...5.0019
DESIGN OF SAMPLING PLAN AND PROCUREMENT OF CHARTER VESSEL...Commercial Fishing, Fish -non-specific, Nets, Number Or Density, Vertical Distribution,...4.0014
WINTER DISTRIBUTION OF FISHES...Environmental Ecology, Fish -non-specific, Salinity, Temperature, Temporal Distribution,...3.0119
DISTRIBUTION OF YOUNG STAGES OF COASTAL FISHES...Estuaries, Fish -non-specific, Maturity & Growth Stages, Number Or Density, Ships and Cruises,...5.0019
EFFECT OF TEMPERATURES AND CIRCULATION OF CONTINENTAL SHELF WATERS ON THE DISTRIBUTION OF FISHES...Fish -non-specific, Surface Environments, Temperature, Water Movement, Currents, Winter Temperature-non-specific,...4.0015
SURF CLAM POPULATION DYNAMICS...Age, Clams, Commercial Fishing, Population Dynamics, Size,...5.0048
STUDIES ON ANACANTHINE FISHES...Animal Taxonomy, Atlantic Ocean-north, Fish -other, Publications -other,...5.0048
EXPLORATION OF LATENT RESOURCES ON THE CONTINENTAL SHELF/SLOPE...Atlantic Ocean-north, Commercial Fishing, Nets, Survey Studies,...5.0102
STUDIES OF THE BENTHIC INVERTEBRATES OF THE ATLANTIC CONTINENTAL SHELF...Atlantic Ocean-north, Benthic Fauna, Population Dynamics, Productivity - Food Chain,...5.0023
RECONNAISSANCE ECLOGIC SURVEY OF THE CONTINENTAL SHELF AND UPPER SLOPE (GULF OCEANOGRAPHIC)...RAPHY PROGRAM...Behavioral Ecology, Biology, Environmental Ecology, Migration, Population Dynamics, Shrimps - Common,...5.0025
THE OCEANOGRAPHY OF NEW ENGLAND FISHING BANKS...Fish -other, Number Or Density, Vertical Distribution, Water Environment-other,...5.0091
BIOGEOGRAPHY OF BENTHIC ORGANISMS...Benthic Organisms (non-specific), Marine Biology (non-specific), Range Or Territorial Dist., Vertical Distribution,...5.0076

Atmospheres-maps

PHYSICAL AND CHEMICAL ATLAS...Convection, General Sea Water Chemistry, Indian Ocean-general, Water Analysis-general, Water Properties-general,...4.0026
OCEANOGRAPHY ATLAS OF THE NORTH CAROLINA CONTINENTAL MARGIN...Continental Shelf, Mapping, North Carolina,...4.0029
INVENTORY AND ATLAS OF GULF COAST SPORT FISHING FACILITIES...Fishing, Gulf of Mexico, Handbooks, Management -other,...5.0026
HISTORICAL CHARTS AND INTERPRETATION OF CHANGES IN SEA SURFACE TEMPERATURE IN THE NORTH PACIFIC OCEAN...Air-sea Boundary-general, Circulation-general, Commercial Fishing, Pacific Ocean-north, Temperature,...5.0179

Atmosphere Composition

AN INVESTIGATION OF TRITIUM IN RAIN WATER...Humidity, Particle-gas Transfer, Precipitation-other, Rain-other, Tritium,...1.0010
SEA, WATER CHEMISTRY...Gases, Industrial-general, Lead, Technique Development, Trace Elec.-atts,...1.0076

Atmosphere Disturbance

Anticyclones-cyclones

TROPOSPHERE METEOROLOGY IN THE TROPICAL ATLANTIC AREA...Atlantic Ocean-general, Clouds-precipitation, Meteorological Studies, Patterns, Tropic,...5.0049
RELATION OF SATELLITE DATA TO LARGE SCALE ATMOSPHERIC CIRCULATION AND ENERGETICS...General Movement, Patterns, Radiation-general, Satellites, Weather Charts-maps,...4.0014

Atmosphere Disturbance

CLOUD PATTERNS RELATED TO SELECTED CIRCULATION SYSTEMS IN EASTERN PACIFIC...Meteorological Studies, Patterns, Photographic, Satellites,...5.0026

Storms-general

DYNAMIC STUDY OF THE TEMPORAL...Air Motion-general, Meteorological Model Studies, Patterns, Tropic, Tropical Cyclones,...5.0061
WAVE, CURRENT AND STORM SURGE RESPONSE TO EXTREME WIND CONDITIONS...Currents-ocean, Forecasting-prediction, Model Studies, Waves, Wind-water Interaction,...2.0107
STUDIES IN THE INDIAN OCEAN...Circulation-general, Data Analysis - General, Indian Ocean-general, Particle-gas Transfer,...2.0073

Tropical Cyclones

TROPICAL STORM INVESTIGATIONS IN THE ATLANTIC, CARIBBEAN, AND GULF OF MEXICO...Meteorological Studies, Satellites, Tropic, Vorticity, Water Boundary-general, Circulation-general, General, Marine Biology (non-specific), Ship Surveys,...5.0023
RESEARCH ON DYNAMICS OF LOW LATITUDE CIRCULATIONS...Convection, Heat Exchange, Meteorological Studies, Patterns, Shear,...3.0060
DYNAMIC STUDY OF THE TEMPORAL...Air Motion-general, Meteorological Model Studies, Satellites, Storms-general, Tropic,...3.0061
ATMOSPHERIC CONDITIONS ASSOCIATED WITH CUMULUS CONVECTION...Convection, Cumulus, Meteorological Model Studies, Shear, Velocity,...2.0057
TRITIUM IN HURRICANES...Aircraft, Heat and Radiation Transfer, Heat Exchange, Particle-gas Transfer, Tracers, Tritium,...3.0047
Atmosphere Optical Phenomena

Atmosphere Radiation

Atmospheric Pollution

Air Pollution Sampling

Atmospheric Pollution-general

Behavior

Dispersion - Transportation

Carbon Monoxide Content of Glacial Ice and the Natural Atmosphere

Carbon, Composition, Gases, Mono-oxide, .3.0068

Pollution Behavior-general

Mesoscale Wind Systems Around the Great Lakes

Land-sea Breezes, Meteorologic Model Studies, Patterns, .3.0064

Washout

Radioactive Aerosol Scavenging by Ocean Spray

Aerosols, Nuclear Explosions - Fallout, Radioactivity-general, Strontium, Waves, .6.0164

Other Sources

Measurement of Common Lead in the Earths Hydrosphere

Types

Aerosols

Radioactive Aerosol Scavenging by Ocean Spray

Nuclear Explosions - Fallout, Radioactivity-general, Strontium, Washout, Waves, .6.0164

Composition of Lead Halide Pollution Aerosols

Activation Analysis, Air Pollution Sampling, Air Pollution-chemistry, Condensation, Oxidation-general, .6.0156

Dust - Particulate Matter

Role of Wind-borne Continental Dust in Ocean Sedimentation Processes

Radioactivity, Trace Elements, Tracers, Velocity, .3.0043

Gases

Sea Water Chemistry

Carbon, Correlation, Dispersion - Transportation, Mono-oxide, .3.0068

Radioactivity

Determination of Tritium in Natural Waters

Fallout Inventory of the Oceans and Related Mechanisms

Atolls

Population Studies of Haustoriiidae and Gammaridae from New England and on Infaunal and Epifaunal Marine Amphipods at Eniwetok Laboratory Facilities, Lagoons, Incinerators, Ocean, Pollution Sources-other, Solid Waste, .8.0327
**SUBJECT INDEX**

| EFFECTS OF HANDLING AND PROCESSING PROCEDURES IN POTENTIAL PATHOGENS ON FISH | Other, Legal Standards, Microbiological, Smoking. Toxicological and Allergy, ... | .6.0044 |
| THERMAL DESTRUCTION OF TYPE E CLOSTRIDIUM BOTULINUM | Differentiation Mechanism, Food (epidemiology), Heat Resistance, Microbiological, Spore Studies, ... | .6.0006 |
| ECOLOGY OF CLOSTRIDIUM BOTULINUM TYPE E IN GREEN BAY | Fish (non-specific), Great Lakes, General, Microbiological, ... | .5.0850 |

**Coliforms (non-specific)**

A STUDY OF COLIFORM BACTERIA AND ESCHERICHIA COLI ON POLLUTED AND UNPOLLUTED OYSTER BOTTOMS OF MISSISSIPPI | Identification, Mississippi River, Sampling, Sewage, Vertical Distribution, ... | .5.0465 |

**Cryophilic Bacteria**

LOW TEMPERATURE GROWTH OF BACTERIA ON FOODS | Fish (non-specific), Growth (non-specific & Ot), Isoenzymes, Microbiological, Refrigeration, Temperature, ... | .5.0496 |

**Escherichia Coli**

BACTERIOLOGICAL SURVEYS FOR MICROBIAL STANDARDS FOR FOOD | Crabs, Food Spoilage Detection, Legal Standards, Microbiological, Staphylococcus (non-specific & Ot), ... | .5.0100 |

**Food Bacteria**

VITAMIN K5 AS A FOOD PRESERVATIVE | Food Processing -other, Microbiological, Repression, Vitamin K, ... | .5.0075 |

SURVIVAL OF FOOD PATHOGENS IN RADIATION | PASTEURIZATION SEAFOOD | Cell, env (non-specific & Ot), Cobalt, Crabs, Radiation, Radiation Sensitivity, ... | .6.0063 |

**Fuel Bacteria**

MICROBIAL ACTIVITY IN NON AQUEOUS SYSTEMS | Growth Rate, Range Or Territorial Distr, ... | .5.0782 |

**Halobacteria**

STUDIES OF PROTEINS UNDER EXTREME ENVIRONMENTS | Cellular Membranes (non-spec.), Cytochromes, Exobiont, Respiration, Salt, ... | .5.0941 |

**Halophilic Bacteria**

DEGRADATION OF MARINE SURFACES BY SALT REQUIRING BACTERIA | Control and Regulation, Dna-satellite, Fouling, Isolation From Nat. environ, Metabolic-biochemical Genetics, ... | .5.0818 |

**Intestinal Bacteria**

PURIFICATION OF HARD CLAMS FROM POLLUTED WATERS | Animal Viruses (non-specific), Clams, Contamination - Water, Estuaries, New Jersey, ... | .5.0467 |

**Luminous Bacteria**

CHEMISTRY AND ENZYMOLGY OF B I O L U M I N E S C E N C E | Anthozoa, Bioluminescence, Earthworms, Kinetics -other, Species, ... | .5.0962 |

**Marine Bacteria**

THE CYCLE OF ORGANIC MATTER IN THE DEEP SEA | Abyssal, Adsorption, Biogenous, Distribution, Origin, ... | ...1.0112 |

PHOTOSYNTHETIC BACTERIA | Bacterial Culture, Classification or Taxonomy, Isolation From Nat. environ, Phototrophic Bacteria, Sulfur Bacteria, ... | .5.0814 |

MICROBIAL CORROSION AND DETERIORATION OF NAVAL MATERIALS | Biological, Classification Or Taxonomy, Fouling, Ionic Effect, Materials Used Undersea, ... | .5.0203 |

**Microbiological Investigations of Threshold P A I 'E L S** | Catalolism and Degradation, Degradation, Fecal- water Mussels, Scallops, Marine Fungi (non-specific), Wood, Wood Preservatives-non-specific, ... | .5.0243 |

**The Role of Marine Organisms in the Degradation of Naval Materials** | Biological, Materials Used Undersea, Model Studier, Reaction Rates, ... | .5.0241 |

**Ecological Significance of Particulate Matter in the Sea** | Atlantic Ocean-north, Intertidal ReaL (non-specific), Organic Matter Content -water, Temporal Distribution, Vortical Distribution, Zooplankton, ... | .5.0754 |

**Paleobotanical Research at Yale University** | Growth Rate, Isolation From Nat. environ, Plant Succession, Plants, Sulfur Bacteria, ... | .5.0952 |

**Comparative Physiology of Barophilic Bacteria** | Ionic Effect, Isolation From Nat. environ, Nutrition, Pressure & Mech Stress, Temperature, ... | .5.0751 |

**Microbial Transformations in Sea Water** | Chemostat, Growth Rate, Isolation From Nat. environ, Nutrition, Organics, ... | .5.0796 |

**Marine Sulfur Oxidizing Bacteria** | Habitat Studies, Irons (inorganic), Isolation From Nat. environ, Range Or Territorial Distr, ... | .5.0768 |

**Geomicrobial Weathering Phenomena Off ANVER'S ISLAND** | Antarctica, Habitat Studies, Identification, Petrography, Weathering, ... | .7.0232 |

**Marine-Bacteria Culture** | Bacterial Culture, Biological, Fouling, Isolation From Nat. environ, Water Bacteria, ... | .5.0849 |

**Research on the Role of Bacteria in the Ocean** | Ditetritification, Elect Trans and Redox, Microorganism Enzymes, Nitrogen Bacteria, Respiration, ... | .5.0793 |

**The Role of Sulfur Bacteria in Corrosion and Deterioration** | Autotrophic, Biological, Fouling, Plasma Membrane, Sulfur Bacteria, ... | .5.0805 |

**Marine Bacteria Enzymes** | Cell, env (non-specific & Ot), Growth (non-specific & Ot), Isolation From Nat. environ, Plant Distri, (non-specific), Proteolytic Enzymes, ... | .5.0824 |

**Formation and Degradation of Manganese Nodules by Marine Bacteria** | Cobalt, Manganese, Nickel, Ocean Mining, Titanium, ... | .7.0025 |

**Mechanisms of Attachment of Marine Bacteria to Surfaces** | Adsorption & Interface, Biological, Corrosion Prevention-other, Fouling, ... | .5.0810 |

**Biochemical Effects of Microorganisms Upon the Salt Marsh Environment** | Identification, Microbiological Analysis, Salinity, Swamps-marshes, Temperature, ... | .5.0762 |

**Biochemical Effects of Microorganisms Upon the Salt Marsh Environment** | Aquatic Soils, Core Analysis, Identification, Salinity, Swamps-marshes, Temperature, Water Level Fluctuation, ... | .5.0763 |

**Physiological Characterization of Certain Marine Bacteria** | Bact, morphology (general), Bacterial Culture, Biology, Isolation From Nat. environ, Metabolism (intracellular), Tissue Techniques, ... | .5.0784 |

**Microbial Corrosion** | Alloys, Biological, Fouling, Sulfur Bacteria, Water, ... | .5.0207 |

**Drag-Reducing Algae** | Algac-General, Coatings-general, Fouling, Natural Occurring, Secretions and Proteins, Wear, Friction, ... | .5.0481 |

**Biological Oceanography & Deterioration - Shallow Water Marine Sediments & Water Column Bacteria** | Biology, Continental Shelf, Instrumentation-general, Nephelometry, Vertical Distribution, ... | .5.0807 |

**Microbiology of Marine and Estuarine Invertebrates** | Estuaries, Microbiological Analysis, Oysters, ... | .5.0790 |

**Nitrification by Marine Microorganisms** | Autotrophic, Bact, morphology (general), Bacterial Culture, Isolation From Nat. environ, Nitrogen Bacteria, Range Or Territorial Distr, ... | .5.0800 |

**Methane Bacteria (non-specific)**

**Primary Production and Decomposition in Estuarine Water** | Estuaries, Florida, Phanopbyta (non-specific & Ot), Primary Productivity, Rhodopbyta (non-specific & Ot), Turnover (metabolic), ... | .5.0954 |

**Mycobacterium Leprae**

**Pacific Biomedical Research** | Buildings, Pacific Ocean, general, Pharmacognosy, ... | .6.0112
Bacteria

**SUBJECT INDEX**

**Nitrogen Bacteria**

RESEARCH ON THE ROLE OF BACTERIA IN THE OCEAN...Dinitrification, Elect Trans and Redox, Marine Bacteria, Microorganism Enzymes, Respiration...5.0783

NITRIFICATION BY MARINE MICROORGANISMS...Autotrophic, Bact. morphology (general), Bacterial Culture, Isolation From Nat. environ., Marine Bacteria, Range Or Territorial Distr...5.0400

**Pedicoccus**

STUDIES OF THE AEROCCOCUS-PEDIOCOCCUS BACTERIA...Bioenergetics, Classification Or Taxonomy, Composition of Macromolecules, Detection...5.0817

**Photosynthetic Bacteria**

PHOTOSYNTHETIC BACTERIA...Bacterial Culture, Classification Or Taxonomy, Isolation From Nat. environ., Marine Bacteria, Sulfur Bacteria...5.0814

**Salmonella (non-specific & Ot)**

INCIDENCE OF BACTERIA OF PUBLIC HEALTH SIGNIFICANCE...Growth Rate, Fish (non-specific), Crabs, Microbiological, Oysters, Radiation, Staphyloc-...5.06038

SURVIVAL MECHANISM OF IRRADIATED MICROORGANISMS IN FOOD...Antibiotics, Cell Injury and Autolysis, Preservatives, Radiation, Radiation Protectors...5.06070

PROGRAM PROJECT - FOOD MICROBIOLOGY...Clostridia (non-specific & Ot), Food (epidemiology), Infection, Intoxication & Poison, Microbiological, Toxicological and Allergy...5.06005

**Staphylococcus (non-spec.& Ot)**

STUDY OF THE BASIC MICROBIOLOGICAL AND BIOCHEMICAL FACTORS IN THE IRRADIATION PRESERVATION OF MARINE PRODUCTS...Bacteria, Fish (non-specific), Microbiological, Radiation, Refrigeration...5.06085

INCIDENCE OF BACTERIA OF PUBLIC HEALTH SIGNIFICANCE IN FRESH COMMERCIAL SHELLFISH...Coliforms (non-specific), Crabs, Marine Biological, Oysters, Radiation, Salmonella (non-specific & Ot)...5.06038

BACTERIOLOGICAL SURVEYS FOR MICROBIAL STANDARDS FOR FOOD...Crabs, Echerichia coli, Food Spoilage Detection, Legal Standards, Microbiological...5.06010

**Streptococcus Fecalis**

BACTERIOLOGICAL STUDY OF THE POLLUTION OF KANIEHGE BAY, OAHU...Bays, Indicators, Coliforms (non-specific), Hawaii, Nitrogen, Sewage...5.06150

**Sulfur Bacteria**

BIOGEOCHEMISTRY OF TERRESTRIAL & EXTRATERRESTRIAL ORGANIC MATTER...Biochemical, Biogenic, Biochemical Process, Diagnesis, Exobiology, Organic...5.07074

PHOTOSYNTHETIC BACTERIA...Bacterial Culture, Classification Or Taxonomy, Isolation From Nat. environ., Marine Bacteria, Photosynthetic Bacteria...5.08114

PALEOBOTANICAL RESEARCH AT YALE UNIVERSITY...Growth Rate, Isolation From Nat. environ., Marine Bacteria, Photosynthetic Bacteria...5.08114

STUDIES ON MICROBIAL SULFATE REDUCTION AND SULFIDE OXIDATION IN MARINE ENVIRONMENTS...Carboxydrates, Classification Or Taxonomy, Growth (non-specific & Ot.), Isolation From Nat. environ., Respiration...5.07097

THE ROLE OF SULFUR BACTERIA IN CORROSION AND DETERIORATION...Autotrophic, Biological, Fouling, Marine Bacteria, Plasma Membrane...5.06085

MICROBIAL CORROSION...Alloys, Biological, Fouling, Marine Bacteria, Water...8.02077

**Thiobacillus**

MARINE SULFUR OXIDIZING BACTERIA...Habitat Studies, Ions (inorganic), Isolates From Nat. environ., Marine Bacteria, Range Or Territorial Distr...5.0758

**Water Bacteria**

MARINE-BACTERIA CULTURE...Bacterial Culture, Biological, Fouling, Isolation From Nat. environ., Marine Bacteria...5.0849

THE ECOLOGIC IMPACT OF THE INTERACTIONS AMONG MICROORGANISMS AND AQUATIC CONTAMINANTS IN LAKE ERIE...Lake Erie, Pollutant - Effects of Primary Productivity, Responses to Growth, Sediments...5.0819

**Bacterial Studies**

Classification Or Taxonomy

PHOTOSYNTHETIC BACTERIA...Bacterial Culture, Isolation From Nat. environ., Marine Bacteria, Photosynthetic Bacteria, Sulfur Bacteria...5.0814

MICROBIAL CORROSION AND DETERIORATION OF NAVAL MATERIALS...Biological, Fouling, Ionic Effect, Marine Bacteria, Materials Used Undersea...5.06038

STUDIES ON MICROBIAL SULFATE REDUCTION AND SULFIDE OXIDATION IN MARINE ENVIRONMENTS...Carboxydrates, Growth (non-specific & Ot.), Isolation From Nat. environ., Respiration, Sulfur Bacteria...5.07097

STUDIES OF THE AEROCCOCUS-PEDIOCOCCUS BACTERIA...Bioenergetics, Composition of Macromolecules, Detection, Pedicoccus...5.0817

Identification

AQUATIC MYXOBACTERIA - CHONDROCoccus COLUMNARIS...Atlantic Salmon, Sebago Salmon, Myxobacteria, Pathology, Warm Water...5.0614

GEOMICROBIOLOGICAL WEATHERING PHENOMENA OFF ANVERS ISLAND...Antarctica, Habitat Studies, Marine Bacteria, Marine Environments...5.0222

BIOCHEMICAL EFFECTS OF MICROORGANISMS UPON THE SALT MARSH ENVIRONMENT...Marine Bacteria, Microbiological Analysis, Salinity, Swamps-marshes, Temperature...5.07062

BIOCHEMICAL EFFECTS OF MICROORGANISMS UPON THE SALT MARSH ENVIRONMENT...Aquatix Sells, Core Analysis, Marine Bacteria, Salinity, Swamps-marshes, Temperature, Water Level Fluctuation...5.07063

A STUDY OF COLIFORM BACTERIA AND ESCHERICHA COLI ON POLLUTED AND UNPOLUTED OYSTER BOTTOMS OF MISSISSIPPI...Coliforms (non-specific), Mississippi River, Sampling, Sewage, Vertical Distribution...5.06045

ORGANIC DEBRIS ON CONNECTICUT BEACHES AND SHORES...Catabolism and Degradation, Connecticut, Organic Matter, Physical-general, Shoreline - Coastline...5.06143

BIOLOGICAL OCEANOGRAPHY AND DETERIORATION, DEEP OCEAN-HIGH PRESSURE BACTERIA...Biological, Biology, Chemistry, Microorganisms (non-specific), Submerials...5.06226

Isolation From Nat. environ.

PHOTOSYNTHETIC BACTERIA...Bacterial Culture, Classification Or Taxonomy, Marine Bacteria, Photosynthetic Bacteria, Sulfur Bacteria...5.0814

PALEOBOTANICAL RESEARCH AT YALE UNIVERSITY...Growth Rate, Marine Bacteria, Plant Succession, Plants, Sulfur Bacteria...5.04052

COMPARATIVE PHYSIOLOGY OF BAROPHILIC BACTERIA...Ionic Effect, Marine Bacteria, Nutrition, Pressure & Mach Stress, Temperature...5.07051

MICROBIAL TRANSFORMATIONS IN SEA WATER...Chemosyn, Growth Rate, Marine Bacteria, Nutrition, Organics...5.07096

STUDIES ON MICROBIAL SULFATE REDUCTION AND SULFIDE OXIDATION IN MARINE ENVIRONMENTS...Carboxydrates, Classification Or Taxonomy, Growth (non-specific & Ot.), Isolation From Nat. environ., Respiration, Sulfur Bacteria...5.07097

MARINE SULFUR OXIDIZING BACTERIA...Habitat Studies, Ions (inorganic), Marine Bacteria, Range Or Territorial Distr., Thiobacillus...5.0758

MARINE-BACTERIA CULTURE...Bacterial Culture, Biological, Fouling, Marine Bacteria, Water Bacteria...5.0849

MARINE BACTERIAL ENZYMES...Cell env.(non-specific & Ot.), Growth (non-specific & Ot.), Marine Bacteria, Plant Distr. (non-specific), Proteolytic Enzymes...5.0824
Subject Index

Bayous

Marine sediments...Atlantic Ocean-south, Magnetic Studies, Ridges, Sea Floor Spreading, Textures-structures...

ABYSSAL PLAIN SEDIMENTATION AND STRATIGRAPHY OFF OREGON...Abyssal, Coring and Dredging, Paleoclimatology, Sedimentation, Turbidity Currents...

DIGITIZING SYSTEM FOR OCEANOGRAPHIC DATA...Analog-digital Converters, Applied Electronics, Digital Computers, Instrumental Services, Seismic Studies, Spectral Analysis...

ATLANTIC OCEAN CRUSTAL STUDIES...Atlantic Ocean-general Coring and Dredging, Crust, Heat Flow Measurements, Seismic Reflection...

GEOLoGICAL AND GEOPHYSICAL INVESTIGATION OF THE BAHAMA BANK...Banks, British West Indies, Crust, Magnetic Studies, Seismic Studies...

GEOPHYSICAL AND GEOLOGICAL STUDY OF THE DAVIS RISE...Coring and Dredging, Geophysical-general, Gravity Studies, Magnetic Studies, Ocean Basins, Pacific Ocean-west, Photography, Reflection, Ridges, Seamounts-guyots...

INDIAN OCEAN DATA REDUCTION...Data Analysis-General, Geophysical-general, Indian Ocean-general, Ocean Basins, Seismology-general...

EASTERN ATLANTIC AND MEDITERRANEAN OCEANOGRAPHY...Acoustical, Atlantic Ocean-north, Data Analysis-General, Mediterranean Sea-general, Oceanography-general...

GRAVITY SURVEY ARCTIC OCEAN...Beaufort Sea, Continental Shelf, Geodetic Surveys, Gravity Studies, Seismic Studies, Structural Studies...

TRANSVERSAL DRIFTS IN BOTTOM PROFLes...Benthonic, Interstitial Areas, Ocean Waves-Currents, Waves...

GLOBAL OCEAN FLOOR ANALYSIS...Acoustical, Benthonic-bottom, Currents-bottom, Geomorphology-topography, Seismic Studies, Subbottom...

HYDROGRAPHIC SURVEY TECHNIQUES...Hydrographic, Reproduction, Technique Development...

DIVER NAVIGATION DEVICE...Diving and Scuba, Diving-system, Navigation, Technique Development...

EVALUATION OF CONTEMPORARY PRECISION NAVIGATION SYSTEMS...Communication & Navigation, Navigation, Navigation Communication, Satellites, Technique Development...

OCEAN ENGINEERING...Commercial Fishing, Fishing Gear, Instrumental Services, Telemetry-other...

Bathymetry

DIGITAL OUTPUT SURVEY DEPTH SOUNDING...Coring, Digital Computer Applications, Reseau Systems, Sonar, Sound Gea...

EXPERIMENTAL VERIFICATION OF WIDE SWATH OCEAN BOTTOM CONTINUING WITH SPLIT BEAM RECEIVERS...Caribbean Sea, Receivers, Sonar, Technique Development, Topographic...

LOW NOISE MULTI-CHANNEL HYDROPHONE CABLE...Amplifiers, Cables and Transmission Lines, Seismic Studies, Telephone, Transmission Lines...

RESEARCH IN MARINE GEOLOGY...Data Analysis-General, Gravity Studies, Magnetic Studies, Seismic Studies, Ships and Cruises...

MARINE GEOLoGY...Acoustical, Geomorphology-topography, Magnetic Studies, Mapping, Sea Floor Spreading...

SUBMARINE TOPOGRAPHY...Origin, Pacific Ocean-south, Photography-general, Sedimentation, Textures-structures...

STRUCTURE OF OCEAN BASINS...Basins, Charts, Indian Ocean-general, Ridges, Structural Studies...

417

Bay of Bengal

CONTINENTAL MARGIN GEOLOGY...Continental Shelves, Fam, Seismic Reflection, Subbottom, Textures-structures...

Bayous

HEAVY MINERAL DISTRIBUTION OF THE WHITE OAK ESTUARY-BOUGUE INLET AREA, NORTH CAROLINA...Distribution, Estuaries, Heavy Minerals, North Carolina...

BAYOU LAFOLUERCE SEDIMENTATION STUDY, LOUISIANA...Channels, Louisiana, Morphology-general, Rate of Deposition, Sediment Yield...

40101
SUBJECT INDEX

Bays

ECOLOGICAL STUDY OF DUXBURY BAY ...Aquatic Ecology, Habitat Studies, Massachusetts, Survey Studies, Tides, ...5.0098

HYDROGRAPHIC AND BIOLOGICAL SURVEY OF MONT- SWEAG BAY AND VICINITY ...Maine, Number Of Density, Organism Sampling Devices, Vertical Distribution, Zooplankton, ...5.0839

PHYSICAL AND BIOLOGICAL OCEANOGRAPHY OF A LU- MINOUS BAY ...Bioluminescence, Circulation-general, Jamaica, Model Studies, Phytoplankton, ...5.0976

AN ECOLOGICAL STUDY OF SOUTH BISCAYNE BAY IN THE VICINITY OF TURKEY POINT ...Applied Ecology, Balance of Nature, Electric Power Plants, Environmental Ecology, Florida, Phytoplankton, Thermal Pollution, ...5.0877

BIOLUMINESCENCE ...Autotrophic, Bioluminescence, Jamaica, Phytoplankton, Responses to Growth, ...5.1016

DIVERSITY, COMMUNITY STRUCTURE AND TROPICAL RELATIONS OF TROPICAL ZOOPLANKTON ...Interbiotic Relat.(non-specific), Productivity - Food Chain, Tropic, Zooplankton, ...5.0782

RECENT MARINE AND NONMARINE SEDIMENTS AND MICROFAUNA OF DELAWARE COASTAL AREAS ...Delaware Bay, Peatlands, Quaternary Period, Sedimentary Structure-general, Shoreline - Coastline, ...5.0207

MASS MORTALITY OF PACIFIC OYSTERS ALONG THE WASHINGTON COAST ...Environmental Ecology, Mortality Rates, Oysters, Pathology, Puget Sound, ...5.0910

MASS MORTALITY OF OYSTERS ALONG THE OREGON COAST ...Invertebrate Pathology, Mortality Rates, Oregon, Oysters, Pathology, ...5.0489

SILVER SALMON STUDIES IN THE RESURRECTION BAY AREA ...Alaska, Aquatic Ecology, Environmental Ecology, Management-other, Salmon -coho,chinook,sockeye, ...5.0189

CREEL CENSUS OF SUMMER FLONDER SPORT FISHERY IN GREAT BAY, NEW JERSEY ...Censusing, Lefteye Flon- ders, Legislation, Life History Studies, New Jersey, ...5.0124

SPORTFISH YIELD OF NATURAL REEFS ...California, Fishery Development-other, Habitat Studies, Population Dynamics, ...5.0119

LOCATING AND MAPPING THE EXISTING SEED OYSTER BEDS IN DELAWARE BAY ...Aquatic Ecology, Delaware Bay, Mapping, Oysters, Spawning & Nesting Sites, ...5.0381

BRISTOL BAY INTERMEDIATE HIGH SEAS-INSHORE TEST FISHING ...Age, Alaska, Commercial Fishing, Salmon - coho,chinook,sockeye, ...5.0022

BRISTOL BAY OFFSHORE TEST FISHING PROGRAM ...Age, Alaska, Commercial Fishing, Nets, Salmon -coho,chin- ook,sockeye, ...5.0023

OSTER SEED PROPAGATION STUDY ...Aquatic Ecology, Commercial Fishing, Oysters, Pacific Ocean-east, Spawning & Nesting Sites, ...5.0012

DETERMINATION OF SAFE LEVELS OF POLLUTION IN PUERTO RICO ...Contamination - Water, Meteorological Studies-general, Pollution - Effects of, Puerto Rico, Recreation Sites, ...5.0182

RESIDENCE TIMES OF WATERS BEHIND BARRIER ISLANDS ...Circulation-general, Simulation Theory, Tides, Water-Interactions, ...5.0018

EFFECTS OF RIVERS ON THE METABOLISM OF TEXAS BAYS ...Nutrients, Pollutants-general, Primary Productivity, Streams, Texas, Water Quality-general, ...5.0197

THE ECOLOGY AND MANAGEMENT OF THE BENTHIC MARINE PLANT COMMUNITIES ...Habitat Studies, Water Depth, Water Levels, ...5.0724

ENVIRONMENTAL BIOLOGY OF TOMALEA BAY DAY ...Aquatic Ecology, Benthic Fauna, California, Mans Activities, Pollution - Effects of, ...5.0850

EFFECTS OF WATER POLLUTION IN SAN FRANCISCO BAY ...Economic Impact, Pollution - Effects of, Recreation Sites, San Francisco Bay, Social Aspects, Water Utilization-domestic, Welfare -well-being, ...6.1410

BIONOMICS OF FISHES AND SHELFISHES ...Aquaculture & Fish-farming, Economics-general, Environmental Ecology, Oregon, Productivity - Food Chain, ...5.0920

HYDROGRAPHY OF APALACHICOLA BAY ...Currents-ocean, Rain-general, Salinity, Sunshine, Temperature, ...5.0147

BACTERIOLOGICAL STUDY OF THE POLLUTION OF KANAPA BAY, OAHU ...Bacteriological, Coliforms (non-specific), Hawaii, Nitrogen, Sewage, Streptococcus Faecalis, ...5.0150

SEDIMENTOLOGY AND GEOLOGIC HISTORY OF HUM- BOLDT BAY, CALIFORNIA ...California, Coring and Dredging, Geologic History-general, Pacific Ocean-east, Physical Properties, ...7.0193

PRIMARY PRODUCTIVITY IN PUERTO GALERA BAY, MIN- DORO, PHILIPPINES ...Philippines, Primary Productivity, Productivity - Food Chain, ...5.1025

A SEDIMENTOLOGIC STUDY OF MOBILE BAY AND PER- DIDO BAY ...Alabama, Distribution, Ocean History, Rate of Deposition, Stratigraphy-general, ...5.0233

AN ECONOMIC EVALUATION OF WATER POLLUTION CONTROL, YAQUINA BAY, OREGON ...Alternative Planning, Benefit-cost Analysis, Model Studies, Oregon, Systems Analysis, Water Quality Control-general, ...5.0173

SOCIO-ECONOMIC STUDY OF NARRAGANSETT BAY, RHODE ISLAND ...Benefit-cost Analysis, Estuaries, Land Use, Rhode Island, Social Aspects, Water Quality Control-general, ...5.0012

MARINE GEOLOGY OF THE SAN FRANCISCO BAY ...Geology-general, Gold, Mechanical Properties, San Francisco Bay, Structural Studies, Tectogenesis, ...5.0035

GEOCHEMISTRY OF SAN FRANCISCO BAY ...Chl-a, Distribution, Mineral Associations, San Francisco Bay, Trace Element Analysis, ...5.0074

HYDROLOGY OF UPPER OLD TAMPA BAY, FLORIDA ...Groundwater Movement, Hydrology-general, Lakes, Permeability, Water Harvesting, Water Quality-general, ...5.0067

INVENTORY OF THE GULF ESTUARY SYSTEM ...Data Acquisition, Estuaries, Fishing, Gulf of Mexico, Sedimentology-general, ...4.0047

SAN PABLO BAY STUDY ...Benthic Fauna, Bottom Sampling Device, Excavation, Pollution - Effects of, ...5.0916

MARINE BIOLOGICAL INVESTIGATIONS STUDIES PRO- JECT (FISHES) ...Alaska, Aquatic Ecology, Fish -non-specific, Population Dynamics, ...5.0011

ADULT SHRIMP STUDIES ...Alaska, Biological Rhythms, Habitat Studies, Life History Studies, Shrimps - Common, ...5.0340

PREDICTING COMMERCIAL SHRIMP ABUNDANCE (SHRIMP DYNAMICS PROGRAM) ...Behavioral Ecology, Commercial Fishing, Environmental Ecology, Population Dynamics, Shrimps - Common, ...5.0499

Beaches

SAND RIPPLES ...Distribution, Grain Size, Ocean Waves - Currents, Ripple Marks, Shape, ...5.0196

MULTISPECTRAL SENSING OF COASTAL ENVIRONMENTS ...Aerial Photography, Depth, E M Radiation-general, Geomorphology-topography, Photography, Shoreline - Coastline, ...4.0166

ENVIRONMENTAL APPLICATIONS OF PASSIVE MICROWAVE SENSORS ...Ice-general, Microwave Radiation, Sea Ice, Sedimentology-general, Snow-general, Soil Engineering Investigation, ...4.0154

DESIGN OF RUBBLE WAVE-ABSORBER ...Energy Dissipators, Harbors, Measuring Devices-other, Shoreline Structures, Waves, ...9.0037

ANALYSIS OF AN ATTEMPT TO CONTROL BEACH ERO- SION AT SCIENTISTS CLIFFS, MARYLAND ...Chesapeake Bay, Engineering Studies-other, Erosion, Groin, Maryland, ...3.0038

DEVELOPMENT OF CRITERIA FOR ARTIFICIAL BEACHES ...Beach, Coastal Engineering-other, Design Criteria, Shoreline Structures, Statistics-general, ...5.0041

OREGON-CALIFORNIA BLACK SANDS ...California, Heavy Mineral Analysis, Heavy Minerals, Mineralogy, Ocean Mining, Potential of Deposits, ...7.0015

SAND DOLLAR COMMUNITIES ...California, Habitat Studies, Productivity - Food Chain, Sea Urchins & Other Echinoderm, ...5.0533

Bearing Capacity

SEA FLOOR STUDIES - DEPOSITIONAL AND EROSION PROCESSES ...Distribution, Erosion, Lithification-general, Sedimentation, Stability Analysis, ...5.0230

GEODETIC OCEANOGRAPHY - PHYSICAL PROPERTIES ...Biological, Chemistry, Photography, Physical Properties, Shear Strength, ...8.0337
### SUBJECT INDEX

**Benthos**

**BOTTOM CURRENTS AND DEEP SEA TIDES**  - Abysmal, Acoustical, Currents-other, Finite Differences, Model Studies, Tides, **.2.0004**

**BOTTOM ENVIRONMENT-GULF OF MEXICO**  - Biology, Chemistry, Gulf of Mexico, Ocean Currents-other, Physical Properties, **.2.0043**

**BIOGRAPHIC STUDY OF THE BENTHOS OF PUERTO RICO AND THE VIRGIN ISLANDS**  - Benthic Fauna, Benthic Flora, Currents-ocean, Range Or Territorial Distir., Temperature, Vertical Distribution, **.6.0652**

**SEA FLOOR ROUGHNESS**  - Acoustical, Attenuation, Bottom Sampling Device, Magnetic Studies, Propagation, Transmission, **.7.0033**


**WOODS HOLE ENVIRONMENTAL STUDIES OF SEA FLOOR PROPERTIES**  - Acoustical, Data Acquisition, Geomorphology-topography, Gravity Studies, Sub-bottom, **.7.0118**

**WOODS HOLE ENVIRONMENTAL STUDIES OCEANIC ACOUSTICS**  - Acoustical, Atlantic Ocean-north, Data Analysis - General, Reverberation, Scattering, **.7.0024**

**SHALLOW WATER MEIOBENTHOS OF THE BERMUDA PLATFORM**  - Benthic Fauna, Bermuda, Continental Shelf, **.5.0649**

**BENTHIC MARINE FAUNA OF THE UPPER SHELF OFF VIRGINIA**  - Animal Taxonomy, Benthic Fauna, Continental Shelf, Organism Sampling Devices, Virginia, **.6.0600**

**ECOLOGY OF ECHINOIDS**  - Behavioral Ecology, Sea Urchins & Other Echinoderm, Vertical Distribution, Water Environment-other, **.5.0571**

**ELECTROMAGNETIC NOISE MEASUREMENTS IN THE SEA**  - Depth, Electromagnetic, Submersibles, Surface Environments, **.1.0138**

**ADVANCED TECHNOLOGY AND BOTTOM PREDICTIONS**  - Acoustical, Data Acquisition, Data Analysis - General, Forecasting-prediction, Model Studies, Seismic Studies, **.1.0045**

**GLOBAL OCEAN FLOOR ANALYSIS**  - Acoustical, Bathymetry, Currents-bottom, Geomorphology-topography, Seismic Studies, Sub-bottom, **.4.0046**

**BOTTOM-REFLECTED SONAR STUDIES**  - Acoustical, Scattering, Sonar, Surface Environments, Transmission, **.1.0025**

**DIVER-ASSISTED OCEANOGRAPHY**  - Continental Shelf, Currents-bottom, Diving and Scuba, Geomorphology-topography, Mapping, Waves-internal, **.4.0098**


**CONSTRUCTION SYSTEMS**  - Engineering Studies-other, Equipment, Submerged Ships, Technique Development, Underwater-construction, **.8.0120**

**FIELD STUDY-CAPE COD, MASS.-ANIMAL DISTRIBUTION**  - Benthic Fauna, (non-specific), Buoy, Environmental Ecology, Sediments-other, Temperature, **.5.0854**

### Beef Husbandry

**Management**

**THE EFFECT OF CONTROLLING SALT-MARSH MOSQUITOES ON BEEF CATTLE PRODUCTION**  - Plant ECOLOGY, Soil Productivity, And Estuarine Animals, Cultural Control Of Insects, Ectoparasitic Insects, Wetlands, **.6.0927**

**STUDY OF FOSSIL SEA TURTLE COLLECTION AT THE INSTITUT ROYAL DES SCIENCES NATURELLES, BRUSSELS, BELGIUM**  - Collect'out, Description Of Fossils, Internal Structure, Reptiles, Tertiary Period, **.7.0177**

---

**Belgium**

**MARINE HEAVY-METALS PRODUCTION INFORMATION, ON WORLDWIDE BASIS**  - Appraisals-general, Deposits-ores, Documents & Literature, Heavy Elements, Ocean Mining, **.7.0006**

### Benthoic-bottom

**THE MARINE ALGAE OF VIRGINIA**  - Algae- General, Chesapeake Bay, Marine Plants, Plant Taxonomy, Virginia, **.5.0698**

**SEA BED INSTALLATION**  - Deep, Diving and Scuba, Stabilization, Sub-bottoms, Underwater-construction, **.5.0331**

**IMPROVEMENT AND APPLICATION OF BENTHIC ALGAL ISOPE PRODUCTIVITY MEASURING METHODS**  - Algae- General, Caribbean, Pacific Ocean-general, Physiological Ecology, Plant Prod. (non-specific), Phytoplankton (non-specific & Oil), **.5.0968**

**COLUMBIA RIVER EFFECTS IN THE NORTHEAST PACIFIC**  - Bed Load, Columbia River, Mixing, Ocean Waves - Currents, Oceanic Fronts, **.2.0065**

**MODIFY 19 OCEAN BOTTOM SEISMOGRAPHS AND CONDUCT TESTS WITH THE DEVICE**  - Equipment, Geophysical Equipment, Seismographs, **.8.0110**

**OPTICAL MEASUREMENTS**  - Currents-ocean, Optical, Photography, Subsurface Environments, **.1.0170**

**SYSTEMATICS AND ECOLOGY OF SUBTIDAL BENTHIC MARINE ALGAE**  - Algae- General, Benthic Flora, Habitat Studies, Marine Plants, Plant Taxonomy, Range Or Territorial Distir., **.5.0701**

**THE INFLUENCE OF DEPOSIT FEEDING BENTHOS ON THE STABILITY OF BOTTOM SEDIMENTS AND COMMUNITY TROPHIC STRUCTURE**  - Benthic Fauna, Massachusetts, Productivity - Food Chain, Suspension, **.5.0659**

**ZOOPHYSIOLOGY OF OCEANIC BENTHIC ANIMALS OFF THE NORTH CAPE, CANADA**  - Adaptation, Atlantic Ocean-north, Benthic Fauna, Environmental Physiology, Water Temperature-non-specific, **.5.1099**

**STUDY OF OCEAN CURRENTS AT SEA FLOOR AND THEIR SPATIAL CORRELATION**  - Currents-bottom, Field Characteristics, Water Motion Recorders, **.2.0003**


**OCEAN BOTTOM EMPLOYED GEOPHYSICAL STATION**  - Automatic Stations, Dynamic Gravimeters, Geophysical Equipment, Gravity Studies, Instrumental Services, Pacific Ocean-east, Temperature, Water Motion Recorders, **.4.0035**

**DEEP SEA PHOTOGRAPHIC SYSTEM AND A BOX CORER**  - Abysal, Coring and Dredging, Photography, **.8.0141**

**SEDIMENTS IN BAFFIN BAY AND THE EFFECTS OF AN ARCTIC ENVIRONMENT ON MARINE SEDIMENTATION**  - Baffin Bay, Origin, Physical Properties, Polar, Sedimentation, **.7.0265**

**DEEP SEA BENTHOS IN THE GULF OF MEXICO**  - Benthic Fauna, Biology, Gulf of Mexico, Population Dynamics, **.5.0655**

**OCEANOGRAPHIC RESEARCH**  - Abyssal, Fouling, Geomorphology-topography, Marine Soils, Tables, Compilations, Catalogs, **.8.0143**

---

419
Subject Index

Benthos

Zoophysiology of Oceanic Benthic Animals Off the North Carolina Coast - Adaptation, Atlantic Ocean-north, Benthonic-bottom, Environmental Physiology, Water Temperature-non-specific, ...5.1009

Deep Water Benthic Polychaetes - Biology, Lugworms, Marine Segmentedworm, Photography, Vertical Distribution, ...5.0540

Recent and Ancient Faunas of a Drowned Island Chain (Mid-Pacific Mountains) - Biofacies, Coring and Dredging, Hawaii, Seamounts-guyots, ...5.0863

Pycnogonida of the Antarctic Regions - Animal Taxonomy, Antarctic, Collections, Sea Spiders, ...5.0667

Benthic Communities - Behavioral Ecology, Bottom Sampling Device, Developmental Physiology, Fouling, Metabolism, Productivity ...5.0551

Deep Sea Benthos in the Gulf of Mexico - Benthonic-bottom, Biology, Gulf of Mexico, Population Dynamics, ...5.0665

Biographic Study of the Benthos of Puerto Rico and the Virgin Islands - Benthic Flora, Benthonic-bottom, Currents-ocean, Range or Territorial Dist., Temperature, Vertical Distribution, ...5.0502

The Determination of the Availability of Sea Robins - Chesapeake Bay, Fish -other, Nets, Vertical Distribution, ...5.0511

Lake Borgne-Chalmette Sound System - Louisiana, Number or Density, Plankton Sampling, River Deltas, Vertical Distribution, ...5.0691

Timbalier - Terrebonne Bays System - Louisiana, Number or Density, Plankton Sampling, River Deltas, Vertical Distribution, ...5.0692

Breton Sound - Mouth of Mississippi River System - Louisiana, Number or Density, Plankton Sampling, River Deltas, Vertical Distribution, ...5.0693

Vermillion - Calcasieu - Sabine System - Louisiana, Number or Density, Plankton Sampling, Salinity, Tides, Vertical Distribution, ...5.0094

Atchafalaya River - Gailou Lake System - Lakes, Louisiana, Number or Density, Plankton Sampling, Vertical Distribution, ...5.0095

Water Quality - Benthic Invertebrate Relationships in Estuaries - Benthonic-bottom, Estuaries, Maine, Pollution - Effects of, Pollution Effects, ...5.0894

The Biology of the Infauna of a Tropcial Soft Bottom Area - Aquatic Ecology, Estuaries, Florida, Intertidal Areas, Pollution - Effects of, ...5.0879

Environmental Biology of Tomales Bay Day - Aquatic Ecology, Bays, California, Mans Activities, Pollution - Effects of, ...5.0860

Shallow Water MeioBenthos of the Bermuda Platform - Benthonic-bottom, Bermuda, Continental Shelf, ...5.0649

Benthic Marine Fauna of the Upper Shelf off Virginia - Animal Taxonomy, Benthonic-bottom, Continental Shelf, Organism Sampling Devices, Virginia, ...5.0660

San Pablo Bay Study - Bays, Bottom Sampling Device, Excavation, Pollution - Effects of, Spill Banks, ...5.0136

Succession, Spacial and Temporal Distribution, and Biology of Benthic Organisms - Benthic Flora, Temporal Distribution, ...5.0638

Studies on Ophidioid Fishes - Abyssal, Animal Taxonomy, Fish -other, Vertebrate Anatomy, Vertical Distribution, ...5.0054

Research on the Macrobenthos of the Great Lakes - Aquatic Ecology, Earthworms, Food Supply, Great Lakes-genera, Water Quality-genera, ...5.0626

Shellfish Explorations - Clams, Commercial Fishing, Mark, Tag Or Capture -other, Population Dynamics, ...5.0514

Studies of the Benthic Invertebrates of the Atlantic Continental Shelf - Atlantic Ocean-north, Continental Shelf, Population Dynamics, Productivity - Food Chains, ...5.0653

Estuarine Studies of Southeastern Alaska - Alaska, Environmental Ecology, Estuaries, Number or Density, Vertical Distribution, ...5.0582

Benthic Flora

Studies with Tropical and Subtropical Microalgae - Algal Culture, Continental Shelf, Primary Productivity, Sub - Tropic, Tropic, ...5.0693

Ecology of Tropical Deep Water Algae - Algae, General, Diving and Scuba, Plant Succession, Temporal Distribution, Tropic, Vertical Distribution, ...5.0722

Measurements of Oxygen Consumption by the Sea Bed in Deep Water of Puget Sound - Chemistry, Oxygen, Oxygen Content -water, Puget Sound, ...5.1015

Trophic Relationships in Sloal Benthic Environments - Biology, Estuaries, Habitat Studies, New England Province, ...5.1047

Systematics and Ecology of Subtidal Benthic Marine Algae - Algae - General, Benthonic-bottom, Habitat Studies, Macroalgae, Plants, Plant Taxonomy, Range or Territorial Dist., ...5.0701

Marine Biology of Red Sea and Eastern Mediterranean - Mapping, Population Dynamics, Red Sea, ...5.0891

Biographic Study of the Benthos of Puerto Rico and the Virgin Islands - Benthic Fauna, Benthonic-bottom, Currents-ocean, Range or Territorial Dist., Temperature, Vertical Distribution, ...5.0652

Succession, Spacial and Temporal Distribution, and Biology of Benthic Organisms - Benthic Fauna, Temporal Distribution, ...5.0638

Benthic Organisms (non-specific)

Marine Communities - Environmental Ecology, Life History Studies, Model Studies, Plankton (non-specific), ...5.0661

Zonation of the Weddell Sea Benthos - Environmental Ecology, Marine Biology (non-specific), Temperature, Weddell Sea, ...5.0868

The Effects of Seal and Fish Predation on Certain Antarctic Benthic Communities - Antarctica, Biology, Fish -non-specific, Predation, Productivity - Food Chain, Seals, ...5.1039

Benthonic Biology - Environmental Ecology, Fouling, Marine Biology (non-specific), Number or Density, Temporal Distribution, ...5.0673

Physiology and Ecology of the Adriatic Benthos - Adriatic Sea, Marine Biology (non-specific), Metabolism, Microclimate-general, Productivity - Food Chain, ...5.0873

Plankton and Benthos Communities of the Great Lakes - Aquatic Ecology, Gastropods - slugs,conch,snails, Lake Erie, Lugworms, Marine Segmentedworm, Plankton (non-specific), ...5.0861

Biogeography of Benthonic Organisms - Continental Shelf, Marine Biology (non-specific), Range or Territorial Dist, Vertical Distribution, ...5.0766

Bering Sea

Stratigraphy of Unconsolidated Sediments on the Continental Shelves of the Chukchi and Northern Bering Seas - Chukchi Sea, Continental Shelf, Core Analysis, Correlation, Oceanic Fronts, Sedimentary History, ...7.0286

Ecology and Nitrogen Cycle in a Marine Plant Community - Nitrogen, Physiological Ecology, Potamogeton, Ruppia, Zostera., Primary Productivity, Sewage, ...5.0576

Tagging Salmon in the Offshore Waters of the North Pacific - Gulf of Alaska, Migration, Number or Density, Range or Territorial Dist., Salmon & Trout - Non-specific, Tags, ...5.0180

Ecology of Eelgrass - Alaska, Food Webs, Phytoplankton, Potamogeton, Ruppia, Zostera., Primary Productivity, ...5.0677

Resources of the Bering Continental Margin - Continental Shelf, Dimension-distribution, Geology-general, Ocean History, Ocean Mining, ...7.0016

Seward Peninsula Nearshore - Heavy Minerals, Potential of Deposition, Sea Level Changes, Submergent, Tectonics-general, ...5.0071

Bottomfish Explorations - Fish -other, Gulf of Alaska, Nets, Vertical Distribution, ...5.0630

Bering Sea King Crab Studies - Commercial Fishing, Crabs, Environmental Ecology, Migration, ...5.0341
**Biophysics & Molec. biology**

**SUBJECT INDEX**

**Photochemistry**

PHOTOBIOLOGICAL STUDIES ON MARINE CHRYSONOMADS...Autotrophic, Coccoliths, Eukaryots and Redox, Photosynthetically Active...5.0932

INTERACTION OF PROTEINS WITH METAL AND HYDROGEN IONS...Globin -incl. myoglobin, Inhibitors, Metal ions, Neuropteryn, Ribonuclease...5.0999

PHOTOBIOLOGY OF MARINE ANIMALS...Photoconception, Physical State, Visual, Visual Organs...5.0313

**Stability**

EFFECT OF LIPIDS ON STABILITY OF BIOLOGICAL MEMBRANES...Cellular Membranes (non-spec.), Coenzyme Q, Electron Microscopy, Tocopherol, Vitamin A...5.1007

**Structure**

Bonding and Binding

RESEARCH STUDIES IN MOLECULAR PHARMACOLOGY...Anesthetic, Diving and Souvha, Mechanism of Action, Permeability, Thermodynamics...6.0100

Composition of Macromolecules

STUDIES OF THE AEROCCOCUS-PEDIOCCOCUS BACTERIA...Bioenergetics, Classification Or Taxonomy, Detection, Pediococcus...5.0817

**Configuration**

STUDIES ON THE STRUCTURE OF HEMERYTHRIN...Biochemical, Comparative Physiologlogy, Hemerythrin, Invertibrates...5.0993

CELL DIVISION, BIOENERGETICS, CHEMISTRY OF MUSCLE...Bioenergetics, Cell Cycle, Glycol, Organic, 5.0987

STRUCTURE AND REACTIVITY OF PROTEINS AND LIPOPROTEINS...Hemoglobin, Physical State...5.0971

**Physical State**

PRIMARY STRUCTURE OF INVERTEBRATE HEMOGLOBINS...Biochemical, Chitons, Gastropoda - slugs,conch,snails, Globin -incl. myoglobin, 5.0610

NEUROSECRETION AND ENDOCRINE PHYSIOLOGY...Crustacea -non-specific, Diabetogenic, Ns, Endocrine System, Hormones, Intermedi, 5.1023

Molec. struct. (gen. & Other)

USEFUL BIOMATERIALS DERIVED FROM THE SEA - AN INTERDISCIPLINARY APPROACH...Antibody Formation, Bioluminescence, Immunology...6.0106

CHEMISTRY AND FUNCTION OF BRAIN PLASMALOGENS...Chem and Metal, Comparative Physiology, Phospholipides, Plasmalogen...5.1003

Subunits

FILAMENTS, MORPHOGENESIS AND CONTRACTION OF MUSCLE...Contraction and Relaxation, Fibers and Filaments...5.0986

CILIA DIFFERENTIATION IN THE SEA URCHIN EMBRYO...Basic Embryology, Cilia and Flagella, Differentiation Mechanism, Proteins, Sea Urchins & Other Echinoderms...5.0516

**Thermodynamics**

Kinetics

CIRCADIAN RHYTHM IN PHOTOSYNTHESIS IN THE MARINE ALGAE GONYAULAX AND ACETABULARIA...Acetabularia, Autotrophic, Biological Rhythms, Control and Regulation, Gonyaulax...5.0685

FACTORS INFLUENCING THE INTENSITY OF BIOLUMINESCENCE...Bioluminescence, Cell. env.(non-specific & Ot.), Marine Biology, Optical, Trace Elements...5.0169

Birds

Albatrosses, Shearwaters...

ECOLOGY OF STORM PETRELS...California, Islands, Mark, Tag Or Capture -other, Spawning & Nesting Sites, Terrestrial Ecology...5.0852

**PHOTOBIOLOGY OF MARINE BIRDS**...Age, Hunting, Mortality Rates, Sex -non-specific, Species, Comparison of...5.0806

Aves -other

MOVEMENTS OF SEABIRDS IN THE HUMBOLDT CURRENT...Biological Rhythms, Humboldt Or Peru Current, Population Dynamics, Temporal Distribution...5.0583

**BIRDS** -non-specific

DISTANT GOAL ORIENTATION...Biological Rhythms, Locomotion -animal, Magnetic Impulses, Mark, Tag Or Capture -other, Orientation, 4.0109

AVIFAUNAL ECOLOGY OF LIMANTOUR ESTERO...California, Food Supply, Game Reserves & Preserves, Habitat Studies, 5.0534

PACIFIC OCEAN BIOLOGICAL SURVEY PROGRAM...Islands, Meteorological Studies, Pacific Ocean-general, Vertical Distribution...5.0568

AUTOMATIC DATA PROCESSING - SEABIRD DISTRIBUTION...Computer Method -general, Nomenclature, Classification, Range Or Territorial Dist., World Wide...4.0020

**Chickens**

STUDIES ON EMBRYONIC CELLS...Basic Embryology, Reproductive System, Sea Squirts - Tunicates, Suspension Culture...5.0815

**Pelicans, Cormorants, darters...**

TELEMETRY STUDIES ON MARINE BIRDS...Albatrosses, Shearwaters,... Bermuda, Tag Or Capture -other, Spawning & Nesting Sites, 5.0531

**Penguins**

DEEP DIVING ANTARCTIC BIRDS AND MAMMALS...Adaptation, Antarctica, Locomotion -animal, Seals, Water Pressure...5.0555

**Perching Birds - Songbirds**

EXPERIMENTAL MANIPULATION OF MECHANICAL AND PHYSIOLOGICAL RHYTHMS - A DUAL APPROACH TO THE BIOLOGICAL CLOCK PROBLEM...Acetabularia, Behavioral Ecology, Biological Rhythms, Crabs...5.1002

**Pigeon**

SENSORY BASIS OF NAVIGATION IN HOMING PIGEONS...Behavior, Biological Rhythms, Environmental Physiology, Locomotion...5.0108

**Shorebirds -gulls,terns,skimmer**

RENAI SALT EXCRETION IN MARINE BIRDS...Kidney and Urinary System, Osmoregulation, Urine...5.0862

SYSTEMATICS AND COLOGY OF MARINE BIRDS...Animal Taxonomy, Handbooks, Range Or Territorial Dist., World Wide...5.0582

**Waterfowl** -non-specific

ECOLOGICAL STUDIES OF THE COPPER RIVER DELTA...Alaska, Censusing, Maps-general, Spawning & Nesting Sites, 5.0855

EVALUATION OF ATLANTIC COAST ESTUARIES...Atlantic Ocean-north, Estuaries, Game Reserves & Preserves, Habitat Studies, Life History Studies...5.0020

WATERFOWL FOOD STUDIES...Food Supply, Management, Plant Prod. (non-specific), South Carolina...5.0653

OCEAN WATER INTRUSION INTO BACK BAY, VIRGINIA, & CURIUTUCK SOUND, NORTH CAROLINA, ON THE
SUBJECT INDEX

WATERFOWL & FRESHWATER FISH HABITAT ...Habitat Studies, North Carolina, Virginia, Water Salinity, ...5.0897
ECOLOGICAL STUDIES OF ATLANTIC AND GULF COASTAL ESTUARIES OF IMPORTANCE TO WATERFOWL ...Agricultural Land Use Effects, Atlantic Oceanic, Construction Land Use Effects, Estuaries, Gulf of Mexico, Habitat Studies, ...5.0896

Black Sea
SUPPORT FOR THE OPERATION OF OCEANOGRAPHIC RESEARCH VESSELS ...Marine Biology, Mediterranean Sea, general, Sedimentation, Ships and Cruises, Water Analysis -general, ...11.0030

Blood Plasma and Serum
IONIC REGULATION IN THE QUEEN CONCH, STROMBUS GIGAS LINNAEUS ...Digestive System, Gastropods -slugs.conch.snails, Osmoregulation, ...5.0407
BLOOD CHEMISTRY OF FISHES ...Bone, Sharks, Vertebrate Anatomy, Vertical Distribution, ...5.0239
BLOOD TYPES AS INDICATORS OF BLUEFISH RACES ...Blood Cells, Blood Typing Studies, Bluefish, Immunology, Polymorphism, ...5.0316
BLOOD TYPES AS INDICATORS OF WHITE MARLIN RACES ...Blood Typing Studies, Marlin, Billfishes, Sulfidah ...Polymorphism, Statistics-general, ...5.0321
IMMUNOLOGY AND SEROLOGY OF MARINE ANIMALS ...Agglutination Tests, Biochemical Analysis, Immunology, Pathology, ...5.0977
PROVIDE FOR ACTIVITIES OF TUNA BLOOD GROUP CENTER ...Blood Typing Studies, Hawaii, Immunology Methods, Tuna, Mackerel, Albacore, ...5.0256
HEMATOLOGICAL CHANGES IN F. HETEROCLITUS UPON EXPOSURE TO TOXIC METALS ...Blood Cells, Cadmium, Kiliufish -Cyprinodon, Lead, Toxins -other, ...5.0322
BLOOD PARASITES OF NORTHWEST FISHES ...Codfishes, Hake, Helminths, Protozoon, Sculpins, Trematoda -other, ...5.0332
OSMOTIC COMPONENTS IN ELASMOMBRANCH BLOOD ...Chondrichthyes -other, Environmental Physiology, Osmoregulation, Water Salinity, Water Temperature-non-specific, ...5.0249

Body Temperature

Hypothermia
METABOLIC ADAPTATION TO COLD ...Cold, Female, Korea, Metabolism in Disease, Regulation, ...5.0212

Regulation
METABOLIC ADAPTATION TO COLD ...Cold, Female, Hypothermia, Korea, Metabolism in Disease, ...6.0092
SUPPORT FOR THE PHYSIOLOGICAL RESEARCH SHIP, R/V ALPHA HELIX ...Insecticides -non-specific, Mycorrhiza, Nerve Effects, Rain Forests, Tropic, ...12.0011
HUMAN TEMPERATURE REGULATION IN WATER ...Cardiac Output, Medical Studies, ...6.0094
THERMAL REGULATION DURING WATER IMMERSION OF MAN ...Calorimetry, Effects on Cardiovan ...5.0235

Borehole Geophysics
GEOTHERMAL STUDIES IN DEEP-SEA DRILL HOLES ...Abyssal, Bathyal, Core Temperature, Earth Interior, Geothermal, Heat Flow Measurements, Heat Flows, Sediments-general, Technical Development, ...7.0122

Boron
ENVIRONMENT OF DEPOSITION OF ARGILLACEOUS SEDIMENTS ...Adsorption Capacity, Chemistry, Clays, Deltas, Mississippi River, ...7.0240
PALEOCLIMATOMIC DETERMINATION BY THE BORON IN LILITE METHOD ...Illinois, Illite, Interstitial - Connate Water, Salinity, Swamps-marshes, ...5.0238

Brackish Water

Bottom Sampling
FARMINGTON RIVER SHAD STUDIES ...Alewife, menhaden, shad, herring, Captive Rearing, Migration, Sampling, Streams, ...5.0203
ROUTINE SAMPLING AT SEVEN INDEX STATIONS ...Data Acquisition, Fish -non-specific, Lake Erie, Plankton Sampling, Sampling, ...5.0214

Bottom Sampling Device
DESIGN AND DEVELOPMENT OF OCEANOGRAPHIC INSTRUMENTATION ...Physical Analysis, Technical Development, Water Motion Recorders, ...8.0090
DEEP-SEA AUTONOMOUS VEHICLES, INSTRUMENTS, BASIC CONTROL DEVICES, AND SPECIAL COLLECTING GEAR ...Abyssal, Organism Sampling Devices, Photography, Sampling, Submersibles, Water Motion Recorders, ...8.0122
BENTHIC COMMUNITIES ...Behavioral Ecology, Benthic Fauna, Developmental Physiology, Fouling, Metabolism, Productivity -Food Chain, ...5.0561
SEA FLOOR ROUGHNESS ...Acoustical, Attenuation, Benthonic-bottom, Magnetic Studies, Propagation, Transmission, ...5.0033
LOCATING AND MAPPING HARD BOTTOM AREAS NEAR EXISTING NATURAL SEED OYSTER BEDS ...Oysters, Spawning & Nesting Sites, ...4.0052
GEOLICAL AND HYDROGRAPHIC STUDY OF THE WILLMINGTON SUBMARINE CANYON AND ADJACENT AREAS ...Geomorphology-topography, Model Studies, Photography, Submarine Canyons, Textures-structures, ...7.0211
SEDIMENT MOVEMENT AND BOTTOM CONDITIONS IN THE DELAWARE ESTUARY ...Sedimentation, Tides, ...7.0212

HEAVY METALS AND SEDIMENTATION PROCESS OF THE NORTH CAROLINA SHELF ...Continental Shelf, Heavy Minerals, Mineralogy, North Carolina, Sedimentation, ...7.0021
DEVELOPMENT OF DIAMOND DRILLING TECHNIQUES, FOR PHOSPHORITE DEPOSITS, USING STANDARD TOOLS PLUS BUOYANCY TANKS ...Disturbed/undisturbed, Drilling and Coring, Phosphate, Soil Sampling, Technical Development, ...8.0248
DEVELOPMENT OF WIRE-LINING CORING TECHNIQUE FOR SAMPLING UNCONSOLIDATED DEPOSITS ...Alaska, Coring and Dredging, Mechanical Properties, Mineralogy, Technical Development, ...8.0249
DEVELOPMENT, TESTING AND EVALUATION OF MODIFICATIONS REQUIRED TO ADAPT DRILLING SAMPLING SYSTEMS TO THE PLATFORM ...Coring and Dredging, Drilling and Coring, Equipment, Platforms, Technical Development, ...8.0256
DEVELOPMENT OF MARINE CHURN DRILL FOR SAMPLING UNCONSOLIDATED DEPOSITS ...Drilling and Coring, Soil Sampling, Technical Development, Unconsolidated Deposits, ...8.0250
SAN PABLO BAY STUDY ...Bays, Benthic Fauna, Excavation, Pollution - Effects of, Soil Banks, ...6.0136

Brackish Water

INVENTORY OF LARVAL FISH ...Aquatic Ecology, Fish -non-specific, Maturity & Growth Stages, ...5.0071
BRACKISH WATER PURIFICATION BY BIOLOGICAL FUEL CELL POWERED ELECTRODIALYSIS ...Biological, Desalination, Desalination Wastes, Electrolysis, Material Recovery Wastes, Water Costs, ...6.0216
CULTURE OF POMPANO IN BRACKISH WATER PONDS ...Aquaculture & Fish-farming, Food Supply, Louisiana, Pompanos, Scads, Jacks, Stocking of Fish & Shellfish, ...5.0064
CULTURE OF ATLANTIC CROAKER IN BRACKISH WATER PONDS ...Aquaculture & Fish-farming, Captive Rearing, Drums, Management, Ponds, Productivity (agricultural), ...5.0065
CULTURE OF RED SWAMP CRAWFISH, PROCAMBUS CLARKI, IN BRACKISH WATER PONDS ...Aquaculture & Fish-farming, Aquatic Ecology, Captive Rearing, Crayfish, ...5.0432
CULTURE OF BLUE, CHANNEL, AND WHITE CATFISH IN BRACKISH WATER PONDS ...Aquaculture & Fish-farming, Blue Catfish, White Catfish, Captive Rearing, Channel Catfish, Louisiana, ...8.0006

423
Brackish Water

RELICT COPEPODS FROM LAKE TUBORG, ELLESMERE ISLAND ...Canada, Carbon-14, Copepods, Lakes, Plankton Sampling... 5.0088

DISTRIBUTION OF ELEMENTS IN FLUVIAL AND BRACKISH ENVIRONMENTS ...Adorption, Adsorption Capacity, Chemical Reactions, Element Ratios, Exchange Capacity, Solution... 7.0221

EXTENT OF BRACKISH WATER IN TIDAL RIVERS, MARYLAND ...Estuaries, Tides, Water Utilization - general... 1.0100

EXPLORATORY COLLECTION AND CARE OF AQUATIC INVERTEBRATES FOR TESTING AT TIBURON ...Bioassay, Captive Rearing, Invertebrates - non-specific, Pesticides - non-specific... 5.0095

British Isles

MONTVILLE STATION TEMPERATURE SURVEY (THAMES RIVER)...Electric, Power Plants, Estuaries, Maps-other, Temperature, Thermal Pollution... 1.0182

British West Indies

DEVELOPMENT EXPERIMENTAL SYSTEM FOR AIR SEA INTERACTIONS ...Air-sea Boundary - general, Buos, Meteorological Studies... 4.0008

BIOGENESIS OF CARBONATE SEDIMENTS, BAHAMA ISLANDS ...Biologic Limestone, Biofacies, Biogeochemical Process, Classification - Taxonomy, Sedimentary Petrogenesis... 7.0241

EFFECTS OF HURRICANE BETSY ON SOME BEHAMA CORAL REEFS ...General Deposition, Reefs, Tropical Cyclones... 7.0209

SUBMARINE GEOLOGY OF THE BAHAMAS AND THE WEST INDIAN ARC ...Geology-general, Ocean Basins, Ridges, Ships and Cruises, Trenches... 7.0028

OCEANOGRAPHY, PLEISTOCENE GEOLOGY AND SEDIMENTS OF LITTLE BAHAMA BANK ...Carbonates-general, Currents-bottom, Energy, Quaternary Period, Water Motion Recorders... 7.0229

CARBONATE SEDIMENTATION IN THE TONGUE OF THE OCEAN, BAHAMAS ...Carbonates, Diagenesis, Paleocology, Sea Level Variations, Sedimentation... 7.0267

SUBSURFACE GEOLOGY OF HOGSTY REEF, AN ATOLL IN THE SOUTHEASTERN BAHAMAS ...Atolls, Paleoenvironments, Physiographic History, Quaternary Period, Submergent, Subsurface... 7.0037

STUDIES OF THE TRANSPORT OF THE FLORIDA CURRENT ...Florida, Gulf Stream, Navigation, Ocean Currents-other, Water Motion Recorders... 2.0017

THE SEDIMENTARY AND DIAGENETIC RECORD OF ENVIRONMENTAL PARAMETERS IN RECENT BAHAMIAN TIDAL FLATS ...Diagenesis, Environmental Effects - geologic, Intertidal Areas, Local Stratigraphy, Paleoclimatology... 7.0163

GEOLOGICAL AND GEOPHYSICAL INVESTIGATION OF THE BAHAMA BANK ...Banks, Bathymetry, Crust, Magnetic Studies, Seismic Studies... 7.0110

ACOUSTIC VIDEO SYSTEM FOR AQUATIC BIOACOUSTICAL AND ETHOLOGICAL RESEARCH ...Acoustical, Behavioral Ecology, Marine Biology, Marine Environments-general... 1.0049

AIR-SEA INTERACTION (WAVES) ...Forecasting-prediction, Heat and Radiation Transfer, Surface Environments, Waves, Wind-water Interaction... 3.0016

WAVE GENERATION ...Profiles, Shear, Tors, Waves, Wind-water Interaction... 3.0103

BARBADOS OCEANOGRAPHIC AND METEOROLOGICAL EXPERIMENT ...Depth, Ocean-lakes, Salinity, Temperature, Wind-water Interaction... 3.0015

Bryoza

PHYLOGENETIC RELATIONS OF FOSSIL AND LIVING GYMNOLAEMATES ...Fouling, Geologic, Other Bryozoa, Phylogenies... 5.0065

THE SYSTEMATICS AND ZOOGEOGRAPHY OF THE BRYOZOA FAUNA OF THE HAWAIIAN ISLANDS ...Animal Taxonomy, Australian, Collections, Hawaii, Range Or TERRITORIAL DISTR. ...5.0542

SYSTEMATIC AND DISTRIBUTIONAL STUDY OF DEEP-SEA ECTOPROCTA (BRYOZOA) ...Adaptation, Animal Taxonomy, Biogeography, Vertical Distribution... 5.0050

EVOLUTION OF PROVINCIAL DISTRIBUTION PATTERNS IN CHILOSTOME BRYOZOA ...Geologic, Order Chilostoma, Paleontology, Population - Distribution, Tertiary Period... 7.0173

Buildings and Land Development

Construction

Equipment

FEASIBILITY STUDY ON HORIZONTAL TEST TANK FOR MODEL STUDIES AND COMPONENT TESTING ...Consultants, Advisory Services, Dredging, Model Studies, Ocean Mining - Tanks... 12.0007

Excavation

HISTORICAL STUDY ON EFFECT OF HARBOR DREDGING ON THE ENVIRONMENT (ENVIRONMENTAL FACTORS PERTINENT TO EFFECTS ON MARINE ENVIRONMENTS)... Dredging, Environmental Effects - geologic, Harbors, Marine Environments-general, Ocean Mining... 6.0135

ENGINEERING EVALUATION OF EXISTING DREDGE SYSTEMS AND OPERATIONS ...Dredging, Ocean Mining... 8.0026

SAN PABLO BAY STUDY ...Bays, Benthic Fauna, Bottom Sampling Device, Pollution - Effects of, Spill Banks... 6.0135

Buoyant, Flotational

PASSIVE BUOANCY SYSTEMS ...Engineering Studies - general, Foum, Porous, Materials Used Undersea, Other-design-and-construction, Submersibles... 8.0363

DEEP SUBMERGENCE SYSTEMS ...Geomorphology-topography, Marine Propulsion, Navigation, Computation, Physical Properties, Submergibles, Welding - other... 8.0051

REINFORCED PLASTIC STRUCTURES ...Laminates, Materials Used Undersea, Plastic Matrix, Strength - Weight Ratio... 8.0212

BUOANCY MATERIALS ...Materials Used Undersea, Microsphere, Microballoon, Plastic Matrix, Submerged Ships... 8.0214

Buoyos

SATELLITE INTERROGATE INTEROCEANIC BUOYS DEVELOPMENT ...Navigation Communication, Satellites... 8.0300

DEVELOPMENT EXPERIMENTAL SYSTEM FOR AIR SEA INTERACTIONS ...Air-sea Boundary - general, British West Indies, Meteorological Studies... 4.0008

MARINE METEOROLOGY UNDERTOONED STATION DEVELOPMENT ...Air Motion Instruments, Automatic Stations, Meteorological Studies, Profiles, Platforms... 8.0285

AIR-SEA INTERACTION PROCESS ...Boundary Layer Studies, Circulation-general, Lakes, Profiles, Wind-water Interaction... 3.0028

BIOLOGY AND CHEMISTRY OF MARINE PLANKTON POPULATIONS ...California, Phytoplankton, Vertical Distribution, Zooplankton... 5.0798

WATER WAVE DOCUMENTATION ...California, Pacific Ocean-general, Water Motion Recorders, Waves... 2.0094

ENERGY TRANSFER NEAR THE EARTHS SURFACE ...Air Motion Instruments, Heat and Radiation Transfer, Thermodynamics, Turbulence... 3.0044

FORMATION OF ANTARCTIC BOTTOM WATERS ...Hydrodynamics, Oceanic Fronts, Salinity, Temperature, Weddell Sea... 4.0152

NATIONAL DATA BUOY STUDY ...Data Acquisition... 8.0281

GEOPHYSICAL INVESTIGATIONS IN THE CORAL SEA ...Coral Sea, Crust, Regional Structure, Seismic Refraction, Structural Studies... 7.0130

DYNAMICS OF MOORED BUOY SYSTEMS USED IN OCEANOGRAPHY R&D AND SURVEILLANCE ...Currents-ocean, Laboratory Analysis, Model Studies, Moorings, Waves... 8.0321

DIRECT AND INDIRECT DETERMINATION OF OCEANIC WATER MASS MOTION ON ALL SCALES ...Biogeography, Physical Oceanography, Water-mass Transport... 8.0281

424
SUBJECT INDEX

Cellular Physiology

DEVELOPMENT OF POLARITY IN THE PUCACEAN CYGOTE... Differentiation, Morphogenesis, Energy Conversion, Plant Developmental Biology, Polarity, Reproductive Physiology, ..5.0972

CRYOGENIC PRESERVATION OF VIABLE FISH SPERM... Artificial Insemination, Fish -non-specific, Freezing Techniques, Male Gametes, ..5.0303

IONIC PERMEABILITIES OF THE GIANT AXON... Effects of Chemical Agents -Microelectrodes, Nervous System, Octopus, Squid, Cutifilament, Permeability, ..5.0979

CONDUCTION AND INTEGRATION...Behavior, Hydra, Portuguese Man-of-war, Polypodia -non-specific, Quarantine, Tissue Protectors, Salmonella (non-specific & Ot), ..6.0070

COMPARATIVE STUDIES OF DINOFLAGELLATE TOXINS -Algae: Dinoflagellates, Algal Culture, Algal Toxins, Toxicology, ..6.0121

Activity and Specialization

AMEBOID MOVEMENT...Cell Transformation, Divison, and Motility -Basic Embryology, Cell Cycle, Microtubules, Nucleic Acids, ..2.0052

CONTRACTION AND RELAXATION...Filaments, Morphogenesis and Contraction of Muscle -Fibrils and Filaments, Subunits, ..5.0985

FINE STRUCTURE OF JELLYFISH (CHRYSAORA QUINQUECUSA)...Tentacle Muscle -Invertebrate Physiology, Jelly, Fish, Microscopy -other, Musculoskeletal System, Skin Or Ectoderm, ..5.0659

STUDIES IN MICRONEUROPHYSIOLOGY -Barnacles, Brain, Gastropods -slug,conch,snails, Musculoskeletal System, ..5.0362

EXCITATION-CONTRACTION COUPLING IN MUSCLE -Crab, Lobsters, Musculoskeletal System, Plasma Membrane, ..5.0438

Motility and Migration

CYTOPLASMIC FILAMENTS AND CELL MOVEMENT IN DEVELOPMENT -Basic Embryology, Fibrils and Filaments, Growth (non-specific & Ot), Proteins, Sea Squirts -Tunicates, ..5.1037

THE ROLE OF CALCIUM IONS IN THE MOTILITY OF SEA URCHIN AND OTHER Spermatozoa -Atpase, Calcium, Male Gametes, Yellow Perch, Darters, ..5.0622

PHOTOCEPTION

PHYSIOLOGY OF LUMINESCENT SIGNAL SYSTEMS...Bioluminescence, Trace Elements, Vival Visous Organs, ..5.0950

LIGHT RECEPTOR CONTROL OF THE DIURAL RHYTHM OF ENZYMES IN THE BULIMINOUSCEND MARINE DINOFLAGELLATE GONYAULAX POLYEDRA...Biological Rhythms, Biosynthesis, Control and Regulation, Gonyaulax, Plant Enzymes, ..5.0760

PHOTOBIOLOGY OF MARINE ANIMALS...Photochemistry, Physical State, Vival Visous Organs, ..5.0313

SECRETIONS AND PRODUCTS

C-14 UPTAKE, LIMITING FACTORS AND EXCRETION PRODUCTS OF ANTARCTIC PHYTOPLANKTON -Antarctic Ocean, Carbon, Phytoplankton, Primary Productivity, ..5.0813

ALGAL SUBSTANCES IN THE MARINE FOOD WEB -Food Chains, Food Webs, Humic Acid, Marine Plants, Phaeophyta (non-specific & Ot), Phenols, ..5.0725

ORGANIC INFLUENCES ON CALCIUM CARBONATE CE-MENTATION -Algae -general, Algal Culture, Biology, Cement Orign, Marine Plants, ..5.0729

DIAGNOSING ALGAE -Algae -general, Coatings-general, Fouling, Marine Bacteria, Natural Occurring, Wear, Friction, ..5.0681

Biological Rhythms

CIRCADIAN RHYTHM IN PHOTOSYNTHESIS IN THE MARINE ALGAE GONYAULAX AND ACETABULARIA -Acetabularia, Autotrophic, Control and Regulation, Gonyaulax, Kinetics, ..5.0685

LIGHT RECEPTOR CONTROL OF THE DIURAL RHYTHM OF ENZYME SYNTHESIS IN THE BULIMINOUSCEND MARINE DINOFLAGELLATE GONYAULAX POLYEDRA...Biological rhythms, Control and Regulation, Gonyaulax, Photo-reception, Plant Enzymes, ..5.0760

Bioluminescence

EXCITED STATES MECHANISMS IN PHOTOBIOLOGY...Chromoluminescence, Energy Conversion, Photochemical-other, Polypeptides, ..4.0162

MECHANISM STUDIES ON BIOLUMINESCENT REACTIONS WITH EMPHASIS ON ENERGY TRANSFER PROBLEMS...Energy Conversion, Luciferase, Luciferin, ..1.0164

BIOLUMINESCENCE...Autotrophic, Bays, Jamaica, Phytoplankton, Responses to Growth, ..1.0165

MID-DEPTH BIOLUMINESCENCE...Crustacea -non-specific, Vertical Distribution, ..1.0162

CHEMISTRY AND ENZYMOLOGY OF BIOLUMINESCENCE...Antibiotics, Earthworms, Kinetics -other, Luminous Bacteria, Species, ..5.0962

BIOLOGICAL ASPECTS OF MIDWATER SOUND SCATTERING...Atlantic Ocean-north, Fish -non-specific, Range Or Territorial Dist., Scattering, Sound Production, Vertical Distribution, ..1.0054

USEFUL BIOMEDICAL MATERIALS DERIVED FROM THE SEA -AN INTERDISCIPLINARY APPROACH...Antibody, Formation, Immunology, Molec.struct. (gen. & Other), ..6.0106

FACTORS INFLUENCING THE INTENSITY OF BIOLUMINESCENCE...Cell, env.(non-specific & Ot), Kinetics, Marine Biology, Optical, Trace Elements, ..1.0169

BIOCHEMISTRY OF MARINE ORGANISMS...Adsorption & Interfaces, Foulng, Phytoplankton, Plant Succession, Spectroscopy, ..5.0766

PHOTOBIOLOGY OF MARINE ANIMALS...Fish -non-specific, Vertebrate Anatomy, Visual, Visual Organs, ..5.0327

Cell Injury and Autolysis

FREEZING AND DRYING OF LIVING CELLS...Animal Ne-matodes -non-specific, Cell. env.(non-specific & Ot), Freeze-dry Techniques, Mollusks -non-specific & Other, Tissue Techniques, ..5.0450

AGING IN HYDROIDS...Aging, Developmental Physiology, Environmental Physiology, Hydra, Portuguese Man-of-war, Senescence, ..5.0597

DETERMINATION OF CHLOROPHYLL DERIVATIVES...Catabolism and Degradation, Fluorometry, Marine Plants, Phytoplankton, ..5.0770

SURVIVAL MECHANISM OF IRRADIATED BACTERIA IN FOODS...Achromobacter Sp, Antibiotics, Fish -non-specific, Mutagens, Radiation, ..5.0699

PROTEIN SYNTHESIS DURING THE EARLY DEVELOPMENT OF THE SEA URCHIN EMBRYO...Basic Embryology, Proteins, Radiation Effects-non-specific, Ribosomes, Sea Urchins & Other Echinoderms, ..5.0857

TISSUE CULTURE -VIROLOGY...Animal Viruses (non-specific), Bacteria (non-specific), Marine Biology, Monolayer Culture, Oysters, Tissues, ..5.0970

CELLULAR REACTION TO INJURY IN THE KIDNEY...Cellular Membranes (non-spe.), Electrot Microscopy, Kidney, Structural Functions, Tissues, ..5.0297

SURVIVAL MECHANISM OF IRRADIATED MICROORGAN-IMS IN FOOD...Antibiotics, Proteasest, Radiation, Radiation Protectors, Salmonella (non-specific & Ot), ..5.0070

Development and Propagation

STUDIES IN MICRONEUROPHYSIOLOGY...Barnacles, Brain, Contraction and Relaxation, Gastropods -slug,conch,snails, Musculoskeletal System, ..5.0362

EXCITATION-CONTRACTION COUPLING IN MUSCLE...Contraction and Relaxation, Crabs, Lobsters, Musculoskeletal System, Plasma Membrane, ..5.0438

Environment

CELL.ENV.(NON-SPECIFIC & OT)

FREEZING AND DRYING OF LIVING CELLS...Animal Ne-matodes -non-specific, Cell Injury and Autolysis, Freeze-dry Techniques, Mollusks -non-specific & Other, Tissue Techniques, ..5.0450

FACTORS INFLUENCING THE INTENSITY OF BIOLUMINESCENCE...Bioluminescence, Kinetics, Marine Biology, Optical, Trace Elements, ..1.0054

PHOTOBIOLOGY OF MARINE ANIMALS...Fish -non-specific, Vertebrate Anatomy, Visual, Visual Organs, ..5.0327
Growth and Differentiation

Survival of food pathogens in radiation pasteurization of seafood...Crabs, Food Bacteria, Radiation, Radiation Sensitivity...5.0063

Elongation of Cell

Growth and cellular morphogenesis in nitella...Biotechnology, Developmental Biology, Nucleus, Plant Developmental Biology, Water Movement...5.0721

Cellular Physiology

Structural analysis of cell division...Basic Embryology, Histochemistry, Nucleus, Sea Urchins & Other Echinoderms...5.0645

Cell transformations, division, and motion...Ameboid Movement, Basic Embryology, Microtubules, Nucleic Acids...5.0224

Studies on the development of dermocystidium marinum...Control and Prevention, Dermocystidium, Fungal Culture, Oysters, Pathology...5.0836

Differentiation Mechanism

Ionocyte formation in gill epithelium of fishes...Biotechnology, Developmental Physiology, Fish, Fish -non-specific, Dendrolobiaceae...5.0301

Molecular aspects of cellular differentiation and division...Basic Embryology, Biochemistry, Cell Cycle, Proteins, Replication, Sea Urchins & Other Echinoderms...5.0985

Studies on gametogenesis in hydromedusae...Basic Embryology, Developmental Physiology, Hydra, Portuguese man-of-war, Reproduction, System, Testosterone...5.1040

Preliminary investigation of growth and differentiation in marine coenocytic algae, Caulerpa prolifera...Caulerpa, Growth and Differentiation, Growth Rate, Plant Developmental Biology...5.0752

Structure and function of cell organelles during growth and development...Acrosomes, Basic Embryology, Nucleus, Ribosomes, Xenopus...5.0535

Development of polarity in the cucacean zygote...Cellular Physiology, Fucus, Plant Developmental Biology, Polarity, Reproductive Physiology...5.0586

Molecular studies of differentiating cells...Basic Embryology, Biochemistry...5.0984

RNA synthesis during sea urchin development...Basic Embryology, Biochemistry, Metabolic-biochemical genetics, Mitochondria, Replication, Sea Urchins & Other Echinoderms...5.0611

Biochemistry of development...Basic Embryology, Control and Regulation, Messenger RNA, Sea Urchins & Other Echinoderms, Trypotophan Oxidase...5.0994

Induction and control of differentiation in algae...Control and Regulation, Nutrition Studies, Photoperiodism, Plant Developmental Biology, Rhodophyta (non-specific & Ot)...5.0708

Continued studies on the influence of the egg cortex on the development of the molluscan embryo...Basic Embryology, Gastroplasts, Glue, Algae, Octopus, Squid, Cuttlefish...5.0243

Ultrastructure of various marine and brackish water organisms...Basic Embryology - Animal, Electron Microscopy, Marine Biology (non-specific), Plant Developmental Biology...5.0640

Cilia differentiation in the sea urchin embryo...Basic Embryology, Cilia and Flagella, Proteins, Sea Urchins & Other Echinoderms...5.0595

Mechanisms of ciliogenesis in animal cells...Basic Embryology...5.1008

Bioweight and paleontology of marine dinoflagellates and hysterochyspheres...Algae, Dinoflagellates, Algal Culture, Plant Developmental Biology, Range or Territorial Dir., Spores, Vertical Distribution...5.0793

Ultrastructural studies of parasitic and saprophytic fungi and protozoa associated with marine invertebrates...Electron Microscopy, Host-parasite interactions, Myxomycetes, Protozoa...5.0833

Ultrastructure of early cleavage stages in the egg of lymanea sp...Basic Embryology, Electron Microscopy, Gastroplasts, Glue, Algae, Squid, Skin, Invertebrate Anatomy, Microtubules, Xenopus...5.0509

Cell division and mitotic apparatus proteins...Fouling, Cell Center & Mitotic Apparatus, Centrioles, Proteins, Sea Urchins & Other Echinoderms...5.0666

Light

Relationship of photosynthesis to respiration of oceanic microalgae...Marine Plants, Mass Spectrometry, Oxygen, Photosynthesis, Respiration...5.0774

Environmental effects on the metabolism of marine algae...Enzymes, Glycolic Acid, Laminitaetaceae (non-specific & Ot), Marine Plants, Photoplation, Responses to Growth, Temperature...5.0821

Light requirements for marine algae...Algae, General, Algal Culture, Autotrophic, Marine Plants, Pigments...5.0703

Temperature

Hydrostatic pressure-temperature, as environmental parameter, on growth, biochemistry and physiology of microorganisms...Growth (non-specific & Ot), Marine Biology (non-specific), Microorganisms (non-specific), Pressure & Mech Stress...5.0821

Comparative physiology of barophilic bacteria...Isolation From Nat. environ., Marine Bacteria, Materials Used Undersea, Pressue & Mech Stress, Temperature...5.0751

Macromolecular basis for adaptation to salinity changes in prymnesium parvum...Adaptation, Growth Rate, Permeability, Prymnesium, Water Salinity...5.1012

Cellular differentiation...Active transport, Basic Embryology, Differentiation Mechanism, Frogs, Skin or Special Derivatives...5.0618

Subject Index
Cellular Physiology

SUBJECT INDEX

LIPASE RESISTANT GLYCERIDES...Fats, Fats and Oils -other, Fish oil, Unsaturred Fats, ...5.1029

Nitrogen Fixation

DYNAMICS OF THE NITROGEN CYCLE IN THE SEA ...General Sea Water Chemistry, Nitrate, Nitrite, Nitrogen, Traceers, ...5.0933

Nucleic Acids

BIOSYNTHETIC PROCESSES DURING DEVELOPMENT OF SEA URCHIN EGGS ...Basic Embryology, Cell Cycle, Messenger RNA, Proteins, Sea Urchins & Other Echinoderms, ...5.0775

ISOLATION AND FUNCTION OF OVARIAN EXTRACTS CAPABLE OF INDUCING COCYTE SHEDDING AND OCYCLE MATURATION IN STARFISH ... Differentiation Mechanisms, Female, Hormones, Reproductive System, Starfishes, ...5.0620

CELL TRANSFORMATIONS, DIVISION, AND MOTION ...Amemboid Movement, Basic Embryology, Cell Cycle, Microtubules, ...5.0775

AN ANALYSIS OF DEVELOPMENT IN ARTEMIA SALINA EMBRYOS ...Basic Embryology, Bio synthesis, Proteins, Ribosomes, Shrimps - Brine Or Fairy, ...5.0406

Nutrition

UPTAKE AND ASSIMILATION OF ORGANIC COMPOUNDS IN MARINE ORGANISMS ...Active Transport, Inverteterbrates - non-specific, Metabolism, Organics, Productivity - Food Chain, ...5.0437

COMPARATIVE PHYSIOLOGY OF BAROPHILIC BACTERIA ...Ionic Effect, Isolation From Nat. environ., Marine Bacteria, Pressure & Mech Stress, Temperatures, ...5.0751

MICROBIAL TRANSFORMATIONS IN SEA WATER ...Chemosat, Growth Rate, Isolation From Nat. environ., Marine Bacteria, Organics, ...5.0796

STUDIES OF THE EFFECTS OF NUTRIENTS ON THE GROWTH OF PHYTOPLANKTON IN THE TROPICAL PACIFIC OCEAN ...Algal Culture, Growth Rate, Pacific Ocean-general, Phytoplankton, Tropic, ...5.0948

Pigments

LIGHT REQUIREMENTS FOR MARINE ALGAE ...Algae-General, Algal Culture, Autotrophic, Light, Marine Plants, ...5.0703

Proteins

BIOLOGICAL PRODUCTIVITY IN THE SARGASSO SEA, THE CIPUL SYSTEM AND IN THE ATLANTIC COASTAL WATERS OFF CAPE HATTERAS ...Continental Shelf, Phytoplankton, Primary Productivity, Productivity - Food Chain, ...5.0495

BIOXYGENATIVE PROCESSES DURING DEVELOPMENT OF SEA URCHIN EGGS ...Basic Embryology, Cell Cycle, Messenger RNA, Nucleic Acids, Sea Urchins & Other Echinoderms, ...5.0775

MOLECULAR ASPECTS OF CELLULAR DIFFERENTIATION AND DIVISION ...Basic Embryology, Biosynthesis, Cell Cycle, Differentiation Mechanism, Replication, Sea Urchins & Other Echinoderms, ...5.0765

CYTOPLASMIC FILAMENTS AND CELL MOVEMENT IN DEVELOPMENT ...Basic Embryology, Fibroblasts and Filaments, Growth (non-specific & Ot.), Motility and Migration, Sea Squirts - Tunicates, ...5.1037

CILIA DIFFERENTIATION IN THE SEA URCHIN EMBRYO ...Basic Embryology, Cilia, Differentiation Mechanism, Sea Urchins & Other Echinoderms, Subunits, ...5.0616

PROTEIN SYNTHESIS DURING THE EARLY DEVELOPMENT OF THE SEA URCHIN EMBRYO ...Basic Embryology, Cell Injury and Autolysis, Radiation Effects -non-specific, Ribosomes, Sea Urchins & Other Echinoderms, ...5.0837

CELL DIVISION AND MITOTIC APPARATUS PROTEINS ...Biosynthesis, Cell Center & Mitot. apparatus, Cell Cycle, Centrioles, Sea Urchins & Other Echinoderms, ...5.0642

PROTEIN SYNTHESIS ACTIVATION IN SEA URCHIN EUGGS ...Basic Embryology, Biosynthesis, Metabolism, Reproductive System, Sea Urchins & Other Echinoderms, ...5.0642

AN ANALYSIS OF DEVELOPMENT IN ARTEMIA SALINA EMBRYOS ...Basic Embryology, Bio synthesis, Nucleic Acids, Ribosomes, Shrimps - Brine Or Fairy, ...5.0406

Respiration

STUDIES OF PROTEINS UNDER EXTREME ENVIRONMENTS ...Cellular Membranes (non-spec.), Cytochromes, Exobiology, Halobacteria, Salt, ...5.0941

STUDIES ON MICROBIAL SULFATE REDUCTION AND SULFIDE OXIDATION IN MARINE ENVIRONMENTS ...Carbohydrates, Classification Or Taxonomy, Growth (non-specific & Ot.), Isolation From Nat. environ., Sulphur Bacteria, ...5.0797

METABOLISM OF COMPLETE WATER COLUMNS ...Antarctic Ocean, Autotrophic, Energy Budgets, Metabolism, ...5.0967

RESEARCH ON THE ROLE OF BACTERIA IN THE OCEAN ...Denitification, Elect Trans and Redox, Marine Bacteria, Microorganism Enzymes, Nitrogen Bacteria, ...5.0783

MICROBES AND CORROSION ...Cathodic Protection, Extracellular enzymes, Fouling, Iron, Metals -non-specific, Microorganisms (non-specific), ...5.0828

Structural Functions

CYTOLOGICAL CHARACTERISTIC ...Animal Taxonomy, Basic Embryology, Cell Cycle, Cytochrome, Speciation, ...5.0577

MORPHOGENESIS OF THE DIATOM SHELL ...Algae-Diatoms, Cellular Membranes (non-spec.), Plant Developmental Biology, Silica, ...5.0734

GAMETOGENESIS AND FERTILIZATION IN THE BLUE CRAB, CALLINECTES SAPIDUS RATHBUN, AND OTHER CRABS ...Crabs, Electron Microscopy, Histochrometry, Cytochem, Reproductive System, ...5.0478

METABOLISM OF NEUROHUMORAL TRANSMITTER SUBSTANCES IN MARINE ANIMALS ...Animal Toxins, Basic Studies, Mech of Transmission, Metaboic Inhibitors, ...5.0981

SUBCELLULAR REACTION TO INJURY IN THE KIDNEY ...Cell Injury and Autolysis, Cellular Membranes (non-spec.), Electros Microscopy, Kidney, Toxins, ...5.0297

STRUCTURAL AND FUNCTIONAL ORGANELLE INTERACTIONS ...Differentiation Mechanism, Marine Plants, Organelle & Membrane Formation, Plant Developmental Biology, Tissue Techniques, ...5.0689

Turnover (metabolic)

PRIMARY PRODUCTION AND DECOMPOSITION IN ESTUARINE WATER ...Estuaries, Florida, Methane Bacteria (non-specific), Phaophysts (non-specific & Ot.), Primary Productivity, Rhodophyta (non-specific & Ot), ...5.0954

Organelle & Membrane Formation

MORPHOGENESIS OF THE DIATOM SHELL ...Algae-Diatoms, Cellular Membranes (non-spec.), Plant Cellular Localization, Plant Developmental Biology, Silica, ...5.0713

STRUCTURAL AND FUNCTIONAL ORGANELLE INTERACTIONS ...Differentiation Mechanism, Marine Plants, Plant Developmental Biology, Structural Functions, Tissue Techniques, ...5.0689

Surface Properties

Adhesion

CELL CONTACT IN RELATION TO GROWTH AND MORPHOGENESIS ...Basic Embryology, Cellular Membranes (non-specific), Electron Microscopy, Porifera, ...5.0996

BIOCHEMICAL BASIS OF SPECIFIC CELL ASSOCIATION ...Basic Embryology, Chickens, Pacific Ocean-general, Phoriferan, ...5.0946

Adsorption & Interface

MECHANISMS OF ATTACHMENT OF MARINE BACTERIA TO SURFACES ...Bacterial, Corrosion Prevention-other, Fouling, Marine Bacteria, ...5.0816

BIOCHEMISTRY OF MARINE ORGANISMS ...Bioluminescence, Fouling, Phytoplankton, Plant Succession, Spec troscopy, ...5.0766

Surface Properties -other

CONTINUED STUDIES ON THE INFLUENCE OF THE EGG CORTEX ON THE DEVELOPMENT OF THE MOLLUSCAN EMBRYO ...Basic Embryology, Differentiation Mechanism, Gastropods - slug, coax, snails. Octopus, Squid, Cuttlefish, ...Plasma Membranes, ...5.0425

Central America

CARIBBEAN GEOGRAPHY ...Beach, Caribbean Sea, Shore Features-general, Shoreline - Coastline, South America, ...7.0288
SUBJECT INDEX

Chemical Analysis (water)

Polarization
- STEEL PILING ...Corrosion Prevention-other, Fouling, Low Alloy Steels, Soils, Water, ...8.0208

Rheological
Viscosity
- EFFECT OF PRESSURE ON CONDUCTIVITY OF SOLUTIONS ...Acoustical, Conductivity, Density, Electrical, Electrolytes, Pressure, Sulfate, Sulfite, ...1.0078
- CHEMICAL PROPERTIES OF SEA WATER AT PRESSURE ...Gases, General Sea Water Chemistry, Interstitial - Conate Water, Pressure, Solubility, ...1.0099

Solution
Solubility
- MASS SPECTROMETRIC AND MANOMETRIC STUDIES OF THE OCEANS AND THE ATMOSPHERE ...Chemical Analysis-water, Circulation-general, Ocean History, Particle-gas Transfer, ...1.0101
- RESEARCH ON THE PHYSICAL CHEMISTRY OF CHEMICAL REACTIONS IN SEA WATER ...Acids, Apatite-general, Carbonate, Bicarbonate. Chemical Reactions, Equilibrium - Chemical, High Pressure Research, Reaction-general, Sulfate, Sulfite, ...1.0137
- PRECISION MEASUREMENTS OF DISSOLVED OXYGEN, NITROGEN AND ARGON IN SEA WATER ...Argon, Gases, Nitrogen, Oxygen, Particle-gas Transfer, Special Mission Ships, ...1.0092
- SHIPBOARD METHODS OF CHEMICAL ANALYSIS ...Caribean Sea, Gases, Mass Spectroscopy, Technique Development, Water Analysis-general, ...1.0091
- CHEMICAL PROPERTIES OF SEA WATER AT PRESSURE ...Gases, General Sea Water Chemistry, Interstitial - Conate Water, Pressure, Solubility, ...1.0099

Surface
Bubble
- PHYSICAL CHEMISTRY OF BUBBLES ...Diffusion, Interface, Particle-gas Transfer, Surface Energy, ...1.0082
- ENVIRONMENTAL REVERBERATION STUDIES ...Acoustical, Electron, Liquids, Reverberation, Scattering, ...1.0039

Monolayers
- PROJECT FOG DROPS ...Condensation, Fog-haze-mist, Fog-mist Dissipation, Surfactants, ...3.0090

Surface Energy
- PHYSICAL CHEMISTRY OF BUBBLES ...Bubble, Diffusion, Interface, Particle-gas Transfer, ...1.0082
- Sulfactants
- PROJECT FOG DROPS ...Condensation, Fog-haze-mist, Fog-mist Dissipation, Monolayers, ...3.0090

Tension
- SURFACE TENSION ...Extraction, Wettability, ...3.0030

Wettability
- SURFACE TENSION ...Extraction, Tension, ...3.0030

Chemical Analysis (water)

- ECOLOGICAL SURVEY OF EFFLUENT DISCHARGE AT TWO PULP MILLS IN HUMBOLDT COUNTY, CALIFORNIA ...California, Effluents-waste Water, Pollution - Effects of, ...8.0058
- OIL MONITOR INSTRUMENTATION ...Infrared Spectroscopy, Oil, ...8.0053
- STUDY OF THE DISTRIBUTION OF RADIONUCLIDES IN THE OCEAN ...Chemical Detailed Exploration of CS137 in the Ocean ...Cesium, Circulation-general, Convection, Pacific Ocean-north, Radioactivity, ...1.0080
- FLUXES OF DISSOLVED GASES AND NUTRIENTS RELATING TO BIOCHEMICAL AND AERATION PROCESSES OFF THE OREGON COAST ...Gases, Oxygen, Organics, Particle-gas Transfer, Phosphate, Phosphite, ...3.0037
- DEVELOPMENT OF AN INSTRUMENT FOR MEASURING THE CONCENTRATION OF DISSOLVED OXYGEN IN SEA WATER IN SITU ...Gases, Instrumental Services, Oxygen, Technique Development, ...1.0099

Ceramics
Glass
VISCOSITY AND VISCOELASTICITY OF LIQUIDS AND GLASSES ...Instrumental Service, Liquid, Morphology, ...State Variables - Ptv, Viscelasticity, Viscosity, ...8.0206
STRENGTH OF GLASS ...Strength, Cohesion, Stress Rupture, Submersion, ...8.0206
STRUCTURAL PLASTICITY-SUBMERGENCE ...Design Data, Epoxyes, Fiber, Filament, Materials Used Undersea, Plastic Matrix, ...8.0213

Cesium
STUDY OF THE DISTRIBUTION OF RADIONUCLIDES IN THE OCEAN DETAILED EXPLORATION OF CS137 IN THE OCEAN ...Chemical Analysis (water), Circulation-general, Convection, Pacific Ocean-north, Radioactivity, ...1.0095

Channels
HARBOR DESIGN STUDIES ...Harbors, Navigation, Waves, ...8.0046
SHOALING PROCESSES ...Sand Bars, Scouring, Sediment Transport-other, Tidewater Areas, Turbulent Flow, ...7.0250
UNSTEADY FLOW AND SALINE INTRUSION IN ESTUARIES ...Computer Applications, Model Studies, Morphology-general, Saline Water Intrusion, Unsteady Flow, ...1.0066
BAYOU LAFOURCHE SEDIMENTATION STUDY. LOUISIANA ...Bayous, Louisiana, Morphology-general, Rate of Deposition, Sediment Yield, ...9.0010

Chemical & Physical Properties
Concentration
OTHER SEDIMENTARY GEOCHEMISTRY ...Authigenesis, Precipitation, Removal-inorganics, Water Chemistry-other, ...7.0190
pH
PH STANDARD REFERENCE MATERIALS FOR USE IN SEA WATER ...Salinity, Standards, Specifications, Water Analysis, Water Chemistry-other, ...1.0087

Density
HYDROGEN PROPERTIES ...Dielectric Properties, Fuel Cell-other, Hydrogen, Marine Propulsion, Refraction, ...8.0157
OXGEN PROPERTIES ...Liquid Propellant Rock, Oxidizers, Oxygen, Specific Heat, State Equations, Thermodynamic Relation, ...8.0174

Diffusion
PHYSICAL CHEMISTRY OF BUBBLES ...Bubble, Interface, Particle-gas Transfer, Surface Energy, ...1.0082

Electrical
Conductivity
PROPERTIES OF SEA WATER ...Compressibility-gas-liquid, Density, Electrical Expansion, Physical Analysis, Thermal, ...1.0153
EFFECT OF PRESSURE ON CONDUCTIVITY OF SOLUTIONS ...Electrolytes, Pressure, Solution, Sulfate, Sulfite, Ultrasonic Spectroscopy, ...1.0079

Electrochemical
Dielectric Properties
HYDROGEN PROPERTIES ...Density, Fuel Cell-other, Hydrogen, Marine Propulsion, Refraction, ...8.0157

Electrolytes
ELECTROLYTE-NON-ELECTROLYTE INTERACTIONS IN SEA WATER AND RELATED SOLUTIONS ...Alkali Metals, Alkaline Earths, Complexes, Saline Water Systems, Thermal Properties-other, Water Analysis-general, ...1.0107
EFFECT OF PRESSURE ON CONDUCTIVITY OF SOLUTIONS ...Acoustical, Conductivity, Density, Electrical, Pressure, Sulfate, Sulfite, Viscosity, ...1.0078
EFFECT OF PRESSURE ON CONDUCTIVITY OF SOLUTIONS ...Conductivity, Pressure, Solution, Sulfate, Sulfite, Ultrasonic Spectroscopy, ...1.0079
Chemical Analysis (water)

MASS SPECTROMETRIC AND MANOMETRIC STUDIES OF THE OCEANS AND THE ATMOSPHERE ...Gases, Mass Spectroscopy, Ocean History, Particle-gas Transfer, Solubility, ...1.0101

DETERMINATION OF VOLATILE ORGANICS IN SEA WATER ...Gas Chromatography, Organics, Organics-general, Technical Development, Water Analysis, ...1.0094

STABLE ISOTOPES ...Atlantic Ocean-north, Atlantic Ocean-south, Carbon, Sampling, Water Chemistry-other, ...1.0108

MARINE RADIOLOGICAL INSTRUMENTATION ...Acoustical, Circulation-general, Laboratory Analysis, Mixing, Radioactivity-general, Sampling, ...8.0062

CHEMICAL CHARACTERISTICS OF THE GREAT LAKES ...Great Lakes-general, Nutrients, Productivity - Food Chain, Water Quality-general, ...1.0116

CHEMICAL ANALYSES ...Chlorinated Hydrocarbons, Estuaries, Substances Or Chemicals, ...6.0149

Chemical Reactions

Condensation

COMPOSITION OF LEAD HALIDE POLLUTION AEROSOLS ...Activation Analysis, Aerosols, Air Pollution Sampling, Air Pollution-chemistry, Oxidation-general, ...6.0156

Decomposition

Biodegradation

HETEROTROPHIC ACTIVITY AND PRIMARY REGENERATION IN THE OCEAN ...Atlantic Ocean-south, Carbon, Gulf of Mexico, Organics, Organics-general, ...1.0114

MICROBIAL CORROSION IN THE MARINE ENVIRONMENT ...Biological, Carbon, Fouling, Marine Fungi (non-specific), Water, ...5.0769

Decomposition-other

NATURAL COMPOUNDS WITH CARBON-PHOSPHORUS BONDS ...Anthozoa, Bond Type, Natural Occurring, Phosphorines, ...6.1013

Electrochemical

Electrode

CHEMICAL METHODOLOGY - APPLICATIONS OF NITRATE SPECIFIC ELECTRODE TO CHEMICAL OCEANOGRAPHY ...Water Analysis-general, ...1.0093

Interfacial

PHASE RELATIONS OF THE HYDRATED CARBONATES OF CALCIUM AND MAGNESIUM ...Carbonate, Bicarbonate, Equilibrium - Chemical, Phase Relationships, Properties and Structure, Surface Chemistry, ...3.0085

Oxidation

Oxidants

HYDROGEN-OXYGEN FUEL CELLS ...Encapsulation, Fuel Cell-other, Gas Generator, Safety, Submersibles, ...8.0160

Oxidation-general

COMPOSITION OF LEAD HALIDE POLLUTION AEROSOLS ...Activation Analysis, Aerosols, Air Pollution Sampling, Air Pollution-chemistry, Condensation, ...6.0156

Oxidation-other

CATALYSIS AND KINETICS OF MANGANOUS ION OXIDATION IN AQUEOUS SOLUTION AND ADSORBED ON THE SURFACES OF SOLID OXIDES ...Adsorption, Heterogeneous Catalysis, Manganese, Oxide, Precipitates, Solution, ...2.0063

Photochemical

Light-catalyzed

POLYPEPTIDE INTERACTIONS ON A STERILE SEASHORE ...Biochemical, Melanin, Origin of Life, Polypeptides, ...5.0942

Photochemical-other

EXCITED STATES MECHANISMS IN PHOTOBIOLOGY ...Biliminescence, Chemiluminescence, Energy Conversion, Polypeptides, ...6.0162

436
SUBJECT INDEX

OCEAN CIRCULATION AND CONTROLLING FACTORS FOR PREDICTION ...Meteorological Studies, Oceanic Fronts, Salinity, Temperature, ...2.0034

HAWAIIAN OCEANOGRAPHY ...Environmental Effects-geologic, geologic, Hydrodynamics, Island, Ocean Currents-other, ...2.0021

CHEMICAL OCEANOGRAPHY ...Biogeochemical Process, Geochemistry, Rare Earth Studies, Trace Elements, ...2.0015

OCEAN KINETICS DYNAMICS ...Chesapeake Bay, Data Reduction and Analysis, Estuaries, Turbulent Flow, Water Motions, ...2.0069

CIRCULATION STUDIES ...Currents-ocean, Gulf of Mexico, Hydrodynamics, Mixing, Pacific Ocean-east, ...2.0042

NORTH ATLANTIC CIRCULATION ...Atlantic Ocean-north, Geomorphology-topography, Gulf Stream, Hydrodynamics, Oceanic Fronts, ...2.0031

LIGHT ISOTOPE STUDIES ...Chemical Reactions, Oxygen, Particle-gas Transfer, ...2.0071

CIRCULATION OF THE PACIFIC ...Density, Oceanic Fronts, Pacific Ocean-general, Sampling, Subsurface Environments, ...2.0061

DESCRIPTIVE OCEANOGRAPHY ...Currents-ocean, Data Analysis - General, Pacific Ocean-east, Wind-water Interaction, ...4.0116

LANGMUIR CIRCULATION AND PLANKTON ECOLOGY ...Phytoplankton, Range or Territorial Distirb., Vertical Distribution, Water Movement, ...5.0794

AIR-SEA INTERACTION AND PLANKTON ECOLOGY ...Environmental Ecology, Marine Biology (non-specific), Number or Density, Plankton (non-specific), ...2.0078

THE CONTRIBUTION OF ADVECTION AND LOCAL HEATING TO THE MAINTENANCE OF THE THERMAL STRUCTURE ...ocean, Temperature, ...2.0036

MARINE HYDRODYNAMICS ...Antarctic Ocean, Laboratory Analysis, Model Studies, Waves, Waves-internal, ...8.0196

DYNAMICAL OCEANOGRAPHY AND GEOPHYSICAL FLUID DYNAMICS ...Acoustic Effects, Forced Convection, Theoretical Analysis, Thermal, Water Tunnels Tables, ...2.0012

STUDIES IN THE INDIAN OCEAN ...Data Analysis - General, Indian Ocean-general, Particle-gas Transfer, Storms-general, ...2.0073

CIRCULATION AROUND OCEANIC ISLANDS ...Density, Islands, Mixing, Thermodynamics, Waves-internal, Wind-water Interaction, ...2.0010

INVESTIGATION OF SHALLOW CURRENT STRUCTURE IN THE WESTERN TROPICAL ATLANTIC OCEAN ...Antarctic Ocean-general, Temperature, Tropics, ...3.0030

CHEMICAL FEATURES OF THE SUBARCTIC BOUNDARY IN THE NORTHERN PACIFIC OCEAN ...Convection, Heat and Radiation Transfer, Mixing, Pacific Ocean-north, Thermal, ...1.0183

MINERAL HYDRODYNAMICS ...Antarctic Ocean, Laboratory Analysis, Model Studies, Waves, Waves-internal, ...8.0196

RADIOSTRONTIUM DEPOSITION OVER THE OCEAN ...Nuclear Explosions - Fallout, Precipitation-general, Radioactive Dating, Radioactivity, Strontium, ...6.0165

STUDY OF EFFECTS OF OFFSHORE DUMPING ...Dispersion - Water, Engineering Studies-other, Pollution - Effects of, Pollution Sources-other, ...7.0026

HISTORICAL CHARTS AND INTERPRETATION OF CHANGES IN SEA SURFACE TEMPERATURE IN THE NORTH PACIFIC OCEAN ...Air-sea Boundary-general, Atlantic maps, Commercial Fishing, Pacific Ocean-north, Temperature, ...1.0179

CHEMICAL OCEANOGRAPHY ...Aquatic Ecology, Convection, Theoretical Development, Trace Elements, ...2.0036

CIRCULATION DYNAMICS (GULF OCEANOGRAPHIC PROGRAM) ...Environmental Changes, Gulf of Mexico, Shrimps-Common, Thermodynamics, ...2.0045

SEA SURFACE SURVEILLANCE ...Caribbean Sea, Temperature Distribution, Tuna, Mackeral, Albacore, ... Vertical Distribution, Water Properties-general, ...2.0019

FISHERY FORECASTING - TEMPERATE FISHERIES ...General Synopsis Observations, Low Temp. but Above 32f, Pacific Ocean-east, Temperature, ...5.0049
Circulation-general

CIRCULATION ON THE CONTINENTAL SHELF ...Atlantic Ocean-north, Continental Shelf, Eastern, Water Motion Recorders, ...1.0027

Classifications

CONTRACT FOR-PROCESSING OF USARP ROCK SAMPLES ...Antarctica, Collections, Coring and Dredging, Petrology, Sampling, Ships and Cruises, Thin Sections, ...7.0060

Climatic Regions

Arid and Desert

SUPPORT OF THE VERMILION SEA FIELD STATION AT BAHIA DE LOS ANGELES, BAJA CALIFORNIA ...Facilities, Gulf of California, Habitat Studies, Temperature, Tides, ...12.0069

GULF OF CALIFORNIA BIOLOGY ...Biology, Gulf of California, Intertidal Areas, Population Dynamics, Tropic, ...5.0856

A UNIFIED APPROACH TO WATER, FOOD AND POWER IN A COASTAL DESERT COMMUNITY ...Desalinization, Deserts, Diesel, Distilling Units, Electric Power Plants, Greenhouse, Use of Impaired Water, ...7.0062

Microclimate-general

PHYSIOLOGY AND ECOLOGY OF THE ADRIATIC BENTHOS ...Adriatic Sea, Benthic Organisms (non-specific), Marine Biology (non-specific), Metabolism, Productivity - Food Chain, ...5.0873

Polar

MARINE BIOLOGY IN ALASKA ...Alaska, Amino Acids -non-specific, Porifera, Trenches, ...5.0854

A SYMMETRICAL ENTRAINED ORGANIC CHEMISTRY OF NATURAL WATERS ...Alaska, Chemical-General, Meetings, Organic, Organic Matter, Organic-General, Organics, Organic-general, Sediments, Water Analysis, Water Chemistry, ...11.0001

PHYSIOLOGICAL STUDIES ON FISHES LACKING HEMOGLOBIN ...Adaptation, Cardiovascular System, Fish, Fish-other, Hemoglobin, Metabolism, ...5.0841

SEDIMENTS IN BAFFIN BAY AND THE EFFECTS OF AN ARCTIC ENVIRONMENT ON MARINE SEDIMENTATION ...Baffin Bay, Benthic-bottom, Origin, Physical Properties, Sedimentation, ...7.0265

SEA ICE MOVEMENT DYNAMICS ...Charts, Forecasting-prediction, Mapping, Model Studies, Sea Ice, ...3.0087

CANADIAN ARCTIC AND SUBARCTIC POLYCHAETES COLLECTED BY E. H. GRAINGER ...Animal Taxonomy, Collections, Lugworms, Marine Segmentedworm, Sub - Polar, ...5.0576

ENVIRONMENT -L MEASURING EQUIPMENT ...Meteorological Studies, Platforms, ...4.0007

ARCTIC EAST OCEANOGRAPHIC PROJECT (OCEANOGRAPHY OF THE BAFFIN BAY REGION) ...Baffin Bay, Circulation-general, Marine Biology, Sea Water Chemistry-other, Water Properties-general, ...4.0125

Sub - Polar

CHEMICAL FEATURES OF THE SUBARCTIC BOUNDARY IN THE NORTHERN PACIFIC OCEAN ...Carbon Dioxide, Circulation-general, Gases, Mixing, Oceanic Fronts, Pacific Ocean-north, ...1.0125

CANADIAN ARCTIC AND SUBARCTIC POLYCHAETES COLLECTED BY E. H. GRAINGER ...Animal Taxonomy, Collections, Lugworms, Marine Segmentedworm, Polar, ...5.0576

Sub - Tropic

STUDIES WITH TROPICAL AND SUBTROPICAL MICROALGAE ...Algal Culture, Benthic Flora, Continental Shelf, Primary Productivity, Sub - Tropic, ...5.0716

ECOLOGY OF PHYTOPLANKTON IN SEMI-TROPICAL ENVIRONMENTS ...Caribbean Sea, Phytoplankton, Range Or Territorial Dist, . Temporal Distribution, Vertical Distribution, ...5.0036

MORPHOLOGY AND TAXONOMY OF MARINE FUNGI ...Habitat Studies, Mangroves, Marine Fungi (non-specific), Plant Morphology, Plant Taxonomy, Tropic, ...5.0716

CHANGES IN THE LIMITING NUTRIENT DUE TO TEMPORAL, GEOGRAPHIC, AND DEPTH VARIATIONS ...Depth, New York, Nutrients, Phytoplankton, Water Depth, Water Levels, ...5.1004

Temperate

TAXONOMIC REVISION OF BATHYLAGIDAE ...Animal Taxonomy, Deepsea Smelts, Tables, Compilations, Catalogs, Tropic, ...5.0655

Tropic

TROPICAL STORM INVESTIGATIONS IN THE ATLANTIC, CARIBBEAN, AND GULF OF MEXICO ...Meteorological Studies, Satellites, Tropical Cyclones, Vorticity, Waves, ...3.0048

DYNAMIC STUDY OF THE TEMPORAL ...Air Motion-general, Meteorological Model Studies, Satellites, Storms-general, Tropical Cyclones, ...5.0051

DISTRIBUTION AND ANALYSIS ...Data Reduction and Analysis, Patterns, Shear, Statistics-general, Tropical Cyclones, ...3.0059

INVESTIGATION OF SHALLOW CURRENT STRUCTURE IN THE WESTERN TROPICAL ATLANTIC ...Atlantic Ocean-general, Circulation-general, Temperature, ...2.0030

THEORY OF LARGE-SCALE ATMOSPHERIC AND OCEANIC PROCESSES ...Circulation-general, Currents-ocean, Model Studies, Weather Forecasting, Wind-water Interaction, ...2.0070

ATMOSPHERIC EFFECTS ON INCOMING SOLAR RADIATION OVER TROPICAL OCEANS ...Cloud Cover, Development of Models, Humidity, Pacific Ocean-general, Sunshine, ...5.0036

PHYSICAL GEOGRAPHY OF TROPICAL COASTAL LOWLANDS ...Development, Geography-physical, Physical, Physical Features-general, Shore Features-general, ...5.0778

GULF OF CALIFORNIA BIOLOGY ...Arid and Desert, Biomass, Gulf of California, Intertidal Areas, Population Dynamics, ...5.0856
SUBJECT INDEX

Climatology

COASTAL MORPHOLOGY...Beach, Deltas, Development, General Information, Services, Shore Features, General, Shoreline --Coastline...7.0297
ECOLOGICAL STUDIES ON TROPICAL INTERTIDAL BRIT-TLESTARS...Brillie Stars, Habitat Studies...5.0615
OBJECTIVE WEATHER ANALYSIS...Research --Development, Technique Development, Weather Forecasting, Wind, Wind-General...4.0042
TROPICAL ANALYSIS AND FORECASTING...Filtering Theory, Mathematical Analysis, Meteorological Model Studies, Pressure-Density, Weather Forecasting...5.0061
ECOLOGY OF PANAMANIAN REEF COMMUNITIES...Behavioral Ecology, Invertebrates --Non-Specific, Panama, Productivity --Food Chain, Reefs...5.0866
STUDIES OF FISH FAMILIES ARIDAE AND ASPREDINIDAE...Animal Taxonomy, Fish --Other, Intertidial Relations (Non-Specific), Neotropical...5.0052
TAXONOMIC REVISION OF BATHYLAGIDAE...Animal Taxonomy, Deepscale Smelts, Tables, Compilations, Catalogs, Temperature, Temperature-General...5.0653
ZOOPLANKTON DISTRIBUTION IN THE TROPICAL ATLANTIC...Atlantic Ocean-General, Plankton Sampling, Range Or Territorial Dist., Temperature, Vertical Distribution, Zooplankton...5.0771
DESCRIPTIVE PHYSICAL OCEANOGRAPHY OF THE EASTERN TROPICAL ATLANTIC...Atlantic Ocean-General, Environmental Ecology, Fish --Non-Specific, Productivity --Food Chain...4.0127
DEVELOP HIGH-SEAS TUNA FISHERY...Commercial Fishing, Fishing Gear, Pacific Ocean-General, Tuna, Mackerel, Albacore...5.0084
146 D EASTROPAC...Marine Biology, Meteorological Studies, Pacific Ocean-East, Tuna, Mackerel, Albacore...5.0864
SCRIBPS TUNA OCEANOGRAPHY RESEARCH PROGRAM...Food Supply, Pacific Ocean-East, Temperature, Tuna, Mackerel, Albacore...5.0200
EASTERN TROPICAL ATLANTIC COOPERATIVE SURVEY 12 SEPTEMBER TO 20 DECEMBER 1968...Atlantic Ocean-General...4.0120
SYMBIOSIS OF TROPICAL ZOANTHIDAE AND ZOOXANTHELLAE...Anthozoa, Messenger RNA, Metabolism, Symbiosis, Zooxanthellae...5.0642

Climatology

Applied Climatology

THREE-DIMENSIONAL GLOBAL CLIMATOLOGY...Air Motion-General, General Movement, Patterns, Spectral Analysis, Tables, Compilations, Catalogs...3.0067

Climatology

ARCTIC AIR, SEA AND ICE...Arctic, Heat and Radiation Transfer, Heat Exchange, Micrometeorology, Sea Ice, Weather Forecasting...4.0088
THE POSTPERSISTENT OCEANOGRAPHY AND BIOLOGY OF THE EASTERN NORTH PACIFIC...Marine Biology, Ocean History, Pacific Ocean-East, Pacific Ocean-North...7.0150

Physical Climatology

WEATHER PROGRAM - STATION T-3...Arctic Ocean, Drift Stations, Energy Exchange Processes, Heat Budget, Patterns, Weather Forecasting...5.0060
CLIMATE CHANGE OVER THE POLAR OCEAN...Arctic Ocean, Heat and Radiation Transfer, Heat Budget, Numerical Analysis-other...3.0058
LINE ISLANDS EXPERIMENT...Boundary Layer Studies, General Synoptic Observations, Line Islands, Satellites, Wind, Water Interaction...3.0063
ARCTIC UNDERSEAS RESEARCH, JOINT USA-Canadian HEAT BUDGET STUDY...Arctic, Heat and Radiation Transfer, Instrumentation-General, Sea Ice...3.0071

Clouds

Cloud Cover

ATMOSPHERIC EFFECTS ON INCOMING SOLAR RADIATION OVER TROPICAL OCEANS...Development of Models, Humidity, Pacific Ocean-General, Sunshine, Tropic...3.0035

Cloud Formation and Evolution

FLUID DYNAMICS CENTER...Cloud Physics, Coasts --Shorelines, Model Studies, Satellites, Tropical Cyclones...8.0179

Cloud Physics

FLUID DYNAMICS CENTER...Cloud Formation and Evolution, Coasts-Shorelines...5.0084

Cloud Temperature

REMOTE SENSORS OCEANOGRAPHY...Aerial Photography, Gulf of Mexico, Infrared Radiation, Satellites, Surface Environments, Temperature...4.0170

Cumulus

ATMOSPHERIC CONDITIONS ASSOCIATED WITH CUMULUS CONVECTION...Convection, Meteorological Model Studies, Shear, Tropical Cyclones, Velocity...3.0045

Height - Ceiling

UTILIZATION OF SYNCHRONOUS SATELLITE DATA...Patterns, Satellites, Technique Development, Velocity, Weather Forecasting...4.0173

Patterns

CLOUD PATTERNS RELATED TO SELECTED CIRCULATION SYSTEMS IN EASTERN PACIFIC...Meteorological Studies, Photographic, Satellites...4.0138
UTILIZATION OF SYNCHRONOUS SATELLITE DATA...Height - Ceiling, Satellites, Technique Development, Velocity, Weather Forecasting...4.0173
ATMOSPHERIC PROCESSES IN THE TROPICS...Data Reduction and Analysis, Shear, Statistics-General, Tropic, Tropical Cyclones...3.0059
INTERACTIONS BETWEEN TURBULENCE, CLOUDS, SEA TEMPERATURE...Data Analysis-General, Indian Ocean-General, Line Islands, Temperature, Turbulence...3.0025
SEVERE STORM CLIMATOLOGY...Tropical Cyclones...3.0054

Radiation Balance

EVALUATION OF LOW LEVEL TEMPERATURE GRADIENTS OVER THE LINE ISLANDS NEAR THE EQUATOR...Atmosphere Radiation, Line Islands, Temperature...1.0180
ANALYSIS AND INTERPRETATION OF SATELLITE RADIATION...Atmosphere Radiation, Heat Budget, Meteorological Model Studies, Radiation-General, Satellites...4.0009

Cns and Peripheral Nerves

Peripheral Nerves

CRANIAL AND NuCCLI...VISUAL PROJECTION IN SUBMAMMALIAN VERTEBRATES...Basic Studies, Fish --Other, Retina, Visual Organs...5.0238

Coatings

Coatings-General

DRAG-REDUCING ALGAE...Algae-General, Fouling, Marine Bacteria, Natural Occurring, Secretions and Products, Wear, Friction...3.0061
SUPPORTING SYSTEMS...Facilities, Underwater-Laboratory...3.0038
DESIGN AND CONSTRUCTION...Environmental Effects-General, Hydrodynamic Structures, Safety, Underwater-Construction, Water...3.0033

441
SUBJECT INDEX

Coatings

Paint and Organic

Paint - General

NEW APPROACHES TO BIOFOULING ASSAY...Bioassays, Corrosion Prevention-other, Fouling, Marine Biology (non-specific), Powder, ...5.0577
FRICIONAL RESISTANCE HULL SCALE AND COATINGS...Corrosion General, Maintenance-system, Materials Used Undersea, Wear, Friction, ...8.0227
EVALUATION OF BOOTTOP PAINT SYSTEMS FOR OCEAN- GOING SHIPS IN A BOOTTOP PAINT TESTING MACHINE...Catalysts, Paint - General, Surface Cleaning, Finishing, Test Methods, Water, ...8.0237
APPLICATION OF ISCC-NBS CENTROID COLORS AND METHOD OF DESIGNATION COLORS...Colorometry, Dyes and Coloring, Photography-chemistry, Pigments, Standards, Specifications, ...4.0697

Primers

EVALUATION OF BOOTTOP PAINT SYSTEMS FOR OCEAN- GOING SHIPS IN A BOOTTOP PAINT TESTING MACHINE...Catalysts, Paint - General, Surface Cleaning, Finishing, Test Methods, Water, ...8.0237

Coelenterata - other

CHEMISTRY AND BIOLOGY OF SOME COELENTERATE...Catalysts, Paint - General, Surface Cleaning, Finishing, Test Methods, Water, ...8.0237

Collections

PORCELLANID CRABS OF AUSTRALIA...Australia, Crabs, Museum, Nomenclature, Classification, ...5.0354
COPEPOD CRABS PARASITIC ON FISHES...Copepoda, Decapoda, Fish, non-specific, Indian Ocean, ...5.0335
THE ALPHEID SHrimp OF AUSTRALIA...Animal Taxonomy, Australia, Publications - other, Shrimps - Common, ...5.0425
TREMATEODES OF FISHES OCCURRING ON THE WEST COAST OF NORTH AMERICA...Comparative Physiology, Nematode, Pacific Ocean-general, Trematoda - other, ...5.0636
ORGANIZATION OF THE ACADEMYS COLLECTION OF RECENT MARINE, TERRESTRIAL, AND FRESHWATER INVERTEBRATES...Animal Taxonomy, Invertebrates - non-specific, ...5.0752
REVISION OF THE CLASSIFICATION AND PHYLOGENY OF THE SUBORDER BALANOMORPHA (CIRripEIDA - THORACICA)...Animal Taxonomy, Barnacles, Handbooks, Nomenclature, Classification, Vertical Distribution, ...5.0704
ECOLOGY OF SKELETAL PLANKTON...Animal Taxonomy, Phytoplankton, Zooplankton, ...5.0387
REVOLUTIONARY STEPS THAT CAN BE TAKEN TO REDUCE THE APEX OF THE BRYOZOAN FAUNA OF THE HAWAIIAN ISLANDS...Animal Taxonomy, Australian, Bryozoa, Collection and Survey of North Carolina, Vertebrates - non-specific, ...5.0480
SHORT FISHES OF ANNOBON AND FERNANDO POO...Art Work - illustrations, Marine Biology, ...5.0542

Cobalt

SURVIVAL OF FOOD PATHOGENS IN RADIATION PASTEURIZATION SEAFOOD...Cell, en (non-specific & Ot.), Crabs, Food Bacteria, Radiation, Radiation Sensitivity, ...6.0603
PARASITES OF ANTARCTIC VERTEBRATES AND INVERTEBRATES...Animal Taxonomy, Antarctic Ocean, Ectoparasites, Endoparasites - other, ...5.0658
CONTRACT FOR PROCESSING OF USARP ROCK SAMPLES...Antarctic Ocean, Classifications, Coring and Dredging, Petrology, Sampling, Ships and Cruises, Thin Sections, ...7.0366
COLLECTION AND SURVEY OF NORTH CAROLINA...Animal Taxonomy, Ocean, Pollutants - non-specific, Other, North Carolina, Survey Studies, ...5.0480
CRUSTACEAN COLLECTION OF EAST COAST OF UNITED STATES...Animal Taxonomy, Bivalves, Crustacea - non-specific, Estuaries, North Carolina, ...5.0481
FISH COLLECTION OF NORTH CAROLINA AND WESTERN ATLANTIC FISHES...Animal Taxonomy, Bivalves, Fresh Water, North Carolina, ...5.0633
REFERENCE COLLECTION OF GULF MARINE ANIMALS...Animal Taxonomy, Gulf of Mexico, Invertebrates - non-specific, Vertebrates - non-specific, ...5.0657
MARINE BIOLOGY STUDIES ON FAIRFAX ISLAND...Australia, Data Acquisition, Islands, Marine Biology, Reefs, ...5.0674
THE TAXONOMY AND ZOO GEOGRAPHY OF THE MAGELONIDAE OF THE WORLD...Animal Taxonomy, Bivalves, Marine Invertebrate Taxonomy, World Wide, ...5.0570
MARINE POLYCHAETE WORMS OFF THE COLUMBIA RIVER, OREGON...Animal Taxonomy, Bivalves, Marine Segmentedworm, Marine Biology, ...5.0573
MARINE NEMATODES OF THE CAPE COD AREA...Animal Taxonomy, Habitat Studies, Nematoda -other, Northeast, ...5.0656
HYPERID AMPHIPODS FROM THE GULF OF GUINEA...Animal Taxonomy, Guinea, Oceanography-general, Shrimp - Amphipods, Vertical Distribution, ...5.0387
RELATIONSHIP BETWEEN WATER TEMPERATURE AND SIZE OF PARASITIC COPEPODS...Copepoda, Host Specificity, Size, Temperature, Water Temperature-non-specific, ...5.0390
CANADIAN ARCTIC AND SUBARCTIC POLYCHAETES COLLECTED BY E. H. GRAINGER...Animal Taxonomy, Lophotrochozoa, Marine Biology, Polar, Sub-Polar, ...5.0576
SYSTEMATICS OF ANTARCTIC SICULUSID CLAMS...Animal Taxonomy, Antarctica, Expeditions, Invertebrates - non-specific, ...5.0578
SYSTEMATIC STUDIES ON MOLLUSKS FROM WALTERS SHOALS, INDIAN OCEAN...Animal Taxonomy, Bivalves, Marine Segmentedworm, Polar, Sub-Polar, ...5.0576
SYSTEMATIC STUDY OF MYDOCOPID OSTRACODS OF THE INDIAN OCEAN...Animal Taxonomy, Bivalves, Marine Biology, India - non-specific & Other, ...5.0642
SYSTEMATIC STUDY OF ANATOMY...Animal Taxonomy, Pacific Ocean-north, Lobsters, ...5.0394
NYPHOPHID LOBSTERS OF THE WESTERN ATLANTIC...Animal Taxonomy, Atlantic Ocean-north, Lobsters, ...5.0396
MARINE BIOLOGICAL INVESTIGATIONS...Animal Taxonomy, Bivalves, Marine Biology, Philippines, Islands, ...5.0640
DESCRIPTIONS OF NEW SHARKS...Animal Taxonomy, Collection and Survey of North Carolina, Pollutants - other, Sharks, ...5.0547
BENTHIC PENAID SHRIMPS (OTHER THAN PENAIDES) FROM THE WESTERN ATLANTIC...Animal Taxonomy, Atlantic Ocean-north, Continental Shelf, Bivalves, ...5.0640
SYSTEMATICS OF CARANGID FISHES...Animal Taxonomy, Bivalves, Marine Biology, Philippine Islands, ...5.0640
COLLECTION AND EXTRACTION OF MARINE INVERTEBRATES AND PLANTS...Extracts, Lyophilization, Marine Plants, ...5.0697

Columbia River

ECOLOGICAL STUDIES OF RADIOACTIVITY IN THE COLUMBIA RIVER ESTUARY AND ADJACENT PACIFIC OCEAN...Contamination - Water, Organism Sampling Devices, Pacific Ocean-north, Pollutants - Path of, Radioactivity-general, ...5.06172

ERIC
**Communication Systems**

- **COOK** INLET ESCAPEMENT ENUMERATION STUDY
  - Alaska, Cernuca, Migration, Organism Sampling Devices, Salmon -coho, sockeye, Sonar
- **CTSM** SONAR
  - Behavioral Ecology, Commercial Fishing, Locomotion -animal, Telemetry, Tuna, Mackerel, Albacore...
  - 8.0058

**Telephone**

- LOW NOISE MULTI-CARRIER HYDROPHONE CABLE
  - Amplifiers, Bathymetry, Cables and Transmission Lines, Seismic Studies, Transmission Lines...
  - 8.0145

**Transponders**

- NAVIGATION RECEIVER
  - Navigation, Nav; other, Radio, Sonar, Transducers...
  - 8.0112

**Communication Theory**

- COMMUNICATION STUDIES ON TURSIOPS TRUNCATUS AND OTHER DELPHINIDS
  - Central Nervous System, Mammals, Neuristors Neurol Nets, Sound Production...
  - 5.0539

**Linguistics**

- COMMUNICATION AND TECHNIQUES FOR THE MARINE ENVIRONMENT
  - Acoustical, Acoustics, Seismic Studies, Transient...
  - 8.1006

**Man Machine Systems**

**Real Time Systems**

- WOODS HOLE SHIPBOARD DATA PROCESSING
  - Reduction and Analysis, Digital Computer Applications, Gravity Studies, Magnetic Studies, Navigation...
  - 8.0031

**X** DEVELOPMENT OF ANALYSIS TECHNIQUES AND EQUIPMENT FOR CLASSIFICATION OF TRANSIENT HYDROACOUSTIC SIGNALS
  - Acoustical, Sonar, Technique Development...
  - 8.0070

**OCEANOGRAPHIC INFORMATION PROCESSING TECHNOLOGY**

- Computer Applications, Data & Statistics Storage, Data Reduction and Analysis, Information Retrieval Methods, Information Storage and File, Oceanography-general...
  - 8.0023

**Statistical Information Theory**

- NATIONAL DATA PROGRAM FOR THE MARINE ENVIRONMENT
  - Oceanography-general...
  - 8.0003

**Coding**

- DIGITAL OUTPUT SURVEY DEPTH SOUNDING
  - Bathymetry, Digital Computer Applications, Readout Systems, Sonar, Sound Gear...
  - 8.0112

**Signal Detection**

- DEVELOPMENT OF ANALYSIS TECHNIQUES FOR CLASSIFYING TRANSIENT HYDROACOUSTIC SIGNALS
  - Acoustical, Acoustics, Seismic Studies, Transient...
  - 8.0006

**Computer Electronics**

**Analog-digital Converters**

- DIGITIZING SYSTEM FOR OCEANOGRAPHIC DATA
  - Analog-digital Converters, Applied Electronics, Bathymetry, Instrumental Services, Seismic Studies, Spectral Analysis...
  - 8.0039

**Data Acquisition Systems**

- TELEMETRY AND ENVIRONMENTAL PREDICTION SYSTEMS
  - Buoy, Meteorological Studies, Moorings, Navigation Communication, Oceanography-general, Technique Development, Telemetry-other...
  - 8.0268

**DEVELOPMENT OF AN ELECTRONIC METHOD FOR THE AUTOMATIC SHIPBOARD RECORDING OF DRILL PERFORMANCE DATA**

- Drilling and Coring, Non-electrical Measurements, Recording Systems, Technique Development...
  - 8.0247

**Data Display**

- ADVANCE SONAR SYSTEMS
  - Instrumental Services, Sonar, Sonar and Echo Soundings, Testing Facilities, Transducers...
  - 8.0006

<table>
<thead>
<tr>
<th>SUBJECT INDEX</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Data Transmission Systems</strong></td>
</tr>
<tr>
<td>STUDIES OF EARTHQUAKES IN THE CAPE MENDOCINE AREA</td>
</tr>
</tbody>
</table>
  - Applied Electronics, Earthquake Location, Earthquakes, Seismic Studies, Telemetry-other...
  - 8.0048
| OCEAN SYSTEM TELEMETRY STUDY |
  - Applied Electronics, Buoy, Data Acquisition, Moorings, Telemetry-other...
  - 8.0002

**Digital Computers**

- DIGITIZING SYSTEM FOR OCEANOGRAPHIC DATA
  - Analog-digital Converters, Applied Electronics, Bathymetry, Instrumental Services, Seismic Studies, Spectral Analysis...
  - 8.0039

**Fault-Out Systems**

- DIGITAL OUTPUT SURVEY DEPTH SOUNDING
  - Bathymetry, Coding, Digital Computer Applications, Sonar, Sound Gear...
  - 8.0125

**Development of Fishnet Bathykymography**

- Commercial Fishing, Fishing Gear, Instrumental Services, Nuts...
  - 8.0102

**Recording Systems**

- FOSDIC APPLICATION TO CURRENT-METCR RECORDS
  - Currents-ocean, Data & Statistics Storage, Research Development, Technique Development, Water Motion Recorder...
  - 8.0072

**Development of an Electronic Method for the Automatic Shipboard Recording of Drill Performance Data**

- Data Acquisition, Data Acquisition Systems, Drilling and Coring, Non-electrical Measurements, Technique Development...
  - 8.0247

**Coast Guards Coastal OceanoGraphic Monitoring Network**

- Automatic Stations, Buoy, Instrumental Services, Telemetry-other, Transducers...
  - 8.0006

**Computer Methods - General**

- ECOLOGICAL, EXPERIMENTAL AND COMPUTER STUDIES OF ENDOGENOUS RHYTHMICITY
  - Biological Rhythms, Brain, Crustacea - non-specific, Locomotion...
  - 8.00261

**Experimental and Biometric Analysis of the Phenomenon of Attack**

- Behavioral Ecology, Bluegills, Bream, Environmental Physiology, Largeemouth Bass, Minnows, Predation...
  - 8.00535

**A Bibliography of the Marine Mollusks of the Indo-Pacific Region**

- Animal Taxonomy, Asia, Bibliography, Mollusks - non-specific & Other...
  - 8.00398

**Automatic Data Processing - Seabird Distribution**

- Birds - non-specific, Nomenclature, Classification, Range or Territorial Dist., World Wide...
  - 8.0020

**Collection, Compilation, and Analysis of Gulf Catch Statistics and Logbook Data**

- Alewife, menhaden, haddock, herring, Commercial Fishing, Fish Studies-other...
  - 8.00126

**Computers**

**Analog Computer Applications**

- ACQUISITION AND INTERPRETATION OF OCEANIC GRAVITY DATA
  - Data Reduction and Analysis, Gravity Studies, Ridge, Structural Analysis, Trenches...
  - 8.0033

**Marine Gravity**

- Geophysical Equipment, Gravity Studies, Navigation, Satellites, Ships and Cruises, Technique Development...
  - 8.0128

**Fish Population Study**

- Environmental Ecology, Fish - other, Killifishes - Cyprinodont, Population Dynamics, Tilapia, Cichlids...
  - 8.0175

**Computer Applications**

- COMPUTER PROCESSING OF MICROSCOPE IMAGERY
  - Microscopy, Resolution...
  - 8.0063

**CATARMAN CONTAINERSHIP FEASIBILITY STUDY**

- Barges-towboats, Freight, Models, Storage...
  - 8.0273

**Ambient Sea Noise Investigation**

- Acoustic, Acoustical, Noise, Waves, Wind-water Interaction...
  - 8.0048

**Simulation Models of Shallow-Water and Coastal Environments**

- Gulf of Mexico, Hydrology, general, Model Studies, Sedimentation, Shoreline - Coastal...
  - 8.0066

444
### SUBJECT INDEX

**Cooperative-studies**

- **FISH GUIDING**  
  (non-specific), Fish  
  (non-specific), Instrumental Services, Management  
  (other), Water Environment  
  (other). [4.0015]

**TECHNIQUES OF PLANNING**  

**Filtering Theory**

- **TROPICAL ANALYSIS AND FORECASTING**  
  (Mathematical Analysis, Meteorology), Model Studies, Pressure-density, Tropical, Weather Forecasting. [3.0061]

**Convection**

- **FISHERIES OCEANOGRAPHY AND ENVIRONMENTAL ASSESSMENT AND PREDICTION**  
  (Commercial Fishing, Oceanography-general, Sputtercraft Sensory Devices, Thermal). [4.0150]

**STUDY OF THE DISTRIBUTION OF RADONICLIDES IN THE OCEAN**  
  (Detailed Exploration of CS137 in the Ocean), Circulation-general, Pacific Ocean-north, Radioactivity. [2.0114]

**AER/SEA INTERACTION STUDY**  
  (Mixing, Profiles, Thermal), Thermocline, Waves. [1.0011]

**CONVEMENT STUDIES**  
  (Pacific Ocean-north, Sonar, Thermal). [1.0214]

**PHYSICAL OCEANOGRAPHY**  

**VERTICAL MOTIONS**  
  (Gulf Stream, Hydrodynamics, Water Motion Recorders). [1.0227]

**THE CONTRIBUTION OF ADVECTION AND LOCAL HEATING TO THE MAINTENANCE OF THE THERMAL STRUCTURE IN THE NORTH PACIFIC OCEAN**  
  (Circulation-general, Heat and Radiation Transfer, Mixing, Pacific Ocean-north, Thermal). [1.0183]

**EUTRICAL VELOCITY OF CURRENTS AND OTHER FLOWS IN SUBMARINE CANYONS**  
  (Facies, Ocean Waves, Stationary, Submarines, Canyon, Turbulence Currents, Water Motion Recorders). [2.0008]

**PHYSICAL AND CHEMICAL ATLAS**  

**RESEARCH IN OCEANIC PHYSICS**  
  (Atlantic Ocean-south, Mixing, Oceanic Fronts, Thermodynamics, Wind-water Interaction). [2.0036]

**MEDITERRANEAN OCEANOGRAPHY**  
  (Data Analysis, General, Heat and Radiation Transfer, Mediterranean Seas-general, Ships and Cruises, Surf uface Environment). [2.0112]

**VERTICAL OCEAN CIRCULATION**  
  (Circulation-general, Model Studies, Oceanic Fronts, Subsurface Environments). [2.0008]

**FUNDAMENTAL PROBLEMS IN HYDRODYNAMICS**  
  (Hydrodynamics, Ordinance, Survey Studies, Waves, Waves-intermittent). [2.0102]

**CHEMICAL OCEANOGRAPHY**  

### Cooperative-studies

**SUPPORT OF THE R/V EASTWARD**  
  (Caribbean Sea, Continental Shelf, Facilities, Marine Biology), Antarctic, Training Grants, Fellowships. [1.0229]

**COOPERATIVE SYSTEMATICS STUDIES IN ANTARCTIC BIOSOLOGY**  
  (Animal Taxonomy, Antarctica, Equipment Purchase Operation, Invertebrates), Transport Services. [1.0225]

**ACCUMULATION OF RADIOACTIVITY BY INVERTEBRATES**  
  (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION), Contamination - Water, Diagnostic Procedures, Radioactivity-general, Reactor Sites & Waste Sites. [5.0264]

**ACCUMULATION OF RADIOACTIVITY BY ORGANISMS IN EXPERIMENTAL MARINE ENVIRONMENTS**  
  (Contamination - Water, Estuaries, Laboratory, Radioactivity). [5.0261]

**THE EFFECTS OF RADIATION ON THE MORPHOLOGY OF MARINE ORGANISMS**  
  (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION), Fish (other), Radiation Sensitivity, Vertebrate Anatomy, Vertebrates. [2.0102]

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**Control of . . .**

- **Aquatic Plants**
  - **Aquatic Vegetable -ns**
  - **ENERGETICS OF PALAEMONES PUGIO AND THE WEEDBED COMMUNITY OF SOUTH CREEK ESTUARY**  
    - Energy Budgets, Estuaries, Habitat Studies, North Carolina, Shrimp - Common. [3.0482]

**Control Systems**

- **FLUIDIC CONTROL SYSTEM COMPENSATOR**  
  (Control-systems, Controls). [4.0193]
SUBJECT INDEX

Coral Sea

SEDIMENT STRUCTURE ...Distribution, Geosynclines, Sediment Transport, Shelf Areas, Textures-structures ...7.0204

GEOPHYSICAL INVESTIGATIONS IN THE CORAL SEA ...Buoys, Crust, Regional Structure, Seismic Refraction, Structural Studies ...7.0130

Core Analysis

GRANT FOR STUDY OF SEA FLOOR CORES AND PHOTOS ...Coring and Dredging, Photography ...7.0258

RADIATION, DOSIMETRY, CORRELATION AND DATING OF CALCAREOUS DEEP-SEA CORES ...Carbonates-general, Correlation, Radioactive Dating, Sedimentation, Thermoluminescence ...7.0251

MARINE SEDIMENTS ...Biology, Chemistry, Physical Properties, Subbottom, Textures-structures ...7.0264

RADIOLARIA IN SEDIMENTS ...Biogenous, Order Radiolaria, Pacific Ocean-general, Population - Distribution, Tertiary Period ...7.0160

X-RADIOMICROSCOPIC AND ELECTRONIC FLUOROSCOPIC EQUIPMENT ...Equipment Purchase, Operation, Instrumental Services, Radiograph, Radiometer, X Ray Tubes ...8.0094

MULTIVARIATE ANALYSIS OF MICROPALEONTOLOGICAL DATA FROM DEEP-SEA CORES ...Data Reduction and Analysis, Development of Models, Multivariate Analysis, Order Foraminifera, Paleotemperature, Population - Distribution ...7.0201

CARBON ISOTOPE GEOTHERMOMETRY ...Carbon, Carbonaceous Substance, Chemistry, Geologic Thermometry, Paleotemperature, Plankton (non-specific), Temperature ...7.0079

LITHOLOGICAL AND MICROPALAEONTOLOGICAL INVESTIGATION OF OCEAN SEDIMENT CORES ...Correlation, Paleoclimatology, Quaternary Period, Sedimentary History, Tertiary Period ...7.0257

STRATIGRAPHIC AND TAXONOMIC-PHYLOGENETIC STUDIES ON PLANKTONIC FORAMINIFERA ...Cretaceous Period, Intercontinental Stratigraphy, Order Foraminifera, Structure-general, Tertiary Period ...7.0102

STRATIGRAPHIC STUDY OF RADIOLARIA IN DEEP SEA QUATERNARY SEDIMENTS ...Collections, Correlation, Geographical Relations, Order Radiolaria, Quaternary Period ...7.0178

CURATING OF BLAKE PLATEAU CORES ...Collections, Continental Shelf, Florida ...12.0025

MARINE GEOLOGY OF THE SUB-ANTARCTIC PACIFIC REGION ...Antarctic Ocean, Diagnosis, Distribution, Origin, Petrology, Sedimentary History ...7.0049

BIOFACIES STUDY OF BENTHONIC FORAMINIFERA IN OCEAN SEDIMENT CORES ...Biofacies, External Structure, Order Foraminifera, Paleontology, Population - Distribution ...7.0179

STRATIGRAPHIC STUDY OF UNSOLIDIFIED SEDIMENTS ON THE CONTINENTAL SLEEVES OF THE CHUKCHI AND NORTHERN BERING SEAS ...Bering Sea, Chukchi Sea, Continental Shelf, Correlation, Oceanic Fronts, Sedimentary History ...7.0278

A PALEOMAGNETIC STUDY OF TERTIARY AND PLEISTOCENE OCEANIC CORES ...Antarctic Ocean, Field Reversals, Pacific Ocean-north, Paleomagnetism, Quaternary Period, Tertiary Period ...7.0166

PALEOTEMPERATURE RESEARCH ...Marine Organisms, Order Foraminifera, Paleotemperature, Quaternary Period ...7.0161

GEOCHEMISTRY OF MID-ATLANTIC RIDGE SEDIMENTS ...Atlantic Ocean-general, Chemistry, Correlation, Geochronology-general, Ridges ...7.0071

AN INVESTIGATION OF THE MASS PHYSICAL PROPERTIES OF CARBONATE MUDS AND ROCKS ...Carbonates-other, Density, Physical Properties, Porosity ...7.0225

DEPOSITIONAL PROCESSES MARGINAL TO LARGE ANTARCTIC ICE SHELVES ...Antarctic Ocean, Diatoms, Environment, Sedimentary History, Sedimentation ...7.0198

MAGNETIC PROPERTIES OF ANTARCTIC MARINE SEDIMENTS AND ROCKS ...Antarctica, Extinction, Field Reversals, Iron & Magnetism ...7.0233

PLEISTOCENE OCEANOGRAPHY AS RECORDED IN DEEP SEA SEDIMENT CORES ...Correlation, Geographical Relations, Paleoclimatology, Paleotemperature, Quaternary Period ...7.0165

LAKE SUPERIOR CORING III ...Lake Superior, Sedimentology-general, Seismic Studies, Subsurface, Textures-structures, ...7.0247

STRATIGRAPHY AND PALEOECOLOGY OF FOSSIL SILEX COFLAGELLATES FROM ANTARCTIC DEEP-SEA CORES ...Antarctic Ocean, Correlation, Field Reversals, Fossil Zones, Paleontology, Paleotemperature, Phylum Protozoa ...7.0169

DEEP SEA SEDIMENTS IN THE NORTH PACIFIC FROM STUDIES OF THEIR RADIOLARIAN CONTENT ...Biogenous, Distribution, Pacific Ocean-north, Protozoa - other, Sedimentation ...7.0285

PROPERTIES AND ORIGIN OF SEDIMENTS IN THE NORTHEAST PACIFIC OCEAN ...Carbon-14, Origin, Pacific Ocean-east, Physical Properties, Washington ...7.0287

RESEARCH IN CORE ANALYSIS ...Acoustical, Coring and Dredging, Geomorphology-topography, Model Studies, Physical Properties, ...7.0263

SEA FLOOR SEDIMENTS AND ROCK STUDIES ...Atlantic Ocean-north, Biogenous, Microfossils, Paleomagnetism, Petrology, Ridges, Sedimentation ...7.0040

BIOCHEMICAL EFFECTS OF MICROORGANISMS UPON THE SALT MARSH ENVIRONMENT ...Aquatic Soils, Identification, Marine Bacteria, Salinity, Swamps-marshes, Temperature, Water Level Fluctuation ...5.0763

ALPINE LITOSTRATIGRAPHY PROJECT ...Dust, Particulate Matter, Extravires, Hawaii, Lakes, Mountains-alpine, Volcanoes ...7.0236

DIAGENESIS OF CARBONATE SEDIMENTS ...Carbonates-general, Diagenesis, Geochemistry-general, Core Flutes, Trace Element Analysis ...7.0266

ABYSSAL OSTRACODES OF THE WORLD ...Abyssal, Shrimps ...Seed Or Mussel, Vertical Distribution, World Wide ...5.0386

GEOPHYSICAL INVESTIGATIONS IN THE CORAL SEA ...Geophysics, Physical Properties, ...7.0204

MASS PHYSICAL PROPERTIES IN MARINE SEDIMENTS ...California, Intertidal, Marine Fauna ...5.0743

GEOLOGICAL OCEANOGRAPHY - ACOUSTICAL PROPERTIES OF SEDIMENTS ...Acoustical, Geomorphology-topography, Mechanical Properties, Physical Properties, Scattering, ...7.0101

Coring and Dredging

GRANT FOR STUDY OF SEA FLOOR CORES AND PHOTOS ...Core Analysis, Photography ...7.0258

ANALYSIS OF PHYSICAL AND CHEMICAL PROPERTIES OF DEEP SEA CORES ...Chemistry, Physical Properties, ...7.0259

RELATIONSHIPS BETWEEN RATES OF SEDIMENT ACCUMULATION & CHANGES WITH DEPTH OF CERTAIN MASS PHYSICAL PROPERTIES IN MARINE SEDIMENTS ...California, Intertidal - Zone, Marine Fauna, Rate of Deposition, Shear Strength ...8.0036

INVESTIGATIVE METHODOLOGY FOR MEASURING OCEANIC PROPERTIES LEADING TO THE TOTAL ENVIRONMENTAL SURVEY OF A SELECTED OCEAN AREA ...Oceanic - Pelagic, Physical Properties, Radioactivity, Submersibles, Technique Development ...8.0061

ARCTIC BASIN HEAT FLOW ...Arctic, Crust, Geothermal Gradient, Heat Flows, Physical Properties ...7.0106

RECENT AND ANCIENT FAUNAS OF A DROWNED ISLAND CHAIN (MID-PACIFIC MOUNTAINS) ...Benthic Fauna, Bioclasts, Hawaii, Seamounts ...5.0663

MOHOLE SITE STUDIES ...Earth Interior, Hawaii, Pacific Ocean-north, Seismic Studies, Structure Location ...7.0097

ABYSSAL PLAIN SEDIMENTATION AND STRATIGRAPHY ...Hawaii, Bathymetry, Physical Properties, Sedimentation, Sedimentation, Turbidity Currents ...7.0272

THE MARINE GEOLOGY OF THE SOUTHERN OCEAN ...Antarctic Ocean, Chemistry, Distribution, Mineralogy, Petrology, ...7.0067

CARBON-14 AGE PROFILE OF A HAWAIIAN REEF ...Anthozoa, Carbon-14, Growth Rate, Hawaii, Reefs, Sea Level Variations ...7.0014

ROCK SAMPLING AND GEOPHYSICAL STUDIES IN THE TONGA KERMADEC TRENCH SOUTHWEST PACIFIC ...American Samoa, Equipped Probe, Physical Properties, Pacific Ocean-west, Photography, Seismic Reflection, Trenches ...7.0093

ATLANTIC OCEAN CRUSTAL STUDIES ...Atlantic Ocean-general, Bathymetry, Crust, Heat Flow Measurements, Seismic Reflection, ...7.0116

STABLE ISOTOPE STUDIES ON COEXISTING MINERALS IN MARINE SEDIMENTS ...Diagenesis, Genetic Relationships, Mineralogy, Red Sea, Salinity, Thermal, ...7.0106

448
SUBJECT INDEX

DEEP-SEA CORE MAGNETOMETER AND A CORE ORIENTATION SYSTEM ...Direction, Magnetometers, Rock & Mineral Magnetics, ...8.0110

METEOROLOGICAL SUPPORT OF DEEP-SEA DRILLING OPERATIONS ...Drilling and Coring, Meteorological Studies, Teaching and Research, Waves, Weather Forecasting, ...12.0013

CORING OF THE VARVED SEDIMENTS IN SAANICH INLET ...Canada, Geotechnology-General, Local Stratigraphy, Pacific Ocean-east, Vessels, ...7.0022

GEOPHYSICAL AND GEOLOGICAL STUDY OF THE DARN WIN RISE ...Bathymetry, Geophysics-general, Gravity Studies, Magnetic Studies, Ocean Basins, Pacific Ocean-west, Photography, Refraction, Ridges, Seamounts-guyots, ...7.0012

CONTRACT FOR PROCESSING OF USARP ROCK SAMPLES ...Antarctica, Classifications, Collections, Petrology, Sampling, Ships and Cruises, Thin Sections, ...7.0060

GEOPHYSICS AND GEOCHEMICAL STUDY OF THE RED SEA MINERAL DEPOSITS ...Gulf of Aden, Ignaceous Activity - Volcanism, Mineralogy, Red Sea, Thermal, ...7.0023

DEEP SEA PHOTOGRAPHIC SYSTEM AND A BOX CORER ... Abyssal, Bathypelagic-bottom, Photography, ...8.0141

EFFECTS OF DEEP SEA SEDIMENTS ON SUDDEN IMPACT ...Oceanography, Physical Properties, Sediments, Physical Properties, Shear Strength, ...7.0028

RESEARCH IN CORE ANALYSIS ...Acoustics, Core Analysis, Geomorphology-topography, Model Studies, Physical Properties, ...7.0263

ESTUARINE DREDGE HOLE INVESTIGATIONS ...Aquatic Ecology, Estuaries, Fish -non-specific, Habitat Studies, ...5.0908

SURVEY OF A POTENTIAL HARD CLAM FISHERY ...Clams, Commercial Fishing, Estuaries, Georgia, Spawning & Nesting Sites, ...5.0420

SEDIMENTOLOGY AND GEOLOGIC HISTORY OF HUMBOLDT BAY, CALIFORNIA ...Bays, California, Geologic History, Pacfic Ocean-east, Physical Properties, ...7.0192

DEVELOPMENT OF OFFSHORE SOURCES OF SAND SUITABLE FOR BEACH RESTORATION AND NOURISHMENT ...Beach, Mapping, Ocean Mining, Shoreline Structures, Size, ...7.0012

DEVELOPMENT OF WIRE-LINE CORING TECHNIQUE FOR SAMPLING CONсолIDATED DEPOSITS ...Alaska, Bottom Sampling Device, Mechanical Properties, Mineralogy, Technique Development, ...8.0249

SAMPLING CAMPAIGN ON CORSAN Dotonin BANK, OFF SOUTHERN CALIFORNIA ...Banks, California, Chemistry, Distribution, Phosphate, Phosphite, ...7.0003

DEVELOPMENT, TESTING AND EVALUATION OF MODIFICATIONS REQUIRED TO ADAPT DRILLING SAMPLING SYSTEMS TO THE PLATFORM ...Bottom Sampling Device, Drilling and Coring, Equipment, Platforms, Technique Development, ...8.0256

LABORATORY MODEL STUDIES OF PENETRATION INTO A SIMULATED COHESIONLESS DETRITUS ...Gravel, Model Steels, Model Studies, Soil Sampling, Technique Development, ...8.0245

LABORATORY MODEL STUDIES ON DISTURBANCE OF DETRITUS BY PENETRATION ...Disturbed/undisturbed, Model Studies, ...8.0252

LABORATORY STUDIES TO CORRELATE ENGINEERING PROPERTIES OF MARINE PLACER MATERIALS WITH SAMPLING TOOL PERFORMANCE ...Gold, Laboratory Analyses, Mechanical Properties, Placer, Scientific-service-support, ...8.0244

Corrosion, Deterioration

Agents

Atmospheric Gases

COMBUSTION OF RESIDUAL FUEL WITH MASSIVE RECIRCULATION ...Alloys, Combustion Products, Fuels, ...8.0226

Biological

MICROBIAL CORROSION AND DETERIORATION OF NAVAL MATERIALS ...Classification Or Taxonomy, Fouling, Toxic Effect, Marine Bacteria, Materials Used Undersea, ...8.0203

PILING PRESERVATIONS THRESHOLD STUDIES ...Fouling, Massachusetts, North Carolina, Preservatives, Wood, ...8.0232

THE ROLE OF AMINE ORGANISMS IN THE DEGRADATION OF NAVAL MATERIALS ...Marine Bacteria, Materials Used Undersea, Model Studies, Reaction Rates, ...8.0241

MICROBIAL CORROSION CULTURE ...Bacterial Culture, Fouling, Isolation From Nat. environ., Marine Bacteria, Water Bacteria, ...5.0849

THE ROLE OF SULFur ...AERIA IN CORROSION AND DETERIORATION ...Autotrophic, Fouling, Marine Bacteria, Plasma Membranes, Sulfur Bacteria, ...5.0005

MICROBIAL CORROSION IN THE MARINE ENVIRONMENT ...Biodegradation, Carbon, Fouling, Marine Fungi (non-specific), Water, ...8.0269

MECHANISMS OF ATTACHMENT OF MARINE BACTERIA TO SURFACES ...Adsorption & Interface, Corrosion Prevention-other, Fouling, Marine Bacteria, ...8.0210

DEEP-WATER FOULING ...Fish -non-specific, Fouling, Prediction, Vertical Distribution, ...8.0233

MICROBIAL CORROSION ...Alloys, Fouling, Marine Bacteria, Sulfur Bacteria, Water, ...8.0207

CHEMICAL WOOD PRESERVATIVE TREATMENTS ...Corrosion Prevention-other, Creosote, Fouling, Wood Pren ravines, ...8.0197

PRESERVATION OF WOODS IN THE MARINE ENVIRONMENT ...Fouling, Habitat Studies, Marine Fungi (non-specific), Materials Used Undersea, Preservatives, Wood, ...8.0216

BIOLOGICAL STUDIES AND DETERIORATION, DEEP OCEAN-HIGH PRESSURE BACTERIA ...Biology, Chemistry, Identification, Microorganisms (non-specific), Submersibles, ...8.0226

Soils

STEEL PILING ...Corrosion Prevention-other, Fouling, Low Alloy Steels, Polarization, Water, ...8.0208

METALS FOR DEFENSE ...Alloys, Corrosion Prevention-other, Water, ...8.0209

Water

CORROSION RESEARCH ...Cathodic Protection, Corrosion General, Galvanic, ...8.0199

ANTIFOULING RESEARCH ...Corrosion Prevention-other, Fouling, Materials Used Undersea, ...8.0200

EVALUATION OF BOOTTOP PAINT SYSTEMS FOR OCEAN-GOING SHIPS IN A BOOTTOP PAINT TESTING MACHINE ...Catalysts, Paint - General, Primers, Surface Cleaning, Finishing, Test Methods, ...8.0237

OCEAN ENGINEERING RESEARCH ...Alloys, Engineering Studies-General, Materials Used Undersea, Moorings, Water Properties, ...8.0050

MICROBIAL CORROSION IN THE MARINE ENVIRONMENT ...Biodegradation, Biological, Carbon, Fouling, Marine Fungi (non-specific), ...8.0769

STEEL PILING ...Corrosion Prevention-other, Fouling, Low Alloy Steels, Polarization, Soils, ...8.0208

METALS FOR DEFENSE ...Alloys, Corrosion Prevention-other, Soils, ...8.0209

MICROBIAL CORROSION ...Alloys, Biological, Fouling, Marine Bacteria, Sulfur Bacteria, ...8.0207

DESIGN AND CONSTRUCTION ...Coatings-general, Environmental Effects, Geology, Hydrodynamic Structures, Safety, Underwater-construction, ...8.0233

CORROSION MITIGATION ...Corrosion Prevention-other, Deep, Fouling, Low Alloy Steels, Pre-stressed, ...8.0205

Corrosion General

CORROSION RESEARCH ...Cathodic Protection, Fouling, Galvanic, Water, ...8.0199

FRICTIONAL RESISTANCE HULL SCALE AND COATINGS ...Maintenance-system, Materials Used Undersea, Paint - General, Wear, Friction, ...8.0227

BIOLOGICAL OCEANOGRAPHY AND DETERIORATION, POLYMER STUDIES ...Lubricants and Fluids, Marine Biology, Marine Biology (non-specific), Plankton (non-specific), Wear, Friction, ...8.0235

Durability, Deterioration

CHEMICAL EXPLOSIONS, PACKAGING AND HANDLING AT SEA ...Ammonia, Explosions, Detonation, Packaging, Safety, ...8.0130

ENERGY CONVERSION MATERIALS AND COMPONENTS ...Electric, Fuel Cell-other, Hydrazine, Hydrocarbon, Pressure, ...8.0223
Corrosion, Deterioration

Effects and Mechanisms

Cavitation

PHYSICAL ACOUSTICS AND THE PROPERTIES OF MATTER ...Acoustical, Constants. Ultrasonic Frequency, Velocimeter, Velocity, Water, ...1.0631

Galvanic

CORROSION RESEARCH ...Cathodic Protection, Corrosion General, Fouling, Water, ...8.0199

Stress Corrosion

STRUCTURAL TITANIUM ALLOYS -120/150 KSI YIELD STRENGTH ...Fatigue, Materials Used Undersea, Strength - Weight Ratio, Stress Concentration-toughness, Titanium, ...8.0220

HY 130-150 STRUCTURAL STEELS ...High Yield, Low Alloy Steel - Other, Materials Used Undersea, Stress Concentration-toughness, Welding - Other, ...8.0221

Prevention

Cathodic Protection

CORROSION RESEARCH ...Corrosion General, Fouling, Galvanic, Water, ...8.0199

MICROBES AND CORROSION ...Extracellular-enzymes, Fouling, Iron, Metals - non-specific, Microorganisms (non-specific), Respiraition, ...8.0228

Corrosion Prevention-other

ANTI-FOULING MEANS FOR MARINE PROPELLERS ...Fouling, Marine Propulsion, Materials Used Undersea, ...8.0240

NEW APPROACHES TO BIOFOULING ASSAY ...Bioassays, Fouling, Materials Undersea, Paint - General, Powder, ...8.0757

ANTIFOULING RESEARCH ...Fouling, Materials Used Undersea, Water, ...8.0206

MECHANISMS OF ATTACHMENT OF MARINE BACTERIA TO SURFACES ...Adhesion & Interface, Biological, Fouling, Marine Bacteria, ...5.0810

STEEL PILING ...Fouling, Low Alloy Steels, Polarization, Soils, Water, ...8.0208

METALS FOR DEFENSE ...Alloys, Soils, Water, ...8.0209

CHEMICAL WOOD PRESERVATIVE TREATMENTS ...Biological, Creosote, Fouling, Wood Preservatives-non-specific, ...8.0197

CORROSION MITIGATION ...Deep, Fouling, Low Alloy Steels, Pre-stressed, Water, ...8.0205

Inhibitors

FOULING OF SENSORS ...Fouling, Instrumentation-general, Marine Biology. Organonmetallics, ...8.0239

Costa Rica

CONTINUITY OF CLIPPERTON AND CLARION FRACTURE ZONES ...Faults, Geomorphology-topography, Gravity Studies, Seismic Reflection, Structural Studies, ...7.0890

Creosote

CHEMICAL WOOD PRESERVATIVE TREATMENTS ...Biological, Corrosion Prevention-other, Fouling, Wood Preservatives-non-specific, ...8.0197

Crustacea

Barnacles

REVISION OF THE CLASSIFICATION AND PHYLOGENY OF THE SUBORDER BALANOMORPHA (CIRRIPEDIA ...THORACICA) ...Animal Taxonomy, Collections, Handbooks, Nomenclature-Classification, Vertical Distribution, ...5.0704

RESEARCH ON THE BIO-SYSTEMATICS OF THE CIRRIPEDIA ...Biological Rhythms, Developmental Physiology, Visual Organs, ...5.0864

BARNACLES OF THE EASTERN PACIFIC ...Life History Studies, Pacific Ocean-east, ...5.0515

SYSTEMATICS OF MARINE SYMBIOTIC CRUSTACEA FROM INVERTEBRATES ...Animal Taxonomy, Coepods, Life History Studies, Symbiosis, ...5.0516

STUDIES ON MOLTING, GROWTH, AND DEVELOPMENT IN ACORNS BARNACLES AND LARVAL DECAPODS ...Biological Rhythms, Developmental Physiology, Endocrine System, Fouling, ...5.0526

MECHANISMS OF CALCIUM CARBONATE DEPOSITION ...Biogeochemical Process, Calcium, Chemical Reactions, Derivatives, Fouling, ...5.1015

STUDIES IN MICRONEUROPHYSIOLOGY ...Brain, Contraction and Relaxation, Gastropods - slugs,conch,snails, Musculoleskeletal System, ...5.0362

Copepods

PARASITIC COPEPODA ...CRUSTACEAROM INVERTEBRATES AND FISHES ...Animal Taxonomy, Ectoparasites, Indian Ocean-general, Invertebrate Anatomy, ...5.0451

COPEPOD CRUSTACEANS PARASITIC ON FISHES ...Collections, Ectoparasites, Fish - non-specific, Indian Ocean-general, Ships and Cruses, Vertical Distribution, ...5.0368

A STUDY OF THE ECOLOGY OF THE MICROFAUNA LIVING BETWEEN INTERTIDAL MARINE SEDIMENTS ...Beach, Crustacea - non-specific, Intertidal Areas, New England Province, Salinity, ...5.0793

SYSTEMATICS OF MARINE SYMBIOTIC CRUSTACEA FROM INVERTEBRATES ...Animal Taxonomy, Barnacles, Life History Studies, Symbiosis, ...5.0516

SYSTEMATIC STUDIES OF ANTARCTIC COPEPODS ...Animal Taxonomy, Antarctic Ocean, Mixing, ...5.0461

PLANKTON ECOLOGY ...Aquatic Ecology. Lake Michigan, Plankton Sampling, Ships and Cruses, Zooplankton, ...5.0803

SYSTEMATICS, BIOLOGY, AND HYDROGRAPHIC RELATIONS OF SOME SPECIES OF CALANUS (CRUSTACEA, COPEPODA) ...Animal Taxonomy, Invertebrate Anatomy, Oceanic Fronts, Vertical Distribution, ...5.0367

ANNUAL PHYTOPLANKTON PRODUCTION IN PUGET SOUND WATERS ...Invertebrate Culture, Phytoplankton, Puget Sound, Standing Crops, Tides, ...5.0931

ENERGY AND ELEMENT TRANSFER IN LOWER MARINE TROPHIC LEVELS ...Energy Budgets, Oregon, Phytoplankton, ...5.0823

BIOCHEMICAL AND BIOPHYSICAL STUDIES OF THE MARINE ENVIRONMENT ...Energy, Energy Budgets, Organics, Productivity - Food Chain, ...5.0767

COPEPODS PARASITIC ON NEEDLEFISHES ...Aquatic Ecology, Ectoparasites, Fish -other, Nomenclature, Classification, Organic Evolution, ...5.0389

RELATIONSHIP BETWEEN WATER TEMPERATURE AND SIZE OF PARASITIC COPEPODS ...Collections, Host Specificity, Size, Temperature, Water Temperature-non-specific, ...5.0390

COPEPODS PARASITIC ON SHARKS OF THE WEST COAST OF FLORIDA ...Animal Taxonomy, Ectoparasites, Florida, Sharks, ...5.0591

SYSTEMATICS OF CALIDOOD COPEPODS ...Animal Taxonomy, Ectoparasites, Host Specificity, Nomenclature, Classification, ...5.0392

SYNECOLOGY OF CARIBBEAN SPONGES ...Algae-General, Caribbean Sea, Porifera, Symbiosis, ...5.0850

RELECT COPEPODS FROM LAKE TUBORG, ELLESMERE ISLAND ...Brackish Water, Canada, Carbon-14, Lakes, Plankton Sampling, ...5.0388

LIFE HISTORY OF THE SHARK COPEPOD, KROYERIA DISPAR ...Developmental Physiology, Ectoparasites, Life History Studies, Whole Body Culture & Bearing, ...5.0393

DEVELOPMENT OF CULTURE METHODS FOR ECOLOGICALLY IMPORTANT MARINE ZOOPLANKTON SPECIES ...Aquatic Ecology, Environmental Physiology, Invertebrate Culture, Zooplankton, ...5.0834

DETERMINATION OF SELECTED ENVIRONMENTAL REQUIREMENTS OF IMPORTANT SPECIES OF MARINE ZOOPLANKTON ...Oxygen, Water Salinity, Water Temperature-non-specific, Zooplankton, ...5.0835

Crabs

CONTROLLED ENVIRONMENTAL FACTORS ON THE DEVELOPMENT OF ESTUARIAN AND OCEANIC CRUSTACEA ...Aquatic Ecology, Developmental Physiology, Estuaries, Salinity, Temperature, ...5.0476

PHYSIOLOGICAL MECHANISMS UNDERLYING THE BEHAVIOR OF MARINE CRUSTACEA ...Behavior, Behavioral Ecology, Shrimps - Common, ...5.0428

PORCELLANID CRABS OF AUSTRALIA ...Australia, Collections, Museum, Non.nomenclature, Classification, ...5.0354
SUBJECT INDEX

Crustacea

NUTRIENT STOK S IN REPRODUCTION IN SEA INVER- 
TEBRATES ...Decapoda - other, Invertebrate Nutrition, 
Reproductive System, Starfishes, ...5.0494

MECHANISMS OF VENTILATORY CONTROL ...Invertebrate 
Physiology, Nervous System, Respiratory System, ...5.0471

EXCITATION-CONTRACTION COUPLING IN MUSCLE 
...Contraction and Relaxation, Lobsters, Muscloskeletal 
System, Plasma Membrane, ...5.0438

Crayfish

CULTURE OF RED SWAMP CRAWFISH, PROCAMBARUS 
CLARKI, IN BRACKISH WATER PONDS ...Aquiculture 
& Fish-farming, Aquatic Ecology, Brickell Water, Captive 
Rearing, ...5.0432

Crustacea - non-specific

MID-DEPTH BOLUIMINESCEENCE ...Bioluminescence, Vertical 
Distribution, ...1.0162

A STUDY OF THE ECOLOGY OF THE MICROFAUNA LIV- 
ING BETWEEN INTERTIDAL MARINE SEDIMENTS 
...Bench, Copepods, Intertidal Areas, New England Province, 
Salinity, ...5.0793

NUTRITIONAL STUDIES ON MARINE ORGANISMS ...Inver- 
tebrate Nutrition, Nutrition Studies, Organics, Phytoplankton, 
...5.1004

ECOLOGICAL, EXPERIMENTAL AND COMPUTER STUDIES 
OF ENDOCORTHEN'S RH TMICITY ...Biological Rhythms, 
Brain, Computer Methods - general, Locomotion, ...5.0351

NEUROENDOCRINE REGULATION ...Brain, Endocrine 
System, Osmoregulation, Sodium, Water, ...5.0426

SHELLFISH EMBRYOLOGY AND LARVAE DEVELOPMENT 
STUDY ...Basic Embryology, Captive Rearing, Mollusks 
-non-specific & Other, Training Grants, Fellowships, ...5.0358

FISH POPULATIONS OF AMERICAN SAMOA ...American 
Samoa, Fish -non-specific, Fishing Gear, Number Or Density, 
...5.0357

SHELLFISHERIES ...Censusing, Commercial Fishing, Legislation, 
Mollusks -non-specific & Other, ...4.0012

CRUSTACEAN COLLECTION OF EAST COAST OF UNITED 
STATES ...Atlantic Ocean-north, Collections, Estuaries, North 
Carolina, ...5.0481

ABYSSAL AND BATHYAL SYNPODIAE OF WORLD ...Abys- 
al, Animal Taxonomy, Bathyal, Vertical Distribution, World 
Wide, ...5.0584

ATLASE OF MARINE FAUNA ...Atlantic Ocean-north, Fish -non- 
specific, Handbooks, Mollusks -non-specific & Other, ...5.0101

PHYSICAL AND CHEMICAL CHARACTERISTICS OF THE 
UPPER CHESAPEAKE BAY ...Chemical-general, Chesapeake 
Bay, Environmental Ecology, Mollusks -non-specific & Other, 
Physical-general, ...1.0150

MARINE BIOLOGICAL ASSESSMENT OF POLLUTIONAL 
FATE ...Contamination - Water, Fish -non-specific, Nets, Pollu- 
...1.0176

NEUROSECRETION AND ENDOCRINE PHYSIOLOGY ...Con- 
figuration, Diabetogenic, No, Endocrine System, Hormones, In-
termedin, ...5.1023

THE STRUCTURE AND FUNCTION OF CRUSTACEAN EYES 
...Invertebrate Anatomy, Light - other, Oceanic - Pelagic, Verti-
cal Distribution, Visual Organs, ...5.0363

Decapoda - Non-specific

LARVAL DEVELOPMENT OF DECAPOD CRUSTACEA 
...Animal Taxonomy, Basic Embryology, Bibliography, Crabs, 
Lobsters, ...5.0410

Decapoda - other

NUTRIENT STORES IN REPRODUCTION IN SEA INVER- 
TEBRATES ...Crabs, Invertebrate Nutrition, Reproductive 
System, Starfishes, ...5.0494

Isopods

ECOLOGICAL AND EVOLUTIONARY IMPLICATIONS OF THE 
ECOTYPES OF ESTUARINE CRUSTACEA ...Chela1, 
Estuaries, Invertebrate Anatomy, Metabolism, Productivity 
- Food Chain, ...5.0418

RELATIONSHIPS AMONG POPULATIONS OF LIMNORIA 
TRIPUNCTATA ...Animal Taxonomy, Population Dynamics, 
Reproductive System, ...5.0477

REPRODUCTIVE RELATIONSHIPS AMONG POPULATIONS OF A MARINE WOOD-BORING ISOPOD ...Animal Taxano-
Crustacea

SUBJECT INDEX

ay, Invertebrate Anatomy, Population Dynamics, Reproductive System.

THE EPICARIDEA OF THE EASTERN PACIFIC ...Animal Taxonomy, Pacific Ocean-east, ...5.0333

EVALUATION OF EFFECTS OF SATURATED HYDROCARBONS ON THE MORTALITY AND GROWTH OF CRAMONENES ...Cremone, Fouling, Petroleum Cpd's.-non-specific, Preservatives, Wax, Paraffin, Wood Preservatives-non-specific, ...5.0176

Lobsters

LARVAL DEVELOPMENT OF SCYLARIID DEBIXANT ...Animal Taxonomy, Developmental Physiology, Environmental Physiology, Invertebrate Nutrition, Laboratory, ...5.0409

MANAGEMENT INVESTIGATIONS OF TWO SPECIES OF SPINY LOBSTERS PANULIRUS JAPONICUS AND P. PENICILLATIUS ...Captive Rearing, Commercial Fishing, Management-other, Tag, ...5.0422

LARVAL STUDY OF THE LOBSTER ...Atlantic Ocean-north, Habitat Studies, Long Island Sound, Mark, Tag Or Capture-other, Maturity & Growth Stages, Plankton Sampling, ...5.0371

COASTAL LOBSTER FISHERY ...Censusing, Commercial Fishing, Legislation, Massachusetts, ...5.0452

OFFSHORE LOBSTER FISHERY ...Censusing, Commercial Fishing, Massachusetts, Nets, ...5.0453

POPULATION STRUCTURE OF THE LOBSTER ...Commercial Fishing, Diving and Scoopa, Long Island Sound, Population Dynamics, Sites, ...5.0688

TAGGING PROGRAM ...Long Island Sound, Number Or Density, Population Dynamics, Tag, Temporal Distribution, ...5.0472

NEPHROPID LOBSTERS OF THE WESTERN ATLANTIC ...Animal Taxonomy, Atlantic Ocean-north, Collections, ...5.0396

LOBSTER RESEARCH ...Commercial Fishing, Environmental Ecology, Habitat Studies, Population Dynamics, ...5.0436

LARVAL DEVELOPMENT OF DECAPOID CRUSTACEA ...Animal Taxonomy, Basic Embryology, Bibliography, Crabs, Decapoda-Non-specific, ...5.0410

EXCITATION-CONTRACTION COUPLING IN MUSCLE ...Contractile and Relaxation, Crabs, Musculoskeletal System, Plasma Membrane, ...5.0438

Shrimp - Amphipods

POPULATION STUDIES OF HAUSTORIDAE AND GAMMARIDAE FROM NEW ENGLAND AND ON INFAUNAL AND EPIFAUNAL MARINE AMPHIPODS AT ENIWETOK ...Atolls, Habitat Studies, Micronesia, Population Dynamics, ...5.0466

SYSTEMATICS OF THE ANTARCTIC AND SUBANTARCTIC GAMMARIDAE AMPHIPODA ...Abyssal, Animal Taxonomy, Antarctic Ocean, Bathyal, Vertical Distribution, ...5.0359

INFAUNA OF LOWER CHESAPEAKE BAY ...Aquatic Ecology, Chesapeake Bay, Population Dynamics, Streams, Virginia, ...5.0661

HYPERID AMPHIPODS FROM THE GULF OF GUINEA ...Animal Taxonomy, Collections, Guinea, Oceanography-general, Vertical Distribution, ...5.0387

Shrimps - Brine Or Fairy

AN ANALYSIS OF DEVELOPMENT IN ARTEMIA SALINA EMByOS ...Basic Embryology, Biochemicals, Nucleic Acids, Proteins, Ribosomes, ...5.0406

GENETIC REGULATION OF HEMOGLOBIN SYNTHESIS IN ARTEMIA ...Environmental Physiology, Hemoglobin, Marker, Mutagens, ...5.0365

Shrimps - Common

PHYSIOLOGICAL MECHANISMS UNDERLYING THE BEHAVIOR OF MARINE CRUSTACEAE ...Behavior, Behavioral Ecology, Crabs, ...5.0438

THE ALPHEID CRUSTACEAE OF AUSTRALIA ...Animal Taxonomy, Australia, Collections, Publications-otherwise, ...5.0425

TEMPERATURE AND SALINITY TOLERANCE OF THE SAND SHRIMP, CRANGON SEPTEMPIS ...Environment Resistance, Environmental Physiology, Estuaries, Salinity, Temperature, ...5.0437

NEUROENDOCRINE PATHWAYS IN OSMOREGULATION IN CRUSTACEANS ...Aquatic Ecology, Crabs, Endocrine System, Environmental Physiology, Osmoregulation, ...5.0427

SHRIMP PRODUCTION IN LOUISIANA SALT-MARSH IMPoundments Under Existing and Managed Conditions ...Aquaculture & Fish-farming, Captive Rearing, Lagoons, Louisiana, Water Movement, Currents, ...5.0435

STUDY ON THE DISTRIBUTION AND ABUNDANCE OF PINK SHRIMP, PANDALUS JORDANI, IN THE PACIFIC OCEAN OFF OREGON ...Censusing, Fishing Gear, Life History Studies, Pacific Ocean-General, Population Dynamics, ...5.0487

SEASONAL ABUNDANCE AND BIOLOGICAL STABILITY OF THE COMMERCIAL SHRIMP OF GEORGIA ...Commercial Fishing, Number Or Density, ...5.0419

PORT SAMPLING - PRESENT CITY, BROOKINGS, PORT ORFORD, ...Crabs, Fish-non-specific, Life History Studies, Nets, ...5.0356

INVESTIGATION OF ECOLOGICAL FACTORS LIMITING PRODUCTION OF THE ALASKAN PANDALID SHRIMP ...Alaska, Commercial Fishing, Life History Studies, Nets, Vertical Distribution, ...5.0345

SHELLFISH AND BOTTOMFISH DATA ...Commercial Fishing, Crabs, Fish-otherwise, Legislation, ...5.0357

LAKE BORNO - CHANDELEUR SOUND SYSTEM ...Data Acquisition, Gulf of Mexico, Maturity & Growth Stages, Nets, Plankton Sampling, Population Dynamics, ...5.0434

COMPARATIVE BIOCHEMISTRY OF PROTEINS FROM GULF FISH ...Blood Proteins-non-specific, Drugs, Gel Electrophoresis, Hemoglobin, ...5.0326

ENERGETICS OF PALAEMONETES PUGIO AND THE WEEDBED COMMUNITY OF SOUTH CREEK ESTATU ...Aquatic Vegetation, Energy Budgets, Estuaries, Habitat Studies, North Carolina, ...5.0483

EFFECTS OF MARSH MANAGEMENT STRUCTURES UPON FISHES ...Alewife, menhaden, shad, herring, Crabs, Engineering Structures-general, Land Use, Spawning & Nesting Sites, Swamp-marshes, ...5.0206

MARINE INVERTEBRATE EXPLORATIONS ...Commercial Fishing, Freshwater Mussels, Scallops, Pacific Ocean-general, Temporal Distribution, Vertical Distribution, ...5.0733

FISHES TAKEN INCIDENTAL TO SHRIMP TROLLING ...Atlantic Ocean-south, Fish-non-specific, Nests, Number Or Density, ...5.0072

ADULT SHRIMP STUDIES ...Alaska, Bays, Biological Rhythms, Habitat Studies, Life History Studies, ...5.0340

EARLY LIFE HISTORY DECAPOID CRUSTACEA ...Animal Distraction, Environmental Ecology, Life History Studies, Reproductive System, ...5.0343

CONTRIBUTIONS TO THE BIOLOGY OF THE ROYAL RED SHRIMP, HYMENOPENAEUS ROBUSTUS ...Atlantic Ocean-south, Maturity & Growth Stages, Number Or Density, Vertical Distribution, ...5.0342

EASTERN PACIFIC SHRIMS OF THE GENUS PENAEUS ...Animal Taxonomy, Life History Studies, Pacific Ocean-general, Range Or Territorial Dist, Vertical Distribution, ...5.0463

BENTHIC PENAEID SHRIMS (OTHER THAN PENAEUS) FROM THE WESTERN ATLANTIC ...Animal Taxonomy, Atlantic Ocean-general, Collections, Continental Shelf, Vertical Distribution, ...5.0404

DIAGNOSTIC CHARACTERS & DEVELOPMENT OF EXTERNAL GENITALIA IN JUVENILE GROOVED SHRIMPS OF GENUS PENAEUS FROM WESTERN ATLANTIC ...Atlantic Ocean-general, Developmental Physiology, Invertebrate Anatomy, Reproductive System, ...5.0485

CIRCULATION DYNAMICS (GULF OCEANOGRAPHY PROGRAM) ...Circulation-general, Environmental Changes, Gulf of Mexico, Thermodynamics, ...2.0045

PREDICTING COMMERCIAL SHRIMP ABUNDANCE (SHRIMP DYNAMICS PROGRAM) ...Bays, Behavioral Ecology, Commercial Fishing, Environmental Ecology, Population Dynamics, ...5.0499

131.116B - LARVAL CULTURE (SHRIMP AQUACULTURE PROGRAM) ...Algal Culture, Aquaculture & Fish-farming, Captive Rearing, Environmental Physiology, Food Supply, ...5.0500

EXPERIMENTAL SEEDING (SHRIMP AQUACULTURE PROGRAM) ...Commercial Fishing & Shrimp, Florida, Population Dynamics, Spawning & Nesting Sites, Stocking of Fish & Shellfish, ...5.0501

RECONNAISSANCE ECOLOGIC SURVEY OF THE CONTINENTAL SHELF AND UPPER SLOPE (GULF OCEANOGRAPHY PROGRAM) ...Behavioral Ecology, Biology, Continental-
Culture (methods & Techniques)

PHYTOPLANKTON SPECIES ...Growth and Differentiation, Marine Biology, Marine Plants, Phytoplankton, Responses to Growth, ...5.0833
INTEGRATED FIELD AND LABORATORY SYSTEM FOR AS-SAYING THE EFFECTS OF POLLUTANTS AND TOXI-CANTS UPON WATER QUALITY ...Algal Culture, Phytoplankton, Pollution - Effects of, Responses to Growth, ...5.0831
STUDY OF TOXIN SYNTHESIS IN PRYMNESSAU PARVUM ...Algal Toxins, Biosynthesis, Gonyaulax, Gymnodinium, Prymnessau, ...6.0124

Bacterial Culture

PHOTOSYNTHETIC BACTERIA ...Classification Or Taxonomy, Isolation From Nat. environ., Marine Bacteria, Photosynthetic Bacteria, Sulfur Bacteria, ...5.0814
MARINE-BACTERIA CULTURE ...Biological, Fouling, Isolation From Nat. environ., Marine Bacteria, Water Bacteria, ...5.0849
PHYSIOLOGICAL CHARACTERIZATION OF CERTAIN MARINE BACT. ORG ...Bact. morphology (general), Biology, Isolation From Nat. environ., Marine Bacteria, Metabolism (intracellular), Tissue Techniques, ...5.0784
DISTRIBUTION OF CL. BOTULINUM E. IN FISH, SHELLFISH AND THE AQUATIC ENVIRONMENT IN OREGON ...Clostridium Botulinum, Oregon, Range Or Territorial Dist., Virulence Pathogenicity, ...5.0822
NITRIFICATION BY MARINE MICROORGANISMS ...Autotrophic, Bact. morphology (general), Isolation From Nat. environ., Marine Bacteria, Nitrogen Bacteria, Range Or Territorial Dist., ...5.0890

Bulk Culture -other

ALGAE AS FOOD FOR MARINE INVERTEBRATE LARVAE HELD IN THE LABORATORY ...Algal Culture, Chesapeake Bay, Invertebrate Nutrition, Invertebrates -non-specific, ...5.0732

THE ENVIRONMENTAL REQUIREMENTS OF MARINE PLANKTONIC ORGANISMS ...Marine Biology (non-specific), pH -water, Plankton (non-specific), Water Salinity, Water Temperature -other, ...5.0921

Fungal Culture

COMPARATIVE BIOCHEMICAL AND MORPHOLOGICAL CHARACTERISTICS OF MARINE FUNGI FROM SHELF-FISH ...Endoparasites -other, Histochemistry - Cytochemistry, Histology and Cytology, Marine Fungi (non-specific), Plant Taxonomy, ...5.0791

STUDIES ON THE DEVELOPMENT OF DERMOCYSTIDUM MARINUM ...Cell Cycle, Control and Prevention, Dermocystidium, Oysters, Pathology, ...5.0836

Invertebrate Culture

ULTRASTRUCTURAL AND AUTORADIOGRAPHIC IN-VESTIGATION OF CALCIFICATION IN FORAMINIFERS ...Calcification, Calcium, Cell Wall, Cell. organ, & Organoids - ect., Foraminifera, Histochemistry and Cytology, ...5.0789
ANNUAL PHYTOPLANKTON PRODUCTION IN PUGET SOUND WATERS ...Copepods, Phytoplankton, Puget Sound, Standing Crops, Tides, ...5.0831
REAR AND DESCRIBE LARVAE OF BIVALVES ...Captive Rearing, Clams, Developmental Physiology, Freshwater Mussels, Scallop, ...5.0857
DEVELOPMENT OF CULTURE METHODS FOR ECOLOGICALLY IMPORTANT MARINE ZOOPLANKTON SPECIES ...Aquatic Ecology, Copepods, Environmental Physiology, Zooplankton, ...5.0834

Monolayer Culture

TISSUE CULTURE - BIOLOGY ...Animal Viruses (non-specific), Bacteria (non-specific), Cell Injury and Autolysis, Marine Biology, Oysters, Tissues, ...5.0978

Organelle Culture

GROWTH AND DIFFERENTIATION OF PLASTIDS ...Acetabularia, Biosynthesis, Cytoplasmic Inheritance, DNA Other, Nucleus (non-specific & Ot.), Photosynthetically Active, ...5.0683

Suspension Culture

MECHANICAL PROPERTIES OF MAMMALIAN CELLS ...Blood Cells, Cellular Membranes (non-spec.), Flow Metering Techniques, Time-lapse Photography, ...5.0992
STUDIES ON EMBRYONIC CELLS ...Basic Embryology, Chickens, Reproductive System, Sea Squirts - Tunicates, ...5.0945

Currents-bottom

STUDY OF OCEAN CURRENTS AT SEA FLOOR AND THEIR SPATIAL CORRELATION ...Benthonic-bottom, Field Characteristics, Water Motion Recorders, ...5.0803
OCEANOGRAPHY, PLEISTOCENE GEOLOGY AND SEDIMENTS OF LITTLE BAHAMA BANK ...British West Indies, Carbonates-general, Energy, Quaternary Period, Water Motion Recorders, ...5.0729
DEEP FLOW, WATER CHARACTERISTICS, TOPOGRAPHY AND SEDIMENTS IN THE CENTRAL PACIFIC AREA ...Abyssal, Distribution, Geomorphology-topography, Pacific Ocean-general, Structural Studies, Water Motion Recorders, ...7.0032
WATER MASSES, CURRENTS AND ORIGIN OF THE ATLANTIC BOTTOM WATER IN THE WEDDELL SEA, ANTARCTICA ...Drifts, Salinity, Sampling, Temperature, Weddel Sea, ...4.0134
TURBULENT PROCESSES AT AIR-SEA AND BOTTOM BOUNDARIES OF THE OCEAN ...Thermal, Turbulence, Waves, Wind-water Interaction, ...3.0033
GLOBAL OCEAN FLOOR ANALYSIS ...Acousticals, Bathymetry, Benthonic-bottom, Geomorphology-topography, Seismic Studies, Subbottom, ...4.0046
DIVER-ASSISTED OCEANOGRAPHY ...Benthonic-bottom, Continental Shelf, Diving and Scuba, Geomorphology-topography, Mapping, Waves-internal, ...4.0098

Currents-longshore

AEGEAN SEA BIOLOGY ...Aegean Sea, Benthic Organisms (non-specific), Plankton (non-specific), Range Or Territorial Dist., ...5.0887
THE POTENTIAl SOURCE, TRANSPORT AND DEPOSITIONAL PATTERNS OF CLASTIC SEDIMENTS IN POR- TIONS OF COASTAL GEORGIA ...Beach, General Mineralogic Properties, Georgia, Microstructure, Size, ...7.0025
RECENT SEDIMENTATION BY TIDAL AND LONGSHORE CURRENTS ON A CARBONATE BANK IN LOWER FLORIDA KEYS ...Banks, Florida, Quaternary Period, Sedimentation, Tides, ...7.0025
MECHANICS OF WAVE ACTION IN DEEP AND SHALLOW WATER ...Geomorphology-topography, Sand Bars, Tidemarin, Waves, Waves-internal, ...5.0100

Currents-ocean

VISIBLE REGION INSTRUMENTATION FOR OCEANO-GRAPHIC SATELLITES ...Geomorphology-topography, Mapping, Photography, Satellites, Shelves, ...5.0089
A STUDY OF THE DEEP CIRCULATION AND DEEP FISH POPULATIONS IN THE PACIFIC OCEAN ...Fish -non-specific, Pacific Ocean-general, Tides, Vertical Distribution, ...2.0005
NUCLEAR OCEANOGRAPHIC TECHNIQUES ...Isotope Dilution, Physical Properties, Radioactivity, Water Analysis, Water Motion Recorders, ...8.0087
OCEAN CIRCULATION STUDIES ...Acoustical, Atlantic Ocean, Hydrodynamics, Statistics-general, Water Motion Recorders, ...5.0040
OCEAN WAVES AND TIDES ...Subsurface Environments, Thermal, Tides, Water Motion Recorders, Waves, ...2.0080
CIRCULATION STUDIES ...Circulation-general, Gulf of Mexico, Hydrodynamics, Mixing, Pacific Ocean-tect., ...2.0042
ARCTIC RESEARCH ...Acoustica, Arctic Ocean, Geomorphology-topography, Magnetic Studies, Sea Ice, ...4.0049
AIR-SEA INTERACTION ...Air-sea Boundary-general, Gulf of Mexico, Thermal, Tropical Cyclones, Weather Forecasting, ...3.0042
LONG RANGE SOFAR FLOATS ...Acoustical, Physical Analysis, Subsurface Environments, Water Motion, Water Motion Recorders, ...2.0025
SUBJECT INDEX

CURRENTS-OCEAN

Development, Technique Development, Water Motion Recorders, .4.0021
OCEANOGRAPHIC RESEARCH .Acoustical, Buoys, Optical, Pressure, Seismic Studies, Sonar, .1.0181
OCEAN CURRENTS AND CIRCULATION .Circulation-general, Data Acquisition, Energy, Model Studies, Temperature, .2.0018
LITERATURE SEARCH AND PRELIMINARY ENGINEERING STUDIES OF ENVIRONMENTAL PROBLEMS ASSOCIATED WITH MARINE DEPOSIT DELINEATION TECHNIQUES .Drilling Operation, Oil and Natural Gas - Sulfur, Survey Studies, Wave Action, .8.0021
HYDROGRAPHY, SEDIMENTATION AND CHEMICAL ASPECTS OF THE REEF ENVIRONMENT .Aquatic Soils, Environmental Ecology, Fish - non-specific, Reefs, .3.0212
DESIGN, CONSTRUCTION AND LONGEVITY OF ARTIFICIAL FISHING REEFS .Atlantic Ocean-north, Reefs, Tides, .5.0013
INVESTIGATE FACTORS DETERMINING DISTRIBUTION OF PHYSICAL AND CHEMICAL PROPERTIES OF THE PACIFIC OCEAN .Hawaii, Mathematical Analysis, Model Studies, Oceanic Fronts, Pacific Ocean-general, .5.0088
INTERNATIONAL NORTH PACIFIC FISHERIES COMMISION SUBARCTIC OCEANOGRAPHY .Depth, Pacific Ocean-north, Range Or Territorial Dist., Salinity, Salmon -cohoe,chinook,sockeye, Temperature, .1.0159
SURVIVAL CRAFT DRIFT AND LEEWAY .Air Motion Instruments, Buoys, Equipment, Ocean-lakes, Operational Aspect, Tables, Conventions, Catalogs, .6.0129

California Current

STUDY OF STABILITY AND SHEAR IN THE TOP 500 METERS OF THE OCEAN .Density, Mixing, Water Motion, Water Motion Recorders, .1.0171
OCEAN CIRCULATION .Circulation-general, Forecasting-prediction, Hydrodynamics, Model Studies, Submarine Canyons, .2.0002
SEA SURVEY INVESTIGATIONS .Fish - non-specific, Population Dynamics, Survey Studies, Vertical Distribution, .4.0117
FOOD HABITS STUDY OF ORGANISMS OF THE PACIFIC OCEAN .California, Mathematical Analysis, Model Studies, Oceanic Fronts, Pacific Ocean-general, .5.0037
CALIFORNIA CURRENT SURVEYS .Environmental Ecology, Fish - non-specific, Pacific Ocean-east, Plankton (non-specific), .4.0114
SPECIES LIFE HISTORY AND DISTRIBUTION .Fish - non-specific, Life History Studies, Maturity & Growth Stages, Number Or Density, Oceanic Fronts, .5.0037
STANDARD MONITORING SITES (ATLANTIC AND PACIFIC OCEAN) .Kuroshio Current, Labrador Current, Platforms, Salinity, Temperature, .4.0084

Gulf Stream

GULF STREAM EDDIES .Data Analysis - General, Data Reduction and Analysis, Hydrodynamics, Temperature, Water Motion, .2.0028
ANALYTICAL OCEANOGRAPHY .Data Analysis - General, Geos, Salinity, Temperature, .4.0044
OCEAN CURRENT TRANSPORT .Navigation, Ocean Waves - Currents, Water Motion Recorders, .2.0016
VERTICAL MOTIONS .Convection, Hydrodynamics, Water Motion Recorders, .2.0060
NORTH ATLANTIC CIRCULATION .Atlantic Ocean-north, Circulation-general, Geomorphology-topography, Hydrodynamics, Oceanic Fronts, .3.0031
STUDIES OF THE TRANSPORT OF THE FLORIDA CURRENT .British West Indies, Florida, Navigation, Ocean Currents-other, Water Motion Recorders, .2.0017
OPERATION OF R/V ALAMINOS .Carbon, Caribbean Sea, Gulf of Mexico, Ships and Cruises, Textures-structures, .12.0046
GULF STREAM TRANSPORT .Automatic Stations, Hydrodynamics, Ships and Cruises, Water Motion Recorders, .2.0029
THEORETICAL AND LABORATORY MODEL STUDIES OF LARGE-SCALE OCEAN CIRCULATION .Circulation-general, Currents-ocean, Forecasting-prediction, Model Studies, Transducers, .2.0023
<table>
<thead>
<tr>
<th>SUBJECT INDEX</th>
<th>Developmental Biology - Animal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sands and Gravels</td>
<td>POTENTIALLY-ECONOMIC SAND AND SILT DEPOSITS IN LAKE ONTARIO, NEW YORK ...Geologic Maps, Lake Ontario, New York, Potential of Deposit, Submergent, ...7.0024</td>
</tr>
<tr>
<td></td>
<td>PUERTO RICO COOP - MONA PASSAGE ...Continental Shelves, Land Economics, Mine Wastes, Oil - Petroleum, Potential of Deposit, Puerto Rico, ...7.0034</td>
</tr>
<tr>
<td>Deposits-ores</td>
<td>MARINE HEAVY-METALS PRODUCTION INFORMATION, ON WORLDWIDE BASIS ...Appraisals-general, Beneficiation, Documents &amp; Literature, Heavy Elements, Ocean Mining, ...7.0006</td>
</tr>
<tr>
<td></td>
<td>OREGON-NORTHERN CALIFORNIA PLACER DEPOSITS ...California, Drilling and Coring, Oregon, Placer, Recognnssance, ...7.0009</td>
</tr>
<tr>
<td>Cobalt</td>
<td>FORMATION AND DEGRADATION OF MANGANESE NODULES BY MARINE BACTERIA ...Manganese, Marine Bacteria, Nickel, Ocean Mining, Titanium, ...7.0025</td>
</tr>
<tr>
<td>Gold</td>
<td>APPLICATION OF NUCLEAR TECHNIQUES TO MARINE MINERALS TECHNOLOGY ...Activation Analysis, Geological Exploration, Manganese, Ocean Mining, Physical Properties, ...8.0008</td>
</tr>
<tr>
<td></td>
<td>MARINE GEOLOGY OF THE SAN FRANCISCO BAY ...Bays, Geology-general, Mechanical Properties, San Francisco Bay, Structural Studies, Tectogenesis, ...7.0035</td>
</tr>
<tr>
<td></td>
<td>LABORATORY STUDIES TO CORRELATE ENGINEERING PROPERTIES OF MARINE PLACER MATERIALS WITH SAMPLING TOOL PERFORMANCE ...Coring and Dredging, Laboratory Analysis, Mechanical Properties, Placer, Scientific-services/support, ...8.0024</td>
</tr>
<tr>
<td>Manganese</td>
<td>APPLICATION OF NUCLEAR TECHNIQUES TO MARINE MINERALS TECHNOLOGY ...Activation Analysis, Geological Exploration, Gold, Ocean Mining, Physical Properties, ...8.0008</td>
</tr>
<tr>
<td></td>
<td>FORMATION AND DEGRADATION OF MANGANESE NODULES BY MARINE BACTERIA ...Cobalt, Marine Bacteria, Nickel, Ocean Mining, Titanium, ...7.0025</td>
</tr>
<tr>
<td>Nickel</td>
<td>FORMATION AND DEGRADATION OF MANGANESE NODULES BY MARINE BACTERIA ...Cobalt, Marine Bacteria, Ocean Mining, Titanium, ...7.0025</td>
</tr>
<tr>
<td>Silver</td>
<td>A STUDY OF THE LEAD OXYCHLORIDES AND RELATED SPECIES FOUND IN THE ANCIENT SLAGS OF LURNIUM, GREECE ...Chemical Reactions, Discretions of Minerals, Greece, Mine Wastes, Mineral Genesis, ...7.0058</td>
</tr>
<tr>
<td>Titanium</td>
<td>FORMATION AND DEGRADATION OF MANGANESE NODULES BY MARINE BACTERIA ...Cobalt, Manganese, Marine Bacteria, Nickel, Ocean Mining, ...7.0025</td>
</tr>
<tr>
<td>Deserts</td>
<td>A UNIFIED APPROACH TO WATER, FOOD AND POWER IN A COASTAL DESERT COMMUNITY ...Arid and Desert, Desalination, Diesel, Distilling Units, Electric Power Plants, Greenhouse, Use of Impaired Water, ...7.0002</td>
</tr>
<tr>
<td>Detectors and Sensors</td>
<td>OCEAN RADIOACTIVITY ...Depth, Neutron Detectors, Proportional Counters, Reactivity, ...1.0009</td>
</tr>
<tr>
<td>Deuterium</td>
<td>LIGHT ISOTOPE STUDIES ...Chemical Reactions, Circulation,general, Isotope-Tracer-other, Mixing, Oxygen, Particle-gas Transfer, ...1.0077</td>
</tr>
</tbody>
</table>
Temperature and Humidity

Cold

METABOLIC ADAPTATION TO COLD...Female, Hypothermia, Korea, Metabolism in Disease, Regulation,...6.0092

Diving and Scuba

SEA BED INSTALLATION...Benthonic-bottom, Deep, Stabilization, Submergibles, Underwater-construction,...8.0031

MAN IN THE SEA...VISUAL ACUITY RESEARCH...Acuity, Divers, Experiments and Tests, Optical, Submersibles,...6.0089

RESEARCH SUBMARINE BEAVER MK IV...Control-systems, Scientific-service-support, Submersibles, Technique Development, Underwater-laboratory,...8.0025

DEEP OCEAN TECHNOLOGY...Continental Shelf, Survey Studies, Technique Development,...6.0049

MANNED DIVING RESEARCH...Decompression Sickness, Divers, Liquid-breathing, Medical Studies,...6.0096

HUMAN PERFORMANCE...Divers, Medical Studies, Pressure,...6.0097

LIFE SUPPORT RESEARCH...Divers, Medical Studies, Subsurface Environments, Technique Development,...6.0027

DECOMPRESSION TABLE DEVELOPMENT...Decompression Sickness, Digital Computer Applications, Divers, Mathematical Biophysics, Medical Studies, Tables, Compilations, Catalogs,...6.0098

SHARK ATTACKS...Behavioral Ecology, Sharks, Water Environment,...6.0090

ECOLOGY OF TROPICAL DEEP WATER ALGAE...Algae-General, Benthic Flora, Plant Succession, Temporal Distribution, Tropic, Vertical Distribution,...5.0722

SUPPORT OF THE RESEARCH VESSEL AHOHANA III...California, Equipment Purchase Operation, Geology-general, Marine Biology, Ships and Cruises,...12.0008

ENVIRONMENTAL PHYSIOLOGY...Life-support-system, Medical Studies, Pressure, Submergibles, Underwater-laboratory,...6.0093

HUMAN PERFORMANCE IN UNUSUAL ENVIRONMENTS...Divers, Facilities, Medical Studies, Pressure,...12.0005

INTRODUCTION OF MARINE GAME FISHES FROM AREAS IN THE PACIFIC...Hawaii, Pacific Ocean-north, Stocking of Fish & Shellfish,...5.0075

SEA LED AND SCUBA RECONNAISSANCE OF INSHORE AND STUDIES ON EFFECT OF ARTIFICIAL SHELTERS ON STANDING CROP OF FISHES...Coastlines-shorelines, Fish-non-specific, Geomorphology-topography, Hawaii, Management-other,...9.0008

LIFE-HISTORY AND BIOLOGICAL WORK IN THE...COMMERCIAL FISHING, Management-other, Population Dynamics,...5.0149

EFFECTS OF LOG RAFTING ON DUNGENESS CRAB...Contamination - Water, Crabs, Forestry, Mans Activities, Pulp, Paper, and Logging,...5.0347

POPULATION STRUCTURE OF THE LUMBER...Commercial Fishing, Lobsters, Long Island Sound, Population Dynamics, Stocking of Fish,...5.0608

HEM AND HEAT TRANSFER...Air, Heat Transfer, Helium, Submersibles, Temperature Effects,...5.0021

INVESTIGATIONS ON THE CRUSTOSE CORALLINES OF THE NORTH ATLANTIC...Atlantic Ocean-north, Marine Plants, Plant Taxonomy, Rhodophyta (non-specific & Ochoteras),...5.0072

SHALLOW WATER OCEANOGRAPHY (SEALAB III)...Diving-system, Environmental Effects-geologic, Instrumentation-general, Underwater-laboratory,...10.046

DEEP OCEAN SYSTEMS...Diving-system, Submersibles, Underwater-construction,...8.0039

SLEEP ASSISTED OCEANOGRAPHY...Benthonic-bottom, Continental Shelf, Currents-bottom, Geomorphology-topography, Marine Geology, Waves-internal,...6.0098

DIVING MEDICINE...Diffusion of Gases, Divers, Occupational Hazards, Pressure,...8.0017

ONE ATOMSOPHERE DIVERS SUIT...Diving-system, Life-support-system, Technique Development,...6.0020

462
Earth Magnetism

Applications

Ore Deposits

Testing and Evaluation of Magnetometer-Gradiometer and Tow Vehicle System...Evaluation Other, Field Testing, Instrumental Services, Magnetic Studies, Placer...8.0116

Exploration Methods

Magnetic Surveys

Geophysical Investigations in the Taiwan-Phillip-Fine-Guinea Region...Bathymetric Studies, Heat Flow Measurements, Seismic Reflection, Seismic Surveys...7.0129

SuBSurface Resistivity...Crust, Earth-telluric Current, Ocean Basins, Resistance, Texas...7.0147

Paleo Field Character

Direction

Deep-Sea Core Magnetometer and a Core Orientation System...Coring and Dredging, Magnetometers, Rock & Mineral Magnetic...8.0140

Field Reversals

Search for Ferromagnetically Trapped Magnetic Monopoles of Cosmic Ray Origin...Magnetic Monopole, Magnetic Studies, Paleomagnetism, Physical Properties...7.0166

Paleomagnetism

Search for Ferromagnetically Trapped Magnetic Monopoles of Cosmic Ray Origin...Field Reversals, Magnetic Monopole, Magnetic Studies, Physical Properties...7.0114

A Paleomagnetic Study of Tertiary and Pleistocene Oceanic Cores...Antarctic Ocean, Core Analysis, Correlation, Fossil Zones, Paleontolgy, Paleotemperature, Phylum Protozoa...7.0169

The Magnetization of Submarine Basalts and Its Effect on Marine Magnetic Anomalies...Anomalies, Extrusives, Magnetic Studies, Paleomagnetism, Seamounts-guyots...7.0153

Fluctuations

Geomagnetic Studies...Airborne Probing, Atmospheric Divisions, Earth-telluric Earth...7.0134

Induction in the Ocean...Crust, Currents-ocean, Earth Interior, Induction, Oceanic Fronts...1.0137

Patterns

Support of Research Vessel at Lamont Geological Observatory...Distributed Marine Biology, Ridges, Seismic Studies, Ships and Cruises...12.0037

Sea Heat Flows

Arctic Basin Heat Flow...Arctic, Coring and Dredging, Crust, Heat Flows, Physical Properties...7.0160

Geothermal Gradient

Arctic Basin Heat Flow...Arctic, Coring and Dredging, Crust, Heat Flows, Physical Properties...7.0160

Detection of Deep-Seated Anomalies in Electrical Conductivity Under the Gulf of California...Anomalies, Conductivity, Continental Drift, Gulf of California, Rift...7.0099

Geothermal Studies in Deep-Sea Drill Holes...Abyssal, Bathyal, Borehole Geophysics, Earth Interior, Geothermal, Heat Flow Measurements, Sediments-general, Technique Development...7.0122

Echinodermata

Brittle Stars

Polychaetes and Echinoderms in the Labrador Sea...Animal Taxonomy, Labrador Sea, Lugworms, Marine Segmentedworms, Reproductive System, Starfishes...5.0603

Ecological Studies on Tropical Intertidal Brittlestars...Habitat Studies, Tropic...5.0615

Echinodermata -other

Intestinal Adsorption and Transport of Nutrients in Echinoderms...Active Transport, Cellular Or Intracellular, Intestine, Metabolism, Sodium...5.0619

Enzyme Structure and Its Relation to Taxonomy...Animal Taxonomy, Conformational Studies, Enzymes -non-specific, Species...5.0654

Sea cucumber

A Systematic Revision of the Holothurian Family Psolidae - Echinodermata - Holothuroidea...Animal Taxonomy, Classification - Taxonomy, Comparative Anatomy, Modern Organisms, Nomenclature, Classification...5.0572

Distribution Maps of Antarctic Holothurians and Echinoïds - Echinodermat...Charts, Environmental Ecology, Sea Urchins & Other Echinoderm, Vertical Distribution...5.0573

Sea Urchins & Other Echinoderm

Biogenic Processes During Development of Sea Urchin EGGs...Basic Embryology, Cell Cycle, Messenger RNA, Nucleic Acids, Proteins...5.0775
MOLECULAR ASPECTS OF CELLULAR DIFFERENTIATION AND DIVISION ...Basic Embryology, Biosynthesis, Cell Cycle, Differentiation Mechanism, Proteins, Replication, ...5.0985
BIOCHEMISTRY OF FERTILIZATION AND EARLY DEVELOPMENT ...Basic Embryology, Fertilization, Reproductive System, Vertebrae - non-specific, ...5.0590
MACROMOLECULAR EVENTS OF FERTILIZATION AND EARLY EMBRYONIC DEVELOPMENT ...Basic Embryology, Biosynthesis, Reproductive System, Ribosomes, ...5.1011
CHARACTERIZATION AND MODE OF ACTION OF PROTEIN VENOMS OF MARINE ANIMALS ...Lechithin, Mechanism of Action, Toxics, Toxins, Venom, ...6.0102
PHYSIOLOGY OF FERTILIZATION AND NUCLEOCYTOSPLASMIC INTERACTIONS IN SEA URCHIN DEVELOPMENT ...Basic Embryology, Messenger RNA, Nucleus (non-specific & Ot.), Reproductive System, Selection & Breeding, ...5.0673
AN EXPERIMENTAL APPROACH TO THE GENETIC CONTROL OF MORPHOGENESIS IN ECHINODERMS ...Biosynthesis, Developmental Physiology, Disease & Anomalies, ...5.0608
FERTILIZATION MECHANISMS AND GAMETE PHYSIOLOGY IN MARINE INVERTEBRATES ...Basic Embryology, Male Gametes, Metabolism, Reproductive System, ...5.0590
RNA SYNTHESIS DURING SEA URCHIN DEVELOPMENT ...Basic Embryology, Differentiation Mechanism, Metabolic-biochemical Genetics, Mitochondria, Replication, ...5.0611
BIOCHEMISTRY OF DEVELOPMENT ...Basic Embryology, Control & Regulation, Differentiation Mechanism, Messenger RNA, Tryptophan Oxidase, ...5.0994
PRESENCE OF ENZYMES RELATED TO DNA SYNTHESIS IN EGG GSTUCCIDERS ...Basic Embryology, Developmental Stages, DNA Polymerase, Enzyme Formation, Nucleoside Kinase, ...5.1034
STABLE ISOTOPE FRACTIONATION IN ECHINODERM CALCITE ...Animal Taxonomy, Biogeochemical Process, Calcite, Carbon, Living Organisms, Marine Organisms, Oxygen, Sea Floor, ...5.0605
MARINE WASTE DISPOSAL AND SEA URCHIN ECOLOGY ...California, Pollution Effects, Productivity - Food Chain, Sewage, ...5.0585
CILIA DIFFERENTIATION IN THE SEA URCHIN EMBRYO ...Basic Embryology, Cilia and Flagella, Differentiation Mechanism, Proteins, Subunits, ...5.0561
CILIA DIFFERENTIATION IN MARINE EMBRYOS ...Basic Embryology, Cilia and Flagella, Lugworms, Marine Segmented-worms, ...5.0564
PROTEIN SYNTHESIS DURING THE EARLY DEVELOPMENT OF THE SEA URCHIN EMBRYO ...Basic Embryology, Cell Injury and Autolysis, Proteins, Radiation Effects - non-specific, Ribosomes, ...5.0583
DISTRIBUTION MAPS OF ANTARCTIC HOLOTHURIANS AND ECHINODERS - ECHINODERMATUM ...Charts, Environmental Ecology, Sea Cucumber, Vertical Distribution, ...5.0573
ECOLOGY OF ECHINOIDS ...Behavioral Ecology, Benthonic-bottom, Vertical Distribution, Water Environment - other, ...5.0571
SAND DOLLAR COMMUNITIES ...Beaches, California, Habitat Studies, Productivity - Food Chain, ...5.0587
ANTIGEN DISTRIBUTION OF DEVELOPING SEA URCHIN EMBRYOS ...Antigen, Basic Embryology, Immunity, Interspecific Genetic RELAT., RNA, ...5.0585
CELL DIVISION AND MITOTIC APPARATUS PROTEINS ...Biosynthesis, Cell Center & Mitotic apparatus, Cell Cycle, Centrioles, Proteins, ...5.0564
STRUCTURAL ANALYSIS OF CELL DIVISION ...Basic Embryology, Cell Cycle, Histochemistry - Cytochem., Nucleolus, Nucleus (non-specific & Or.), ...5.0645
MODE OF ACTION OF MARINE TOXINS ...Animal Toxins, Antigen, Blood Globulins, Enzyme-substrate, ...5.0603
PROTEIN SYNTHESIS ACTIVATION IN SEA URCHIN EGGS ...Basic Embryology, Biosynthesis, Metabolism, Proteins, Reproductive System, ...5.0543

Starfishes

UTILIZATION OF ENVIRONMENTAL NUTRITIONAL RESOURCES IN DIGESTIVE SYSTEM ...Basic Embryology, Environmental Physiology, Invertebrate Nutrition, Maturity & Growth Stages, Metabolism, ...5.0591

Ecology (animal)

POPULATION STUDIES ON INTERTIDAL INVERTEBRATES ...Australia, Gastropods - slugs,conch,snails, Growth Rate, Longevity, Oregon, ...5.1021
PREDATOR-PREY RELATIONSHIPS BETWEEN ECHINODERS AND MOLLUSCE ...Behavior, Behavioral Ecology, Gastropods - slugs,conch,snails, Predation, ...5.0585
POLYCHAETES AND ECHINODERS IN THE LABRADOR SEA ...Animal Taxonomy, Brittle Stars, Labrador Sea, Lugworms, Marine Segmentedworm, Reproductive System, ...5.0603
BOLATON AND FUNCTION OF OVARIAN EXTRACTS CAPABLE OF INDUCING OCYTO NUCLEAR MATURATION IN STARFISH ...Differentiation Mechanism, Female, Hormones, Nucleic Acides, Reproductive System, ...5.0620
NUTRIENT STORES IN REPRODUCTION IN SEA INVERTEBRATES ...Crabs, Decapods - other, Invertebrate Nutrition, Reproductive System, ...5.0949

Ecology (animal)

BIOLOGY CONFERENCE SERIES ...Marine Biology, Meetings, Plant Ecology (non-specific), ...11.0035
MARINE BIOLOGY RESEARCH AT THE BERMUDA BIOLOGICAL STATION ...Bermuda, Marine Biology, Marine Biology (non-specific), Plant Ecology (non-specific), ...12.0006
SYSTEMATICS MORPHOLOGY AND ECOLOGY OF THE GENUS ERYVILIA (MOLLUSCA: PELECYPODA) IN THE WESTERN ATLANTIC ...Animal Taxonomy, Atlantic Ocean, general, Freshwater Mussels, Scallops, Invertebrate Anatomy, ...5.0545

Applied Ecology

Biological Control
ENHANCEMENT OF RECREATIONAL USES OF ESTUARINE WATERS THROUGH STUDY OF POTENTIAL CONTROL METHODS FOR STINGING SEA NETTLES ...Chesapeake Bay, Eutrophication, Jelly Fish, Recreation Sites, Water Quality, ...5.0605

Pollution Effects

ECOLOGICAL SURVEY OF EFFLUENT DISCHARGE AT TWO PULP MILLS IN HUMBOLDT COUNTY, CALIFORNIA ...California, Chemical Analysis (water), Effluents-waste Water, Pollution - Effects of, Pulp, Paper, and Logging, ...5.0585
COLUMBIA RIVER STUDIES ...Columbia River, Contamination ...Water, Invertebrates, Oysters, Radioactivity-general, Reproductive System, ...5.0583
ECOLOGICAL EFFECTS OF ENVIRONMENTAL & LOW LEVEL POLLUTION STRESSES ON METABOLIC REQUIREMENTS FOR GROWTH OF GULF COAST FISHES ...Environmental Ecology, Gulf of Mexico, Metabolism, Pollution - Effects of, Pollution Sources-general, Stress, ...5.0328
OPTIMUM ECOLOGICAL DESIGNS FOR ESTUARINE SYSTEMS OF NORTH CAROLINA ...Domestic Wastes, Estuaries, Marine Biology (specific), North Carolina, Pollution - Effects of, Productivity - Food Chain, ...5.0591

ESTUARINE WATER QUALITY AND FISH DISTRIBUTION ...Contamination - Water, Environmental Physiology, Estuaries, Pulp, Paper, and Logging, Salmon & Trout - Non-specific, ...5.0517

IMPACT AND FATE OF POLLUTION IN ESTUARIAL WATERS ...Degradation, Estuaries, Massachusetts, Pesticides - non-specific, Pollutants - Path of, ...5.0615
WATER QUALITY - BENTHIC INVERTEBRATE RELATIONSHIPS IN ESTUARIES ...Benthic Fauna, Benthonic-bottom, Estuaries, Maine, Pollution - Effects of, ...5.0603
ENTERIC BACTERIA AND VIRUSES IN SEWAGE, WATER, AND SHELLFISH ...Bacterial Pollutant Sources, Califorinos (specific), Oysters, Sewage, Viral Pollutant Sources, ...5.0602

MARINE WASTE DISPOSAL AND SEA URCHIN ECOLOGY ...California, Productivity - Food Chain, Sea Urchins & Other Echinoderm, Seaweed, ...5.0949

DEMONSTRATION OF THE LIMITATIONS AND EFFECTS OF WASTE DISPOSAL IN AN OCEAN SHELF ...Marine Plants, Ocean, Outlet, Pollution - Effects of, Sewers, ...5.0146

465
### Ecology (animal)

#### SUBJECT INDEX

<table>
<thead>
<tr>
<th>Title</th>
<th>Subtitle</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEASUREMENT OF RADIONUCLIDES IN ESTUARINE AND MARINE ENVIRONMENTS (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION)</td>
<td>Estuaries, Marine Environments-general, Pollution - Effects of</td>
<td>5.0381</td>
</tr>
<tr>
<td>RATES OF PESTICIDE BUILDUP IN SALMONIDS RECENTLY INTRODUCED IN THE GREAT LAKES</td>
<td>Pesticides - Aquatic Or Soil-equal cycles, Bioassay, Fish, Persistence of Residues, Pesticides(non-specific)</td>
<td>5.0881</td>
</tr>
<tr>
<td>MECHANISMS OF PESTICIDE ACCUMULATION IN AQUATIC ENVIRONMENTS</td>
<td>Chlorine Dioxide, Food Chains, Animal And/or Man, Insecticides(non-specific), Productivity - Food Chain</td>
<td>6.0154</td>
</tr>
<tr>
<td>ESTUARINE ECOSYSTEMS</td>
<td>Aquatic Ecology, Estuaries, Pesticide, Pollution - Effects of, Population Dynamics</td>
<td>5.0883</td>
</tr>
<tr>
<td>HISTOPATHOLOGIC EFFECTS OF POLLUTANTS ON CELLS AND TISSUES OF MARINE FISHES</td>
<td>Contamination - Water, Killifish - Cyprinodon, Pathology, Pollution - Effects of</td>
<td>5.0323</td>
</tr>
<tr>
<td>HISTOPATHOLOGIC EFFECTS OF POLLUTANTS ON CELLS AND TISSUES OF MARINE INVERTEBRATES</td>
<td>Clams, Contamination - Water, Invertebrate Pathology, Pathology, Pollution - Effects of, Pollution Sources-other</td>
<td>5.0497</td>
</tr>
<tr>
<td>USE OF MARINE PLANKTONIC ORGANISMS FOR EVALUATING THE QUALITY OF MARINE AND ESTUARINE WATERS</td>
<td>Bioassays, Estuaries, Phytoplankton, Pollution - Effects of</td>
<td>5.0882</td>
</tr>
<tr>
<td>PESTICIDE RESISTANT FISH IN NATURAL ECOSYSTEMS</td>
<td>Animal Resistance -other, Endrin, Fish, Food Chains, Animal And/or Man, Rates, Doses, Concentrations</td>
<td>5.0277</td>
</tr>
<tr>
<td>MICROBIOLOGY OF ESTUARINE AND SHELFFISH POLLUTION</td>
<td>Bioindicators, Clams, Estuaries, Oysters, Sanitation</td>
<td>5.0152</td>
</tr>
<tr>
<td>PUBLIC HEALTH ECOLOGY</td>
<td>ASPECTS OF RELATIONSHIPS BETWEEN MARINE ECOLOGY AND HUMAN HEALTH</td>
<td>5.0812</td>
</tr>
<tr>
<td>REACTOR SITES &amp; RAD WASTE</td>
<td>MEASUREMENT OF RADIONUCLIDES IN ESTUARINE AND MARINE ENVIRONMENTS (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION)</td>
<td>5.0889</td>
</tr>
<tr>
<td>ACCUMULATION OF RADIOACTIVITY BY INVERTEBRATES (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION)</td>
<td>Contaminated - Water, Cooperative-studies, Diagnostic Procedures, Radioactivity</td>
<td>5.0092</td>
</tr>
<tr>
<td>AQUATIC ECOLOGY</td>
<td>COLOGICAL STUDY OF DUXBURY BAY</td>
<td>5.0898</td>
</tr>
<tr>
<td>MICROBIOLOGICAL ASSAYS OF SEAWATER USING RADIOISOTOPES</td>
<td>Ciliates, Environmental Ecology, Environmental Physiology, Food Chain, Phytoplankton, Productivity - Food Chain, Thermocline</td>
<td>5.0811</td>
</tr>
<tr>
<td>CONTROLLED ENVIRONMENTAL FACTORS ON THE DEVELOPMENT OF ESTUARINE AND OCEANIC CRUSTACEA</td>
<td>Copepods, Developmental Physiology, Estuaries, Salinity, Temperature</td>
<td>5.0476</td>
</tr>
</tbody>
</table>

#### YEAR-ROUND PROGRAM OF RESEARCH IN MARINE ECOLOGY
- **Animal Taxonomy**, Marine Biology (non-specific), Plant Ecology, Taxonomy, Training Grants, Fellowships | 5.0899 |

#### LIVING AND FOSSIL ZOOPLANKTON, AND RELATED PROBLEMS OF PALAEONTOLOGY
- **Biology**, Ecological, Microfossils, Palaeoecology, Zooplankton | 5.0832 |

#### FACTORS AFFECTING HORIZONTAL DISTRIBUTION OF MESOPELAGIC FISHES
- Atlantic Ocean-north, Behavioral Ecology, Fish -non-specific, Range Or Territorial Dist., Vertical Distribution | 5.0145 |

#### MECHANISMS OF HOMEING AND ORIENTATION OF SALMO CLARKI IN YELLOWSTONE LAKE AND ITS TRIBUTARIES
- Behavior, Biological Rhythms, Cutthroat Trout, Wyoming | 5.0279 |

#### NEUROENDOCRINE PATHWAYS IN OSMOREGULATION IN CRUSTACEANS
- Endocrine Systems, Environmental Physiology, Osmoregulation, Shrimps - Common | 5.0427 |

#### SYSTEMATICS OF ANTARCTIC HYMENOSTOMATIDA (PROTOZOA)
- Animal Taxonomy, Antarctic, Ciliates, Habitat Studies | 5.0815 |

#### PLANKTON ECOLOGY
- Copepods, Lake Michigan, Plankton Sampling, Shrimp and Crayfish, Zooplankton | 5.0863 |

#### INVESTIGATE THE FEASIBILITY OF INTRODUCING SOCKEYE SALMON INTO RESERVOIRS
- Captive Rearing, Oregon, Reservoirs and Impoundments, Salmon -coho,chinook,sockeye, Stocking of Fish & Shellfish | 5.0141 |

#### EFFECTS OF PESTICIDES ON ESTUARINE PRODUCTIVITY
- Estuaries, Mann Activities, Persistence of Residues, Pesticides -non-specific, Pollutants - Effects of | 5.0880 |

#### LIFE HISTORY STUDY OF THE MOL, POLYDACCTYLUUS SEXFILIS
- Fish -other, Life History Studies, Management -other,.Tags | 5.0279 |

#### ESTUARINE DREDGE HOLE INVESTIGATIONS
- Coring and Dredging, Estuaries, Fish -non-specific, Habitat Studies | 5.0908 |

#### SILVER SALMON STUDIES IN THE RESURRECTION BAY AREA
- Alaska, Bays, Environmental Ecology, Management -other, Salmon -coho,chinook,sockeye | 5.0899 |

#### INVENTORY OF LARVAL FISH
- Brackish Water, Fish -non-specific, Maturity & Growth Stages | 5.0097 |

#### PRE-EMERGENT FRY PINK SALMON FORECAST
- *Southeastern Alaska*, Censusing, Number Or Density, Salmon -coho,chinook,sockeye, Spawning & Nesting Sites | 5.0019 |

#### LOCALIZING AND MAPPING THE EXISTING SEED OYSTER BEDS IN DELAWARE BAY
- Bays, Delaware Bay, Mapping, Oysters, Spawning & Nesting Sites | 5.0381 |

#### COPPER RIVER SOCKEYE SALMON INVESTIGATIONS
- Alaska, Biological Rhythms, Migration, Population Dynamics, Salmon -coho,chinook,sockeye, Stocking of Fish & Shellfish | 5.0025 |

#### FLUSHING PATTERN OF CERTAIN TIDAL STREAMS IN DELAWARE
- Circulation -water, Delaware, Discharge, Industrial-general, Tidal Streams | 5.0013 |

#### EFFECTS OF THERMAL POLLUTION ON PRODUCTIVITY AND STABILITY OF ESTUARINE COMMUNITIES
- Environmental Ecology, Estuaries, Plant Prod. (non-specific), Pollution - Effects of | 5.0152 |

#### FLUSHING PATTERN OF CERTAIN TIDAL STREAMS IN DELAWARE
- Circulation -water, Delaware, Discharge, Industrial-general, Tidal Streams | 5.0013 |

#### THE BIOLOGY OF THE INFANNA OF A TROPICAL SOFT BOTTOM AREA
- Benthic Fauna, Estuaries, Florida, Intertidal Areas, Pollution - Effects of | 5.0080 |

#### ENVIRONMENTAL BIOLOGY OF TOMALES BAY
- Benthic Fauna, California, Marine Activities, Pollution - Effects of | 5.0080 |
Ecology (animal)

SOCKEYE SALMON MIGRATORY BEHAVIOR AND BIOLOGICAL STATISTICS COLLECTION, SOUTHEAST-\(\text{RIN ALASKA}\) ...Alaska, Aquatic Ecology, Censusing, Migration, Salmon, Sockeye ...Salmon (non-specific), ...5.0193

ALBACORE TUNA ...Environmental Ecology, Life History Studies, Tags, Tuna, Mackerel, Albacore, ...5.0143

ECOLOGY OF ECHINOIDS ...Benthonic-bottom, Sea Urchins & Other Echinoderms, Vertical Distribution, Water Environment -other, ...5.0571

REPRODUCTIVE ISOLATING MECHANISMS IN PANAMA\-\-AN INSHORE MARINE FISHES ...Comparative Physiology, Fish -non-specific, Panama, Reproduction Studies (general), ...5.0244

ECOLOGY OF PANAMANIAN REEF COMMUNITIES ...Invertebrates -non-specific, Panama, Productivity - Food Chain, Reefs, Tropic, ...5.0866

BIOLOGICAL FALSE TARGETS AND RELATED ACOUSTIC CHARACTERISTICS ...Animal Taxonomy, Fish -non-specific, Sound Production, ...1.0041

LIFE HISTORY -ND BEHAVIOR OF FISHES ON ARTIFICIAL REEFS ...Fish -non-specific, Habitat Studies, Life History Studies, Population Dynamics, ...5.0121

DIURNAL-NOCTURNAL ACTIVITY OF THE QUEENFISH, SERIPHUS POLITUS ...Aquatic Ecology, Biological Rhythms, Drums, Fish -other, Other, Sound Production, ...5.0230

ECOLOGY OF THE KELP FORESTS ...California, Environmental Ecology, Fish -non-specific, Habitat Studies, Laminariaceae (non-specific) ...5.0194

NATURAL HISTORY OF Predators AND COMPETITORS (Predator Control Program) ...Competition, Control of Nuisance Species, Environmental Ecology, Oysters, Prediction, ...5.0377

FUR SEAL RESEARCH, PELAGIC INVESTIGATIONS ...Food Supply, Seals, Vertical Distribution, ...5.0667

ADULT SALMON BEHAVIOR STUDIES IN RIVERS AND AT NAMS (SONIC TRACKING) ...Engineering Structures-general, Salmon & Trout - Non-specific, Streams, Tags, Telemetry, ...5.0111

MECHANISMS AFFECTING THE VERTICAL AND HORIZONTAL DISTRIBUTION OF TUNAS AND RELATED SPECIES ...Environmental Ecology, Mark, Tag Or Capture -other, Tuna, Mackerel, Albacore, ...Vertical Distribution, ...5.0086

INTERRELATIONS OF ALEWIVES AND ASSOCIATED SPECIES ...Alewife, menhaden, shad, herring, Competition, Lake Michigan, Predation, Vertical Distribution, ...5.0111

MARINE FISH BEHAVIOR ...Commercial Fishing, Fish -non-specific, Fishing Gear, ...5.0176

FISHWAY RESEARCH (BONNEVILLE LABORATORY) ...Engineering Structures-general, Environmental Ecology, Management -other, Migration, Salmon & Trout - Non-specific, ...5.0016

PREDICTING COMMERCIAL SHRIMP ABUNDANCE (SHRIMP DYNAMICS PROGRAM) ...Bays, Commercial Fishing, Environmental Ecology, Population Dynamics ..., Shrimp -Common, ...5.0499

RECONNAISSANCE ECLOGIC SURVEY OF THE CONTINENTAL SHELF AND UPPER SLOPE (GULF OCEANOGRAPHY PROGRAM) ...Biology, Continental Shelf, Environmental Ecology, Migration, Population Dynamics, Shrimps -Common, ...5.0592

SCHOOLING BEHAVIOR ...Alewife, menhaden, shad, herring, Anchovies, Environmental Ecology, Tuna, Mackerel, Albacore, ...5.0059

CTFM SONAR ...Commercial Fishing, Locomotion -animal, Sonar and Echo Sounding, Telemetry, Tuna, Mackerel, Albacore, ...5.0026

SEALAB III PARTICIPATION ...bioluminescence, Divers, Diving and Scuba, Medical Studies, Submersibles, ...5.0091

Competition

INTERACTIONS OF INTERDITAL POPULATIONS ...Habitat Studies, Intertidal Areas, Population Dynamics, Predation, ...5.0086

TRAMMEL NET SAMPLING IN ESTUARINE AREAS ...Estuaries, Fish -non-specific, Lakes, Nets, Population Dynamics, ...5.0096

NATURAL HISTORY OF PREDATORS AND COMPETITORS (Predator Control Program) ...Behavioral Ecology, Control of Nuisance Species, Environmental Ecology, Oysters, Prediction, ...5.0377

METHODS OF CONTROL OF PREDATORS AND COMPETITORS (Predator Control Program) ...Control of Nuisance Species, Gastropods -slugs, conch, anais, Oysters, Predation, ...5.0087

INTERRELATIONS OF SMELT WITH NATIVE SPECIES ...Food Supply, Lake Superior, Life History Studies, Number Or Density, Smelts, ...5.0182

INTERRELATIONS OF ALEWIVES AND ASSOCIATED SPECIES ...Alewife, menhaden, shad, herring, Behavioral Ecology, Lake Michigan, Predation, Vertical Distribution, ...5.0111

Interbenthic Relat.(non-specific)

ECOLOGICAL SIGNIFICANCE OF PARTICULATE MATTER IN THE SEA ...Atlantic Ocean-north, Marine Bacteria, Organic Matter Content -water, Temporal Distribution, Vertical Distribution, Zooplankton, ...5.0734

RELATIONSHIPS BETWEEN PHYTOPLANKTON AND ZOOPLANKTON IN THE CARIBBEAN SEA ...Caribbean Sea, Phytoplankton, Sargassum, Vertical Distribution, Zooplankton, ...5.0779

DIVERSITY, COMMUNITY STRUCTURE AND TROPHIC RELATIONS OF TROPICAL ZOOPLANKTON ...Bays, Productivity - Food Chain, Tropic, Zooplankton, ...5.0765

SEAL BIOLOGY AND HARVEST ...Alaska, Environmental Ecology, Life History Studies, Reproduction Studies (general), Seals, ...5.0022

STUDIES OF SOCKEYE SALMON, ONCORHYNCHUS NERKA, IN THE NUSHAGAK DISTRICT, ALASKA ...Alaska, Commercial Fishing, Lakes, Population Dynamics, Salmon - coho, chinook, sockeye, Spawning & Nesting Sites, ...5.0028

STUDIES OF FISH FAMILIES ARIDAE AND ASPIDINIDAE ...Animal Taxonomy, Fish -other, Neotropical, Tropic, ...5.0052

THE ROLE OF THE SENORITA, OXYJULIS CALIFORNICA, AS A CLEANING ORGANISM ...California, Ectoparasites, Fish -other, Fishery Development -other, ...5.0193

CHARACTERISTICS OF LAKE SUPERIOR WHITEFISH ...Commercial Fishing, Lake Superior, Life History Studies, Salmon & Trout - Non-specific, Tags, ...5.0183

DISTRIBUTION AND ABUNDANCE OF ZOOPLANKTON IN LAKE ERIE ...Aquatic Ecology, Computer Applications, Environmental Ecology, Lake Erie, Population Dynamics, ...5.0082

Predation

PREDATOR PREY RELATIONSHIPS BETWEEN ECHINODERMS AND MOLLUSCE ...Behavior, Behavioral Ecology, Gastropods -slugs, conch, anais, Starfishes, ...5.0081

CHEMISTRY AND BIOLOGY OF SOME COELENTERATE NEMATOCYSTS ...Animal Toxins, Cell, organ & Organoids - other, Coelenterata -other, Invertebrate Physiology, ...5.0076

SIMULATION STUDIES OF ECOLOGICAL COMMUNITIES ...Mortality Rates, Number Or Density, Population Dynamics, Productivity - Food Chain, ...5.0086

EXPERIMENTAL AND BIOMATHEMATICAL ANALYSIS OF THE PHENOMENON OF ATTACK ...Behavioral Ecology, Bluegills, Bream, Computer Methods -general, Environmental Physiology, Largemouth Bass, Minnows, ...5.0035

THE EFFECTS OF SEAL AND FISH PREDATION ON CERTAIN ANTARCTIC BENTHIC COMMUNITIES ...Antarctica, Benthic Organisms (non-specific), Behavioral Ecology, Fish -non-specific, Productivity - Food Chain, Seals, ...5.0092

INTERACTIONS OF INTERDITAL POPULATIONS ...Competition, Habitat Studies, Intertidal Areas, Population Dynamics, ...5.0064

DEEP-WATER FOULING ...Biological, Fish -non-specific, Fouling, Vertical Distribution, ...5.0323

ESTIMATE OF STANDING CROP OF OYSTERS AND SURVEY OF OYSTER PREDATORS IN GEORGIA ...Censusing, Georgia, Oyster ...5.0416

PRELIMINARY MODIFICATIONS AND CONTROL OF NATURAL GROWING AREA ENVIRONMENTS ...Capture Rearing, Cams, Growth Rate, Mineral Content -water, Oysters, ...5.0045

INFLUENCE OF UNLIMITED FOOD SUPPLY ON RHYMTHIC ACTIVITY OF BLUEFISH ...Biological Rhythms, Bluefish, Food Supply, ...5.0012

NATURAL HISTORY OF PREDATORS AND COMPETITORS (Predator Control Program) ...Behavioral Ecology, Competition, Control of Nuisance Species, Environmental Ecology, Oysters, ...5.0077

474
SUBJECT INDEX

Ecology (animal)

RECONNAISSANCE ECOLOGIC SURVEY OF THE CONTI-
NENTAL SHELF AND UPPER SLOPE (GULF OCEANO-
GRAPHY PROGRAM) ...Behavioral Ecology, Biology, Continent-
al Shelf, Environmental Ecology, Population Dynamics, Shrimps - Common, ...5.0502

AERIAL SEA SURFACE TEMPERATURE SURVEYS OF U. S.
COASTAL WATERS ...Aircraft, Infrared Radiation, Productiv-
ity - Food Chain, Temperature, Water Temperature-non-
specific, ...4.0148

Population Dynamics

POPULATION STUDIES OF HAUSTORIDAE AND GAM-
MABIDAE FROM NEW ENGLAND AND ON THE AUNAL
AND EPEAUNAL MARINE AMPHIBIDS AT HAYETOR
...Atolls, Habitat Studies, Micronesia, Shrimp - Amphipods,
...5.0646

RELATIONSHIPS AMONG POPULATIONS OF LIMNORIA
TRIPLUNCTATA ...Animal Taxonomy, Iopods, Reproductive
System, ...5.0477

PRODUCTIVITY OF OCEANIC POPULATIONS OF VERTI-
CALLY MIGRATING ANIMALS ...Migration, Plankton (non-
specific), Productivity (agricultural), Vertical Distribution,
...5.1019

DEVELOPMENT AND EVALUATION OF A NEW TECHNIQUE
FOR SAMPLING ZOOPLANKTON ...Organism Sampling
Devices, Productivity - Food Chain, Technique Development,
Vertical Distribution, Zooplankton, ...5.0786

SIMULATION STUDIES OF ECOLOGICAL COMMUNITIES
...Mortality Rates, Number Or Density, Predation, Productivity
- Food Chain, ...5.0473

REPRODUCTIVE RELATIONSHIPS AMONG POPULATIONS
OF A MARINE WOOD-BORING ISOPOD ...Animal Taxo-
my, Invertebrate Anatomy, Iopods, Reproductive System,
...5.0514

MROIZOOPLANTERS IN THE MARINE FOOD CHAIN
...Organism Sampling Devices, Productivity - Food Chain, Ver-
tical Distribution, Zooplankton, ...5.0748

POPULATION DYNAMICS OF ANTARCTIC SEALS ...Aerial
Photography, Antarctica, Migration, Seals, ...5.0634

PELAGIC SHARKS OFF SOUTHERN CALIFORNIA ...Environ-
mental Ecology, Pacific Ocean-general, Population Dynamics,
...5.0636

ECOLOGY OF MARINE BIVALVE MOLLUSCAN LARVAE
...Behavioral Ecology, Clams, Fouling, Productivity - Food
Chain, Vertical Distribution, ...5.0370

BIOMETRY ...Marine Biology, Navigation, Statistics-general,
Temporal Distribution, ...4.0019

ARCTIC PLANKTON ECOLOGY ...Acoustical, Arctic, Marine
Biology (non-specific), Oceanic Fronts, Plankton (non-
specific), ...1.0017

DEEP SEA BENTHOS IN THE GULF OF MEXICO ...Benthic
Fauna, Benthonic-bottom, Biology, Gulf of Mexico, ...5.0655

GULF OF CALIFORNIA BIOLOGY ...Arid and Desert, Biolu-
tinance, Gulf of California, Intertidal Areas, Tropic,
...5.0856

INTERACTIONS OF INTERTIDAL POPULATIONS ...Competition,
Habitat Studies, Inertial Areas, Predation, ...5.0748

BIOLIGIC SOUND SCATTERING ...Acoustical, Reverberation,
Scattering, Vertical Distribution, Zooplankton, ...1.0050

MARINE BIOLOGY OF RED SEA AND EASTERN MEDITER-
RANEAN ...Benthic Flora, Mapping, Red Sea, ...5.0891

ECOLOGICAL INVESTIGATIONS OF SOME COMMON
MARINE FISHES OFF THE MEDITERRANEAN COAST OF
ISRAEL ...Fish non-specific, Mediterranean Sea-general,
Productivity - Food Chain, Range Or Territorial Distr.,
...5.0080

EFFECTS OF PESTICIDES ON ESTUARINE PRODUCTIVITY
...Agricultic Ecology, Estuaries, Mann Activities, Persistence of
Residues, Pesticides -non-specific, Pollution - Effects of, Stand-
ing Crops, ...5.0080

SEA OTTER ...Alaska, Metamorphosis, Range Or Territorial
Dist. ...Sea Lions, Fur Seals, Stocking of Mammals, ...5.0528

WALRUS BIOLOGY AND POPULATION ...Behavioral Ecology,
Censusing, Migration, Reproduction Studies (general), Seals,
...5.0523

POPULATION STUDIES OF ANADROMOUS FISH - UPPER
COOK INLET DRAINAGES ...Alaska, Captive Rearing, Cen-
susing, Salmon -coho,chinook,sockeye, ...Streems, ...5.0620

CHEMICAL AND PHYSICAL DATA ...Fish -non-specific, Tem-
perature, Turbidity & Suspended Matter, Water Movement,
...5.0542

FARMINGTON RIVER SHAD STUDIES ...Alewife,men-
haden,shad,herring, Bottom Sampling, Captive Rearing,
Sampling, Strains, ...5.0203

MOVEMENTS OF FRESHWATER CATFISH IN THE ESTUA-
RIES OF SOUTHWEST LOUISIANA ...Blue Catfish, White
Catfish, Environment Resistance, Estuaries, Louisiana, Water
Salinity, ...5.0490

ECOLOGY OF RECREATIONALLY IMPORTANT
ESTUARINE FISHES IN OREGON ...Aquatic Ecology, En-
vironmental Ecology, Estuaries, Fishing, Oregon, Population
Dynamics, ...5.0116

MIGRATORY HABITS OF LARGE SHARKS ...Atlantic Ocean-
north, Fishing, Sharks, Tags, ...5.0147

ABUNDANCE AND MIGRATION STUDIES OF THE WHITE
SEAPERCH (P. FURCATUS), PILE PERCH (R. VACCA),
STRIPEE SEAPERCH (E. LATERALIS) AND STARRY
FLOU ...Environmental Ecology, Fish -other, Number Or Den-
sity, Oregon, Righteye Flounders, ...5.0934

EFFECT OF ENVIRONMENTAL CHANGES ON BLUE CRAB
ABUNDANCE ...Crabs, Environmental Ecology, Life History
Studies, Number Or Density, Population Dynamics, ...5.0473

TAGGING ...Alewife,menhaden,shad,herring, Population Dyna-
ics, Tags, Telemetry,Vertebrate Anatomy, ...5.0127

BRISTOL BAY ESTUARINE ECOLOGY ...Alaska, Estuaries,
Fishing, Gear, Life History Studies, Oceanic Fronts, Salmon
-coho,chinook,sockeye, ...5.0004

NAKNEK SYSTEM RED SALMON STUDIES ...Alaska, Growth
Rate, Number Or Density, Salmon -coho,chinook,sockeye,
...Streems, ...5.0203

ADMINISTRATION OF WHALING ACT, PROTECTED AND
NON-COMMERCIAL WHALES ...Censusing, Growth Rate, Mammals,
Reproduction Studies (general), Vertebrate Anatomy,
...5.0069

COLLECTION OF JUVENILE MIGRANTS FROM RIVERS
AND STREAMS ...Electric Power Plants, Environmental Engi-
neering Structures-general, Fish -non-specific, Management -other,
Streams, ...5.0513

JUVENILE MIGRATION RATES ...Columbia River, Mark, Tag
Or Capture -other, Salmon & Trout -Non-specific, Snake
River, Water Environment -other, ...5.0223

ADULT MIGRATION RATES ...Columbia River, Environmental
Ecology, Management -other, Pre-impoundment Sites, Salmon
-coho,chinook,sockeye, ...5.0173

ELECTRIC BARRIER OPERATIONS ...Control of Nuisance Spec-
ies, Lake Michigan, Lake Superior, Lampreys, Population
Dynamics, ...5.0620

MIGRATION OF ATLANTIC TUNAS ...Africa, Atlantic Ocean-
general, Tags, Tuna, Mackerel, Albacore, ...5.0864

BERING SEA CRAB STUDIES ...Bering Sea, Commercial
Fishing, Crabs, Environmental Ecology, ...5.0341

ADULT SALMON BEHAVIOR STUDIES IN RIVERS AND AT
DAMS %SONIC TRACKING4O ...Columbia River, Construc-
tion Land Use Effects, Pre-impoundment Sites, Salmon & Trout
-Non-specific, Telemetry, ...5.0169

EFFECT OF SUPERSATURATION OF DISSOLVED
NITROGEN ON EMBRIO MATURATION ...Aquatic Ecol-
ogy, Columbia River, Gases, Dissolved -water, Mortality Rates,
Nitrogen, Salmon & Trout -Non-specific, ...5.0221

FISH BEHAVIOR AND PHYSIOLOGY ...Behavior, Engineering
Structures-general, Environmental Physiology, Salmon & Trout
-Non-specific, Thermal Pollution, ...5.0331

FISHWAY RESEARCH (BONNEVILLE LABORATORY)
...Behavioral Ecology, Engineering Structures-general, Environ-
mental Ecology, Management -other, Salmon & Trout - Non-
specific, ...8.0016

PROTECTION OF FINGERLING SALMON IN TURBINES
...Conservation, Land Use Effects, Engineering Structures-
general, Mortality Rates, Salmon & Trout -Non-specific, Snake
River, ...8.0014
Ecology (animal)

SUBJECT INDEX

Currents, Water Salinity, Water Temperature, Non-specific, ...5.0207
INVESTIGATION OF ANADROMOUS DOLLY VARDEN POPULATIONS IN HOOD BAY DRAINAGES, SOUTHEASTERN ALASKA ...Alaska, Lake Trout, Brook Trout, Migration, Streams, ...5.0013
TRAMMEL NET SAMPLING IN ESTUARINE AREAS ...Competition, Eutrophication, Fish - non-specific, Lakes, Nets, ...5.0696
FISH POPULATIONS IN THE CHENA RIVER ...Alaska, Pikes, Pickeral, Muskelunge, Salmon & Trout - Non-specific, Streams, ...5.0029
HAIR SEALS ...Age, Dispersion - other, Metamorphosis, Seals, Spawning & Nesting Sites, ...5.0052
SPOTFISH YIELD OF NATURAL REEFS ...Bays, California, Fishery Development - other, Habitat Studies, ...5.0199
ESTIMATION OF PARAMETERS OF STRIPED BASS POPULATION AND DESCRIPTION OF THE FISHERY OF LOWER CHESAPEAKE BAY ...Age, Sex, - sea, White Perch, Censusing, Chesapeake Bay, Fishing Gear, ...5.0151
STUDY ON THE DISTRIBUTION AND ABUNDANCE OF PINK SHRIMP, PANDALUS JORDANI, IN THE PACIFIC OCEAN OFF OREGON ...Censusing, Fishing Gear, Life History Studies, Pacific Ocean-general, Shrimp, Common, ...5.0487
IDENTIFICATION OF WINTER FLounder SUBPOPULATIONS ...Commercial Fishing, Legislation, Nets, Righteye Flounder, Tugs, ...5.0180
KVICHER RIVER TOTAL SMOLT ...Alaska, Censusing, Fish - non-specific, Migration, Mortality Rates, Nets, ...5.0002
SEA SURVEY INVESTIGATIONS ...California Current, Fish - non-specific, Fishery Studies, Vertical Distribution, ...4.0117
KING CRAB SAMPLING GEAR STUDY ...Alaska, Censusing, Crabs, Fishing Gear, Spawning & Nesting Sites, ...5.0113
DUNGENESS CRAB POPULATION DYNAMICS STUDY ...Alaska, Life History Studies, Tugs, ...5.0436
ARCTIC-YUKON-KUSKOKWIM AREA ANADROMOUS FISH INVESTIGATIONS ...Alaska, Commercial Fishing, Life History Studies, Salmon & Trout - Non-specific, Salmon -coh0,chinook,sockeye..., ...5.0024
MEASUREMENT OF BIOLOGICAL FACTORS OF VARIOUS ARCTIC-YUKON-KUSKOKWIM AREA ANADROMOUS FISH ...Alaska, Aquatic Ecology, Biological Rhythms, Migration, Salmon, ...5.0448
COPPER RIVER SOCKEYE SALMON INVESTIGATIONS ...Alaska, Aquatic Ecology, Biological Rhythms, Migration, Salmon -coh0,chinook,sockeye..., Stocking of Fish & Skatefish, ...5.0025
TAG RECOVERY, ENGLISH SOLE, PETRALE SOLE, AND PACIFIC HERRING ...Codfishes, Hake, Migration, Righteye Flounders, Tugs, Washington, ...5.0119
POPULATION STRUCTURE OF THE LOBSTER ...Commercial Fishing, Diving and Scuba, Lobsters, Long Island Sound, Size, ...5.0688
TAGGING PROGRAM ...Lobsters, Long Island Sound, Number Or Density, Tags, Temporal Distribution, ...5.0372
LAKE BORGO - CHANDELER SOUND SYSTEM ...Data Acquisition, Gulf of Mexico, Maturity & Growth Stages, Nets, Plankton Sampling, Shrimps - Common, ...5.0434
BIOMETRIC AND CHEMICAL STUDY OF VIRGINIA'S ESTUARIES ...Estuaries, Nitrogen, Phosphorus, Phytoplankton, Primary Productivity, Virginia, ...5.0158
STUDIES OF SOCKEYE SALMON, ONCORHYNCHUS NERKA, IN THE NUSHAGAK DISTRICT, ALASKA ...Sockeye, Fingerling, Alaska, Commercial Fishing, Interbiotic Relat. (non-specific), Lakes, Salmon -coh0,chinook,sockeye..., Spawning & Nesting Sites, ...5.0028
REPOPULATION OF DECIMATED SECTIONS OF WARM-WATER STREAMS BY LONGEARED SUNFISH, LEPOMIS MEGALGOLUS (RANBORUS) ...Aquatic Ecology, Stocking of Fish & Skatefish, Streams, Sunfish, Rock & Roanoke Bass, Warm Water, ...5.0097
A NON-DESTRUCTIVE METHOD FOR ESTIMATING POPULATION DENSITY AND DISTANCE TO NEAREST NEIGHBOR FOR ESTUARINE MOLLUSCS ...Aquatic Ecology, Estuaries, Mollusks - non-specific & Other, Number Or Density, Range Or Territorial Dist., ...5.0039
THE POPULATION ECOLOGY OF GEMMA GEMMA (PELECYPODA, VENERIDAE), A DOMINANT SPECIES IN BARNSTABLE HARBOR, MASS ...Clams, Harbors, Massachusetts, ...5.0460
MARINE SPORTS FISHES RESEARCH ...Delaware Bay, Fish - other, Killifishes - Cyprinodonts, Water Salinity, Water Temperature, Non-specific, ...5.0248
ECOLOGY OF COMMERCIAL FISH SPECIES IN NORTHERN LAKE MICHIGAN ...Commercial Fishing, Fish - non-specific, Lake Michigan, Number Or Density, Vertical Distribution, ...5.0112
INVESTIGATIONS OF COMMERCIAL FISH POPULATIONS IN WESTERN LAKE SUPERIOR ...Alewife, menhaden, shad, herring, Commercial Fishing, Lake Superior, Lakes, Nets, ...5.0113
ECOLOGY OF RECREATIONALLY IMPORTANT ESTUARINE FISHES IN OREGON ...Aquatic Ecology, Environmental Ecology, Estuaries, Fishing, Migration, Oregon, ...5.0216
EFFECTS OF KRAFT PULP MILL EFFLUENTS ON THE GROWTH AND PRODUCTION OF FISH ...Contamination - Water, Industrial Wastes, Pollution - Effects of, Pollution Effects, Pulp, Paper, and Logging, Salmon & Trout - Non-specific, ...5.0311
POPULATION ESTIMATES OF JUVENILE COHO SALMON IN SIX COASTAL STREAMS ...Environmental Ecology, Mortality & Growth Stages, Salmon -coh0,chinook,sockeye..., ...5.0144
INFANOA OF LOWER CHESAPEAKE BAY ...Aquatic Ecology, Chesapeake Bay, Shrimp - amphipods, Streams, Virginia, ...5.0581
MOVEMENTS OF SEABIRDS IN THE HUMMELDORF CURRENT ...Aves - other, Biological Rhythms, Humboldt Or Peru Current, Temporal Distribution, ...5.0461
LIFE HISTORY AND BEHAVIOR OF FISHES ON ARTIFICIAL REEFS ...Behavioral Ecology, Fish - non-specific, Habitat Studies, ...5.0121
TRACKING MIGRATIONS OF BLUEFISH POPULATIONS ALONG ATLANTIC COAST TO LEARN BIOLOGY OF THE SPECIES (MIGRATORY HABITS OF BLUEFISH) ...Atlantic Ocean-north, Bluefish, Migration, Tugs, ...5.0120
TAGGING PROGRAM WITH WOODS HOLE AND INTERNATIONAL GAME FISH ASSOCIATION FOR MARLIN, SAILFISH AND OTHER GAME SPECIES MIGRATION STUDIES ...Marlin, Billfishes, Sailfish, Migration, Pacific Ocean-general, Tugs, ...5.0833
AGE AND GROWTH OF BLUEFISH ...Age, Atlantic Ocean-north, Bluefish, Growth Rate, ...5.0287
SURF CLAM POPULATION DYNAMICS ...Age, Clams, Commercial Fishing, Continental Shelf, Size, ...5.0448
FISH POPULATION STUDY ...Chemical Measurements - water, Commercial Fishing, Fish - non-specific, Food Supply, Water Temperature, Non-specific, ...5.0174
ZOOPLANKTON OF THE GULF OF MAINE ...Atlantic Ocean-north, Plankton Sampling, Vertical Distribution, Zooplankton, ...5.0789
BIOSTATISTICS OF HERRING ...Age, Alewife, menhaden, shad, herring, Atlantic Ocean-north, Environmental Ecology, Growth Rate, Propriepcorts, ...5.0099
EFFECT OF ENVIRONMENTAL CHANGES ON BLUE CRAB ABUNDANCE ...Crabs, Environmental Ecology, Life History Studies, Migration, Number Or Density, ...5.0473
INVESTIGATION OF THE BIOLOGY AND POPULATION STRUCTURE OF GULF MENHADEN ...Alewife, menhaden,shad,herring, Bone, Gulf of Mexico, Handebooks, Vertebrate Anatomy, ...5.0128
POPULATION STUDIES ...Alewife, menhaden, shad, herring, Animal Dist. (non-specific), Animal Taxonomy, Environmental Ecology, ...5.0130
TAGGING ...Alewife, menhaden, shad, herring, Migration, Tugs, Telemetry, Vertebrate Anatomy, ...5.0127
KARLUK LAKE RESEARCH STATION ...Life History Studies, Mortality Rates, Productivity (agricultural), Salmon -coh0,chinook,sockeye..., ...5.0066
GULF-PENINSULA KING CRAB STUDIES ...Commercial Fishing, Crabs, Gulf of Alaska, Habitat Studies, ...5.0342
GULF OF ALASKA DEMERSAL FISH INVESTIGATIONS ...Fish - non-specific, Gulf of Alaska, Productivity (agricultural), Vertical Distribution, ...5.0009
SUBJECT INDEX

ECOLOGY (animal)

INVESTIGATE POPULATION DYNAMICS OF ALBACORE...American Salvage, Commercial Fishing, Tuna, Mackerel, Albacore...Water Environment -other,...5.0083

ASSSESSMENT OF CENTRAL PACIFIC TUNA RESOURCES...Commercial Fishing, Pacific Ocean-general, Size, Tuna, Mackerel, Albacore,...5.0083

INVESTIGATE TUNA RESOURCES OF THE TRUST TERRITORIES...Caroline Islands, Commercial Fishing, Environmental Ecology, Tuna, Mackerel, Albacore,...5.0083

INVESTIGATE POPULATION DYNAMICS OF SKIPJACK TUNA IN HAWAIIAN WATERS...Commercial Fishing, Economics, Environmental Ecology, Hawaii, Tuna, Mackerel, Albacore,...5.0083

FISH POPULATION PARAMETERS...Age, Biological Rhythms, Life History Studies, Size,...5.0039

SUBPOPULATIONS...Anchovies, Commercial Fishing, Pacific Ocean-general,...5.0042

INTERNATIONAL WEDDELL SEA OCEANOGRAPHIC EXPEDITION...Organics, Primary Productivity, Productivity - Food Chain, Seals, Weddell Sea,...5.0012

PHYSIOLOGICAL VARIATION AND ECOLOGY OF MOLLUSKS...Energy Budgets, Gastropods -slug,conch,snails, Metabolism, Reproductive System, Respiratory System,...5.0047

Productivity - Food Chain

A NEW APPROACH TO NUTRITION, PHYSIOLOGY, AND MINERAL CYCLING OF FORAMINIFERA...Axenic Culture, Foraminifera, Invertebrate Nutrition, Metabolism,...5.0069

FIELD EXPERIMENTS ON THE FLUX OF RADIONUCLIDES THROUGH A SALT MARSH ECOSYSTEM...Chloride (non-specific & Ot), Georgia, Model Studies, Swamps-marshes, Water Cycle,...5.0065

MICROBIOLOGICAL ASSAYS OF SEAWATER USING RADIOISOTOPES...Aquatic Ecology, Ciliates, Environmental Ecology, Food Chains, Phytoplankton, Thiamine,...5.0011

BIOLOGY AND CHEMISTRY OF MARINE PLANKTON POPULATIONS...Buoys, Chlorophyll, Phytoplankton, Vertical Distribution, Zooplankton,...5.0078

THE BIOLOGY AND CHEMISTRY OF TRACE ELEMENTS IN MARINE AND ESTUARINE WATERS...Chesapeake Bay, Estuaries, Phytoplankton, Trace Element Analysis, Zooplankton,...5.0075

BIOLIGICAL PRODUCTIVITY IN THE SARGASSO SEA, THE GULF STREAM AND IN THE ATLANTIC COASTAL WATERS OFF CAPE HATTERAS...Continental Shelf, Phytoplankton, Primary Productivity, Proteins,...5.0015

SEASONAL DISTRIBUTION AND ABUNDANCE OF DEMERAL FISH AND INVERTEBRATES IN THE MATURE WATERS ADJACENT TO THE MOUTH OF THE COLUMBIA RIVER...Benthic Fauna, Number Or Density, Radioactivity-general, Temporal Distribution, Vertical Distribution,...5.0093

UPTAKE AND ASSIMILATION OF ORGANIC COMPOUNDS IN MARINE ORGANSMS...Active Transport, Invertebrates - non-specific, Metabo2+am, Nutrition, Organisms,...5.0027

DISTRIBUTION AND BIOLOGY OF PACIFIC ZOOPLANKTON...Animal Taxonomy, Pacific Ocean-general, Range Or Territorial Dist., Vertical Distribution, Zooplankton,...5.0075

ECOLOGICAL AND EVOLUTIONARY IMPLICATIONS OF THE ECOTYPES OF ESTUARINE CRUSTACEA...Classical, Estuaries, Invertebrate Anatomy, Insects, Metabolism,...5.0041

ECOLOGY OF THE PORITES FURCATA REEF-FLAT COMMUNITY...Anchovies, Panama, Puerto Rico, Reefs,...5.0067

DEVELOPMENT AND EVALUATION OF A NEW TECHNIQUE FOR SAMPLING ZOOPLANKTON...Organism Sampling Devices, Populatana Dynamics, Technique Development, Vertical Distribution, Zooplankton,...5.0057

SIMULATION STUDIES OF ECOLOGICAL COMMUNITIES...Mortality Rates, Number Or Density, Population Dynamics, Predation,...5.0062

EXPERIMENTAL STUDIES ON THE BIOLOGY AND FOOD CHAIN ECONOMICS OF THE CHAETOGNATHS...Energy Budgets, Reproductive System, Whole Body Culture & Rearing, Zooplankton,...5.0077

STANFORD BIOLOGICAL OCEANOGRAPHY...Marine Biology, Phytoplankton, Primary Productivity, Ships and Cruises, Training Grants, Fellowships, Zooplankton,...11.0005

MARINE BIOLOGICAL INVESTIGATIONS - NEXTON OF IN -SIDE WATERS OF SOUTHWESTERN ALASKA...Alaska, Plankton Sampling, Temporal Distribution, Zooplankton,...5.0021

FUR SEAL RESEARCH, POPULATION DYNAMICS...Age, Growth Rates, Life History Studies, Mark, Tag Or Capture - other, Seals,...5.0067

POPULATION DYNAMICS OF NEW ENGLAND GROUND -FISH...Atlantic Ocean-north, Codfishes, Hake, Lefteye Flounders, Rockfish, Scorpaenids,...5.0013

POPULATION STRUCTURE OF THE ALEWIFE AND COREGONIDS...Alaska, Char, Lake Michigan, Life History Studies, Nets, Yellow Perch, Darters,...5.0014

SEA LAMPREY AMMOCETE REESTABLISHMENT STUDIES...Agriculture, Control of Nuisance Species, Great Lakes-general, Lampreys, Larvicides, Life History Studies,...5.0052

ELECTRIC BARRIER OPERATIONS...Control of Nuisance Species, Lake Michigan, Lake Superior, Lampreys, Migration,...5.0053

POPULATION DYNAMICS OF ATLANTIC TUNAS...Atlantic Ocean-general, Censusing, Commercial Fishing, Tuna, Mackerel, Albacore,...5.0036

GREAT LAKES GEAR RESEARCH...Commercial Fishing, Fish non-specific, Fishing Gear, Great Lakes-general, Lakes,...5.0036

DISTRIBUTION AND ABUNDANCE OF ZOOPLANKTON IN LAKE ERIE...Aquatic Ecology, Computer Applications, Environmental Ecology, Intertidal Relat.(non-specific), Lake Erie,...5.0082

SHELLFISH EXPLORATIONS...Benthic Fauna, Clams, Commercial Fishing, Mark, Tag Or Capture -other,...5.0014

SEA CLAM EXPLORATIONS...Animal Dist.(non-specific), Atlantic Ocean-north, Clams, Commercial Fishing,...5.0045

STUDIES OF THE BENTHIC INVERTEBRATES OF THE ATLANTIC CONTINENTAL SHELF...Atlantic Ocean-north, Benthic Fauna, Continental Shelf, Productivity - Food Chain,...5.0063

LOBSTER RESEARCH...Commercial Fishing, Environmental Ecology, Habitat Studies, Lobsters,...5.0045

MARINE BIOLOGICAL INVESTIGATIONS STUDIES PROJECT (FISHERIES)...Alaska, Aquatic Ecology, Bays, Fish non-specific,...5.0041

ESTUARINE ECOSYSTEMS...Aquatic Ecology, Estuaries, Pesticides, Pollution - Effects of, Pollution Effects,...5.0081

FISH POPULATION STUDY...Analog Computer Applications, Environmental Ecology, Fish -other, Killifish, Salpins, Sprague, Tilapia, Cichlids,...5.0017

POPULATION DYNAMICS (BIOMETRICS) OF EXPLOITED FISH GROUPS OF THE NORTH PACIFIC OCEAN AND PACIFIC COAST...Marine Biology, Meteorological Studies, Model Studies, Number Or Density, Pacific Ocean-north,...5.0017

GREAT LAKES EXPLORATIONS...Commercial Fishing, Fish non-specific, Fishing Gear, Great Lakes-general,...5.0016

PREDICTING COMMERCIAL SHRIMP ABDUNDANCE (SHRIMP DYNAMICS PROGRAM)...Bays, Behavioral Ecology, Commercial Fishing, Environmental Ecology, Shrimps - Cerithidae,...5.0049

EXPERIMENTAL SEEDING (SHRIMP AQUACULTURE PROGRAM)...Captive Rearing, Florida, Shrimps - Common, Snails - rearing Sites, Stocking of Fish & Shellfish,...5.0051

RECONNAISSANCE ECLOGIC SURVEY OF THE CONTINENTAL SHELF AND UPPER SLOPE (GULF OCEANOGRAPHY PROGRAM)...Behavioral Ecology, Biology, Continental Shelf, Environmental Ecology, Migration, Shrimps - Common,...5.0052

POPULATION DYNAMICS (SHRIMP DYNAMICS PROGRAM)...Commercial Fishing, Gulf of Mexico, Mortality Rates, Shrimp - Common,...5.0063

INVESTIGATION TUNA SUBPOPULATIONS THROUGH THE USE OF BLOOD GROUPS AND INHERITED PROTEINS...Blood Proteins -non-specific, Blood Proteins, Fish -other, Pacific Ocean-general, Tuna, Mackerel, Albacore,...5.0076

DEVELOP TECHNIQUES FOR CAPTURING JUVENILE TUNAS...Alaska, Capturing Tuna, Mackerel, Albacore,...5.0076
**Ecology (animal)**

**SUBJECT INDEX**

DIVERSITY, COMMUNITY STRUCTURE AND TROPHIC RELATIONS OF TROPICAL ZOOPLANKTON ...Bays, Intertidal Relat.(non-specific), Tropic, Zooplankton, ...5.0765

THE INFLUENCE OF DEPOSIT FEEDING BENTHOS ON THE STABILITY OF BOTTOM SEDIMENTS AND COMMUNITY TROPHIC STRUCTURE ...Benthic Fauna, Benthonic-bottom, Metabolism, ...5.0359

METABOLISM OF MARINE ECOSYSTEMS ...Energy Budgets, Food Webs, Metabolism, Other, Plankton (non-specific), ...5.0966

THE ROLE OF COPROPHAGY IN MARINE FOOD CHAINS ...Feces, Invertebrate Nutrition, Nutrition -other, ...5.0963

MICROZOOPLANKTERS IN THE MARINE FOOD CHAIN ...Population Dynamics, Vertical Distribution, Zooplankton, ...5.0748

BIOLOGICAL COLONIZATION OF A RECENTLY FORMED ISLAND ...Humanitat Studies, Iceland, Islands, Succession, Volcanoes, ...5.0925

OPTIMUM ECOLOGICAL DESIGNS FOR ESTUARINE SYSTEMS OF NORTH CAROLINA ...Domestic Wastes-general, Estuaries, Marine Biology (non-specific), North Carolina, Pollution - Effects of, Pollution Effects, ...5.0913

LIPID COMPOSITION OF ANTARCTIC MARINE ORGANISMS ...Antarctica, Benthic Organisms (non-specific), Biology, Fish -non-specific, Predation, Seals, ...1.1039

BENTHIC COMMUNITIES ...Behavioral Ecology, Benthic Fauna, Bottom Sampling Device, Developmental Physiology, Fossiling, Metabolism, ...5.8551

ECOLOGY OF MARINE BIVALVE MOLLUSCAN LARVAE ...Behavioral Ecology, Clams, Fouling, Population Dynamics, Vertical Distribution, ...5.0370

DRIFT-STATION BIOLOGY ...Alaska, Animal Taxonomy, Arctic Ocean, Ocean Fronts, Sea ice, ...5.0743

ECOLOGICAL INVESTIGATIONS OF SOME COMMON MARINE FISHES OFF THE MEDITERRANEAN COAST OF ISRAEL ...Behavorial Ecology, Mediterranean Sea-general, Population Dynamics, Range Or Territorial Dist., ...5.0889

MEASUREMENT OF BIOLOGICAL FACTORS OF VARIOUS HABITATS, AND THEIR RELATION TO THE BIOLOGY OF THE COMMERCIALLY IMPORTANT SPECIES ...Chemical Measurements -water, Habitat Studies, Physical Measurements - water, Plankton (non-specific), Population Dynamics, ...5.0819

PRODUCTIVITY STUDIES IN NORTH CAROLINA SALT MARESHES ...Aerial Photography, Mapping, North Carolina, Primary Productivity, Swamps-marshes, Tidewater Areas, ...5.1017

MARINE WASTE DISPOSAL ...SEA WATER ...Antarctic Ocean, Fish -non-specific, Salt Marshes, Aerial Photography, Mapping, North Carolina, Primary Productivity, Swamps-marshes, Tidewater Areas, ...5.1017

Marine Waste Disposal of Marine Wastes - general, Population Dynamics, Standing Crops, ...5.0955

BIONOMICS OF FISHES AND SHELLFISHES ...Aquaculture & Fish-farming, Bays, Economics-general, Environmental Ecology, Oregon, ...5.0920

PLANKTON ECOLOGY OF BAR-BUILT ESTUARIES ...Estuaries, North Carolina, Phytoplankton, Primary Productivity, Zooplankton, ...5.0816

ECOLOGY OF SABELLARID REEFS IN DELAWARE BAY ...Eco-Behavioral Ecology, Delaware Bay, Environmental Ecology, Lugworms, Marine Segmentedworm, Vertical Distribution, ...5.0871

ECOLOGY OF MARSH FORAMINIFERA ...Foraminifera, Lagoons, Rate of Deposition, Swamps-marshes, ...5.0747

PRIMARY PRODUCTIVITY IN PUERTO GALERA BAY, MINDOLO, PHILIPPINES ...Bays, Philippines, Primary Productivity, ...5.1025

MARINE BIOLOGY PROGRAM ...Distribution, Puerto Rico, Radiocology, Rare Earths, Trace Elements, ...1.0128

BIOTRAC - BIOPHYSICAL STIMULATION OF THE MARINE ENVIRONMENT ...Copepods, Energy, Energy Budgets, Organisms, ...5.0767

ECOLOGY OF PANAMANIAN REEF COMMUNITIES ...Behavioral Ecology, Invertebrates - non-specific, Panama, Reefs, Tropic, ...5.0866

CORAL ATOLL ECOLOGY ...Anthozoa, Atolls, Bibliography, Data Analysis - General, ...5.0872

PHYSIOLOGY AND ECOLOGY OF THE ADRATIC BENTHOS ...Adriatic Sea, Benthic Organisms (non-specific), Marine Biology (non-specific), Metabolism, Microcirculation-general, ...5.0872

SAND DOLLAR COMMUNITIES ...Beaches, California, Habitat Studies, Sea Urchins & Other Echinoderms, ...5.0633

ECOLOGY AND DISTRIBUTION OF OYSTERS AND CLAMS ...Animal Distr. (non-specific), Clams, Oysters, Ponds, ...5.0446

SEDIMENT MINERALOGY ...A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION ...Adsortion, Chemistry, Forward Webs, Radioactivity, Radioactivity-general, ...7.0677

PHYSIOLOGY AND BEHAVIOR ...Behavior, Chemical Measurements - water, Environmental Physiology, Lake Michigan, Physical Measurements - water, ...5.0964

ANCIENT PHYSIOLOGICAL AND BEHAVIORAL TRADITIONS IN THE GREAT LAKES ...Chemical Analysis (water), Great Lakes-general, Nutrients, Water Quality-general, ...1.0116

FEEDING HABITS OF ATLANTIC TUNAS AND NENKTON ECOLOGY ...Atlantic Ocean-general, Food Supply, Plankton (non-specific), Tuna, Mackerel, Albacore, ...5.0204

RELATION OF ENVIRONMENTAL FACTORS TO THE PRODUCTIVITY OF ESTUARINE SEDIMENTARY FAUNA ...Aquatic Ecology, Environmental Ecology, Estuaries, Florida, ...5.0699

MECHANISMS OF PESTICIDE ACCUMULATION IN AQUATIC ORGANISMS ...Chlorinated Hydrocarbons, Fish Foods, Aquaculture & Fish-farming, Insecticides - non-specific, Pollution Effects, ...5.0185

STUDIES OF THE BENTHIC INVERTEBRATES OF THE ATLANTIC CONTINENTAL SHELF ...Atlantic Ocean-north, Benthic Fauna, Continental Shelf, Population Dynamics, ...5.0623

BIOLOGICAL OCEANOGRAPHY (GULF OCEANOGRAPHY PROGRAM) ...Environmental Ecology, Food Supply, Gulf of Mexico, Shrimps - Common, ...5.0628

PRIMARY PRODUCTIVITY ...Marine Plants, Primary Productivity, Standing Crops, ...5.0955

DESCRIPTIVE PHYSICAL OCEANOGRAPHY OF THE EASTERN TROPICAL ATLANTIC ...Atlantic Ocean-general, Environmental Ecology, Fish - non-specific, Tropic, ...4.0127

PRODUCTIVITY MEASURES ...Number Or Density, Ocean Currents-other, Organism Sampling Devices, Pacific Ocean-city, Primary Productivity, Zooplankton, ...5.0940

INTERNATIONAL WEDDELL SEA OCEANOGRAPHIC EXPEDITION ...Organisms, Poplation Dynamics, Primary Productivity, Seals, Weddell Sea, ...4.0121

AERIAL SEABIRD TEMPERATURE SURVEYS OF U.S. COASTAL WATERS ...Aircraft, Infrared Radiation, Migration, Temperature, Water Temperature-non-specific, ...4.0148

ENERGY TRANSFER IN LOWER MARINE TROPHIC LEVELS ...Aquatic Ecology, Energy Budgets, Environmental Ecology, Vertical Distribution, ...5.1020

**Succession**

BIOLOGICAL RESEARCH ON THE VOLCANIC ISLAND SURFESY AND ENVIRON ...Iceland, Migration, Volcanoes, ...5.0899

BIOLOGICAL COLONIZATION OF A RECENTLY FORMED ISLAND ...Habitat Studies, Iceland, Islands, Productivity - Food Chain, Volcanoes, ...5.0925

ECOLOGICAL SUCCESSION ON SURFSEY ...Fouling, Iceland, Plant Succession, Volcanoes, ...5.0690

SUCCESSION, SPACIAL AND TEMPORAL DISTRIBUTION, AND BIOLOGY OF BENTHIC ORGANISMS ...Benthic Fauna, Benthic Flora, Temporal Distribution, ...5.0638

**Terrestrial Ecology**

ECOLOGY OF STORM PETRELS ...Albatrosses, Shearwaters, California, Islands, Mark, Tag Or Capture - other, Spawning & Nesting Sites, ...5.0652

**Ecology (plant)**

Applied Ecology

AN ECLOGICAL STUDY OF SOUTH BISCAYNE BAY IN THE VICINITY OF TURKEY POINT ...Behavioral ecology, Florida,束ectric Power Plants, Environmental Ecology, Florida, Phytoplankton, Thermal Pollution, ...5.0677

480
SUBJECT INDEX

Aquatic Plant Group

Aquatic Plants (non-specific)
- Quantitative and qualitative measurement of aquatic vegetation-currituck sound...Estuaries, range or territorial distr., saline water intrusion, salinity, vertical distribution, .5.0717
- Lower plants
- Aquatic plants (non-specific)

Balance of Nature

An ecological study of south bays in the vicinity of turkey point...Appl. ecology, bays, electric power plants, environmental ecology, Florida, phytoplankton, thermal pollution, .5.0877

Biomes

Rain forests
Support for the physiological research ship, R/V alpha helix...Insecticides, non-specific, mycorrhiza, nerve effects, regulation, tropical, .12.0011

Distribution

Plant distr. (non-specific)
- Marine bacterial enzymes...Cell env.(non-specific & ot.), growth (non-specific & ot.), isolation from nat. environ., marine bacteria, protolytic enzymes, .5.0834
- Range or territorial distr.
- Microbial activity in non aqueous systems...Growth rate, .5.0782
- Systematics, morphology, and ecological distribution of algo and wood-inhabiting marine and freshwater fungi of surtsey and iceland...Aquatic fungi (non-specific), islands, marine fungi (non-specific), plant taxonomy, .5.0714
- Taxonomy of calcareous green algae...Chlorophyceae (non-specific & ot.), Indian ocean-general, plant morphology, plant taxonomy, reproductive physiology, .5.0718
- Ecology of phytoplankton in semi-tropical environments...Caribbean sea, phytoplankton, sub-tropical, temporal distribution, vertical distribution, .5.0778
- Langmuir circulation and plankton ecology...Circulation-general, phytoplankton, vertical distribution, water movement, current, wind or air movement, zooplankton, .5.0794
- Studies of the phytoflagyean orders chordaries and punctaries...Algal culture, Atlantic ocean-north, Phaeophyta (non-specific & ot), tropical distribution, .5.0718
- Systematics and ecology of surficial benthic marine algae...Algae-general, benthic flora, benthic-bottom, habitat studies, marine plants, plant taxonomy, .5.0701
- Marine sulfur oxidizing bacteria...Habitat studies, lons (inorganic), isolation from nat. environ., marine bacteria, thioacetal, .5.0758
- Laccustine and estuarine fungi...Aquatic fungi (non-specific), host-parasite interactions, marine fungi (non-specific), phytoplankton, plant morphology, plant taxonomy, .5.0721
- Biology and paleontology of marine dinoflagellates and hystericospheres...Algae-dinoflagellata, algal culture, cell cycle, plant developmental biology, spores, vertical distribution, .5.0799

Ecology (plant)

DISTRIBUTION OF ANARCTIC MARINE FUNGI...Antarctica, marine fungi (non-specific), phycocyanins, plant taxonomy, ships and cruises, vertical distribution, .5.0604

PREDICTION OF BIOLOGICAL POPULATIONS FROM THE PHYSICAL OCEANIC ENVIRONMENT...Marine environments-general, phytoplankton, ships and cruises, temporal distribution, vertical distribution, .5.0844

AEGEAN SEA BIOLOGY...Aegean sea, benthic organisms (non-specific), currents-longshore, plankton (non-specific), temporal distribution, .5.0847

Biographical study of the benthos of puerto rico and the virgin islands...Benthic fauna, benthic flora, benthonic-bottom, currents-ocean, temperature, vertical distribution, .5.0652

Quantitative and qualitative measurement of aquatic vegetation-currituck sound...Aquatic plants (non-specific), estuaries, saline water intrusion, salinity, vertical distribution, .5.0717

TAXONOMY AND ECOLOGY OF INSHORE MARINE MICROBIO...Algae-general, animal taxonomy, aquatic ecology, plant taxonomy, proteoza-other, .5.0768

DISTRIBUTION OF CL. BOTULINUM E. IN FISH, SHELLFISH AND THE AQUATIC ENVIRONMENT IN OREGON...Bacterial culture, Clostridium botulinum, Oregon, virulence and pathogenicity, .5.0822

Coral atoll flora...Atolls, floras, plant taxonomy, .5.0692

Biogeography of benthonic organisms...Benthic organisms (non-specific), continental shelf, marine biology (non-specific), vertical distribution, .5.0876

Nitrification by marine microorganisms...Autotrophic, bact. morphology (general), bacterial culture, isolation from nat. environ., marine bacteria, nitrogen bacteria, .5.0809

Studies on the protistan causing malpeque disease...Invertebrate pathology, myxomycetes, oysters, pathologic taxonomy, .5.0498

Temporal Distribution

Ecology of tropical deep water algae...Algae-general, benthic flora, diving and scuba, plant succession, tropical, vertical distribution, .5.0722

Ecology of phytoplankton in semi-tropical environments...Caribbean sea, phytoplankton, range or territorial distr., sub-tropical, vertical distribution, .5.0778

Studies of the phaeophycean orders chordaries and punctaries...Algal culture, Atlantic ocean-north, Phaeophyta (non-specific & ot), range or territorial distr., .5.0715

Prediction of biological populations from the physical oceanic environment...Marine environments-general, phytoplankton, range or territorial distr., ships and cruises, vertical distribution, .5.0844

Biological oceanography...Arctic, organics, phycography, .5.1038

Aegean sea biology...Aegean sea, benthic organisms (non-specific), currents-longshore, plankton (non-specific), range or territorial distr., .5.0887

Succession, spacial and temporal distribution, and biology of benthic organisms...Benthic flora, benthic fauna, .5.0643

Seasonal variations of algal populations...Algas-general, algal culture, nutrition studies, .5.0705

Vertical Distribution

Biological and chemistry of marine plankton populations...Buoys, chlorophyll, phytoplankton, zooplankton, .5.0798

Ecology of tropical deep water algae...Algae-general, benthic flora, diving and scuba, plant succession, temporal distribution, tropical, .5.0722

Ecology of phytoplankton in semi-tropical environments...Caribbean sea, phytoplankton, range or territorial distr., sub-tropical, vertical distribution, .5.0778

The characteristics, mechanisms and biogeochemical consequences of phytoplankton flotation...Organics, phytoplankton, plant lipids, silicon, size, .5.0626

Relationships between phytoplankton and zooplankton in the caribbean sea...Caribbean sea,
SUBJECT INDEX

Ecology (plant)
Interbiotic Relat.(non-specific), Phytoplankton, Sargassum, Zooplankton, ...5.0779

Biology and Paleontology of Marine Dinoflagellates and Hystrix spheres - Algae
Dinoflagellates, Algal Culture, Cell Cycle, Plant Developmental Biology, Range Or Territorial Dist., Spores, ...5.0799

Distribution of Antarctic Marine Fungi - Antarctic, Marine Fungi (non-specific), Phycocyanetes, Plant Taxonomy, Range, Or Territorial Dist., Ships and Cruises, ...5.0694

Prediction of Biological Populations from Physical Ocean Environment - Marine Environment-general, Phytoplankton, Range Or Territorial Dist., Ships and Cruises, Temporal Distribution, ...5.0844

Quantitative and Qualitative Measurement of Aquatic Vegetation-Currituck Sound ...Aquatic Plants (non-specific), Estuaries, Range Or Territorial Dist., Saline Water Intrusion, Salinity, ...5.0465

Biological Oceanography & Deterioration - Shallow Water Marine Sediments & Water Column Bacteria ...Biological, Continental Shelf, Instrumentation-general, Marine Bacteria, Nephelometry, ...5.0807

Ecology of Cystostridium Botulinum Type E in Green Bay ...Fish -non-specific, Great Lakes-general, Microbiological, ...5.0850

Ecological Types - other
Ecological Studies of the Marine Red Alga Chondrus crispus Stackhouse ...Ag Uses of Nat. resource-other, Algal Culture, Chondrus, Growth and Differentiation, Reproductive Physiology, ...5.1070

The Occurrence and Effects of Plankton in the Sea ...Air-sea Boundary-general, Marine Biology, Plankton (non-specific), ...5.0781

The Ecological Architectures of the Marine Biosphere ...Marine Biology, Marine Biology (non-specific), ...5.0859

Ecosystems
Plant Ecosystems (non-specific)
Organic Production of Epifaunal Organisms ...Energy Budgets, Epiphytic Relationships, Marine Biology (non-specific), Organisms, Primary Productivity, Reefs, ...5.1032

Plant Succession
Ecology of Tropical, Deep Water Algae ...Algae-General, Benthic Flora, Diving and Scuba, Temporal Distribution, Troph of Vertical Distribution, ...5.0722
Palebotanical Research at Yale University ...Growth Rate, Isolation From Nat. environ., Marine Bacteria, Plants, Sulfur Bacteria, ...5.0652
Ecological Succession on Surtsay ...Fouling, Iceland, Succession, Volcanoes, ...5.0890
Biochemistry of Marine Organisms ...Adsorption & Interface, Algae=============algae, Phytoplankton, Spec troscopy, ...5.0766

Epiphytic Relationships
Organic Production of Epifaunal Organisms ...Energy Budgets, Marine Biology (non-specific), Organisms, Plant Ecosystems (non-specific), Primary Productivity, Reefs, ...5.1052

Floras
Coral Atoll Flora ...Atolls, Plant Taxonomy, Range Or Territorial Dist., ...5.0692

Food Chains
The Accumulation of Fission Products by Marine Fish and Shells ...Elk Island, Chthamalus, ...5.0617
Effects of Ingestion of Radioactive Fish and the Nature and Biology of Toxins in Certain Fishes ...Fish -non-specific, Food (epidemiology), Radioactive Isotopes, Toxicological and Allergy, ...5.0108

Microbiological Assays of Seawater Using Radiotracer Techniques ...Aquatic Ecology, Ciliates, Environmental Ecology, Environmental Physiology, Phytoplankton, Productivity - Food Chain, Thiamine, ...5.0611

Algal Substances in the Marine Food Web ...Food Webs, Marine Algae, Marine Plants, Phaeophyta (non-specific & Or), Phenols, Secretions and Products, ...5.0725

Food Metabolism of Marine Ecosystems ...Energy Budgets, Metabolism, Other, Plantakton (non-specific), Productivity - Food Chain, ...5.0696

Algal Substances in the Marine Food Web ...Food Chains, Humic Acid, Marine Plants, Phaeophyta (non-specific & Or), Phenols, Secretions and Products, ...5.0725

Ecology of Eelgrass ...Algae, Bering Sea, Phytoplankton, Potamogeton, Ruppia, Zoster, Primary Productivity, ...5.0677

Sediment Mineralogy (A Cooperative Agreement with the Atomic Energy Commission) ...Adsorption, Chemistry, Productivity - Food Chain, Radioactivity, Radioactivity-general, ...5.0707

Habitat Studies
Marine Algae of the Mangrove Root Community ...Algae-General, Mangroves, Marine Plants, Puerto Rico, Roots, ...5.0673

Morphology and Taxonomy of Marine Fungi ...Mangroves, Marine Fungi (non-specific), Plant Morphology, Plant Taxonomy, Sub - Trope, Tropical, ...5.0716

Taxonomic Relationships in Shool Benthic Environments ...Benthic Flora, Biology, Estuaries, New England Province, ...5.1072

Systematics and Ecology of Sub-dal Benthic Marine Algae ...Algae-General, Benthic Flora, Benthonic-bottom, Marine Plants, Plant Taxonomy, Range Or Territorial Dist., ...5.0701

Marine Sulfur Oxidizing Bacteria ...Ions (inorganic),Isolation From Nat. environ., Marine Bacteria, Range Or Territorial Dist., Thilobacillus, ...5.0758

Physiology and Ecology of Marine Diatoms ...Algae-Diatoms, Algal Culture, Marine Plants, Nutrition Studies, Physiological Ecology, Plant Taxonomy, ...5.1203

Ecology of Marine Endolithic Algae ...Algae-General, Boring - Tracks - Trails, Calcium, Niches, Textures-structures, ...5.0690

Support of the Vermilion Sea Field Station at Bahia de Los Angeles, Baja California ...Arid and Desert, Facilities, Gulf of California, Tee&lt;erature, Tides, ...12.0009

Restoration, Propagation, and Management of Marine Algae ...Applied Ecology, Growth and Differentiation, Laminariaeae (non-specif.&ot), Marine Plants, Pacific Ocean-east, ...5.0680

Geodetecological Weathering Phenomena Off Anvers Island ...Antarctica, Life-ecosystem, Marine Bacteria, Petrology, Weathering, ...7.0323

Ecological Studies of Rocky Subtidal Areas ...Animal Taxonomy, Marine Plants, Plant Taxonomy, ...5.0701

The Effects of Pollution on Benthic Marine Plant Communities ...Bays, Water Depth, Water Levels, ...5.0674

Experimental Ecology of Lower Marine Fungi ...Marine Fungi (non-specific), Phycocyanetes, Plant Developmental Biology, ...5.0698

Energetics of Palamoneetes Pugio and the Weebed Community of South Creek Estuary ...Aquat Vegetation -I, Energy Budgets, Estuaries, North Carolina, Shrimps - Common, ...5.0483

Preservation of Woods in the Marine Environment ...Biological, Fouling, Marine Fungi (non-specific), Materials Used Undersea, Preservatives, Wood, ...5.0216

Film Project (Kelp Forests) ...California, Cinematography, Fishery Development, I, Laminariaeaceae (non-specif.&ot), ...5.0767

Ecology of the Kelp Forests ...Behavioral Ecology, California, Environmental Ecology, Fish =non-specific, Laminariaeaceae (non-specific.&ot), ...5.0619

Environmental Conditions and Population Dynamics in Selected Unpolluted Estuarial
<table>
<thead>
<tr>
<th>SUBJECT INDEX</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ecology (plant)</strong></td>
</tr>
<tr>
<td>...Aquatic Ecology, Environmental Ecology, Estuaries, Pollution - Effects of, Thermal Pollution, ...6.0152</td>
</tr>
<tr>
<td>ULTRAVIOLET ABSORPTION IN COASTAL WATERS</td>
</tr>
<tr>
<td>WATERFOWL FOOD STUDIES</td>
</tr>
<tr>
<td><strong>Primary Productivity</strong></td>
</tr>
<tr>
<td>BIOLOGICAL PRODUCTIVITY IN THE SARGASSO SEA, THE GULF STREAM AND IN THE ATLANTIC COASTAL WATERS OFF CAPE HATTERAS</td>
</tr>
</tbody>
</table>
| C-14 UPTAKE, LIMITING FACTORS AND EXCRETION PRODUCTS OF ANTARCTIC PHYTOPLANET 
| Antarctic Ocean, Carbon, Phytoplankton, Secretions and Products, ...5.0613 |
| STUDIES WITH TROPICAL AND SUBTROPICAL MICROG 
| Algal Culture, Benthic Flora, Continental Shelf, Sub- Tropic, ...5.0693 |
| ORGANIC PRODUCTION OF EPIFAUNAL ORGANISMS | Energy Budgets, Epiphytic Relationships, Marine Biology (non-specific), Organisms, Plant Ecology (non-specific), Red Sea, ...5.1032 |
| **EcoLOGICAL STUDIES OF THE SOUTHEASTERN FLORIDA SEA GRASS COMMUNITY - PRIMARY PRODUCTIVITY BY THALASSIA TESTUDINUM KONIG 
| Elodea, Waterweed, Thalassa, Florida, Submerged Plants, Translocation, Tropic, ...5.0693 |
| STANFORD BIOLOGICAL OCEANOGRAPHY | ...Marine Biology, Phytoplankton, Productivity - Food Chain, Phytoplankton, ...5.0845 |
| NUTRIENT LIMITATION AND SOURCES OF NITROGEN FOR MARINE PRIMARY PRODUCTIO 
| Marine Plants, Mathematical Biophysics, Nitrogen Fixation, Other Models, Phytoplankton, ...5.0693 |
| **EcoLOGICAL PRODUCTIVITY INVESTIGATIONS OF THE WATERS SURROUNDING ANTARCTICA** | Optical, Organics, Phytoplankton, Standing Crops, Weddell Sea, ...5.1032 |
| PRODUCTIVITY STUDIES IN NORTH CAROLINA SALT MARSHES | Aerial Photography, Mapping, North Carolina, Phytoplankton, Productivity - Food Chain, Swamps-marshes, Tidewater Areas, ...5.1017 |
| BIOLOGICAL AND CHEMICAL STUDY OF VIRGINIA'S ESTUARIES | Estuaries, Nitrogen, Phytoplankton, Phytoplankton, Population Dynamics, Virginia, ...5.0503 |
| THE ECOLOGIC IMPACT OF THE INTERACTIONS AMONG MICROORGANISMS AND AQUATIC CONTAMINANTS IN LAKE ERIE | ...Lake Erie, Pollution - Effects of, Responses to Growth, Sediments, Water Bacteria, ...5.0613 |
| EFFECTS OF RIVERS ON THE METABOLISM OF TEXAS BAYS | ...Bays, Nutrients, Pollutants-general, Streams, Texas, Water Quality-general, ...5.0617 |
| **PRIMARY PRODUCTION AND DECOMPOSITION IN ESTUARINE WATER** | Estuaries, Florida, Methane Bacteria (non-specific), Phytoplankton (non-specific & Or), Rhodophyta (non-specific), ...5.0693 |
| **ECOLOGY AND NITROGEN CYCLE IN A MARINE PLANT COMMUNITY** | ...Bering Sea, Nitrogen, Phytoplankton, Phytoplankton, Zoostera, ...5.0617 |
| **PLANKTONIC ECOLOGY OF BAR-BUILT ESTUARIES** | ...Estuaries, North Carolina, Phytoplankton, Productivity - Food Chain, Zooplankton, ...5.0616 |
| **PRIMARY PRODUCTIVITY IN PUERTO GALERA BAY, MIN 
| DORO, PHILIPPINES | ...Bays, Philippines, Phytoplankton, ...5.1025 |
| ECOLOGY OF EELGRASS | ...Alaska, Bering Sea, Food Webs, Phytoplankton, Potamogeton, Ruppia, Zostera, ...5.0677 |
| TIDE MARSH ECOLOGY AND WILDLIFE | Management, Mammals (non-specific), Phytoplankton, Phytoplankton, Potamogeton, ...5.0677 |
| **PRODUCTIVITY OF ESTUARINE AND MARINE ECOSYSTEMS (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION)** | Phytoplankton, Zooplankton Research, ...5.0683 |
| PRIMARY PRODUCTIVITY | ...Marine Plants, Phytoplankton, Zooplankton, ...5.0693 |

| **AND COASTAL AREAS** | Aquatic Ecology, Contamination - Water, Marine Biology (non-specific), Pollution - Effects of, Toxic Substances -non-specific, ...5.0922 |
| **WATER QUALITY AND FUNGI-NEMATODE-SEAGRASS RELATIONSHIPS** | ...Elodea, Waterweed, Thalassia, Florida, Marine Fungi (non-specific), Nematoda -other, ...5.0878 |

**Mapping**

| BIOLOGICAL RESEARCH ON THE VOLCANIC ISLAND SURTSEY AND ENVIRON | ...Iceland, Migration, Volcanoes, ...5.0689 |
| **MARINE BIOLOGY OF RED SEA AND EASTERN MEDITER 
| RANEAN** | ...Benthic Flora, Population Dynamics, Red Sea, ...5.0689 |
| **PRODUCTIVITY STUDIES IN NORTH CAROLINA SALT MARSHES** | ...Aerial Photography, North Carolina, Phytoplankton, Productivity - Food Chain, Swamps-marshes, ...5.0689 |

**Niches**

| ECOLOGY OF MARINE ENDOLITHIC ALGAE | ...Algae- General, Boring - Tracks - Trails, Calcium, Habitat Studies, Textures-structures, ...5.0690 |

**Phenology**

| BIOLOGY-MIDDLE EAST WATERS | ...Cell Cycle, Marine Biology (non-specific), Middle-east-general, Red Sea, Reproductive System, Synchronization, ...5.0693 |

**Physiological Ecology**

| IMPROVEMENT AND APPLICATION OF BENTHIC ALGAL ISOPTOPIC PRODUCTIVITY MEASURING METHODS | ...Algae- General, Benthic-bottom, Caulerpae, Pacific Ocean-general, Plant Prod. (non-specific), Rhodophyta (non-specific & Or), ...5.0698 |

| PHYSIOLOGY AND ECOLOGY OF MARINE DIATOMS | ...Algae- Diatoms, Algal Culture, Habitat Studies, Marine Plants, Nutrition Studies, Plant Taxonomy, ...5.0735 |
| ECOLOGY AND NITROGEN CYCLE IN A MARINE PLANT COMMUNITY | ...Bering Sea, Nitrogen, Potamogeton, Ruppia, Zostera, ...5.0676 |

**Plant Ecology (non-specific)**

| BIOLOGY CONFERENCE SERIES | ...Ecology (animal), Marine Biology, Meetings, ...11.0035 |
| **MARINE BIOLOGY RESEARCH AT THE BERMD 
| A BIOTIC** | ...Bermuda. Ecology (animal), Marine Biology, Marine Biology (non-specific), ...12.0006 |
| **YEAR-ROUND PROGRAM OF RESEARCH IN MARINE ECOLOGY** | ...Animal Taxonomy, Aquatic Ecology, Marine Biology (non-specific), Plant Taxonomy, Training Grants, Fellowships, ...5.0699 |

**Productivity**

| Plant Prod. (non-specific) | IMPROVEMENT AND APPLICATION OF BENTHIC ALGAL ISOPTOPIC PRODUCTIVITY MEASURING METHODS | ...Algae- General, Benthic-bottom, Caulerpae, Pacific Ocean-general, Physiological Ecology, Rhodophyta (non-specific & Or), ...5.0698 |
| OCEANOGRAPHIC VESSEL OPERATIONS | ...Equipment Purchase Operation, Geology-general, Pacific Ocean-north, Plankton (non-specific), Ships and Cruises, ...12.0047 |
| HOLOGRAPHIC STUDIES OF MARINE ORGANISMS | ...Acoustical, Holography, Lasers-masers, Plankton (non-specific), ...5.0660 |

| EFFECTS OF THERMAL POLLUTION ON PRODUCTIVITY AND STABILITY OF ESTUARINE COMMUNITIES | ...Aquatic Ecology, Environmental Ecology, Estuaries, Pollution - Effects of, Thermal Pollution, ...6.0152 |
| ULTRAVIOLET ABSORPTION IN COASTAL WATERS | Biological, Marine Plants, Physical Parameters, Sewage, Total Organic Carbon, Ultra - Violet Radiation, ...5.0613 |
| WATERFOWL FOOD STUDIES | Food Supply, Management, South Carolina, Waterfowl -non-specific, ...5.0653 |
SUBJECT INDEX

Economic Theory

SEARCH AND RESCUE - U.S. COAST GUARD ...Consultants, Advisory Services, Operational Aspect, Safety, ...8,0130
SYSTEM OPERATIONS AND ACOUSTIC PHYSICS ...Acoustical, Instrumentation-general, Liquids, Standards, Specifications, Systems Analysis, ...12,0020

Application

TECHNIQUES OF PLANNING ...Control Systems, Management, Mathematical Analysis, Operations Research, Planning, Southern, Systems Analysis, ...9,0017

Cost Analysis

OPTIMIZATION METHODS APPLIED TO THE PRELIMINARY DESIGN OF A NAVAL AUXILIARY ...Algorithms, Engineering Studies-other, Optimization Technique, Other-design-and-construction, Requirement, ...8,0297
MARINE TRANSPORTATION ANALYSIS MODEL ...Input - Output Analysis, Models, Ports & Harbors, Water Vessel, ...8,0031
NUCLEAR FUEL COST ANALYSIS MODEL ...Applications, Fuel, Nuclear Power, ...4,0070
ADVANCED MARINE TRANSPORTATION SYSTEM/ANALYSIS MODEL ...Algorithms, Consumption, Input - Output Analysis, Merchant-ships, Models, Systems Analysis, ...4,0068

Analysis of the Effects on Operating Costs and Return on Investment of Variations in Operating Parameters ...Costs, Economics, Ocean Mining, Systems Analysis, ...4,0174

Design of Experiments

OPTIMIZATION METHOD APPLIED TO THE PRELIMINARY DESIGN OF A NAVAL SALVAGE TUG ...Algorithms, Operational Aspect, Optimization Technique, Other-design-and-construction, Random Variables, ...8,0367

Management Science

MARINE TRANSPORTATION ECONOMIC ANALYSIS ...Economic Analysis, Freight, Production & Processing, Water Transportation, ...4,0179

Optimization Technique

SYSTEM DESIGN STUDY FOR THE U.S. NAVAL OCEANOGRAPHIC OFFICE INTELLIGENCE DATA HANDLING SYSTEM ...Data Analysis - General, Data Reduction and Analysis, Geophysics-general, Mapping, Systems Analysis, ...4,0016

Programming

HYDRODYNAMIC FLOW FIELD STUDY ...Ship Resistance Stability, Viscous Wave, ...8,0170

Systems Analysis

ERROR ANALYSIS OF SEVERAL BOTTOM REFERENCED NAVIGATION SYSTEMS FOR SMALL SUBMERSIBLES ...Error Analysis, Navigation, Operational Aspect, Sonar, Submersibles, Subsurface Environments, ...4,0111
A SHIPBOARD DIGITAL DATA ACQUISITION SYSTEM ...Data Acquisition, Seismic Studies, Tape Storage, ...4,0036
SYSTEM DESIGN STUDY FOR THE U.S. NAVAL OCEANOGRAPHIC OFFICE INTELLIGENCE DATA HANDLING SYSTEM ...Data Analysis - General, Data Reduction and Analysis, Geophysics-general, Mapping, Optimization Technique, ...4,0016
AN ECONOMIC EVALUATION OF WATER POLLUTION CONTROL, YAQUINA BAY, ORE ...Alternative Planning, Bays, Benefit-cost Analysis, Model Studies, Oregon, Water Quality Control-general, ...6,0173
ADVANCED MARINE TRANSPORTATION SYSTEM/ANALYSIS MODEL ...Algorithms, Consumption, Cost Analysis, Input - Output Analysis, Merchant-ships, Models, ...4,0068

SYSTEM OPERATIONS AND ACOUSTIC PHYSICS ...Acoustical, Economic Theory, Instrumentation-general, Liquids, Standards, Specifications, ...12,0020
ANALYSIS OF THE EFFECT ON OPERATING COSTS AND RETURN ON INVESTMENT OF VARIATIONS IN OPERATING PARAMETERS ...Cost Analysis, Costs, Economics, Ocean Mining, ...4,0174

Economics

STUDY OF OCEANOGRAPHIC MARKETS ...Consumption, Manufacturing, Oceanography-general, Trends,projections, ...4,0175

SCIENCE AND ENGINEERING GOALS FOR THE INTERNATIONAL DECADE OF OCEAN EXPLORATION ...Oceanography-general, Planning, Project Review, Science & Technology, ...4,0118
FISHING VESSEL CONSTRUCTION COSTS AND THE U.S. FISHING VESSEL CONSTRUCTION DIFFERENTIAL SUBSIDY ...Commercial Fishing, Costs, Fiscal, Other-design-and-construction, Surface Ships, ...4,0181
SECOND HAND PRICES FOR TANKERS ...Model Studies, Price & Value, Tankers, Trends,projections, ...4,0184

PRELIMINARY STUDIES OF INTERNATIONAL REGIMES FOR MARINE RESOURCES ...Legal Studies-general, Oceanography-general, Social Aspects, ...10,0001

USE OF TIDAL POWER AND OTHER OCEAN ENERGY SOURCES ...Bibliography, Engineering Studies-other, Mechanical Power-other, Survey Studies, Tides, ...8,0084
FINANCING OF FISHING VESSELS ...Commercial Fishing, Fish & Shellfish, Rhode Island, Savings and Investment, ...4,0185
ECONOMIC IMPACT OF MARINE-ORIENTED ACTIVITIES IN THE SOUTHERN NEW ENGLAND MARINE REGION ...Northeast, Regional Economic Impact, ...4,0187
Benefit-cost Analysis

SYSTEMS ANALYSIS ASSISTANCE TO HEADQUATERS U. S. COAST GUARD ...Model Studies, Sea Ice, Ships and Cruises, Systems Analysis, ...12.0015

STREAM IMPROVEMENT PLANNING ...Engineering Structure-general, ...Fish & Shellfish, Management- ...4.0086

AN ECONOMIC EVALUATION OF WATER POLLUTION CONTROL, YAQUINA BAY, ...Aquaculture & Fish-farming, Commercial Fishing, Consumer Pref. & Consumption, ...6.0019

SOCIO-ECONOMIC STUDY OF NARRAGANSETT BAY, RHODE ISLAND ...Bays, Estuaries, Land Use, Rhode Island, Social Aspects, Water Quality Control-general, ...9.0019

Commodities

Fish & Shellfish

RADIATION PRESERVATION OF FISHERY PRODUCTS ...Commercial Fishing, Fish -non-specific, Organoleptic Studies, Radiation, Shelf Life & Storage, ...4.0068

SYSTEMS ENGINEERING AND DEVELOPMENT OF COMMERCIALLY VALUABLE MARINE RESOURCES IN THE DELAWARE AREA ...Aquaculture & Fish-farming, Commercial Fishing, ...4.0084

DETERMINATION OF THE STRUCTURE & ECONOMIC IMPORTANCE OF THE VARIOUS SEGMENTS OF THE SEAFOOD INDUSTRY ...Commercial Fishing, Consumer Pref. & Consumption, Fish -non-specific, ...9.0019

CONSUMER EDUCATION AND MARKET DEVELOPMENT ...Atlantic Ocean-north, Northeast, ...6.0022

REGIONAL DEMAND IN THE U.S. AND TRENDS IN THE FISHING AND SEAFOOD PROCESSING INDUSTRIES OF THE CHESAPEAKE BAY AREA ...Chesapeake Bay, Commercial Fishing, Consumer Pref. & Consumption, Fish -non-specific, Market Structure, ...6.0028

CONSUMER EVALUATION OF FISH PRODUCTS ...Consumer Pref. & Consumption, Fish -non-specific, Organoleptic Studies, Smoking, ...6.0004

MARKET STRUCTURE OF THE COMMERCIAL FISHING INDUSTRY - Cattle Rations -other, Commercial Fishing, Fish Meals, Market Structure, Marketing, Poultry Rations -other, ...4.0017

ECONOMIC ANALYSIS OF THE MARKET STRUCTURE OF THE COMMERCIAL FISHING INDUSTRY IN THE NORTHEAST ...Commercial Fishing, Market Structure, Marketing, Math Models, Northeast, Productivity (agricultural), ...6.0015

ECONOMIC ANALYSIS OF THE MARKET STRUCTURE OF THE COMMERCIAL FISHING INDUSTRY IN THE NORTHEAST ...Commercial Fishing, Market Structure, Maryland, Northeast, Processing, ...4.0182

THE RHODE ISLAND HARD CLAM - QUAGHAUG - INDUSTRY ...Clams, Costs, Production & Processing, Rhode Island, ...5.0043

FINANCING OF FISHING VESSELS ...Commercial Fishing, Economics, Rhode Island, Savings and Investment, ...4.0015

COMMERCIAL BENEFIT STUDIES ...Commercial Fishing, ...6.0037

PROCESSING AND PRODUCT DEVELOPMENT OF EDEIBLE FISH AND SHELLFISH ...Commercial Fishing, ...6.0047

INCREASE EFFICIENCY OF HAWAIIAN LONGLINE FISHERY ...Commercial Fishing, Fishing Gear, Hawaii, Production & Processing, Technique Development, Technological Development, ...11.0022

Economic Efficiency

ECONOMICS OF WATER QUALITY FOR A REGIONAL SYSTEM ...Delaware River, Estuaries, Finance, Regional Areas, Water Demand, Water Quality-general, ...9.0018

Economic Impact

SURFACE AND GROUND WATER POTENTIALITIES OF THE MULLICA RIVER BASIN ...Aqueducts, Conjunctive Use, Estuaries, Systems Analysis, Water Quality-general, Water Transfer, ...9.0014

EFFECTS OF WATER POLLUTION IN SAN FRANCISCO BAY ...Bays, Pollution - Effects of, Recreation Sites, San Francisco Bay, Social Aspects, Water Utilization -domestic, Welfare Economics, ...6.0014

Economics-general

BIONOMICS OF FISHES AND SHELLFISHES ...Aquaculture & Fish-farming, Bays, Environmental Ecology, Oregon, Productivity - Food Chain, ...5.0020

Finance

PUBLIC INVESTMENT CRITERIA FOR WATER-ORIENTED RECREATION IN THE LAKE ERIE BASIN ...Regional Planning, Costs, Fiscal, Pollution Abatement, Projected Demand, Recreation Sites, ...9.0016

ECONOMICS OF WATER QUALITY FOR A REGIONAL SYSTEM ...Delaware River, Economic Efficiency, Estuaries, Regional Areas, Water Demand, Water Quality-general, ...5.0018

Income Analysis

Consumption

STUDY OF OCEANOGRAPHIC MARKETS ...Economics, Manufacturing, Oceanography-general, Trends, ...4.0176

COMPETITIVE MERCHANT SHIP PROJECT (BULK) DRY BULK COMMODITY FORECASTS ...Freight, Merchant-ships, Transportation Systems, ...5.0029

REGIONAL DEMAND IN THE U.S. AND TRENDS IN THE FISHING AND SEAFOOD PROCESSING INDUSTRIES OF THE CHESAPEAKE BAY AREA ...Chesapeake Bay, Commercial Fishing, Consumer Pref. & Consumption, Fish -non-specific, Market Structure, ...6.0028

MARKET STRUCTURE OF COMMERCIAL FISHING INDUSTRY IN THE NORTHEAST ...Commercial Fishing, Haddock, Market Structure, Northeast, Refrigeration, ...4.0016

ADVANCED MARINE TRANSPORTATION SYSTEM/ANALYSIS MODEL ...Algorithms, Cost Analysis, Input - Output Analysis, Merchant-ships, Models, Systems Analysis, ...4.0068

Fiscal

FISHING VESSEL CONSTRUCTION COSTS AND THE U.S. FISHING VESSEL CONSTRUCTION DIFFERENTIAL SUBSIDY ...Commercial Fishing, Costs, Economics, Other-design-and-construction, Surface Ships, ...4.0181

PUBLIC INVESTMENT CRITERIA FOR WATER-ORIENTED RECREATION IN THE LAKE ERIE BASIN ...Alternative Planning, Costs, Finance, Pollution Abatement, Projected Demand, Recreation Sites, ...9.0016

Savings and Investment

INSTITUTIONAL ARRANGEMENTS FOR THE MARINE SCIENCES ...International Affairs, Management, Management and Administration, Oceanography-general, ...10.0005

FINANCING OF FISHING VESSELS ...Commercial Fishing, Economics, Fish & Shellfish, Rhode Island, ...4.0015

Methods & Measures

Input - Output Analysis

MARINE TRANSPORTATION ANALYSIS MODEL ...Cost Analysis, Models, Ports & Harbors, Water Vessel, ...8.0031

ADVANCED MARINE TRANSPORTATION SYSTEM/ANALYSIS MODEL ...Algorithms, Consumption, Cost Analysis, Merchant-ships, Models, Systems Analysis, ...4.0068

Simulation

149A FISHERY SYSTEMS ANALYSIS ...California, Commercial Fishing, Nets, Production & Processing, Tuna, Alaska, ...4.0175
### SUBJECT INDEX

<table>
<thead>
<tr>
<th>Electric Components</th>
<th>Electric Power Transmission</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Power Transmission Systems</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Power Sources</strong></td>
<td>- Benthonic-bottom, Safety, Submerged Ships, Technique Development, Underwater-construction, 8.0156</td>
</tr>
<tr>
<td><strong>Electro-osmosis</strong></td>
<td>- ELECTROKINETIC SOIL STUDY, Buried Structures, Electroosmosis, Electrophoresis, Laboratory Analysis, Marine Soils, Stabilization, 8.0342</td>
</tr>
<tr>
<td><strong>Electroanalyses</strong></td>
<td>- AN ANALYSIS OF PHOSPHORUS AND NITROGEN COMPOUNDS IN TIDAL MARSHLAND DRAINAGE, LABORATORY PROCEDURES, Colorimetry, Computer Applications, Management, Nitrogen, Phosphate, Phosphite, Swamps-marshes, 8.0761</td>
</tr>
<tr>
<td><strong>Electrochemistry</strong></td>
<td>- BRACKISH WATER PURIFICATION BY BIOLOGICAL FUEL CELL POWERED ELECTRODIALYSIS, Biological, Brackish Water, Desalination, Desalination Wastes, Electrolysis, Material Recovery Wastes, 8.0161</td>
</tr>
<tr>
<td><strong>Electromechanical Design</strong></td>
<td>- A DESIGN PROGRAM FOR SUPERCONDUCTING ELECTRICAL MACHINES, Electrical, Instrumental Services, Marine Propulsion, Superconductive Device, 8.0112</td>
</tr>
<tr>
<td><strong>Electron Emission</strong></td>
<td>- INVESTIGATION OF NUCLEAR THERMIonic POWER FOR MARINE APplications, Marine Environmental-general, Nuclear Power, Power Conversion Systems, Thermoelectric, 8.0115</td>
</tr>
<tr>
<td><strong>Electronic Components</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Cables and Transmission Lines</strong></td>
<td>- SUBMARINE SEISMIC PROFILES OF THE WORLDS OCEANS, Atlantic Ocean-general, Data Analysis, General, Indian Ocean-general, Seismic Studies, Subbottom, 8.0120</td>
</tr>
<tr>
<td><strong>Low Noise Multi-Channel Hydrophone Cable</strong></td>
<td>- Amplifiers, Bathymetry, Seismic Studies, Telephone, Transmission Lines, 8.0145</td>
</tr>
<tr>
<td><strong>Collection, Analysis, Interpretation, and Presentation of Oceanographic GeoLogic Data in Connection with Submarine Cable System Development</strong></td>
<td>- Data Acquisition, Data Analysis, General, Submerged Ships, Transmission Lines, 8.0104</td>
</tr>
<tr>
<td><strong>Electronic Components-other</strong></td>
<td>- INSTRUMENT STUDIES, Evaluation Other, Instrumental Services, Testing Facilities, 8.0104</td>
</tr>
<tr>
<td><strong>Electronic Tubes</strong></td>
<td>- INSTRUMENT STUDIES, Evaluation Other, Instrumental Services, Testing Facilities, 8.0104</td>
</tr>
<tr>
<td><strong>X Ray Tubes</strong></td>
<td>- X-RADIOGRAPHIC AND ELECTRONIC FLUOROSCOPIC EQUIPMENT, Core Analysis, Equipment Particulate Operation, Instrumental Services, Radiograph, Radiometer, 8.0104</td>
</tr>
<tr>
<td><strong>Electronic-flash-lights</strong></td>
<td>- PSYCHOPHYSICAL EFFECTS OF XENON FLASHTUBES, Navigation Communication, Optical Sources, Lamps, Visible, Xenon, 8.0105</td>
</tr>
</tbody>
</table>
Electronic Components

SUBJECT INDEX

Signal Analysis-other
- SOUND TRANSMISSION IN THE SEA ...Acoustical, Sonar, Transmission, ...8.0030
- UNDERWATER ACOUSTIC ANALYSIS ...Acoustical, Forecasting-prediction, Phase Relationships, Transmission, Water Properties-general, ...8.0038
- SIGNAL COHERENCE AND ARRAY DESIGN STUDIES ...Acoustical, Coherence, Reflection, Spectra, Waveform, ...8.0024

Spectrum
- MOVABLE OCEAN MEASUREMENT SYSTEM ...Acoustical, Instrumental Services, Platforms, Spectral Distribution, ...8.0117
- AUDITORY DETECTION ...Fog-haze-mist, Interference, Spectral Distribution, Wave Analyzer, ...8.0095

Transient
- DEVELOPMENT OF ANALYSIS TECHNIQUES FOR CLASSIFYING TRANSIENT HYDROACOUSTIC SIGNALS ...Acoustical, Acoustics, Seismic Studies, Signal Detection, ...8.0068
- Wave Analyzer
- AUDITORY DETECTION ...Fog-haze-mist, Interference, Spectral Distribution, Spectrum, ...8.0095
- Waveform
- SIGNAL COHERENCE AND ARRAY DESIGN STUDIES ...Acoustical, Coherence, Reflection, Signal Analysis-other, Spectra, ...8.0024
- SUBMERGED OPERATIONS COMMUNICATIONS (SUBCOM) ...Converters - Coders, Diving and Scuba, ...8.0023

Solid State
- Amplifiers
- EXPERIMENTAL HIGH RESOLUTION SUB-BOTTOM PROFILING SYSTEM ...Receivers, Sonar, Sonar and Echo Soundin, Subbottom, Transducers, ...8.0109
- LOW NOISE MULTI-CHANNEL HYDROPHONE CABLE ...Bathymetry, Cables and Transmission Lines, Seismic Studies, Telephone, Transmission Lines, ...8.0145
- AEROLOGICAL INSTRUMENTS ...Field Testing, Humidity Instruments, Instrumental Services, Microwave Techniques, Technique Development, ...8.0082
- FREQUENCY TIME RESEARCH ENGINEERING ...Electromagnetic Transmission, Frequencies-other, Frequency Conversion, Time Measurements, Very Low Frequency, ...8.0068
- Detectors
- VISUAL LANDING AIDS FIELD ...Atmosphere Optical Phenomena, Electric Lighting Systems, Fog-haze-mist, Infrared Radiation, Lighting, ...8.0086

Signal Generators
- WWV BROADCASTS ...Navigation, ...8.0089
- SATELLITE TIME DISSEMINATION ...Airborne Probing, Communication & Navigation, Doppler, Navigation, Standards, Specifications, Time Measurements, ...4.0091
- WWVB- WWVL BROADCASTS ...Frequency Standards, Low Frequency, Navigation, Radio, Standards, Specifications, Time Measurements, Very Low Frequency, ...8.0090

Superconductive Device
- A DESIGN PROGRAM FOR SUPERCONDUCTING ELECTRICAL MACHINES ...Electrical, Electromechanical Design, Instrumental Services, Marine Propulsion, ...8.0132

Transmission Lines
- LOW NOISE MULTI-CHANNEL HYDROPHONE CABLE ...Amplifiers, Bathymetry, Cables and Transmission Lines, Seismic Studies, Telephone, ...8.0145
- COLLECTION, ANALYSIS, INTERPRETATION, AND PRESENTATION OF OCEANOGRAPHIC GEOLOGIC DATA IN CONNECTION WITH SUBMARINE CABLE SYSTEM DEVELOPMENT ...Cables and Transmission Lines, Data Acquisition, Data Analysis - General, Submerged Ships, ...7.0043

Ultrasound Technology
- ENVIRONMENTAL TEST AND EVALUATION ...Acoustic, Testing Facilities, Transducers, ...8.0128

Electronic Components

Transducers
- NAVIGATION RECEIVER ...Navigation, Navigation Systems-other, Radio, Sonar, Transponders, ...4.0112
- EXPERIMENTAL HIGH RESOLUTION SUB-BOTTOM PROFILING SYSTEM ...Amplifiers, Receivers, Sonar, Sonar and Echo Soundin, Subbottom, ...8.0109
- PRESSURE INSENSITIVE VELOCIMETER ...Acoustical, Instrumental Services, Pressure, Velocimeter, Velocity, ...8.0055
- TURBULENCE STRUCTURE AND NOISE STUDY ...Additives, Noise, Turbulent, ...1.0002
- PRECISION QUARTZ CAPACITANCE PRESSURE TRANSDUCERS ...Capacitance, Pressure, Quartz, Technique Development, ...8.0121
- ADVANCE SONAR SYSTEMS ...Data Display, Instrumental Services, Sonar, Sonar and Echo Soundin, Testing Facilities, ...8.0096
- TRANSDUCER RESEARCH ...Packaging, Sealant, Submersibles, ...8.0095
- NEW SEA GRAVITY METER ...Capacitance, Geophysical Equipment, Gravimetric, Gravity Studies, Instrumental Services, ...8.0067
- THEORETICAL AND LABORATORY MODEL STUDIES OF LARGE-SCALE OCEAN CIRCULATION ...Circulation-general, Currents-ocean, Forecasting-prediction, Gulf Stream, Model Studies, ...2.0023
- ARCTIC SEISMIC TRANSDUCER EVALUATION ...Applied Electronics, Arctic, Evaluation Other, Ice Acoustics, Propagation, ...8.0119
- DEEP SUBMERGENCE DISSOLVED OXYGEN TRANSDUCER ...Gases, Instrumental Services, Oxygen, Submersibles, ...8.0057
- HUMIDITY SENSORS ...Barium, Fluoride, Humidity Instruments, Stability, ...8.0083
- AUTOMATED FLOW SYSTEM CALIBRATION ...Aircraft, Controls, Digital Computer Applications, Fluids, ...8.0071
- ENVIRONMENTAL TEST AND EVALUATION ...Acoustic, Testing Facilities, Ultrasonic Technology, ...8.0128
- COAST GUARDS COASTAL OCEANOGRAPHIC MONITORING NETWORK ...Automatic Stations, Buoys, Instrumental Services, Recording Systems, Telemetry-other, ...4.0006

Electronics

Electric Circuits and Networks
- TESTING AND EVALUATION OF HIGH-RESOLUTION ACOUSTIC SUBBOTTOM PROFILER THROUGH MODIFICATION OF OFF-THE-SHELF COMPONENTS ...Distribution, Evaluation Other, Field Testing, Sonar, ...8.0115

Microwave Techniques
- MICROWAVE RADIOMETER DEVELOPMENT ...Instrumental Services, Microwave Radiation, Radiation Detection, Radiation-terrestrial, Wave Form, ...8.0056
- AEROLOGICAL INSTRUMENTS ...Amplifiers, Field Testing, Humidity Instruments, Instrumental Services, Technique Development, ...8.0082

Signal Analysis

Doppler
- INTEGRATION OF DOPPLER SATELLITE AND LORAC NAVIGATIONAL SERVICES ...Loran, Navigation, Satellites, ...4.0110

Interference
- STUDY OF PROBABILITY OF DETECTION AND FALSE ALARM RATE OF FREQUENCY ACOUSTIC TELEMETRYING SYSTEM ...Acoustical, Oil and Natural Gas - Sulfur, ...8.0106
- AUDITORY DETECTION ...Fog-haze-mist, Spectral Distribution, Spectrum, Wave Analyzer, ...8.0095

Noise
- TURBULENCE STRUCTURE AND NOISE STUDY ...Additives, Turbulent, ...1.0002
- AMBIENT SEA NOISE INVESTIGATION ...Acoustic, Acoustical, Computer Applications, Waves, Wind-water Interaction, ...1.0048
- ARCTIC ACOUSTIC RESEARCH ...Applied Electronics, Arctic, Ice Acoustics, Transmission, ...1.0001

488
SUBJECT INDEX

Electrophoresis

Disc Electrophoresis

Electrophoretic Profiles for the Identification of Fish Species...Fish -non-specific, Gel Electrophoresis, Infection, Intoxication & Poi, Leg. J Standards, ...E0014

Electrophoresis -non-specific

Stock Identification of Atlantic Tunas...Atlantic Ocean-general, Caribbean Sea, Tuna, Mackerel, Albacore, ...E0025

Gel Electrophoresis

Comparative Biochemistry of Proteins from Gulf Fish...Blood Proteins -non-specific, Drums, Hemoglobin, Shrimps - Common, ...E0036

Electrophoretic Profiles for the Identification of Fish Species...Disc Electrophoresis, Fish -non-specific, Infection, Intoxication & Poi, Legal Standards, ...E0014

Elementary Particles

Magnetic Monopole

Search for Ferromagnetically Trapped Magnetic Monopoles of Cosmic Ray Origin...Field Reversals, Magnetic Studies, Paleomagnetism, Physical Properties, ...E0114

Encapsulation

Hydrogen-Oxygen Fuel Cells...Fuel Cell-other, Gas Generator, Oxidants, Safety, Submersibles, ...E0160

Endogenous Biological Extracts

Control of Plant Pathogens Using Active Antimicrobial Substances Isolated from Marine Algae...Bacteria, Fungi -non-specific, Growth Substances, Marine Plants, Nutrition In Disease, ...E0127

Energy

Oceanography, Pleistocene Geology and Sediments of Little Bahama Bank...British West Indies, Carbonates-general, Currents-bottom, Quaternary Period, Water Motion Recorders, ...E0229

Study of Oceanic Turbulence...Hydrodynamics, Mixing, Subsurface Environments, Turbulence - Sea Water, Water Motion, ...E0052

Biochemical and Biophysical Studies of the Marine Environment...Copepods, Energy Budgets, Organics, Productivity - Food Chain, ...E0067

Ocean Currents and Circulation...Circulation-general, Currents-ocean, Data Acquisition, Model Studies, Temperature, ...E0015

Great Lakes Research - Coastal Area Sedimentation...Beach, Development, General Transport Effects, Great Lakes-general, Model Studies, Sedimentation, ...E0124

Engineering Geology

Preliminary Studies to Correlate Selected Mineralogic and Geologic Properties with Engineering Properties...Alaska, Mineralogy, Petrology, Ships and Cruises, Trace Element Analysis, ...E0160

Engineering Mechanics

Analysis

Visco-elastic Dynamic Vibration Absorber...Close Channel, Drag, Energy Dissipators, Hydraulic Equipment, Vibrating Systems-other, Viscous, ...E0185

Forces and Loading

Random

An Investigation of the S/N Fatigue Life Gage...Stress Recorders, ...E0100

Static

Determination of Flow in an Axial-to-Radial Diffuser with Swirl...Configuration of Body, Impinging Jets, Model Apparatus-other, Pressure Gradient, Rotors-propellers, ...E0195

Mechanical Vibrations

Non-linear

Investigation of the Non-Linear Characteristics of Fluid-Suspended Vehicles...Dimensionless-parameters-other, Hydrofoils Crafts, Non Linear, Non-linear, Simulation Theory, Stability, ...E0184

Response

An Analysis of the Response of Cylindrical Ducts to Internal, Zero Mean Flow, Air-Cafried Acoustic Excitation...Acoustic Field, Close Channel, Geometric Configuration, ...E0181

Vibrating Systems-other

Visco-elastic Dynamic Vibration Absorber...Analysis, Close Channel, Drag, Energy Dissipators, Hydraulic Equipment, Viscous, ...E0195

Moments

Stresses Developed on the Surface of Cylindrical Joints Subjected to Multiple Loads...Analysis Structural, Geometric Configuration, Joints, Stress Concentration, Stresses, ...E0304

Stability

Investigation of the Non-Linear Characteristics of Fluid-Suspended Vehicles...Dimensionless-parameters-other, Hydrofoils Crafts, Non Linear, Non-linear, Simulation Theory, ...E0184

Wave Action on Structures...Engineering Structures-general, Hydrodynamic Structures, Models, Shoreline Structures, Wave Action, Waves, ...E0175

Strength

A Study of the Interface Locations between Dissimilar Materials and Other Aspects of a Composite Midship Section...Bulkheads, Hull, Hydrodynamic Structures, ...E0204

Stress Concentration

Stresses Developed on the Surface of Cylindrical Joints Subjected to Multiple Loads...Analysis Structural, Geometric Configuration, Joints, Moments, Stresses, ...E0304

Stresses

Stresses Developed on the Surface of Cylindrical Joints Subjected to Multiple Loads...Analysis Structural, Geometric Configuration, Joints, Moments, Stress Concentration, ...E0304

Engineering Structures-general

Stream Improvement Planning...Benefit-cost Analysis, Fish -non-specific, Management-other, Planning, Streams, ...E0220

Effects of Marsh Management Structures Upon Fishes...Alewife, Menhaden, Shad, Herring, Crabs, Land Use, Shrimps - Common, Spawning & Nesting Sites, Swamps-marshes, ...E0206

Stability of Rubble-Mound Breakwaters...Breakwaters, Design Criteria, Hydrodynamics, Shoreline Structures, Wave Action, Waves, ...E0045

Wave Action on Structures...Hydrodynamic Structures, Models, Shoreline Structures, Stability, Wave Action, Waves, ...E0175

Correlation of Beach Properties and Incident Waves...Beach, Development, General Transport Effects, Sea Level Variations, Shoreline Structures, Waves, ...E0204

Adult Salmon Behavior Studies in Rivers and at Dams (Sonar Tracking)...Behavioral Ecology, Salmon & Trout - Non-specific, Streams, Tags, Telemetry, ...E0111

Collection of Juvenile Migrants from Rivers and Streams...Electric Power Plants, Fish -non-specific, Management-other, Migration, Streams, ...E0113
SUBJECT INDEX

Environmental Effects-geologic

HAWAIIAN OCEANOGRAPHY --Circulation-general, Hawaii, Hydrodynamics, Islands, Ocean Currents-other, ...0.0021

THE PORNIFERA OF FANNING ISLAND, CENTRAL PACIFIC

ECOLOGY AND SEDIMENTARY PATTERNS OF FORAMINIFERA --Chromat, Environmental Ecology, Foraminifera, Vertical Distribution, ...0.0074

THE SEDIMENTARY AND DIAGENETIC RECORD OF ENVIRONMENTAL PARAMETERS IN RECENT BAHAMIAN TIDAL PLAINS & British West Indies, Diagenetic, Intertidal Areas, Local Stratigraphy, Paleoclimatology, ...0.0013

THEORETICAL STUDIES OF TSUNAMI PROPAGATION --Depth, Forecasting-prediction, Geomorphology-topography, Tsunami, Waves, ...0.0022

ARCTIC FIELD RESEARCH --Arctic Ocean, Bibliography, Geophysics-general, Russia, ...1.0013

UTILIZATION OF PHYSICAL AND MATHEMATICAL MODELS IN MARINE WATER RESOURCES RESEARCH AND MANAGEMENT --Estuaries, Management, Mathematical Analysis, Model Studies, Shoreline-Coastline, ...0.0038

OCEANOGRAPHIC RESEARCH-INVESTIGATIONS IN SHALLOW WATER --Acoustical, Model Studies, Salinity, Stratification, ...0.0009

SHALLOW WATER OCEANOGRAPHY (SEALAB III) --Diving & Scuba, Diving-system, Instrumentation-general, Underwater-laboratory, ...0.0014

ARCTIC UNDERSEA RESEARCH, PHYSICAL AND CHEMICAL PROPERTIES OF SEA ICE --Arctic Ocean, Ice Properties-general, Model Studies, Sea Ice, ...0.0070

SHALLOW WATER OCEANOGRAPHY --Continental Shelf, Forecasting-prediction, Pressure, Subsurface Environment, Waves, ...0.0012

PREDICTIVE OCEAN ACOUSTICS --Acoustical, Forecasting-prediction, Transmission, Velocity, ...0.0004

DESIGN AND CONSTRUCTION --Coatings-general, Hydrodynamic Structures, Safety, Underwater-construction, Water, ...0.0033

LABORATORY STUDIES TO DETERMINE ROCK PROPERTIES UNDER HYDROSTATIC (SEA WATER) PRESSURE --Marine Environments-general, Physical Properties, Rock Mechanics, Survey Studies, ...0.0030

HISTORICAL STUDY ON EFFECT OF HARBOR DREDGING ON THE ENVIRONMENT (ENVIRONMENTAL FACTORS PERTINENT TO EFFECTS ON MARINE ENVIRONMENTS) --Dredging, Excavation, Harbors, Marine Environments-general, Ocean Mining, ...0.0013

THE EFFECTS OF ENVIRONMENTAL CONDITIONS ON THE SPAWNING AND SURVIVAL OF FRY OF THE WALLEYE --Eutrophication, Lake Erie, Pollution - Effects of, Temperature, Walleye, ...0.0029

SURVEY, EVALUATION & SUMMARIZATION OF LITERATURE ON ENVIRONMENTAL REQUIREMENTS OF MARINE ORGANISMS LEVELS OF POTENTIAL TOXICANTS --Chemical, Geochronology, Library, Marine Biology, Marine Environments-general, Survey Studies, ...0.0037

Environmental Factors-geologic

SURVEY, EVALUATION & SUMMARIZATION OF LITERATURE ON ENVIRONMENTAL REQUIREMENTS OF MARINE ORGANISMS LEVELS OF POTENTIAL TOXICANTS (ABBREV --Biology, Environmental Effects-geologic, Geosciences, Library, Marine Biology, Marine Environments-general, Survey Studies, ...0.0037

PHYSICAL GEOGRAPHY OF TROPICAL COASTAL LOWLANDS --Development, Geography-physical, Physical Features-general, Shore Features-general, Tropic, ...0.0028

ISLAND-CURRENT INTERACTIONS --Acoustical Currents, Data Analysis - General, Island, Model, ...2.0116

PALEONTOLOGICAL EVIDENCE OF CYCLES IN THE EARTH-MOON SYSTEM --Comparative Studies-other, Environmental Changes, Invertebrates, Origins, Shells, Thin Sections, ...0.0017

DRAINAGE PATTERN DEVELOPMENT ON TIDAL MARSHES --Aerial Photography, Drainage, Swamps-marshes, ...0.0021

Environments - Animal

Chemical Measurements -water

MEASUREMENT OF BIOLOGICAL FACTORS OF VARIOUS HABITUATS, AND THEIR RELATION TO THE BIOLOGY OF THE COMMERCIALLY IMPORTANT SPECIES --Habitat Studies, Physical Measurements-water, Plankton (non-specific), Population Dynamics, Productivity, Food Chain, ...0.0019

FISH POPULATION STUDY --Commercial Fishing, Fish (non-specific), Food Supply, Population Dynamics, Water Temperature-non-specific, ...0.0017

PHYSIOLOGY AND BEHAVIOR --Behavior, Environmental Physiology, Lake Michigan, Physical Measurements-water, Productivity, Food Chain, ...0.0004

Contamination - Water

THE ACCUMULATION OF FISSION PRODUCTS BY MARINE FISH AND SHELLFISH --Chloride (non-specific), Estuaries, Food Chains, Radioactivity-general, Radioecology, ...0.0027

ECOLOGICAL STUDIES OF RADIOACTIVITY IN THE COLUMBIA RIVER ESTUARY AND ADJACENT PACIFIC OCEAN --Columbia River, Organism Susceptible Devices, Pacific Ocean-north, Pollutants - Path of, Radioactivity-general, ...0.0012

COLUMBIA RIVER STUDIES --Columbia River, Invertebrates, Oysters, Pollution Effects, Radioactivity-general, Reproductive System, ...0.0018

EFFECTS OF LOG RAFTING ON DUNGENESS CRAB --Crabs, Diving and Scuba, Forestry, Mass Activities, Pulp, Paper, and Logging, ...0.0017

DETERMINATION OF SAFE LEVELS OF POLLUTION IN PUERTO RICO --...Coastal Studies, Environmental Ecology, Environmental Physiology, Estuaries, Pollution Effects, Pulp, Paper, and Logging, Salmon & Trout - Non-specific, ...0.0017

ESTUARINE WATER QUALITY AND FISH DISTRIBUTION --Environmental Physiology, Estuaries, Pollution Effects, Pulp, Paper, and Logging, Salmon & Trout - Non-specific, ...0.0017

EFFECTS OF KRAFT PULP MILL EFFLUENTS ON THE GROWTH AND PRODUCTION OF FISH --Industrial wastes, Pollution - Effects of, Population Dynamics, Pulp, Paper, and Logging, Salmon & Trout - Non-specific, ...0.0011

EFFECT OF EURASIAN WATERMILFOIL CONTROL PROCEDURES ON WILDLIFE AND OTHER ORGANISMS IN AQUATIC ENVIRONMENTS --Diquat, Evaluation, Water Milfoil, Waterweed, ...2.04-4, ...0.0000

ACCUMULATION OF RADIOACTIVITY BY INVERTEBRATES (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION) --Cooperative-studies, Diagnostic Procedures, Radioactivity-general, Reactor Sites & Radios, ...0.0047
Radioactive Fallout
PHYSICAL AND RADIOLOGICAL CHEMISTRY OF OCEAN SOLUTIONS ...Chemical Reactions, Octopus, Squid, Cuttlefish ...Pacific Ocean-north, Radioactivity-general, Traceurs, ...1.0133
THE EFFECTS OF RADIATION ON THE PHYSIOLOGY OF MARINE ORGANISMS (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION) ...Cooperative-studies, ...5.0294
Seasonal
Spring
SPRING DISTRIBUTION OF FISHES ...Commercial Fishing, Continental Shelf, Identification, Environmental Ecology, Fsh -non-specific, Temporal Distribution, ...5.0154
Winter
EFFECT OF PROCESS ON SHELLFISH ...Clams, Processed Product Quality, Processing, Sanitation, Shell Life & Storage, ...5.0020
WINTER DISTRIBUTION OF FISHES ...Continental Shelf, Environmental Ecology, Fsh -non-specific, Salinity, Temperature, Temporal Distribution, ...5.0153
Temperature - water
High Temp. -85F Or Above
EFFECTS OF HOT WATER MASSES ON MARINE FISHES ...Atlantic Ocean-north, Behavior, Fish -non-specific, Oceanic Fronts, Thermal, ...5.0210
EFFECTS OF HIGH TEMPERATURE, LOW OXYGEN, AND PH ENVIRONS ON THE SURVIVAL OF AQUATIC INSECTS AND CRUSTACEAE IMPORTANT AS TROUT FOOD ...Aquatic Ecology, Food Supply, Guess, Dissolved -water, Lake Superior, Ph, Acidity -water, ...5.0444
Low Temp. - but Above 32F
LIPID COMPOSITION OF ANTARCTIC MARINE ORGANISMS AND SEA WATER ...Antarctic Ocean, Fish -non-specific, Gulf of Mexico, Lignis, Phytoplankton, Productivity - Food Chain, Zoolankton, ...5.1031
THE PURCHASE AND INTRODUCTION OF BROOD STOCK ...Oystershells, Spawning & Nesting Sites, Stocking of Fish & Shellfish, Warm Water, ...5.0026
RELATION OF TEMPERATURE TO RHYTHMIC BEHAVIOR ...Behavior, Biological Rhythms, Bluefish, Environmental Physiology, Locomotion -animal, ...5.0284
ESTUARINE BIOLOGY - RESPONSE OF LARVAE TO TEMPERATURE AND SALINITY ...Alewife,menhaden,shad,herring, Captive Rearing, Estuaries, Longevity, Maturity & Growth Stages, Water Salinity, ...5.0123
PREDICTION OF ENVIRONMENT ...Biological-general, Columbia River, Environmental Ecology, Physical-general, Reservoirs and Impoundments, Salmon & Trout - Non-specific, Snake River, Temperature, Thermal Pollution, ...5.0225
FISHERY FORECASTING - TEMPERATE FISHERIES ...Circulation-general, General Synoptic Observations, Pacific Ocean-east, Temperature, ...5.0197
INITIATION OF METAMORPHOSIS IN AURELIA ...Biological Rhythms, Growth Rate, Jelly Fish, Metabolism, Water Light Quality & Quantity, ...5.0599
Warm Water
AQUATIC MYXOBACTERIA - CHONDROCoccus COLUM- NARIUS ...Atlantic Salmon, Sebago Salmon, Identification, Myxobacteria, Pathology, ...5.0848
THE PURCHASE AND INTRODUCTION OF BROOD STOCK ...Low Temp. - but Above 32F, Oysters, Ponds, Spawning & Nesting Sites, Stocking of Fish & Shellfish, ...5.0026
REPULULATION OF DECIMATED SECTIONS OF WARM-WATER STREAMS BY LONGEARI SUNFISH, LEPOMIS MEGALOTIS (RAFINESQUE) ...Aquatic Ecology, Population Dynamics, Stocking of Fish & Shellfish, Streams, Sunfish, Rock & Rounoke Bass, ...5.0097
Water Temperature-non-specific
EFFECTS OF IRRADIATION, TEMPERATURE AND OTHER ENVIRONMENTAL FACTORS ON SALMONID EMBRYOS ...Basic Embryology, Radiation Effects-non-specific, Salmon & Trout - Non-specific, Water Light Quality & Quantity, X and Gamma RAY, Data, ...5.0136
TEMPERATURE NEEDS FOR GONADAL DEVELOPMENT AND SPawning OF DIFFERENT PHYSIOLOGICAL

SUBJECT INDEX  Environments - Animal
RACES OF THE AMERICAN OYSTER, CRASSOSTREA VIRGINICA ...Behavior, Biological Rhythms, Environmental Physiology, Oysters, Reproductive System, ...5.0352
EVOLUTIONARY DIVERGENCE OF ONUPHID POLYCHAETES ...Comparative Physiology, Environment Resistance, Environmental Physiology, Eutrophic Nutrition, Lugworms, Marine Segmentedworm, ...5.0063
ZOOPHYSIOLOGY OF OCEANIC BENTHIC ANIMALS OFF THE NORTH CAROLINA COAST ...Eutrophic, Atlantic Ocean-north, Benthic Fauna, Benthonic-bottom, Environmental Physiology, ...5.1009
THERMALMETABOLIC RELATIONSHIPS OF STENTHER- MAL FISHES ...Antarctica, Environmental Physiology, Fish - non-specific, Proprioreceptors, Thermoregulation, Water Pressure, ...5.0212
LOCATION OF INSHORE SPawning AREAS ...Bluefish, Long Island Sound, Nets, Spawning & Nesting Sites, ...5.0201
CHEMICAL AND PHYSICAL DATA ...Fish -non-specific, Population Dynamics, Temperature, Turbulence & Suspended Matter, Water Movement, Currents, Water Salinity, ...5.0207
A STUDY OF THE ICTHYOPLANKTON ASSOCIATED WITH TWO OF NEW JERSEYS COASTAL INLETS ...Estuaries, Nets, Salinity, Thermal, Water Salinity, Zoolankton, ...5.0806
THE INFLUENCE OF ENVIRONMENTAL FACTORS UPON DEVELOPING MERISTIC STRUCTURES IN THE MARINE FISH, FUNDULUS MALLIS (WALBAUM) ...Developmental Physiology, Environmental Physiology, Killifish - Cyprinodon, ...5.0129
MARINE SPORTS FISHES RESEARCH ...Delaware Bay, Fish - other, Killifish - Cyprinodon, Population Dynamics, Water Salinity, ...5.0248
RELATIONSHIP BETWEEN WATER TEMPERATURE AND SIZE OF PARASITIC COPEPODS ...Collections, Copepods, Host Specificity, Size, Temperature, ...5.0390
TEMPERATURE TOLERANCE OF MARINE ANIMALS THROUGH BEHAVIORAL RESPONSES ...Adaptation, Environ- ment Resistance, Mortality Rates, Thermal, ...5.0118
THERMAL PREFERENCES OF MARINE FISHES AND INVERTEBRATES ...Behavior, Fish -non-specific, Invertebrates - non-specific, Thermal, ...5.0209
EFFECT OF TEMPERATURES AND CIRCULATION OF CONTINENTAL SHELF WATERS ON THE DISTRIBUTION OF FISHES ...Continental Shelf, Fish -non-specific, Surface Environments, Temperature, Water Movement, Currents, ...4.0165
LIFE HISTORY OF CLUPEA HARENGUS PALLASSI ...Alewife,menhaden,shad,herring, Aquaculture & Fish-farming, Artificial Insemination, Life History Studies, Water Salinity, ...5.0035
HYPOTHETICAL DISTRIBUTION OF 14 SPECIES OF AT- LANTIC COASTAL GAME FISHES ...Aquatic Ecology, Atlantic Ocean-general, Environmental Ecology, Fish - other, ...5.0123
FISH POPULATION STUDY ...Chemical Measurements -water, Commercial Fishing, Fish -non-specific, Food Supply, Population Dynamics, ...5.0174
INVESTIGATE SEASONAL VARIATIONS, SURFACE WATER TYPES, HAWAIIAN AREA (KOKO HEAD) ...Commercial Fishing, Hawaii, Heat and Radiation Transfer, Oceanic Fronts, Salinity, Temperature, Tuna, Mackerel, Albacore, Water Salinity, ...5.0148
MONITORING SURVEY AND TIME-SERIES ANALYSIS OF SURFACE TEMPERATURE IN THE NORTH PACIFIC OCEAN ...Pacific Ocean-north, Subsurface Environments, Temperature, Thermocline, ...1.0176
PINK SALMON INVESTIGATIONS - EARLY SEA LIFE OF SALMON ...Alaska, Environmental Physiology, Life History Studies, Parasitology -other, ...5.0187
SCRIBPS TUNA OCEANOGRAPHY RESEARCH PROGRAM ...Food Supply, Pacific Ocean-east, Temperature, Tropic, Tuna, Mackerel, Albacore, ...5.0200
DETERMINATION OF SELECTED ENVIRONMENTAL REQUIREMENTS OF IMPORTANT SPECIES OF MARINE ZOOPLANKTON ...Copepods, Oxygen, Water Salinity, Zoolankton, ...5.0835
AERIAL SEA SURFACE TEMPERATURE SURVEYS OF U.S. COASTAL WATERS ...Aircraft, Infrared Radiation, Migration, Productivity - Food Chain, Temperature, ...4.0148
THERMAL ACCLIMATION PATTERNS IN PARASITES AND HOSTS ...Adaptation, Host Resistance, Host Specificity, Life History Studies, Monogenea, ...5.0643
Environments - Animal

OSMOTIC COMPONENTS IN ELASMOMBRANCH BLOOD
...Blood Plasma and Serum, Chondrichthyes -other, Environmental Physiology, Osmoregulation, Water Salinity, ...5.0249

Turbidity & Suspended Matter

CHEMICAL AND PHYSICAL DATA ...Fish -non-specific, Population Dynamics, Temperature, Water Movement, Currents, Water Salinity, Water Temperature-non-specific, ...5.0207

EVALUATION OF HABITAT ALTERATION, CURRITUCK SOUND ...Fish -non-specific, Habitat Studies, North Carolina, Water Salinity, ...5.0914

Types of Animal Environments

Islands

ECOLOGY OF STORM PETRELS ...Albatrosses, Shearwater-nas, ...California, Mark, Tag Or Capture -other, Spawning & Nesting Sites, Terrestrial Ecology, ...5.0532

PACIFIC OCEAN BIOLOGICAL SURVEY PROGRAM ...Birds -non-specific, Meteorological Studies, Pacific Ocean-general, Vertical Distribution, ...5.0568

Laboratory

LARVAL DEVELOPMENT OF SCYLLARIDEAN LOBSTERS ...Animal Taxonomy, Developmental Physiology, Environmental Physiology, Invertebrate Nutrition, Lobsters, ...5.0409

REPRODUCTION AND EMBRYONIC SURVIVAL IN ASCIDA NIGRA (SAVIGNY) ...Basic Embryology, Biological Rhythms, Reproductive System, Sea Squirts - Tunicates, Whole Body Culture & Rearing, ...5.0600

ACCUMULATION OF RADIOACTIVITY BY ORGANISMS IN EXPERIMENTAL, MARINE ENVIRONMENTS ...Contamination - Water, Cooperative-studies, Estuaries, Radioactivity, ...5.0911

LABORATORY BIOASSAYS ...Contamination - Water, Fish, Laboratory Animals, Pollution - Effects of, Pollution Sources-general, ...5.0882

Water Environment -other

SHARK ATTACKS ...Behavioral Ecology, Diving and Scuba, Sharks, ...6.0090

ECOLOGY OF ECHINOIDS ...Behavioral Ecology, Benthonic-bottom, Sea Urchins & Other Echinoderms, Vertical Distribution, ...5.0571

JUVENILE MIGRATION RATES ...Columbia River, Mark, Tag Or Capture -other, Migration, Salmon & Trout - non-specific, Snake River, ...5.0223

EARLY LIFE HISTORY OF COREGONIDS ...Cisco, Lake Herring, Environmental Ecology, Life History Studies, Maturity & Growth Stages, Technique Development, ...5.0110

FISH GUIDING ...Animal Distr. (non-specific), Control Systems, Fish -non-specific, Instrumental Services, Management -other, ...5.0015

SPACE APPLICATIONS TO FISHERIES OCEANOGRAPHY (GULF OCEANOGRAPHY PROGRAM) ...Commercial Fishing, Computer Applications, Forecasting-prediction, Satellites, ...4.0172

FOOD AND EXPERIMENTAL ENVIRONMENTS (SHRIMP AQUACULTURE PROGRAM) ...Aquaculture & Fish-farming, Captive Rearing, Digestive System, Food Supply, Shrimp - non-specific, ...5.0805

INVESTIGATE POPULATION DYNAMICS OF ALBACORE ...American Samoa, Commercial Fishing, Population Dynamics, Tuna, Mackerel, Albacore, ...5.0081

THE OCEANOGRAPHY OF NEW ENGLAND FISHING BANKS ...Continental Shelf, Fish -other, Number Or Density, Vertical Distribution, ...5.0901

ESTUARINE ECOLOGY--INDIAN RIVER, DELAWARE ...Delaware, Estuaries, Tidewater Areas, ...5.0875

Water Light Quality & Quantity

EFFECTS OF IRRADIATION, TEMPERATURE AND OTHER ENVIRONMENTAL FACTORS ON SALMONID EMBRYOS ...Basic Embryology, Radiation Effects-non-specific, Salmon & Trout - non-specific, Water Temperature-non-specific, X and Gamma Rays, ...5.0336

RHYTHMIC ACTIVITY OF BLUEFISH UNDER EXPERIMENTALLY VARIED LIGHT REGIMES ...Adaptation, Biological Rhythms, Bluefish, Environmental Physiology, Photoperiod, ...5.0286

INITIATION OF METAMORPHOSIS IN AURELIA ...Biological Rhythms, Growth Rate, Jelly Fish, Low Temp. -but Above 32f, Metabolism, ...5.0599

Water Movement, Currents

LANGMUIR CIRCULATION AND PLANKTON ECOLOGY ...Circulation-general, Phytoplankton, Range Or Territorial Dist., Vertical Distribution, Wind Or Air Movement, Zooplankton, ...5.0794

SHRIMP PRODUCTION IN LOUISIANA SALT-MARSH IM-POUNDMENTS UNDER EXISTING AND MANAGED CONDITIONS ...Aquaculture & Fish-farming, Captive Rearing, Lagoons, Louisiana, Shrimps - Common, ...5.0435

CHEMICAL AND PHYSICAL DATA ...Fish -non-specific, Population Dynamics, Temperature, Turbidity & Suspended Matter, Water Salinity, Water Temperature-non-specific, ...5.0207

EFFECT OF TEMPERATURES AND CIRCULATION OF CONTINENTAL SHELF WATERS ON THE DISTRIBUTION OF FISHES ...Continental Shelf, Fish -non-specific, Surface Environments, Temperature, Water Temperature-non-specific, ...4.0165

Water Pressure

STUDIES IN THE PHYSIOLOGY AND BIOCHEMISTRY OF DEEP-SEA FISHES ...Environmental Physiology, Fish -non-specific, Metabolism, Vertical Distribution, ...5.0237

ENERGY REQUIREMENTS OF MARINE ORGANISMS ...Energy, Sharks, Thermoregulation, Tuna, Mackerel, Albacore, ...5.0273

THERMALMETABOLIC RELATIONSHIPS OF STENTH-ERMAL FISHES ...Antarctica, Environmental Physiology, Fish -non-specific, Proprioceptors, Thermoregulation, Water Temperature-non-specific, ...5.0312

DEEP DIVING ANTARCTIC BIRDS AND MAMMALS ...Adaptation, Antarctica, Locomotion -animal, Penguins, Seals, ...5.0555

PRESSURE EFFECTS ON MARINE ORGANISMS ...Abyssal, Environmental Physiology, Pressure, Vertical Distribution, ...5.0943

MARINE PHYSIOLOGY ...Cardiovacular System, Fish, Osmoregulation, Thermoregulation, ...5.0947

Water Salinity

CHEMICAL AND PHYSICAL DATA ...Fish -non-specific, Population Dynamics, Temperature, Turbidity & Suspended Matter, Water Movement, Currents, Water Temperature-non-specific, ...5.0207

EVALUATION OF HABITAT ALTERATION, CURRITUCK SOUND ...Fish -non-specific, Habitat Studies, North Carolina, Turbidity & Suspended Matter, ...5.0914

A STUDY OF THE ICHTHYOPLANKTON ASSOCIATED WITH TWO OF NEW JERSEYS COASTAL INLETS ...Estuaries, Nets, Salinity, Thermal, Water Temperature-non-specific, Zooplankton, ...5.0806

MARINE SPORTS FISHES RESEARCH ...Delaware Bay, Fish -other, Killifish - Cyprinodon, Population Dynamics, Water Temperature-non-specific, ...5.0248

MOVEMENTS OF FRESHWATER CATFISH IN THE ESTUARIES OF SOUTHWEST LITHUANIA ...Blue Catfish, White Catfish, Environment Resistance, Estuaries, Lithuania, Migration, ...5.0090

EPIDEMIOLOGY OF SALMON POISONING DISEASE ...Epidemiological, Helminths, Infectious Conditions and Disease, Pathology, Salmon & Trout - non-specific, ...5.0306

OCEAN WATER INTRUSION INTO BACK BAY, VIRGINIA, & CURRITUCK SOUND, NORTH CAROLINA, ON THE WATERFOWL & FRESHWATER FISH HABITAT ...Habitat Studies, North Carolina, Virginia, Waterfowl -non-specific, ...5.0897

LIFE HISTORY OF CLUPEA HARENGUS PALLASI ...Alewife,menhaden,shad,herring, Aquaculture & Fish-farming, Artificial Insemination, Life History Studies, Water Temperature-non-specific, ...5.0336

PINK SALMON INVESTIGATIONS - INTERTIDAL ECOLOGY ...Alaska, Life History Studies, Salmon -coho,chinook,sockeye ...Spawning & Nesting Sites, Tidal Streams, ...5.0186
SUBJECT INDEX

INVESTIGATE SEASONAL VARIATIONS, SURFACE WATER TYPES, HAPAAN AREA (KOKO HEAD) ..Commercial Fishing, Hawaii, Heat and Radiation Transfer, Oceanic Fronts, Salinity, Temperature, Tuna, Mackarel, Albacore... Water Temperature-non-specific... 1.0148

DROPOUT OF SALMON FROM GILL NETS ..Commercial Fishing, Management -other, Mortality Rates, Nets, Salmon & Trout - Non-specific... 5.0177

GROWTH, CONDITION, AND SURVIVAL OF SHELLFISH ..Adaptation, Environmental Physiology, Maryland, Oysters, Water Quality-general... 5.0447

DETERMINATION OF SELECTED ENVIRONMENTAL REQUIREMENTS OF IMPORTANT SPECIES OF MARINE ZOOPLANKTON ..Copepods, Oxygen, Water Temperature-non-specific, Zooplankton... 5.0635

FUNCTION OF THE INTERRENAL GLAND IN TELEOST FISHES ..Blood Cells, Kidney and Urinary System, Osmoregulation, Pinula, Tilapia, Cichlids... 5.0233

OSMOTIC COMPONENTS IN ELASMOBRANCH BLOOD ..Blood Plasma and Serum, Chondrichthyes -other, Environmental Physiology, Osmoregulation, Water Temperature-non-specific... 5.0249

OPERANT OSMOTIC REGULATION IN A MARINE ANIMAL ..Environment Resistance, Learning and Retention, Octopus, Squid, Cuttlefish... Osmoregulation, 5.0664

WIND OR AIR MOVEMENT

LANGMUIR CIRCULATION AND PLANKTON ECOLOGY ..Circulation-general, Phytoplankton, Range Or Territorial Dist., Vertical Distribution, Water Movement, Currents, Zooplankton... 5.0794

Environments - Plant

Contamination, Pollution-water

EFFECTS OF PETROLEUM AND PETROLEUM WASTES UPON IMPORTANT SPECIES OF ESTUARINE PHYTOPLANKTON AND ZOOPLANKTON ..Contamination Water, Estuaries, Oil, Oil and Natural Gas - Sulfur, Phytoplankton, Zooplankton... 5.0810

ISOLATION AND TAXONOMY OF YEASTS IN LAKES AND SEWAGE ..Biolindicators, Plant Taxonomy, Streams, Yeasts (non-specific)... 5.0787

Energy Budgets

ORGANIC PRODUCTION OF EPIFAUNAL ORGANISMS ..Epiphytic Relationships, Marine Biology (non-specific), Organisms, Plant Ecosystems (non-specific), Primary Productivity, Reefs... 5.0832

CALORIC STUDIES OF SPARTINA AND THE MARSH CRAB SESARMA RETICULATUM ..Calorimetry, Chloroideae (non-specific & Ot), Crabs, Swamps-marshes... 5.0830

ENERGETICS OF PELAGEMONES PUGIO AND THE WEEDBED COMMUNITY OF SOUTH CREEK ESTUARY ..Aquatic Vegetation -ns, Estuaries, Habitat Studies, North Carolina, Shrimps - Common... 5.0842

ENERGY AND ELEMENT TRANSFER IN LOWER MARINE TROPHIC LEVELS ..Copepods, Oregon, Phytoplankton... 5.0623

Mineral Content -water

STUDIES ON INORGANIC NUTRIENT ASSIMILATION RATES IN ESTUARINE PONDS ..Estuaries, Nitrogen, Nutrients, Phytoplankton, Self-purification... 5.0991

Oxygen Content -water

MEASUREMENTS OF OXYGEN CONSUMPTION BY THE SEA BED IN DEEP WATER OF PUGET SOUND ..Benthic Flora, Chemistry, Oxygen, Puget Sound... 5.1036

OXYGEN RESOURCES OF TIDAL WATERS ..Autotrophic, Marine Biology (non-specific), Oxygen, Pollution Sources-general, Tides... 5.1119

pH -water

THE ENVIRONMENTAL REQUIREMENTS OF MARINE PLANKTONIC ORGANISMS ..Bulk Culture -other, Marine Biology (non-specific), Phytoplankton (non-specific), Water Salinity, Water Temperature -other... 5.0921

Temperature -water

Water Temperature -other

ARTIC BIOLOGICAL OCEANOGRAPHY ..Adaptation, Arctic Ocean, Growth and Differentiation, Phytoplankton, Potamogeton, Ruppia, Zostera... Water - Light Qual. & Quant... 5.0853

THE ENVIRONMENTAL REQUIREMENTS OF MARINE PLANKTONIC ORGANISMS ..Bulk Culture -other, Marine Biology (non-specific), pH -water, Phytoplankton (non-specific), Water Salinity... 5.0921

Types of Plant Environments

Greenhouse

A UNIFIED APPROACH TO WATER, FOOD AND POWER IN A COASTAL DESERT COMMUNITY ..Arid and Desert, Desalination, Deserts, Diesel, Distilling Units, Electric Power Plants, Use of Impaired Water... 7.0002

WATER - LIGHT QUAL. & QUANT.

ARTIC BIOLOGICAL OCEANOGRAPHY ..Adaptation, Arctic Ocean, Growth and Differentiation, Phytoplankton, Potamogeton, Ruppia, Zostera, Water Temperature -other... 5.0853

Water Depth, Water Levels

THE EFFECTS OF POLLUTION ON BENTHIC MARINE PLANT COMMUNITIES ..Bays, Habitat Studies... 5.0724

CHANGES IN THE LIMITING NUTRIENT DUE TO TEMPORAL, GEOGRAPHIC, AND DEPTH VARIATIONS ..Depth, New York, Nutrients, Phytoplankton, Sub - Tropic... 5.1004

Water Salinity

MACROMOLECULAR BASIS FOR ADAPTATION TO SALINITY CHANGES IN PRYMNESIUM PARVUM ..Adaptation, Growth Rate, Ionic Effect, Permeability, Prymnesium... 5.1012

THE ENVIRONMENTAL REQUIREMENTS OF MARINE PLANKTONIC ORGANISMS ..Bulk Culture -other, Marine Biology (non-specific), pH -water, Phytoplankton (non-specific), Water Temperature -other... 5.0921

Enzyme Studies

Comparative Enzymology

Developmental Stages

PRESENCE OF ENZYMES RELATED TO DNA SYNTHESIS IN EGGS OF ECHINODERMS ..Basic Embryology, DNA Polymerase, Enzyme Formation, Nucleoside Kinase, Sea Urchins & Other Echinoderms... 5.1034

FORMATION AND METABOLISM OF NEUROHUMORAL TRANSMITTER SUBSTANCES IN MARINE ANIMALS ..Basic Studies, Biochemical, Quantitative & Qualitative... 3.0990

Species

CHEMISTRY AND ENZYMOLOGY OF BIOULUMINESCENCE ..Anthozoa, Bioluminescence, Earthworms, Kinetics -other, Luminous Bacteria... 5.0962

ENZYME STRUCTURE AND ITS RELATION TO TAXONOMY ..Animal Taxonomy, Conformational Studies, Echinodermata -other, Enzymes -non-specific... 5.0654

Conformational Studies

ENZYME STRUCTURE AND ITS RELATION TO TAXONOMY ..Animal Taxonomy, Echinodermata -other, Enzymes -non-specific, Species... 5.0654

Enzyme Formation

PRESENCE OF ENZYMES RELATED TO DNA SYNTHESIS IN EGGS OF ECHINODERMS ..Basic Embryology, Developmental Stages, DNA Polymerase, Nucleoside Kinase, Sea Urchins & Other Echinoderms... 5.1034

495
subject index

formation and metabolism of neurohumoral transmitter substances in marine animals...basic studies, biochemical, developmental stages, sharks, 5.0980

enzymes

atpase

the role of calcium ions in the motility of sea urchin and other spermatozoa...calcin, male gametes, motility and migration, yellow perch, duckets, 5.0622

ton transport mechanism in giant axon...active transport, cell free metabolism, nervous system, orotopus, squid, cuttelfish, plasma membranes, 5.0369

carbonic anhydrase

biological transport of gases and other substances...active transport, carbon dioxide, fish, gases, kidney and urinary system, 5.0240

cholinesterase

a histochemical study of the central nervous system of limulus polyphemus...histochemistry - cytochem, horseshoe or king crabs, nervous system, organo-enzyme assn, blood and lymph, 5.1000

biochemical characterization of cholinesterases in the blood and central nervous system of limulus polyphemus...blood and lymph, enzyme-substrate, horseshoe or king crabs, nervous system, reaction rates, 5.0468

coenzyme q

effect of lipids on stability of biochemical membranes...cellular membranes (non-spec.), electron microscopy, stability, toxopherol, vitamin a, 5.1007

cytochromes

studies of proteins under extreme environments...cellular membranes (non-spec.), exobiology, halobacteria, respiration, salt, 5.0941

dna polymerase

preence of enzymes related to dna synthesis in eggs of eichinoderms...basic embryology, developmental stages, enzyme formation, nucleoside kinase, sea urchins & other echinoderms, 5.1034

dopa decarboxylase

biosynthesis of 3-hydroxytyramine in monos-troma funicum...biosynthesis, chlorophycea (non-spec.&), marine plants, tyramine, tyrosinase, 5.0720

enzyme inhibitors

study of thiaminase in hawaii fish...enzymatic, fish - non-specific, hawaii, thiaminase, toxicological and allergy, 5.0260

enzymes -non-specific

biochemistry and physiological ecology of poisoned fish...fish - non-specific, metabolism, muscle, pathology, toxins - non-specific, 5.0635

enzyme structure and its relation to taxonomy...animal taxonomy, conformational studies, echnoderms -other, species, 5.0654

extracellular-enzymes

microbes and corrosion...cathodic protection, fouling, iron, metals - non-specific, microorganisms (non-specific), respiration, 5.0228

Luciferase

mechanism studies on bioluminescent reactions with emphasis on energy transfer problems...bioluminescence, energy conversion, luciferin, 1.0164
<table>
<thead>
<tr>
<th>SUBJECT INDEX</th>
<th>Equipment Purchase Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microorganism Enzymes</td>
<td>THERMAL DESTRUCTION OF TYPE E CLOSTRIDIUM BOTULINUM ...Clostridium Botulinum, Differentiation Mechanism, Heat Resistance, Microbiological Study, ...6.0006</td>
</tr>
<tr>
<td>Nucleoside Kinase</td>
<td>PROGRAM PROJECT - FOOD MICROBIOLOGY ...Clostridia (non-specific &amp; Ot), Infection, Intoxication &amp; Poli, Microbiological, Salmonella (non-specific &amp; Ot), Toxicological and Allergy, ...6.0005</td>
</tr>
<tr>
<td>Plant Enzymes</td>
<td>ANAEROBIC BACTERIA IN THE MARINE ENVIRONMENT ...Fish (non-specific), Isolation From Nat. environ., Microbiological, ...5.0846</td>
</tr>
<tr>
<td>Proteolytic Enzymes</td>
<td>STUDIES ON VIBRIO FOOD POISONING ...Bacteria, Bacterial Endotoxins, Microbiological, Toxicological and Allergy, Vasomotor, ...6.0114</td>
</tr>
<tr>
<td>Ribonuclease</td>
<td>Occupational Hazards</td>
</tr>
<tr>
<td>Tryptophan Oxidase</td>
<td>DIVING MEDICINE ...Diffusion of Gases, *Oners, Diving and Scuba, Pressure, ...6.0017</td>
</tr>
<tr>
<td>Tyrosinase</td>
<td>SUBMARINE MEDICINE ...Life-support-system, Naval Personnel, Ordinance, Safety, ...6.0019</td>
</tr>
<tr>
<td>Renin</td>
<td>Mechanism of Transmission</td>
</tr>
<tr>
<td></td>
<td>ASPECTS OF RELATIONSHIPS BETWEEN MARINE ECOLOGY AND HUMAN HEALTH ...Environmental Ecology, Marine Biology (non-specific), Public Health Ecology, Toxic Substances (non-specific), ...6.0182</td>
</tr>
<tr>
<td></td>
<td>Epizootiology</td>
</tr>
<tr>
<td></td>
<td>PATHOLOGY - EPIZOOTIOLOGY ...Mortality Rates, Oysters, Pathology, Protozoa, ...6.0041</td>
</tr>
<tr>
<td></td>
<td>Control and Prevention</td>
</tr>
<tr>
<td></td>
<td>STUDIES ON THE DEVELOPMENT OF DERMOCYSTIDIUM MARINUM ...Cell Cycle, Dermocystidium, Fungal Culture, Oysters, Pathology, ...6.0036</td>
</tr>
<tr>
<td></td>
<td>Incidence and Prevalence</td>
</tr>
<tr>
<td></td>
<td>EPIDEMIOLOGY OF SALMON POISONING DISEASE ...Helminths, Infectious Conditions and Dis, Pathology, Salmon &amp; Trout - Nc-specific, Water Salinity, ...5.0306</td>
</tr>
<tr>
<td></td>
<td>Mode of Transmission</td>
</tr>
<tr>
<td></td>
<td>INFECTIOUS DISEASES OF SALMONID FISHES ...Bacteria (non-specific), Infectious Conditions and Dis, Pathology, Protozoa-other, Salmon &amp; Trout - Non-specific, ...5.0602</td>
</tr>
<tr>
<td></td>
<td>Invertebrates</td>
</tr>
<tr>
<td></td>
<td>NATURAL HISTORY OF SALMON POISONING RICKETTSI A ...Flukes, Helminths, Neorickettsia Helminth, Reservoirs, ...5.0642</td>
</tr>
<tr>
<td></td>
<td>Equipment Purchase Operation</td>
</tr>
<tr>
<td></td>
<td>STUDIES ON THE PHYSIOLOGY OF MARINE ORGANISMS USING RADIOISOTOPES ...Facilities, Marine Plants, Radiotopes -non-specific, ...12.0031</td>
</tr>
<tr>
<td></td>
<td>SUPPORT OF RESEARCH VESSEL VELERO 4 ...California, Diving and Scuba, Geology-general, Marine Biology, Training Grants, Fellowships, ...4.0115</td>
</tr>
<tr>
<td></td>
<td>SUPPORT OF THE RESEARCH VESSEL AHOYOHIA III ...California, Diving and Scuba, Geology-general, Marine Biology, Ships and Cruises, ...12.0008</td>
</tr>
<tr>
<td></td>
<td>X-RADIOGRAPHIC AND ELECTRONIC FLUOROSCOPIC EQUIPMENT ...Core Analysis, Instrumental Services, Radiograph, Radiometer, X Ray Tubes, ...8.0094</td>
</tr>
<tr>
<td></td>
<td>LENGTHENING AND INCREASING OCEANOGRAPHIC CAPABILITIES OF R/V ACONA ...Modification-conversion, Oceanography-general, Pacific Ocean-north, Shoreline - Coastline, Special Mission Ships, ...12.0002</td>
</tr>
<tr>
<td></td>
<td>RESEARCH VESSEL U.S.S. ELTANIN ...Antarctica, Geophysics-general, Scientific-service-support, Special Mission Ships, Teaching and Research, ...12.0036</td>
</tr>
<tr>
<td></td>
<td>ROCK SAMPLING AND GEOPHYSICAL STUDIES IN THE TONGA KERMADE TRENCH SOUTHWEST PACIFIC ...American Samoa, Coring and Dredging, Pacific Ocean-west, Photography, Seismic Reflection, Trenches, ...7.0093</td>
</tr>
</tbody>
</table>
Equipment Purchase Operation

RARE GAS STUDY OF INTERPLANETARY MATERIAL IN PELAGIC SEDIMENTS...Chemistry, Cosmogeneous, Element Ratios, Mass Spectroscopy, Mineralogy, X-ray,...7.0081

OCEANOGRAPHIC VESSEL OPERATIONS...Geology-general, Pacific Ocean-north, Plankton (non-specific), Plant Prod. (non-specific), Ships and Cruises,...12.0047

COOPERATIVE SYSTEMATICS STUDIES IN ANTARCTIC BIOLOGY...Animal Taxonomy, Antarctica, Cooperative-studies, Invertebrates-non-specific,...5.0581

SHIPBOARD GRAVITY SENSOR AND GYROCOMPASS...Geophysical Equipment, Gyro, Scientific-service-support,...8.0103

SPECIALIZED RESEARCH EQUIPMENT FOR SEA ICE STUDIES...Alteration, Sea Ice,...3.0086

UNDERWATER CAMERA SYSTEM...Pacific Ocean-north, Photography, Sediments-general, Structural Studies,...8.0154

AQUISITION OF A SUITABLE PROTOTYPE FISHING VESSEL AND GEAR...American Samoa, Commercial Fishing, Neta, Tuna, Mackerel, Albacore,...12.0004

PURCHASE OF MATERIALS FOR & CONSTRUCTION OF AQUISITION OF A SUITABLE PROTOTYPE FISHING VESSEL AND GEAR...American Samoa, Commercial Fishing, Neta, Tuna, Mackerel, Albacore,...12.0004

SUPPORT OF THE MARINE BIOLOGY PROGRAM AT THE LAMONT GEOLOGICAL OBSERVATORY...Marine Biology, New York,...1.0063

RESEARCH FLIGHT FACILITY...Aircraft, General Synoptic Observations, Technique Development, Tropical Cyclones,...4.0158

Erosion Control

Wind Erosion

MESO WIND PATTERNS IN THE CENTRAL CALIFORNIA VALLEY...Atmospheric Pollution-general, California, Drift (pesticide), Herbicides-non-specific, Land-sea Breezes,...3.0056

Erosion-general

HYDRAULICS AND DYNAMICS OF ESTUARIES...Estuaries, Flow Characteristics-water, Sedimentation, Sedimentology-general, Water Level Fluctuation, Waves,...7.0102

Estuaries

(A) ANNUAL SUPPLY OF PARTICULATE MATTER IN THE GREAT BAY ESTUARY (B) LATE PLEISTOCENE HISTORY OF THE GREAT...New Hampshire, Organics, Quaternary Period, Sampling, Sedimentary History,...1.0155

APOLLO TEST SITE EXPERIMENT...Aircraft, Hydraulics-general, Hydrology-general, Recognition Systems, Remote Sensing-general,...4.0146

THE ACCUMULATION OF FISSION PRODUCTS BY MARINE FISH AND SHELLFISH...Chloride (non-specific & Ot), Contamination-water, Food Chains, Radioactivity-general, Radioecology,...6.0167

THE BIOLOGY AND CHEMISTRY OF TRACE ELEMENTS IN MARINE AND ESTUARINE WATERS...Chesapeake Bay, Phytoplankton, Productivity- Food Chain, Trace Element Analysis, Zooplankton,...5.0975

MOVEMENT OF RADIONUCLIDES IN THE COLUMBIA RIVER ESTUARY...Columbia River, Discharge, Radioactivity, Salinity, Sediment Transport-other,...5.0179

OCEAN KINETIC DYNAMICS...Chesapeake Bay, Circulation-data, Reduction Analysis, Turbulent Flow, Water Motion,...2.0069

TURBULENT DIFFUSION STUDY...Chesapeake Bay, Dispersion-water, Tracers-general, Turbulent Flow, Water Motion,...2.0056

ESTUARINE SEDIMENTATION PROCESSES...General Deposition, Intertidal Areas, Morphology-general, New England Province, Tidal Streams, Tides,...7.0344

CONTROLLED ENVIRONMENTAL FACTORS ON THE DEVELOPMENT OF ESTUARINE AND OCEANIC CRUSTACEA...Aquatic Ecology, Crabs, Developmental Physiology, Salinity, Temperature,...5.0476

ECOLOGICAL AND EVOLUTIONARY IMPLICATIONS OF THE ECOLOGICAL TYPES OF ESTUARINE CRUSTACEA...Classical, Invertebrate Anatomy, Isopods, Metabolism, Productivity- Food Chain,...5.0418

TEMPERATURE AND SALINITY TOLERANCE OF THE SAND SHRIMP CRANGON SEPTEMSPINOSA...Environmental Resistance, Environmental Physiology, Salinity, Shrimps-common Temperature,...5.0437

SUPPORT OF UNIVERSITY OF GEORGIA MARINE INSTITUTE RESEARCH VESSEL OPERATION...Continental Shelf, Continental Slope, Distribution, Environmental Ecology, Geomorphology-topography, Marine Biology, Pollution Sources-general, Ships and Cruises, Textures-structures,...12.0036

TROPIC RELATIONSHIPS IN SHOAL BENTHIC ENVIRONMENTS...Benthic Flora, Biology, Habitat Studies, New England Province,...5.1027

ECOLOGICAL STUDY OF CHARLOTTE HARBOR ESTUARY AND SHARK PROGRAM OF MOTE MARINE LAB...Florida, Manatee Activities,...5.0084

OPTIMUM ECOLOGICAL DESIGNS FOR ESTUARINE SYSTEMS OF NORTH CAROLINA...Domestic Wastes-general, Marine Biology (non-specific), North Carolina, Pollution-Effects-of, Pollution Effects, Productivity-Food Chain,...5.0013

ESTUARINE SEDIMENTARY MODELS...Circulation-general, Distribution, Grain Size, Model Studies, Textures-structures,...4.0079

THE INSTITUTE FOR THE DEVELOPMENT OF RIVERINE AND ESTUARINE SYSTEMS (IDRES)...Delaware River, Waste Disposal-general,...12.0043

FIORD OCEANOGRAPHY...Alaska, Fjords, Hydrodynamics, Model Studies, Simulation Theory,...4.0040

SEA WATER OPTICS STUDIES...Optical, Size Frequency Distribution, Suspension,...1.0166

EFFECTS OF PESTICIDES ON ESTUARINE PRODUCTIVITY...Aquatic Ecology, Man Activities, Persistence of Residues, Pesticides-non-specific, Pollution-Effects-of, Population Dynamics, Standing Crops,...5.0880

ESTUARINE DREDGE HOLE INVESTIGATIONS...Aquatic Ecology, Coring and Dredging, Fish-non-specific, Habitat Studies,...5.0098

A STUDY OF THE ICHTHYOPLANKTON ASSOCIATED WITH TWO OF NEW JERSEYS COASTAL INLETS...Nets, Salinity, Thermal, Water Salinity, Water Temperature-non-specific, Zooplankton,...5.0806

TRAMMEL NET SAMPLING IN ESTUARINE AREAS...Competition, Fish-non-specific, Lakes, Nets, Population Dynamics,...5.0096

QUANTITATIVE AND QUALITATIVE MEASUREMENT OF AQUATIC VEGETATION-CURRITUCK SOUND...Aquatic Plants (non-specific), Range Or Territorial Distr., Saline Water Intrusion, Salinity, Vertical Distribution,...5.0717

CHARTING OF SUBTIDAL OYSTER BEDS AND EXPERIMENTAL TRANSPLANTING OF SEED OYSTERS FROM POLLUTED SEED OYSTER BEDS...Captive Rearing, Commercial Fishing, Oysters, South Carolina, Stocking of Fish & Shellfish,...8.0111

SURVEY OF A POTENTIAL HARD CLAM FISHERY...Clams, Commercial Fishing, Coring and Dredging, Georgia, Spanning & Nesting Sites,...5.0420

A STUDY OF SELECTED CHEMICAL AND BIOLOGICAL CONDITIONS OF THE LOWER TRINITY RIVER AND THE UPPER TRINITY BAY...Commercial Fishing, Man Activities, Pollution-Effects-of, Spanning & Nesting Sites, Texas,...5.0926

CHANGES DURING EUTROPHICATION OF AN ESTUARY...Eutrophication, North Carolina, Plankton (non-specific), Pollution-Effects-of,...5.0015

ESTUARINE WATER QUALITY AND FISH DISTRIBUTION...Contamination-water, Environmental Physiology, Pollution Effects, Pulp, Paper, and Logging, Salmon & Trout (non-specific),...5.0178

EFFECTS OF THERMAL POLLUTION ON PRODUCTIVITY AND STABILITY OF ESTUARINE COMMUNITIES...Aquatic Ecology, Environmental Ecology, Plant Prod. (non-specific), Pollution-Effects-of, Thermal Pollution,...6.0152

ENHANCEMENT OF RECREATIONAL USES OF ESTUARINE WATERS THROUGH STUDY OF POTENTIAL CONTROL METHODS FOR STINGING SEA NETTLES...Biological Control, Chesapeake Bay, Jelly Fish, Recreation Sites, Water Quality-general,...5.0605

INTERSTITIAL WATER OF GLACIAL-MARINE SEDIMENT...Alaska, Glacial Clastics, Intertidal - Connect Water, Water-supply-general,...7.0188

498
SUBJECT INDEX

IMPACT AND FATE OF POLLUTION IN ESTUARIAL WATERS ...Degradation, Massachusetts, Pesticides -non-specific, Pollutants - Path of, Pollution Effects, ...6.0153

THE NEW DIRECTION OF WIND ON RECREATIONAL TIDAL STREAMS IN FLORIDA ...Air-sea Boundary-other, Florida, Tides, Water Level Fluctuation, Wind-general, ...2.0082

WATER QUALITY AND BENTHIC INVERTEBRATE-BED RELATIONSHIPS IN ESTUARIES ...Benthic Fauna, Benthonic-bottom, Maine, Pollution - Effects of, Pollution Effects, ...5.0894

CURRENT STUDY ON THE NEUSE RIVER AND ESTUARY ...Discharge, Dyes, North Carolina, Tracers, Water Motion, ...3.0057

BIOLGICAL AND CHEMICAL STUDY OF VIRGINIA'S ESTUARIES ...Nitrogen, Phosphorus, Phytoplankton, Population Dynamics, Primary Productivity, Virginia, ...1.0158

UTILIZATION OF PHYSICAL AND MATHEMATICAL MODELS IN MARINE WATER RESOURCES RESEARCH AND MANAGEMENT ...Environmental Effects-geologic, Management, Mathematical Analysis, Model Studies, Shoreline ...4.0014

HORIZONTAL DISPERSION IN SHALLOW ESTUARIES OF IRREGULAR SHAPE ...Circulation - water, Dispersion -water, Gulf of Mexico, Model Studies, Water Quality-general, ...2.0044

EXPERIMENTAL AND THEORETICAL STUDY OF THE HYDRODYNAMICS OF DISPERSION IN RIVERS AND ESTUARIES ...Dispersion -water, Flow Characteristics-water, Model Studies, Streams, Water Motion, ...2.0057

SURFACE AND GROUND WATER POTENTIALITIES OF THE MISSISSIPPI RIVER BASIN ...Aquifer Systems, Conjoint Use, Economic Impact, Systems Analysis, Water Quality-general, Water Transfer, ...5.0614

ECONOMICS OF WATER QUALITY FOR A REGIONAL SYSTEM ...Delaware River, Economic Efficiency, Finance, Regional Areas, Water Demand, Water Quality-general, ...9.0018

THE BIOLOGY OF THE INFAUNA OF A TROPICAL SOFT BOTTOM AREA ...Aquatic Ecology, Benthic Fauna, Florida, Intertidal Areas, Pollution - Effects of, ...5.0879

CHEMICAL EXCHANGES ACROSS SEDIMENT-WATER INTERFACES ...Chemical, Chemical-general, Exchange Capacity, Salinity, Solution Chemistry, ...7.0279

PRIMARY PRODUCTION AND DECOMPOSITION IN ESTUARIES ...Ions and Gases, Model Studies, Oxygen, Water Quality Control-general, Vegetation, Water Quality-general, ...6.0118

MOINTON STATION TEMPERATURE SURVEY (THAMES RIVER) ...British Isles, Electric Power Plants, Maps-other, Temperature, Thermal Pollution, ...1.0182

PLANKTON ECOLOGY OF BARK-BUILT ESTUARIES ...North Carolina, Phytoplankton, Primary Productivity, Productivity - Food Chain, Zooplankton, ...5.0816

COLLECTION AND SURVEY OF NORTH CAROLINA MARINE AND ESTUARINE MOLLUSCA ...Collections, Mollusks -non-specific & Other, North Carolina, Survey Studies, ...5.0484

CRUSTACEAN COLLECTION OF EAST COAST OF UNITED STATES ...Atlantic Ocean-north, Collections, Crustacea -non-specific, North Carolina, ...5.0481

FORECAST OF KODIAK ISLAND PINK SALMON RUNS FROM ABUNDANCE OF JUVENILES IN ESTUARIES ...Alaska, Fishing Gear, Maturity & Growth Stages, Migration, ...Number Or Density, Salmon -ook,chinook,sockeye,, ...5.0179

QUATERNARY OF THE HUDSON RIVER ESTUARY ...Fjords, Hudson River, Paleoenvironments, Quaternary Period, Valleys and Canyons, ...7.0256

EVALUATION OF ATLANTIC COAST ESTUARIES ...Atlantic Ocean-north, Game Reserves & Preserves, Habitat Studies, Life History Studies, Waterfowl -non-specific, ...9.0020

ENERGETICS OF PALAEMONETES PUGIO AND THE WEEDBED COMMUNITY OF SOUTH CREEK ESTUARY ...Carbohydrates, Energy Budgets, Habitat Studies, ...5.0842

HEAVY MINERAL DISTRIBUTION OF THE WHITE OAK ESTUARY-BOGUE INLET AREA, NORTH CAROLINA ...Bayous, Distribution, Heavy Minerals, North Carolina, ...7.0269

A NON-DESTRUCTIVE METHOD FOR ESTIMATING POPULATION DENSITY AND DISTANCE TO NEAREST NEIGHBOR FOR ESTUARINE MOLLUSCS ...Aquatic Ecolgo, Molluscs -non-specific & Other, Number Or Density, Population Dynamics, Range Or Territorial Dist., ...5.0439

STUDIES ON INORGANIC NUTRIENT ASSIMILATION RATES IN ESTUARINE PONDS ...Mineral Content-water, Nitrogen, Nutrients, Phosphorus, Self-purification, ...5.0891

ECOLOGICAL STUDIES OF THE BLUE CRAB, CALINLECTES SAPIIDUS ...Aquatic Ecology, Crabs, Life History Studies, ...5.0437

MOVEMENTS OF FRESHWATER CATFISH IN THE ESTUARIES OF SOUTHWEST LOUISIANA ...Blue Catfish, White Catfish, Environment Resistance, Louisiana, Migration, Water Salinity, ...5.0900

AN ENVIRONMENTAL SURVEY OF THE DAMARISCTA RIVER ESTUARY, LINCOLN COUNTY, MAINE ...Circulation-water, Nutrients, Pollution - Effects of, Sedimentology-general, ...5.0895

EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS ...Biodegradation, Persistence of Residues, Pollution - Effects of, Sevin, Swamps-marshes, ...5.0918

ECOLOGY OF RECREATIONALLY IMPORTANT ESTUARINE FISHES IN OREGON ...Aquatic Ecology, Environmental Ecology, Fishing, Migration, Oregon, Pollution Dynamics, ...5.0816

FISH GENETICS AND ECOLOGY ...DNA Other, Fish -non-specific & Ot, Life History Studies, ...5.0309

SOCIO-ECONOMIC STUDY OF NARRAGANSETT BAY, RHODE ISLAND ...Bays, Benefit-cost Analysis, Land Use, Rhode Island, Social Aspects, Water Quality Control-general, ...5.0919

GALVESTON BAY STUDY ...Numerical Analysis-other, Optimization, Simulation, Tides, Waste Water Treatment-general, ...4.0062

HYDRAULICS AND DYNAMICS OF ESTUARIES ...Erosion-general, Flow Characteristics-water, Sedimentation, Sedimentology-general, Water Level Fluctuation, Waves, ...7.0210

MOBEMENT OF RADIONUCLIDES IN THE LOWER COLUMBIA RIVER ...Absorbed Load, Adsorption Capacity, Columbia River, Pollutants - Path Of, Radioactivity-general, ...5.0878

THE MOVEMENT OF RADIONUCLIDES IN THE COLUMBIA RIVER ESTUARY ...Absorbed Load, Adsorption Capacity, Columbia River, Pollutants - Path Of, Radioactivity-general, ...6.0119

DELWARE ESTUARY SEDIMENTATION STUDY ...Delaware Bay, Salinity, Sediment Yield, Sedimentation, Supply Rate, ...7.0275

INFLUENCE OF INDUSTRIAL AND MUNICIPAL WASTES ON ESTUARINE AND OFF SHORE WATER QUALITY ...Domestic Wastes-general, Industrial Wastes, Pollution - Effects of, Washington, ...6.0192

HYDROLOGY OF COASTAL AREA IN THE VICINITY OF RICEDORO, GEORGIA ...Aquifers, Artesian Flow, Dispersion -water, Georgia, Saline Water Intrusion, Water Quality-general, ...9.0007

EAST COAST CONTINENTAL MARGIN WOODS HOLE OCEANOGRAPHIC INSTITUTE CONTRACT ...Chemistry, Continental Shelf, Intertidal - Connate Water, Maine, ...4.0119

REMOTE SENSING OF ESTUARINE WATER AND VEGETATION, MARYLAND ...Aerial Photography, Bioindicators, Chemical-general, Physical-general, Remote Sensor, ...4.0114

F. E. W. AND SALINITY IN THE HUDSON ESTUARY, NEW YORK ...Fresh Water, Inflow, Management, Salinity, Tides, ...2.0075

DISPERSION PROCESSES IN ESTUARIES AND RIVERS ...Dispersion -water, Dyes, Streams, Synhetic Hydrology, ...4.0186

REMOTE SENSING OF DELAWARE ESTUARY ...Aircraft, Delaware, Pollutants-general, ...4.0168

COORDINATION OF ESTUARINE REMOTE SENSING IN ATLANTIC COAST REGION ...Aerial Photography, Atlantic Ocean-general, Satellites, ...4.0169

SALT-WATER ENCROACHMENT IN NORTH CAROLINA ESTUARIES ...Chemical-general, Flow Characteristics-water, Industrial-general, Saline Water Intrusion, Sampling, ...6.0168

499
Estuaries

EcoLOGICAL STUDIES F ATLANTIC AND GULF COASTAL ESTUARIES OF IMPORTANCE TO WATER-FOIW, ...Agricultural Land Use Effects, Atlantic Ocean-general, Construction Land Use Effects, Gulf of Mexico, Habitats-specific, Waterfowl-specific, non-specific, DISTRIBUTION OF YOUNG STAGES OF COASTAL FISHES, Continental Shelf, Fish, non-specific, Maturity & Growth Stages, Number Or Density, Ships and Cruises, ...5.0919

INVENTORY OF THE GULF ESTUARY SYSTEM ...Bays, Data Acquisition, Fishing, Gulf of Mexico, Sedimentology-general, ...4.0047

ESTIMATION OF JUVENILE ABUNDANCE IN ESTUARINE NURSERIES ...Alewife, menhaden, shad, herring, Aquatic Ecology, Gulf of Mexico, Maturity & Growth Stages, Number Or Density, ...5.0210

ESTUARINE BIOLOGY-RESPONSE OF LARVAE TO TEMPERATURE AND SALINITY ...Alewife, menhaden, shad, herring, Captive Rearing, Longevity, Low Temp., but Above 32F, Maturity & Growth Stages, Water Salinity, ...5.0213

PRODUCTIVITY OF ESTUARINE AND MARINE ECOSYSTEMS (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION) ...Algae- General, Marine Plants, Phytoplankton, Primary Productivity, Standing Croops, ...5.1010

MEASUREMENT OF RADIONUCLES IN ESTUARINE AND MARINE ENVIRONMENTS (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION) ...Marine Environments-general, Pollution - Effects of, Pollution Effects, Radioactivity-general, Reactor Sites & Rad Waste, ...5.0912

ACCUMULATION OF RADIONUCLES BY VERTEBRATES (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION) ...Biological, Irradiated, Marine Fauna, Radioactivity-general, ...5.0913

ACCUMULATION OF RADIONUCLES BY VERTEBRATES (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION) ...Biological, Irradiated, Marine Fauna, Radioactivity-general, ...5.0913

ACCUMULATION OF RADIOACTIVITY BY ORGANISMS IN ESTUARINE AND SHELLFISH POLLUTED WATERS ...Bioassays, Phytoplankton, Pollution - Water, Intestinal Bacteria, New Jersey, ...5.0467

YOUNG FISHES OF A TIDAL ZONE ...Fish -non-specific, Habitat Studies, Life History Studies, Size, Temporal Distribution, ...5.0073

BRISTOL BAY ESTUARINE ECOLOGY ...Alaska, Fishing Gear, Life History Studies, Migration, Oceanic Fronts, Salmon - coho, chinook, sockeye, ...5.0004

CHUM SALMON INVESTIGATIONS ...Environmental Ecology, Food Supply, Growth Rate, Life History Studies, Number Or Density, Salinity - coho, chinook, sockeye, ...5.0007

COASTAL AND INSHORE OCEANOGRAPHY ...Alaska, Marine Biology, Shoreline - Coastline, Water Analysis-general, Water Properties-general, ...5.0851

YOUNG FISHES OF A TIDAL ZONE ...Fish -non-specific, Habitat Studies, Life History Studies, Size, Temporal Distribution, ...5.0073

PESTICIDE MONITORING PROGRAM ...Bioindicators, Gas Chromatography, Monitoring Systems, Oysters, Persistence of Residues ...5.0147

RELATION OF ENVIRONMENTAL FACTORS TO THE QUALITY OF MARINE AND ESTUARINE WATERS ...Bioassays, Phytoplankton, Pollution - Effects of, Pollution Effects, Zooplankton, ...5.0830

EVALUATING THE QUALITY OF MARINE AND ESTUARINE WATERS ...Bioassays, Phytoplankton, Pollution - Effects of, Pollution Effects, Zooplankton, ...5.0830

EFFECT OF PETROLEUM AND PETROLEUM WASTES UPON IMPORTANT SPECIES OF ESTUARINE PHYTOPLANKTON AND ZOOPLANKTON ...Contamination - Water, Contamination, Pollution-water, Oil, Oil and Natural Gas - Sulfur, Phytoplankton, Zooplankton, ...5.0830

EFFECT OF NITROTRIACETIC ACID (NTA) UPON THE TOXICITY OF METALS TO SELECTED SPECIES OF ESTUARINE PHYTOPLANKTON ...Acids, Carbon, Chemicals (incl. alginates), Isotope, Trace-ther, Phytoplankton, ...5.0829

PURIFICATION OF HARD CLAMS FROM POLLUTED WATERS ...Animal Viruses (non-specific), Clams, Contamination - Water, Intestinal Bacteria, New Jersey, ...5.0467

EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS ...Durlahan, Mode of Action -animal, Model Studies, Pollution - Effects of, Sevin, ...5.0919

MICROBIOLOGY OF ESTUARINE AND SHELLFISH POLLUTION ...Bioindicators, Clams, Oysters, Pollution Effects, Sanitation, Waste Water Treatment-general, ...6.0162

Ethylene

DIMETHYLNITROSAMINE IN CURED, SMOKED WHITE FISH AND FISH BLOOMED WITH CHEMICALS OR COMPOUNDS OF NITROGEN ...Fish -other, Fish Protein Concentrate, Flour, Nitrosourea, Nitrosourea Compounds, Nitrous Oxide, ...6.0007

Eutrophication

A STUDY OF THE OPEN WATER DISTRIBUTION AND ABUNDANCE OF NET-PLANKTON AS AN INDEX OF EUTROPHICATION IN LAKE SUPERIOR ...Bioindicators, Data Acquisition, Lake Superior, Plankton Sampling, Zooplankton, ...5.0160

CHANGES DURING EUTROPHICATION OF AN ESTUARY ...Estuaries, North Carolina, Plankton (non-specific), Pollution - Effects of, ...5.0915

EFFECTS OF NITRIFYING MICROSCOPIC SUBSTANCES ON THE BIOLOGICAL ENRICHMENT OF WATER ...Adaptation, Capacity, Chemical, Fish, Microorganisms (non-specific), Pollution - Effects of, Sediments, ...6.0169

EUTROPHICATION OF TIDAL WATERS ...Growth and Differentiation, Model Studies, Nutrients, Photosynthesis, Tidal Water Areas, ...5.0909

WATER QUALITY AND NUTRIENTS, SACRAMENTO-SAN JOAQUIN RIVER SYSTEM ...Environmental Ecology, Fish -non-specific, Nutrients, Plankton (non-specific), Water Quality-general, ...6.0139

THE EFFECTS OF ENVIRONMENTAL CONDITIONS ON THE SPAWNING AND SURVIVAL OF FRY OF THE WALLEYE ...Environmental Effects-geologic, Lake Erie, Pollution - Effects of, Temperature, Walleyes, ...5.0299

500
Evaluation

- MOBILITY OF OIL-TYPE PRESERVATIVES IN IMMERSED WOOD
- EFFECT OF BURLATIN WATER MILFOX CONTROL PROCEDURES ON WILDFIRE AND OTHER ORGANISMS IN AQUATIC ENVIRONMENTS

Field Testing

- MOBILITY OF OIL-TYPE PRESERVATIVES IN IMMERSED LAKE MICHIGAN CHEMICAL CONTROL OF SEA LAMPREY
- TESTING AND EVALUATION OF ARCTIC SEISMIC TRANSDUCER
- TESTING AND EVALUATION OF MAGNETOMETER AND TOW VEHICLE SYSTEM

Evaporation

- PROJECT EVAPORATION
- HUMIDITY STANDARDS AND MEASUREMENTS
- EVAPORATION OF WATER

Expenditures

- TRANSPORTATION EXPENSES FOR PARTICIPATION IN USC&GSS OCEANOGRAPHER GLOBAL EXPEDITION
- SYSTEMATICS OF ANTARCTIC SICULUS AND ECHINUS COLLECTED BY THE ELTANIN EXPEDITION

Explosions, Detonation

- CHEMICAL EXPLOSIONS, PACKAGING AND HANDLING AT SEA
- SURFACE TENSION

Extraction

- THE EXTRACTION OF POTASSIUM FROM FRESH AND SALINE WATERS BY CLAY MINERALS
- SURFACE TENSION

SUBJECT INDEX

- PROCESS ENGINEERING
- FACILITIES

- COLLECTION AND EXTRACTION OF MARINE INVERTEBRATES AND PLANTS
- MANAGEMENT OF THE EIHWETOK MARINE BIOLOGICAL LABORATORY
- RESEARCH TRAINING LABORATORY
- STUDENT RESEARCH AT THE MARINE SCIENCE CENTER
- SUPPORT OF RESEARCH VESSEL VELERO 4
- SUPPORT OF THE R/V EASTWARD
- COOPERATIVE RESEARCH AND TRAINING PROGRAM IN BIOLOGICAL OCEANOGRAPHY
- RESSEARCH VESSEL OPERATIONS
- HAUSFELD II, JAPAN
- EMBRYOLOGY
- IN AQUATIC ENVIRONMENTS
- TECHNIQUE DEVELOPMENT
- PARTICLE-GAS TRANSFER
- HUMAN PERFORMANCE IN UNUSUAL ENVIRONMENTS
- HODSON LABORATORIES
Facilities

SUPPORTING SYSTEMS ...Underwater-laboratory, ...8.0338

BIOLGICAL INVESTIGATIONS WITH ISOTOPES ...Algae-General, Isotopes -non-specific, Marine Plants, Radiation Effects -non-specific, Radioecology, ...11.0025

LABORATORY OF NEUROBIOLOGY ...Nervous System, Puerto Rico, ...12.0044

PROVIDE RESEARCH FACILITIES AND SERVICES ...Marine Biology, ...12.0033

RADIOBIOLOGICAL RESEARCH ON MARINE ORGANISMS ...Marine Biology, Marine Biology (non-specific), ...11.0029

Fats

Lecithin

CHARACTERIZATION AND MODE OF ACTION OF PROTEIN VENOMS OF MARINE ANIMALS ...Mechanism of Action, Sea Urchins & Other Echinoderm, Toxicology, Toxins, Venom, ...6.0102

Lipid Hydroperoxides

STEROLS AND LIPIDS IN WATER POLLUTION ...Chemical Identification, Effluents-waste Water, Pollutants - Path of, Sewage, Sterols, ...6.0116

Oils -fats

SPECTRAL SIGNATURES OF FISH SCHOOL IDENTIFICATION ...Atomic Absorption, Fish -non-specific, Oil, Spectral Reflectance, ...4.0151

DETECTION AND CLASSIFICATION OF FISH AND MINERAL OIL SLEETS BY REMOTE SENSING FROM ORBITAL ALTITUDE ...Fish -non-specific, Oil, Spectral Reflectance, Ultra - Violet Radiation, ...4.0140

Phospholipids

DEVELOPMENTAL ANALYSIS OF FUNDULUS ...Basic Embryology, Central Nervous System, Fats, Killifishes - Cyprinodon, Transplants, ...5.0316

CHEMISTRY AND FUNCTION OF BRAIN PLASMALOGENS ...Chen and Metab, Comparative Physiology, Molec. struct. (gen. & Other), Plasmalogen, ...5.1003

Plant Lipids

THE CHARACTERISTICS, MECHANISMS AND BIOGEOCHEMICAL CONSEQUENCES OF PHYTOPLANKTON FLOTATION ...Organics, Phytoplankton, Silicon, Size, Vertical Distribution, ...5.0826

Plasmalogen

CHEMISTRY AND FUNCTION OF BRAIN PLASMALOGENS ...Chen and Metab, Comparative Physiology, Molec. struct. (gen. & Other), Plasmalogen, ...5.1003

Unsaturated Fats

THE COMPOSITION, NUTRITIVE VALUE AND QUALITY OF FISHERY PRODUCTS WITH SPECIAL EMPHASIS ON LIPID AND ITS INTERACTION ...Anti-oxidants, Fats, Fats - Lipids, Fish -non-specific, Radiation, ...6.0076

LIPASE RESISTANT GLYCERIDES ...Fats, Fats and Oils -other, Fish -other, Lipids, ...5.1029

Fats - Lipids & Oils

OYSTER FATNESS STUDY ...Aquaculture & Fish-farming, Food Supply, Growth Rate, Invertebrate Nutrition, Oysters, ...5.0512

REPORT DISTRIBUTION ...Commercial Fishing, Oysters, Periodicals, Spawning & Nesting Sites, ...11.0041

Feces

THE ROLE OF COPROPHAGY IN MARINE FOOD CHAINS ...Invertebrate Nutrition, Nutrition -other, Productivity - Food Chain, ...5.0963

SUBJECT INDEX

Feed Science and Technology

Fish Meals

MARKET STRUCTURE OF THE COMMERCIAL FISHERY INDUSTRY ...Cattle Rations -other, Commercial Fishing, Fish & Shellfish, Market Structure, Marketing, Poultry Rations -other, ...4.0177

UTILIZATION OF LATENT MARINE RESOURCES AND WASTE PRODUCTS ...Fish -other, Fish Protein Concentrate, Proteins, Proteins and Amino Acids, Salmon & Trout - Non-specific, ...6.0068

PROCESSING KING CRAB ...Commercial Fishing, Crabs, Fish & Shellfish, Freezing, Organoleptic Studies, ...6.0003

DEVELOPMENT OF MECHANIZATION DEVICE PROTOTYPES ...Design, Machinery, Equipment, Fish Protein Concentrate, Shrimp, ...6.0051

UTILIZATION OF FRESHWATER FISH FOR ANIMAL FOODS ...Fish & Shellfish, Heating, Steaming, Sea Lions, Fur Seals, Thiaminase, ...6.0009

BOTTOM FISH, FISH WASTE, SCRAP FISH & OTHER SEA PRODUCTS FOR FUR ANIMAL DIETS ...Alewife, men- haden, shad, herring, Algae, Clams, Chub, Noritrops, Management, Sea Lions, Fur Seals, ...6.0001

Processing and Preservation

Heating, Steaming

UTILIZATION OF FRESHWATER FISH FOR ANIMAL FOODS ...Fish & Shellfish, Fish Meals, Sea Lions, Fur Seals, Thiaminase, ...5.0979

Purified Diets

NUTRITION OF SALMONID FISHES ...Captive Rearing, Diet Or Ration -other, in Vivo-see Also Feed Rations, Salmon & Trout - Non-specific, ...5.0304

Quality Evaluation of Feed

In Vivo-see Also Feed Rations

NUTRITION OF SALMONID FISHES ...Captive Rearing, Diet Or Ration -other, Purified Diets, Salmon & Trout - Non-specific, ...5.0304

Rations

Cattle Rations -other

MARKET STRUCTURE OF THE COMMERCIAL FISHING INDUSTRY ...Commercial Fishing, Fish & Shellfish, Fish Meals, Market Structure, Marketing, Poultry Rations -other, ...4.0177

Poultry Rations -other

MARKET STRUCTURE OF THE COMMERCIAL FISHING INDUSTRY ...Cattle Rations -other, Commercial Fishing, Fish & Shellfish, Fish Meals, Market Structure, Marketing, ...4.0177

Supplements, Feed Additives

Antioxidants

BOTTOM FISH, FISH WASTE, SCRAP FISH & OTHER SEA PRODUCTS FOR FUR ANIMAL DIETS ...Alewife, men- haden, shad, herring, Chub, Noritrops, Fish Meals, Management, Sea Lions, Fur Seals, ...6.0001

Ferrous Alloys

Low Alloy Steels

EFFECTS OF MATERIAL VARIATIONS IN THE COMPUTERIZED DESIGN OF PRIMARY HULL STRUCTURE ...Bulkheads, Computer Applications, Engineering Studies, Fish, Materials Used Undersea, Strength, Cohesion, ...8 3296

WEIGHT ANALYSES IN FISHING BOATS ...Approximations, Hull, Measuring Devices-other, Pressure Effects, ...8.0295

WEIGHT EQUILIBRATION ...Corrosion Prevention-other, Fouling, Polarization, Soils, Water, ...8.0208

CORROSION MITIGATION ...Corrosion Prevention-other, Deep, Fouling, Pre-stressed, Water, ...8.0205

High Yield

HY 130-150 STRUCTURAL STEELS ...Low Alloy Steels - Other, Materials Used Undersea, Stress Concentration -toughness, Stress Corrosion, Welding - Other, ...8.0221
SUBJECT INDEX

HY 80-110 STRUCTURAL STEELS ...Materials Used Undersea, Stress Concentration-toughness, Welding - Other, .8.0222
HY 180/210 STRUCTURAL STEELS ...Low Alloy Steels - Other, Maraging, Materials Used Undersea, Precipitation Hardening, Stress Concentration-toughness, Welding - Other, .8.0224
Low Alloy Steels - Other
HY 130-150 STRUCTURAL STEELS ...High Yield, Maraging, Materials Used Undersea, Precipitation Hardening, Stress Concentration-toughness, Welding - Other, .8.0224

Stainless Steels
Maraging
HY 180/210 STRUCTURAL STEELS ...High Yield, Low Alloy Steels - Other, Maraging, Materials Used Undersea, Stress Concentration-toughness, Welding - Other, .8.0224

Precipitation Hardening
HY 180/210 STRUCTURAL STEELS ...High Yield, Low Alloy Steels - Other, Maraging, Materials Used Undersea, Stress Concentration-toughness, Welding - Other, .8.0224

Fiber, Filament
PRODUCTION OF PLATES OF FIBER COMPOSITES BY SOILIDIFICATION, FORMING AND A COMBINATION OF BOTH ...Aluminum, Intermetallic Compound, Metal Matrix, Nickel, Orientation, ...8.0230
STRUCTURAL PLASTICS-DEEP SUBMERGENCE ...Design Data, Epoxies, Glass, Materials Used Undersea, Plastic Matrix, ...8.0213

Fire Control
SONAR ACCURACY ...Acoustic, Acoustical, Instrumental Services, Platforms, Sonar, Transmission, ...1.0051

Fish
Alevine, 'tenhaden, shad, he ring
TAXONOMY AND DISTRIBUTION OF CLupeoids AND REVISION OF THE GENUS ILISHA OF THE FAMILY CLupeidae ...Animal Taxonomy, Handbooks, Indian Ocean-general, Nomenclature, Classification, Range Or Territorial Dist., ...5.0088

POTENTIAL FISHERY FOR RIVER HERRINGS IN CONNECTICUT RIVER ...Connecticut River, Data Acquisition, Life History Studies, Nets, Spawning & Nesting Sites, Survey Studies, ...5.0091

BIOLoGY OF ANADROMOUS Alosids ...Mortality Rates, Spawning & Nesting Sites, Streams, Tidal Streams, Virginia, ...5.0150
A STUDY OF THE RATE AND PATTERN OF SHAD MIGRATION IN THE CONNECTICUT RIVER UTILIZING SONIC TRACKING APPARATUS ...Connecticut River, Migration, Spawning & Nesting Sites, Tags, Telemetry, ...5.0046

ANADROMOUS FISHERY ...Censusing, Commercial Fishing, Massachusetts, ...4.0011

STUDY OF THE RIVER PHASE OF THE LIFE HISTORIES OF ALOSA PSEUDOHARENGUS AND AESTIVAVIS ...Aquatic Ecology, Connecticut River, Life History Studies, Spawning & Nesting Sites, ...5.0245
FARMINGTON RIVER SHAD STUDIES ...Bottom Sampling, Captive Rearing, Migration, Sampling, Streams, ...5.0203

EFFECTS OF MARSH MANAGEMENT STRUCTURES UPON FISHES ...Crabs, Engineering Structures-general, Land Use, Shrimps - Common, Spawning & Nesting Sites, Swamps-marshes, ...5.0206

INVESTIGATION OF COMMERCIAL FISH POPULATIONS IN WESTERN LAKE SUPERIOR ...Commercial, shing, Lake Superior, Lakes, Nets, Population Dynamics, ...5.0111

LIFE HISTORY OF CLupeA HARENGUS PALLASI ...Aquaculture & Fish-farming, Artificial Insemination, Life History Studies, Salinity, Water Temperature-non-specific, ...5.0035

ABUNDANCE AND AVAILABILITY OF PRE-RECRUIT HERRING ...Aquatic Ecology, Environmental Ecology, Life History Studies, Number Or Density, Vertical Distribution, ...5.0208

RACIAL STUDIES OF HERRING ...Animal Taxonomy, Atlantic Ocean-north, Biochemical Analysis, Blood Typing Studies, Management other, ...5.0265

BIOSTATISTICS OF HERRING ...Age, Atlantic Ocean-north, Environmental Ecology, Growth Rate, Population Dynamics, Propriocessors, ...5.0099

COLLECTION, COMPIlATION, AND ANALYSIS OF GULF CATCH STATISTICS AND LOGBOOK DATA ...Commercial Fishing, Computer Methods -general, Fish Studies -other, ...5.0126

INVESTIGATION OF THE BIOLOGY AND POPULATION STRUCTURE OF GULF MENHADEN ...Bone, Gulf of Mexico, Handbooks, Population Dynamics, Vertebrate Anatomy, ...5.0128

ESTIMATION OF JUVENILE ABUNDANCE IN ESTUARINE NURSERIES ...Aquatic Ecology, Eutrophies, Gulf of Mexico, Maturity & Growth Stages, Number Or Density, ...5.0131

SAMPLING OF THE ATLANTIC COMMERCIAL CATCH ...Atlantic Ocean-general, Commercial Fishing, Nets, Number Or Density, ...5.0129

POPULATION STUDIES ...Animal Distr. (non-specific), Animal Taxonomy, Environmental Ecology, Population Dynamics, ...5.0130

ESTUARINE BIOLOGY--RESPONSE OF LARVAE TO TEMPERATURE AND SALINITY ...Captive Rearing, Estuaries, Longevity, Low Temp. -but Above 32f, Maturity & Growth Stages, Water Salinity, ...5.0123

TAOGING ...Migration, Population Dynamics, Tags, Telemetry, Vertebrate Anatomy, ...5.0127

MARINE BIOLOGICAL INVESTIGATIONS - ANALYSIS OF HERRING FISHERY DATA ...Age, Alaska, Data Analysis - General, Dispersion -other, ...5.0010

POPULATION STRUCTURE OF THE ALEWIFE AND COREGONIDAE ...Aquatic Ecology, Cisco, Lake Herring, Environmental Ecology, Lake Michigan, Population Dynamics, ...5.0106

INTERRELATIONS OF ALEWIVES AND ASSOCIATED SPECIES ...Behavioral Ecology, Competition, Lake Michigan, Predation, Vertical Distribution, ...5.0111

TAXONOMY AND BIOLOGY OF CLupeOID FISHES ...Anchovies, Animal Taxonomy, Atlantic Ocean-general, Handbooks, ...5.0060

SCHOOLING BEHAVIOR ...Anchovies, Behavioral Ecology, Environmental Ecology, Tuna, Mackerel, Albacore, ...5.0038

FEEDING BEHAVIOR ...Anchovies, Behavior, Environmental Physiology, Food Supply, Sensory Organs, ...5.0040

REARING MARINE FISH ...Anchovies, Captive Rearing, Environmental Physiology, Tuna, Mackerel, Albacore, ...5.0041

BOTTOM FISH, FISH WASTE, SCRAP FISH & OTHER SEA PRODUCTS FOR FUR ANIMAL DIETS ...Antioxidants, Chubs, Notropis, Fish Meals, Management, Sea Lions, Fur Seals, ...6.0001

Anchovies
TAXONOMY AND BIOLOGY OF CLupeOID FISHES ...Alevine, menhaden, shad, herring, Animal Taxonomy, Atlantic Ocean-general, Handbooks, ...5.0060

DETERMINE ALTERNATE LIVEBAIT SPECIES ...Captive Rearing, Commercial Fishing, Food Supply, Hawaii, Tuna, Mackerel, Albacore, ...5.0080

SCHOOLING BEHAVIOR ...Alevine, menhaden, shad, herring, Behavioral Ecology, Environmental Ecology, Tuna, Mackerel, Albacore, ...5.0038

FEEDING BEHAVIOR ...Alevine, menhaden, shad, herring, Behavior, Environmental Physiology, Food Supply, Sensory Organs, ...5.0040

REARING MARINE FISH ...Alevine, menhaden, shad, herring, Captive Rearing, Environmental Physiology, Tuna, Mackerel, Albacore, ...5.0041

SUBPOPULATIONS ...Commercial Fishing, Pacific Ocean-general, Population Dynamics, ...5.0042

Atlantic Salmon, Sebago Salmon
AQUATIC MYXOBACTERIA - CHONDROCoccus COLUMNARIS ...Identification, Myxobacteria, Pathology, Warm Water, ...5.0048

COMPARATIVE BEHAVIOR OF HATCHERY-REARED AND WILD SALMONIDS ...Behavior, Captive Rearing, Environmental Physiology, Lake Trout, Brook Trout, ...5.0264
CULTURE OF ATLANTIC CROAKER IN BRACKISH WATER PONDS ...Aquaculture & Fish-farming, Brackish Water, Captive Rearing, Management, Ponds, Productivity (agricultural), ...5.0005

DIURNAL-NOCTURNAL ACTIVITY OF THE QUEENFISH, SERIPHUS POLITUS ...Aquatic Ecology, Behavioral Ecology, Biological Rhythms, Fish -other, Other, Sound Production, ...5.0230

FISH -non-specific

FISHERIES RESOURCES IDENTIFICATION AND ASSESSMENT ...Aerial Photography, Behavioral Ecology, Commercial Fishing, Optical, Spectral Reflectance, ...4.0149

SPECTRAL SIGNATURES OF FISH SCHOOL IDENTIFICATION ...Aerial Photography, Atomic Absorption, Oils, Oils -fats, Spectral Reflectance, ...4.0151

REMOTE SENSOR SYSTEMS INTERGRATION AND PRESENT OPERATIONS DESCRIBED ...Commercial Fishing, Remote Sensing -other, Spacecraft Sensory Devices, Spectral Reflectance, ...4.0154

SPECTRAL WEIGHTLESSNESS IN FISH ...Behavior, Cardiovascular System, Gravitational Fields, Gravity, Proprioceptors, ...5.0275

DETECTION AND CLASSIFICATION OF FISH AND MINERAL OIL SLICKS BY REMOTE SENSING FROM ORBITAL ALTITUDE ...Oil, Oils -fats, Spectral Reflectance, Ultra -Violet Radiation, ...4.0140

A STUDY OF THE DEEP CIRCULATION AND DEEP FISH POPULATIONS IN THE PACIFIC OCEAN ...Currents-ocean, Pacific Ocean-general, Tides, Vertical Distribution, ...5.0005

IONOCYTE FORMATION IN THE GILL EPITHELIUM OF FISHES ...Biosynthesis, Developmental Physiology, Differentiation Mechanism, Fish, Osmoregulation, ...5.0301

COMPARATIVE STUDY OF SPECTRAL REFLECTANCE IN FISHES ...Comparative Physiology, Fish, Metabolism, Nitrogen, Vertebrate Anatomy, ...5.1022

SPATIAL ORIENTATION OF FISHES AND ITS SENSORY BASES ...Behavior, Environmental Physiology, Migration, Orientation, Sensory Organs, ...5.0338

COPEPOD CRUSTACEANS PARASITIC ON FISHES ...Collections, Copepods, Ectoparasites, Indian Ocean-general, Ships and Cruises, Vertical Distribution, ...5.0368

STRUCTURE OF THE FISH FAUNA OF A FLORIDA CORAL REEF ...Ecological, Reefs, Vertical Distribution, ...5.0265

STUDIES IN THE PHYSIOLOGY AND BIOCHEMISTRY OF DEEP-SEA FISHES ...Environmental Physiology, Metabolism, Vertical Distribution, Water Pressure, ...5.0237

MARINE ZOOGEOGRAPHY ...Tables, Compilations, Catalogues, ...5.093

ICHTHYOFAUNA OF THE FLORIDA CURRENT ...Florida, Number Or Density, Temporal Distribution, Vertical Distribution, ...5.0066

BIOLOGICAL ASPECTS OF MIDWATER SOUND SCATTERING ...Atlantic Ocean-north, Bioluminescence, Range Or Territorial Depth, Vertical Distribution, Sound Production, Vertical Distribution, ...5.0054

SHORE FISHES OF ANNOBON AND FERNANDO POO ...Art Work-illustration-ecc, Atlantic Ocean-general, Collections, Museums, ...5.0067

RENEWAL RESEARCH PROPOSAL FOR HEARING AND ALLIED SENSES IN FISHES ...Auditory, Behavior, Sound Production, ...5.093

MORPHOGENETIC MOVEMENTS IN FISH EMBRYOS ...Basic Embryology, Morphological Action, ...5.0281

NUTRITION AND PHYSIOLOGY OF MARINE FISH IN CONTROLLED GNOTOBOTIC ENVIRONMENTS ...Aquaria, Environmental Physiology, Germ Free Animal, Nutrition -other, ...5.0317

OCEANIC FISHES OF THE TROPICAL ATLANTIC ...Atlantic Ocean-south, Survey Studies, Tropic, Vertical Distribution, ...5.0068

FACTORs AFFECTING HORIZONTAL DISTRIBUTION OF MESOPELAGIC FISHES ...Aquatic Ecology, Atlantic Ocean-north, Behavioral Ecology, Range Or Territorial Distr., Vertical Distribution, ...5.0105

ACOUSTICO-LATERALS FUNCTION IN FISH ORIENTATION AND COMMUNICATION ...Auditory, Behavior, Orientation, Sensory Organs, Signal Detection, ...5.0289

SCHOOLING BEHAVIOR IN FISHES ...Behavior, Sensory Organs, Social Behavior, Visual Organs, ...5.0125

PARASITISM IN DEEPSA FISHES ...Helminths, Host Specificity, Protozoa, Vertical Distribution, ...5.0243

DISTRIBUTION OF THE MID-WATER FISHES OF THE GULF OF CALIFORNIA ...Environmental Ecology, Gulf of California, Nets, Organism Sampling Devices, Vertical Distribution, ...5.0043

LIPID COMPOSITION OF ANTARCTIC MARINE ORGANISMS AND SEA WATER ...Antarctic Ocean, Gulf of Mexico, Lipids, Low Temp., But Above 32f, Phytoplankton, Productivity - Food Chain, Zooplankton, ...5.1631

THE EFFECTS OF SEAL AND FISH PREDATION ON CERTAIN ANTARCTIC BENTHIC COMMUNITIES ...Antarctica, Benthic Organisms (non-specific), Biocolonization, Productivity - Food Chain, Seals, ...5.1039

THERMAL-METABOLIC RELATIONSHIPS OF STENOTHERMAL FISHES ...Antarctic, Benthic Organisms (non-specific), Fish, Predation, Productivity - Food Chain, ...5.0960

DEEP-WATER FOULING ...Biological, Fouling, Predation, Vertical Distribution, ...8.0333

VENOMOUS FISHES AND SEA SNAKES OF SOUTHEAST ASIA ...Behavior, Snakes, Southeast Asia, Venom, Vertebrate Anatomy, ...5.0455

CRYOGENIC PRESERVATION OF VIABLE FISH SPERM ...Artificial Insemination, Cellular Physiology, Freezing Techniques, Male Gametes, ...5.0365

ECOLOGICAL INVESTIGATIONS OF SOME COMMON MARINE FISHES OFF THE MEDITERRANEAN COAST OF ISRAEL ...Mediterranean Sea-general, Population Dynamics, Productivity - Food Chain, Range Or Territorial Dist., ...5.0089

SEA SLED AND SCUBA RECONNAISSANCE OF INSHORE AND DEEP-WATER FOULING ...Biological, Fouling, Predation, Vertical Distribution, ...8.0003

ESTUARINE DREDGE HOLE INVESTIGATIONS ...Aquatic Ecology, Coring and Dredging, Estuaries, Habitat Studies, ...5.0089

CHEMICAL AND PHYSICAL DATA ...Population Dynamics, Temperature, Turbidity & Suspended Matter, Water Movement, Currents, Water Salinity, Water Temperature-non-specific, ...5.0289

INVENTORY OF LARVAL FISH ...Coastlines-shorelines, Diving and Scuba, Geomorphology-topography, Hawaii, Management -other, ...5.0038

ESTUARINE AND ECOLOGICAL INVESTIGATIONS IN ESTUARINE AREAS ...Aquatic Ecology, Coring and Dredging, Estuaries, Habitat Studies, ...5.0089

A STUDY OF THE SEASONAL ABUNDANCE, DISTRIBUTION AND SPECIES COMPOSITION OF MARINE FISHES IN THE FLORIDA CORAL REEF ...Aquatic Ecology, Gulf of Mexico, Marine Fishes, Range Or Territorial Dist., Vertical Distribution, Zooplankton, ...5.0114

TRAMMEL NET SAMPLING IN ESTUARINE AREAS ...Aquatic Ecology, Mollusks, Marine Organisms, Range Or Territorial Dist., Vertical Distribution, Zooplankton, ...5.0114

SEA SURVEY INVESTIGATIONS ...California Current, Population Dynamics, Survey Studies, Vertical Distribution, ...4.0117
### SUBJECT INDEX

**DEVELOPMENT OF UNDER-ICE HORIZONTAL SONAR SCANNING EQUIPMENT AND TECHNIQUES FOR LOCATING FISH SCHOOLS** Behavior, Commercial Fishing, Lakes, Nets, Sonar, 5.0138

**STREAM IMPROVEMENT PLANNING** Benefit-cost Analysis, Engineering Structures—general, Management—other, Planning, Streams, 5.0239

**FISH POPULATION OFF THE ISLAND OF TUTUILA, AMERICAN SAMOA** American Samoa, Animal Taxonomy, Commercial Fishing, Fishing Gear, Number Or Density, 5.0032

**FISH POPULATIONS OF AMERICAN SAMOA** American Samoa, Crustacea—non-specific, Fishing Gear, Number Or Density, 5.0033

**GEAR EVALUATION** American Samoa, Fishing Gear, Nets, 5.0114

**KVICHAK RIVER SMOLT STUDY LITERATURE SURVEY** Alaska, Censusing, Migration, Number Or Density, Survey Studies, 5.0003

**INTERVIEW AND OBSERVATION** Censusing, Commercial Fishing, Continental Shelf, Range Or Territorial Dist., 5.0156

**DESIGN OF SAMPLING PLAN AND PROCUREMENT OF CHARTER VESSELS** Commercial Fishing, Continental Shelf, Nets, Number Or Density, Vertical Distribution, 5.0014

**WINTER DISTRIBUTION OF FISHES** Continental Shelf, Environmental Ecology, Salinity, Temperature, Temporal Distribution, Winter, 5.0153

**SPRING DISTRIBUTION OF FISHES** Commercial Fishing, Continental Shelf, Data Acquisition, Environmental Ecology, Spring, Temporal Distribution, 5.0154

**FISH COLLECTION OF NORTH CAROLINA AND WESTERN ATLANTIC FISHES** Atlantic Ocean-north, Collections, Fresh Water, North Carolina, 5.0133

**ECOLOGY OF COMMERCIAL FISH SPECIES IN NORTHERN LAKE MICHIGAN** Commercial Fishing, Lake Michigan, Number Or Density, Population Dynamics, Vertical Distribution, 5.0112

**APPLICATION OF BIOTELEMETRY TO THE STUDY OF MARINE VERTEBRATES** Behavioral Sciences, Central Nervous System, Locomotion—animal, Telemeters, Telemetry, 5.0637

**BIOCHEMISTRY AND PHYSIOLOGICAL ECOLOGY OF FISH** Enzymes—non-specific Metabolism, Muscle, Pathology, Toxins—non-specific, 5.0305

**OREGON FISHES: THEIR CLASSIFICATION, DISTRIBUTION AND BIOLOGY** Animal Taxonomy, Fresh Water, Oregon, Vertical Distribution, 5.0125

**CRYOGENIC PRESERVATION OF Viable FISH SPERM** Fertility, Freezing Techniques, Male Gametes, Rapid Freeze, 5.0130

**EARLY LIFE OF BOREAL FOOD FISH AND SHELLFISH** Animal Taxonomy, Life History Studies, Mollusks—non-specific, Mortality Rates, 5.0139

**FISH GENETICS AND ECOLOGY** DNA Other, Estuaries, Life History Studies, 5.0309

**REPRODUCTIVE ISOLATING MECHANISMS IN PANAMANIAN AND NORTH AMERICAN MARINE FISHES** Behavioral Ecology, Comparative Physiology, Panama, Reproduction Studies (general), 5.0244

**STUDY OF FISH MUCUS BIOCHEMISTRY** Locomotion—animal, Mucus, 5.0172

**BIOLOGICAL FALSE TARGETS AND RELATED ACOUSTIC CHARACTERISTICS** Animal Taxonomy, Behavioral Ecology, Scared Production, 5.0184

**WATER QUALITY AND NUTRIENTS, SACRAMENTO-SAN JOAQUIN RIVER SYSTEM** Environmental Ecology, Eutrophication, Nutrients, Plankton (non-specific), Water Quality—general, 6.0139

**DISTRIBUTION OF YOUNG STAGES OF COASTAL FISHES** Continental Shelf, Estuaries, Maturity & Growth Stages, Number Or Density, ships and Cruises, 5.0119

**INFLUENCE OF THE PHYSICAL ENVIRONMENT ON DISTRIBUTION OF YOUNG STAGES OF COASTAL GAME FISHES** Continental Shelf, Environmental Ecology, Maturity & Growth Stages, Physical—general, Range Or Territorial Dist., 5.0211

**EXPLORATORY COLLECTION AND CARE OF FISH FOR TESTING AT TIBURON** Biosaoy, California, Laboratory Animals, San Francisco Bay, 5.0116

### THERMAL PREFERENCES OF MARINE FISHES AND INVERTEBRATES
- Behavior, Invertebrates—non-specific, Thermal, Water Temperature—non-specific, 5.0209

### EFFECTS OF HOT WATER MASSES ON MARINE FISHES
- Atlantic Ocean—north, Behavior, High Temp., 5.0250
- Oceanic Fronts, Thermal, 5.0210

### TOXICANT TOLERANCE STUDIES-SCREENING OF PESTICIDES AND FISH AT TIBURON
- California, Laboratory Animals, Pesticides—non-specific, Screening Potential Pesticides, 5.0278

### LIFE HISTORY AND BEHAVIOR OF FISHES ON ARTIFICIAL REEFS
- Behavioral Ecology, Habitat Studies, Life History Studies, Population Dynamics, 5.0121

### HYDROGRAPHY, SEDIMENTATION AND CHEMICAL ASPECTS OF THE REEF ENVIRONMENT
- Aquatic Soils, Currents—ocean, Environmental Ecology, Reefs, 5.0212

### ECOLOGY OF THE KELP FORESTS
- Behavioral Ecology, Environmental Ecology, Habitat Studies, Laminariaceae (non-specific), 5.0194

### 1965 SALT-WATER ANGLING SURVEY
- Animal Taxonomy, Censusing, Fishing, 5.0011

### EFFECT OF TEMPERATURES AND CIRCULATION OF CONTINENTAL SHELF WATERS ON THE DISTRIBUTION OF FISHES
- Continental Shelf, Surface Environments, Temperature, Water Movement, Currents, Water Temperature—non-specific, 5.0165

### MARINE BIOLOGICAL INVESTIGATIONS - TAXONOMIC COLLECTION OF THE FRESH AND SALTWATER FISHES OF ALASKA
- Alaska, Animal Taxonomy, Collections, Fresh Water, 5.0008

### GULF OF ALASKA DEMERSAL FISH INVESTIGATIONS
- Gulf of Alaska, Population Dynamics, Productivity (agricultural), Vertical Distribution, 5.0089

### COLLECTION OF JUVENILE MIGRANTS FROM RIVERS AND STREAMS
- Electric Power Plants, Engineering Structures—general, Management—other, Migration, Streams, 5.0013

### ROUTINE SAMPLING AT SEVEN INDEX STATIONS
- Bottom Sampling, Data Acquisition, Lake Erie, Plankton Sampling, Sampling, 5.0214

### YOUNG FISHES OF A TIDAL ZONE
- Estuaries, Habitat Studies, Life History Studies, Size, Temporal Distribution, 5.0073

### FISHES TAKEN INCIDENTAL TO SHRIMP TRAWLING
- Atlantic Ocean—south, Nets, Number Or Density, Shrimps—commercial, 5.0072

### SYSTEMATIC STUDIES OF FISHES
- Animal Taxonomy, Developmental Physiology, Life History Studies, Vertebrate Anatomy, 5.0089

### IDENTIFICATION AND DESCRIPTION OF FISH LARVAE
- Animal Taxonomy, Atlantic Ocean—north, Life History Studies, Southern, 5.0074

### BEHAVIOR OF LARVAL FISHES
- Behavior, Captive Rearing, Commercial Fishing, Environmental Physiology, Maturity & Growth Stages, 5.0052

### ARTIFICIAL SELECTION - FISH
- Female Gametes, Genetic Resistance, Pesticides—non-specific, Pollution—effects of, Selection & Breeding, 5.0256

### GREAT LAKES GEAR RESEARCH
- Commercial Fishing, Fishing Gear, Great Lakes—general, Lakes, Population Dynamics, 5.0136

### MONITORING OF PESTICIDE LEVELS IN THE GREAT LAKES
- Great Lakes—general, Insecticides—non-specific, Monitoring Systems, Pollutants—general, Sampling, 6.0120

### ESTABLISHMENT AND PERPETUATION OF STOCKS OF EXPERIMENTAL FISH
- Behavioral Ecology, Environmental Ecology, Environmental Physiology, Great Lakes—general, Life History Studies, 5.0109

### MARINE FISH BEHAVIOR
- Behavioral Ecology, Commercial Fishing, Fishing Gear, 5.0176
Fish

SUBJECT INDEX

FISH POPULATION STUDY ...Analog Computer Applications, Environmental Ecology, Killifishes - Cyprinodon, Population Dynamics, Tiltapia, Cichlids, 5.0175

THE OCEANOGRAPHY OF NEW ENGLAND FISHING BANKS ...Continental Shelf, Number Or Density, Vertical Distribution, Water Environment -other, 5.0961

IMMUNE MECHANISMS AND RESISTANCE FACTORS IN MARINE FISHES ...Antigen, Histochemical Test, Serology and Immunology, 5.0255

VISUAL PROJECTION IN SURMMAMALIAN VERTEBRATES ...Basic Studies, Cranial and Nuclii, Retina, Visual Organs, 5.0238

Gambusia, Molly

EVOLUTION OF ALL-FEMALE FISHES ...Female, Other, Reproduction Studies (general), 5.0247

PHYSIOLOGY AND ASSAY OF PROLACTIN IN FISH ...Bloasays, Biochemical, Immunology, Luteotrophic Hormone, Pituitary, 5.0329

Killifishes - Cyprinodon

STUDIES OF FISH ENDOCRINOLOGY ...Environmental Physiology, Fresh Water, Hormone, Testes, Thyroid, 5.0246

DEVELOPMENTAL ANALYSIS OF FUNDULUS ...Basic Embryology, Central Nervous System, Fats, Phospholipids, Transplants, 5.0316

THE INFLUENCE OF ENVIRONMENTAL FACTORS UPON DEVELOPING MORPHIC STRUCTURES IN THE MARINE FISH, FUNDULUS MAJALIS (WALBAUM) ...Basic Embryology, Developmental Physiology, Environmental Physiology, Water Temperature-non-specific, 5.0292

MARINE SPORTS FISHES RESEARCH ...Delaware Bay, Fish -other, Population Dynamics, Water Salinity, Water Temperature-non-specific, 5.0248

FISH POPULATION STUDY ...Analog Computer Applications, Environmental Ecology, Fish -other, 5.0246

HISTOPATHOLOGIC EFFECTS OF POLLUTANTS ON CELLS AND TISSUES OF MARINE FISHES ...Contamination, Water, Pathology, Pollution - Effects of, Pollution Effects, 5.0323

HEMATOLOGICAL CHANGES IN F. HETEROCITUS UPON EXPOSURE TO TOXIC METALS ...Blood Cells, Blood Plasma and Serum, Cadmium, Lead, Toxins -other, 5.0328

PHARMACOLOGY OF METAL POISONING IN ESTUARINE FISHES ...Contamination - Water, Estuaries, Metals -non-specific, Stress, 5.0324

COMPARATIVE TOXICITIES OF METALS TO ESTUARINE FISHES ...Bloasays, Estuaries, Industrial Wastes, Solid Waste, Toxins -other, 5.0314

Lake Trout, Brook Trout

COMPARATIVE BEHAVIOR OF HATCHERY-READED AND WILD SALMONIDS ...Atlantic Salmon, Sebago Salmon, Behavior, Captive Rearing, Environmental Physiology, 5.0264

INVESTIGATION OF ANADROMOUS DOLLY VARDEN POPULATIONS IN HODD BAY DRAINAGES, SOUTHEASTERN ALASKA ...Alaska, Migration, Population Dynamics, Streams, 5.0013

ASSESSMENT OF LAKE SUPERIOR LAKE TROUT ...Aquatic Ecology, Commercial Fishing, Lampreys, Life History Studies, 5.0736

RATES OF PESTICIDE BUILDUP IN SALMONIDS RECENTLY INTRODUCED IN THE GREAT LAKES ...Fish, Insecticides -non-specific, Lake Michigan, Lake Superior, Pollution Effects, Salmon -coho, chinook, sockeye, 5.0154

Lampreys

BIOLOGY OF THE LARVAL SEA LAMPERY ...Control of Nuisance Species, Developmental Physiology, Environmental Ecology, Great Lakes-general, Life History Studies, 5.0633

EFFECTS OF CHEMICALS ON THE PHYSIOLOGY OF SEA LAMPREY AMMOCETES (PETROMYZON MARINUS) ...Contamination - Water, Control of Nuisance Species, Environmental Physiology, Maturity & Growth Stages, 5.0631

ASSESSMENT OF LAKE SUPERIOR LAKE TROUT ...Aquatic Ecology, Commercial Fishing, Lake Trout, Brook Trout, Life History Studies, 5.0736

LAKE SUPERIOR CHEMICAL CONTROL OF SEA LAMPREY ...Aquatic Ecology, Control of Nuisance Species, Lake Superior, Larvicides, Streams, 5.0628

LAKE MICHIGAN CHEMICAL CONTROL OF SEA LAMPREY ...Animal Pollutant Sources, Control of Nuisance Species, Evaluation, Lake Michigan, Larvicides, 6.0158

SEA LAMPREY AMMOCETE REESTABLISHMENT STUDIES ...Aquatic Ecology, Control of Nuisance Species, Great Lakes, Larvicides, Life History Studies, Population Dynamics, 5.0629

ELECTRIC BARRIER OPERATIONS ...Control of Nuisance Species, Lake Michigan, Lake Superior, Migration, Population Dynamics, 5.0630

BIOASSAY ...Animal Pollutant Sources, Evaluation, Pesticides -non-specific, Streams, Water Properties-general, 5.0632

Largemouth Bass

EXPERIMENTAL AND BIOMATHEMATICAL ANALYSIS OF THE PHENOMENON OF ATTACK ...Behavioral Ecology, Bluegills, Bream, Computer Methods -general, Environmental Physiology, Minnows, Predation, 5.0538

Lefteye Flounders

CREEL CENSUS OF SUMMER FLOUNDER SPORT FISHERY IN GREAT BAY, NEW JERSEY ...Days, Censusing, Legislation, Life History Studies, New Jersey, 5.0124

POPULATION DYNAMICS OF NEW ENGLAND GROUND-FISH ...Atlantic Ocean-north, Codfishes, Hake, Population Dynamics, Rockfish, Scaionfish, 5.0103

Marlin, Billfishes, Sailfish...

LIFE HISTORY OF BILLFISHES ...California, Censusing, Life History Studies, Mexico, 5.0195

ENVIRONMENTAL EFFECTS ON ISTDHORID FISH DISTRIBUTION ...Environmental Ecology, Gulf of Mexico, Ships and Cruises, Temporal Distribution, 5.0070

BLOOD TYPES AS INDICATORS OF WHITE MARLIN RACES ...Blood Plasma and Serum, Blood Typing Studies, Polymermorphism, Statistics-general, 5.0321

HEMOGLOBIN VARIATIONS AS INDICATORS OF WHITE MARLIN RACES ...Hemoglobin, Morphological Action, 5.0322

TAGGING PROGRAM WITH WOODS HOLE AND INTERNATIONAL GAME FISH ASSOCIATION FOR MARLIN, SAILFISH AND OTHER GAME SPECIES MIGRATION STUDIES ...Migration, Pacific Ocean-general, Population Dynamics, Tags, 5.0036

Minnows

CYTOTAXONOMIC STUDIES OF TELEOST FISHES ...Abyssal, Animal Taxonomy, Blood Cells, Sets of Chromosomes, 5.0242

EXPERIMENTAL AND BIOMATHEMATICAL ANALYSIS OF THE PHENOMENON OF ATTACK ...Behavioral Ecology, Bluegills, Bream, Computer Methods -general, Environmental Physiology, Largemouth Bass, Predation, 5.0535

Pikes, Pickeral, Muskellunge

FISH POPULATIONS IN THE CHENA RIVER ...Alaska, Population Dynamics, Salmon & Trout - Non-specific, Streams, 5.0029

Pompanos, Scads, Jacks

CULTURE OF POMPANO IN BRACKISH WATER PONDS ...Aquaculture & Fish-farming, Brackish Water, Food Supply, Louisiana, Stocking of Fish & Shellfish, 5.0004

SYSTEMATICS OF CARANGID FISHES ...Animal Taxonomy, Collections, Handbooks, Maturity & Growth Stages, Species, Comparison of, 5.0061

Porgies

SPORT FISH BEHAVIORAL STUDIES ...Basses -sea,white, White Perch, Behavioral Ecology, Habitat Studies, Rockfish, Scionfish, 5.0045

Rainbow Trout, Steelhead Trout

EVALUATION, COORDINATION, AND PLANNING OF PACIFIC SALMON AND STEELHEAD RESEARCH AND MANAGEMENT ACTIVITIES ...Commercial Fishing, Fishery
Fish

SUBJECT INDEX

PROTECTION OF FINGERLING SALMON IN TURBINES...Construction, Land Use Effects, Engineering Structures-general, Migration, Mortality Rates, Snake River, ...8.0014

EPIDEMIOLOGY OF SALMON POISONING DISEASE...FECAL HELMINTHS, Nematodes, Helminth, Pathology, Virulence and Pathogenicity, ...5.0307

Salmon -coho,chinook,sockeye...

INVESTIGATE THE FEASIBILITY OF INTRODUCING SOCKEYE SALMON INTO RESERVOIRS...Aquatic Ecology, Captive Rearing, Oregon, Reservoirs and Impoundments, Stocking of Fish & Shellfish, ...6.0141

POPULATION STUDIES OF ANADROMOUS FISH - UPPER COOK INLET DRAINAGES...Alaska, Captive Rearing, Censusing, Population Dynamics, Streams, ...6.0020

SILVER SALMON STUDIES IN THE RESURRECTION BAY AREA...Alaska, Aquatic Ecology, Bays, Environmental Ecology, Management -other, ...5.0167

TAG DETECTION ...Commercial Fishing, Number Or Density, Puget Sound, Streams, Tags, ...5.0016

TAG LOSS ...Captive Rearing, Size, Tags, Washington, Weight, ...5.0157

PRE-EMERGENT FRY PINK SALMON FORECAST...SOUTHEASTERN ALASKA...Alaska, Aquatic Ecology, Captive Rearing, Spawning & Nesting Sites, ...5.0019

INVESTIGATION OF SPAWNING GROUND POTENTIALS AND GROWTH AND SURVIVAL OF JUVENILE SOCKEYE SALMON IN FRAZER LAKE SYSTEM...Alaska, Censusing, Lakes, Nets, Spawning & Nesting Sites, Tags, ...5.0019

COOK INLET ESCAPEMENT ENUMERATION STUDY...Alaska, Censusing, Migration, Organism Sampling Devices, Sonar, Sonar and Echo Sounding, ...6.0112

IDENTIFICATION OF RED SALMON STOCKS TAKEN IN THE CAPE KUMILK-ANIAKCHAK BAY FISHERY ...C哟IK-NIK AREA)...Alaska, Commercial Fishing, Spawning & Nesting Sites, Streams, ...5.0021

MANAGEMENT OF THE OCEAN SALMON FISHERY WITH EMPHASIS ON THE BARBLESS HOOKS AS A MANAGEMENT TOOL...Commercial Fishing, Fishing Gear, ...8.0142

ARCTIC-YUKON-KUSKOKWIM AREA ANADROMOUS FISH INVESTIGATIONS...Alaska, Commercial Fishing, Life History Studies, Population Dynamics, Salmon & Trout - Non-specific, ...5.0024

RESTORATION AND REHABILITATION OF EARTHQUAKE DAMAGE TO PINK AND CHUM SALMON STUDIES IN PRINCE WILLIAM SOUND...Alaska, Earthquakes, Flow Characteristics -water, Spawning & Nesting Sites, Stream Rehabilitation, Tectonics-general, ...5.0191

BRISTOL BAY INTERMEDIATE HIGH SEAS-INSHORE TEST FISHING...Age, Alaska, Bays, Commercial Fishing, ...5.0022

SOCKEYE SALMON MIGRATORY BEHAVIOR AND BIOLOGICAL STATISTICS COLLECTION,SOUTHEASTERN ALASKA...Alaska, Behavioral Ecology, Censusing, Migration, Streams, ...5.0027

OFFSHORE SALMON ABUNDANCE INDEX...Alaska, Commercial Fishing, Number Or Density, Streams, ...5.0028

EVALUATION, COORDINATION AND PLANNING OF PACIFIC SALMON-AGED STEELHEAD RESEARCH AND MANAGEMENT ACTIVITIES...Commercial Fishing, Fishery Development -other, Management -other, Meetings, Rainbow Trout, Steelhead Trout, ...5.0140

MEASUREMENT OF SPAWNING SUCCESS AND FRY QUALITY OF CHUM SALMON UTILIZING A SPAWNING CHANNEL AT BIG BEEF CREEK, WASHINGTON...Management -other, Number Or Density, Quality -non-specific, Spawning & Nesting Sites, Washington, ...5.0029

COPPER RIVER SOCKEYE SALMON INVESTIGATIONS...Alaska, Aquatic Ecology, Biological Rhythms, Migration, Population Dynamics, Stocking of Fish & Shellfish, ...5.0026

COPPER RIVER SOCKEYE SALMON INVESTIGATIONS...Alaska, Aquatic Ecology, Behavioral Ecology, Censusing, Migration, ...5.0016

PRE-EMERGENT FRY PINK SALMON FORECAST (KODIAK, ALASKA)...Alaska, Maturity & Growth Stages, Number Or Density, Spawning & Nesting Sites, ...5.0017

COOK INLET CATCH AND ESCAPEMENT AGE AND SEX COMPOSITION STUDIES...Age, Alaska, Migration, Nets, Sex -non-specific, Spawning & Nesting Sites, ...5.0014

COOK INLET SMOLT ENUMERATION STUDY...Alaska, Censusing, Productivity (agricultural), Spawning & Nesting Sites, ...5.0015

TAG EXTRACTION ...Tags, ...5.0016

SAMPLING OF MARKED COHO...Censusing, Columbia River, Mark, Tag Or Capture -other, Number Or Density, Stocking of Fish & Shellfish, ...5.0016

RECOVERY OF MARKED COHO...Commercial Fishing, Data Acquisition, Tags, ...5.0163

MARKED COHO LIBERATION...Captive Rearing, Columbia River, Mark, Tag Or Capture -other, Puget Sound, ...5.0016

FORECAST OF KODIAK ISLAND PINK SALMON RUNS FROM ABUNDANCE OF JUVENILES IN ESTUARIES...Alaska, Estuaries, Fishing Gear, Maturity & Growth Stages, Migration, Number Or Density, ...5.0179

STUDIES OF SOCKEYE SALMON, ONCORHYNCHUS NERKA, IN THE NUSHAGAK DISTRICT, ALASKA...Alaska, Commercial Fishing, Fishery Management -other, ...5.0167

EVALUATION OF ESCAPEMENT OF ADULT SALMON TO OREGON COASTAL STREAMS...Environmental Ecology, Number Or Density, Oregon, Spawning & Nesting Sites, ...5.0028

POPULATION ESTIMATES OF JUVENILE COHO SALMON IN SIX COASTAL STREAMS...Environmental Ecology, Maturity & Growth Stages, Population Dynamics, Streams, ...5.0014

SPRING CHINOOK SALMON ECOLOGY STUDY...Aquatic Ecology, Mark, Tag Or Capture -other, Oregon, Physical-General, Productivity (agricultural), Streams, ...5.0018

ANALYSIS OF SALMONID SCALES...Animal Taxonomy, Columbia River, Growth Rate, Rainbow Trout, Steelhead Trout, Scales, ...5.0135

MANAGEMENT OF COLUMBIA RIVER COMMERCIAL FISHERY...Aquatic Ecology, Columbia River, Commercial Fishing, Legislation, ...5.0165

BRISTOL BAY ESTUARINE ECOLOGY...Alaska, Estuaries, Fishing Gear, Life History Studies, Migration Oceanic Fronts, ...5.0004

NAKNEK SYSTEM RED SALMON STUDY...Alaska, Growth Rate, Migration, Number Or Density, Strirams, ...5.0005

KARLUK LAKE RESEARCH STATION...Life History Studies, Migration, Mortality Rates, Population Dynamics, Productivity (agricultural), Spawning & Nesting Sites, ...5.0006

CHUM SALMON INVESTIGATIONS...Environmental Ecology, Estuaries, Food Supply, Growth Rate, Life History Studies, Number Or Density, ...5.0007

PINK SALMON INVESTIGATIONS - FRESHWATER ECOLOGY...Aquatic Ecology, Environmental Ecology, Maturity & Growth Stages, Mortality Rates, Spawning & Nesting Sites, ...5.0188

PINK SALMON INVESTIGATIONS - INTERRUIMAL ECOLOGY...Alaska, Life History Studies, Spawning & Nesting Sites, Tidal Streams, Water Salinity, ...5.0186

ADULT MIGRATION RATES...Columbia River, Environmental Ecology, Management -other, Migration, Pre-impoundment Sites, ...5.0173

RATES OF PESTICIDE BUILDUP IN SALMONIDS RECENTLY INTRODUCED IN THE GREAT LAKES...Fish, Insecticides -non-specific, Lake Michigan, Lake Superior, Lake Trout, Brook Trout, Pollution Effects, ...5.0154

PINK SALMON INVESTIGATIONS - FRESHWATER ECOLOGY...Alaska, Aquatic Ecology, Commercial Fishing, Environmental Ecology, Maturity & Growth Stages, Mortality Rates, Spawning & Nesting Sites, ...5.0188

INTERNATIONAL NORTH PACIFIC FISHERIES COMMISSION SUBARCTIC OCEANOGRAPHY...Currents-ocean, Depth, Pacific Ocean-north, Range Or Territorial Distr., Salinity, Temperature, ...5.0119

OCEAN GROWTH AND MORTALITY OF SALMON...Growth Rate, Mortality Rates, Scales, Tags, ...5.0017

PACIFIC FISH PHYSIOLOGY AND BIOCHEMISTRY (SALMON IMMUNOCHEMISTRY)...Immunology, Maturity & Growth Stages, Stress, ...5.0032

ANALYSIS OF JAPANESE CATCH STATISTICS...Commercial Fishing, Japan, Number Or Density, Pacific Ocean-north, ...5.0166

IDENTIFICATION OF SOCKEYE SALMON STOCKS BY BONE MINERALS...Animal Taxonomy, Bone, Chemical Analysis, Pacific Ocean-general, ...5.0133

510
GULF OF ALASKA SOCKEYE SALMON SCALES, PROTOCOL AREA SOCKEYE SALMON SCALES, AND GULF OF ALASKA PINK SALMON SCALES...Animal Taxonomy, Gulf of Alaska, Life History Studies, Scales...5.0334

Sculpins
PHARMACOLOGY AND CHEMISTRY OF TOXIC MARINE ANIMALS...Animal Toxins, Female Gametes, Toxiconlogy...6.0104

BLOOD PLASMA OF NORTHWEST FISHES...Blood Plasma and Serum, Codfishes, Hake, Halminths, Proctozoon, Trematoda...other...5.0335

Sharks
FACTORS AFFECTING THE BEHAVIOR OF SHARKS...Behavior, Sensory Organs...5.0262

SHARK ATTACKS...Behavioral Ecology, Diving and Scuba, Water Environment...other...6.0096

SHARK RESEARCH...Control of Nuisance Species, Fish Repellents, Tags, Temporal Distribution...5.0047

ENERGY REQUIREMENTS OF MARINE ORGANISMS...Energy, Thermoregulation, Tuna, Mackerel, Albacore...Water Pressure...5.0273

ECOLOGICAL STUDY OF CHARLOTTE HARBOR ESTUARY AND SHARK PROGRAM OF MOTE MARINE LAB...Estuaries, Florida, Man's Activities...5.0884

PELAGIC SHARKS OFF SOUTHERN CALIFORNIA...Environmental Ecology, Pacific Ocean-east, Population Dynamics, Vertical Distribution...5.0816

EXPERIMENTAL ANALYSIS OF HEARING AND ACOUSTIC ORIENTATION IN SHARKS...Auditory, Behavior, Shark Repellents...5.0277

BEHAVIOR AND SENSORY PHYSIOLOGY OF SHARKS...Auditory, Behavioral Ecology, Fish Repellents, Tape Recording, Audio, Visual Organs...5.0255

BLOOD CHEMISTRY OF FISHES...Blood Plasma and Serum, Bone, Vertebrate Anatomy, Vertical Distribution...5.0239

DISTURBANCE AND MIGRATION OF CENTRAL AMERICAN FRESHWATER ELASMOBRANCHS...Caribbean Sea, Migration, Nicaragua, Osmoregulation, Rays, Skates, Mantas, Sawfish...5.0117

FURTHER STUDIES ON A FLUORESCENT COMPOUND IN THE DOGFISH LEAF...Fluorescent, Visual, Visual Organs...5.0271

COPEPODS PARASITIC ON SHARKS OF THE WEST COAST OF FLORIDA...Animal Taxonomy, Copepods, Ectoparasites, Florida...5.0397

ELASMOBRANCH PHARMACOLOGY...Drug Evaluation, Mechanism of Action, Neuroeffect...6.0138

STUDIES OF SHARK REPELLENTS AND OTHER ANTI-SHARK MEASURES...Fish Repellents, Shark Repellents...5.0132

ELASMOBRANCH PHARMACOLOGY...Drug Evaluation, Fish Repellents, Mechanism of Action...6.0119

MARINE ANIMAL TOXINS...Fish Repellents, Mechanism of Action, Toxins...5.0016

MIGRATORY HABITS OF LARGE SHARKS...Atlantic Ocean-north, Fishing, Migration, Tags...5.0147

AGE DETERMINATION OF LARGE ATLANTIC SHARKS...Age, Atlantic Ocean-north, Growth Rate...5.0128

DESCRIPTIONS OF NEW SHARKS...Animal Taxonomy, Collections, Nomenclature, Classification, Publications...other...5.0057

A REVISION OF THE CAT SHARKS, SCYLLOHINIDAE...Animal Taxonomy, Nomenclature, Classification, Vertebrate Anatomy...5.0058

LOCAL FISHERY SYSTEMS DEVELOPMENT...California, Commercial Fishing, Shrimp...Common, Sw., Fish...5.0198

FORMATION AND METABOLISM OF NEUROHUMORAL TRANSMITTER SUBSTANCES IN MARINE ANIMALS...Basic Studies, Biochemical, Developmental Stages, Quantitative & Qualitative...5.0109

THE PHYSIOLOGY OF TUNA AND OTHER PELAGIC FISH...Blood...other, Environmental Physiology, Thermoregulation, Tuna, Mackerel, Albacore...5.0272

OSMOREGULATION...Aquatic Ecology, Osmoregulation, Rays, Skates, Mantas, Sawfish, Streams...5.0280

511

SUBJECT INDEX

Smelts
INTERRELATIONS OF SMELT WITH NATIVE SPECIES...Competition, Food Supply, Lake Superior, Life History Studies, Number Or Density...5.0182

LAKE SUPERIOR EXPLORATIONS...Commercial Fishing, Lake Superior, Management...other, Nets, Smelts...5.0107

Snappers
DEVELOP FISHERIES FOR NON-TUNA RESOURCES...Commercial Fishing, Fishing Gear, Hawaii, Pacific Ocean-general...5.0086

Suckers
LAKE SUPERIOR EXPLORATIONS...Commercial Fishing, Lake Superior, Management...other, Nets, Smelts...5.0107

LIFE HISTORY OF THE HUMBOT AND LONNOSE SUCKER...Codfishes, Hako, Lake Superior, Lakes, Life History Studies...5.0184

Sunfish, Rock & Roanoke Bass
REPOPULATION OF DECIMATED SECTIONS OF WARM-WATER STREAMS BY LONGEAN SUNFISH, LEPOMIS MEGALOTIS (RAFINESQUE)...Aquatic Ecology, Population Dynamics, Stocking of Fish & Shellfish, Streams, Warm Water...5.0097

Swordfish
STUDIES ON THE SPORT FISHERY FOR BILLFISHES AND TUNAS IN THE WESTERN ATLANTIC AND SOUTHEASTERN PACIFIC OCEAN...Atlantic Ocean-general, Fishing, Pacific Ocean-general, Tuna, Mackerel, Albacore...5.0069

LOCAL FISHERY SYSTEMS DEVELOPMENT...California, Commercial Fishing, Sharks, Shrimp...Common, 5.0198

Tilapia, Cichlids
MOTIVATIONAL ANALYSIS OF COURTSHIP BEHAVIOR...Aggression, Behavior, Social Behavior...5.0231

EXPERIMENTAL STUDIES OF BEHAVIOR IN A CICHLID FISH...Behavior, Parental Care, Sex, Sizes...5.0232

FISH POPULATION STUDY...Analog Computer Applications, Environmental Ecology, Fish, Behavior, Killifishes...Cyprinodon, Population Dynamics...5.0175

FUNCTION OF THE INTERRENAAL GLAND IN TELOELEST FISHES...Blood Cells, Kidney and Urinary System, Osmoregulation, Pituitary, Water Salinity...5.0235

Tuna, Mackerel, Albacore
DEVELOPMENT OF TECHNIQUES FOR THE AQUACULTURE OF POMPANO...Aquaculture & Fish-farming, Environmental Physiology, Florida, Maturity & Growth Stages, Pathology...5.0007

ENERGY REQUIREMENTS OF MARINE ORGANISMS...Energy, Sharks, Thermoregulation, Water Pressure...5.0273

STUDIES ON THE SPORT FISHERY FOR BILLFISHES AND TUNAS IN THE WESTERN ATLANTIC AND SOUTHEASTERN PACIFIC OCEAN...Atlantic Ocean-general, Fishing, Pacific Ocean-general, Swordfish...5.0069

ACQUISITION OF A SUITABLE PROTOTYPE FISHING VESSEL AND GEAR...American Samoa, Commercial Fishing, Equipment Purchase Operation, Nets...12.0004

ALBACORE TUNA...Behavioral Ecology, Environmental Ecology, Life History Studies, Tags...5.0143

SYSTEMATIC STUDIES ON THE FAMILY SCOMBRIDAE...Animal Taxonomy, Indian Ocean-general, Nomenclature, Classification, Vertebrate Anatomy...5.0056

INVESTIGATE SYSTEMATICS AND ECOLOGY OF TUNA LARVAE AND JUVENILES...Animal Taxonomy, Artificial Insemination, Maturity & Growth Stages, Spawning...5.0079

INVESTIGATE SEASONAL VARIATIONS, SURFACE WATER TYPES, HAWAIIAN AREA (KOKO HEAD)...Commercial Fishing, Hawaii, Heat and Radiation Transfer, Oceanic Fronts, Salinity, Temperature, Water Salinity, Water Temperature-non-specific...10.1048

REPRODUCTION AND FECUNDITY OF TUNAS...Behavior, Biological Rhythms, Female Gametes, Fertility...5.0159

DISTRIBUTION AND ECOLOGY OF ATLANTIC TUNAS...Atlantic Ocean-general, Environmental Ecology, Range Or Territorial Dist., Temporal Distribution...5.0063
MIGRATION OF ATLANTIC TUNAS ...Africa, Atlantic Ocean-general, Migration, Tags, ...5.0064
FEEDING HABITS OF ATLANTIC TUNAS AND NEKTONT ECOLOGY ...Atlantic Ocean-general, Food Supply, Plankton (non-specific), Productivity - Food Chain, ...5.0204
POPULATION DYNAMICS OF ATLANTIC TUNAS ...Atlantic Ocean-general, Censusing, Commercial Fishing, Population Dynamics, ...5.0065
MECHANISMS AFFECTING THE VERTICAL AND HORIZONTAL DISTRIBUTION OF TUNAS AND RELATED SPECIES ...Atlantic Ocean-general, Population Dynamics, ...5.0076
SEA SURFACE SURVEILLANCE ...Caribbean Sea, Circulation-general, Temporal Distribution, Vertical Distribution, Water Properties-general, ...5.0019
DESIGN AND DEVELOPMENT OF NEKTON SAMPLER ...Food Supply, Nektonic - Swimming, Organism Sampling Devices, Plankton Sampling, ...5.0129
ECOLOGY AND TAXONOMY OF TROPICAL ATLANTIC SCOMBRID EGGS AND LARVAE ...Anchovies, Captive Rearing, Environmental Regulation, ...5.0259
AN ECOLOGICAL STUDY OF THE LAYSAN AND BLACK-FOOTED ALBATROSSES ...Age, Albatrosses, Shearwaters, ...Animal Distr. (non-specific), Mark, Tag Or Capture - other, Vertical Distribution, ...5.0080
INCREASE EFFICIENCY OF HAWAIIAN SKIPJACK FISHERY ...Captive Rearing, Commercial Fishing, Food Supply, Hawaii, ...5.0017
DEVELOP TECHNIQUES FOR CAPTURING JUVENILE TUNAS ...Blood Typing Studies, Nets, Population Dynamics, Vertical Distribution, Behavioral Ecology, Environmental Ecology, ...5.0077
INVESTIGATE PHYSIOLOGY OF TUNAS ...Behavior, Blood - other, Environmental Physiology, Muscle, Olfactory, ...5.0259
DETERMINE ALTERNATE LIVEBAIT SPECIES ...Anchovies, Captive Rearing, Commercial Fishing, Food Supply, Hawaii, ...5.0010
INVESTIGATE POPULATION DYNAMICS OF ALBACORE ...American Samoa, Commercial Fishing, Population Dynamics, Water Environment - other, ...5.0081
ASSESSMENT OF CENTRAL PACIFIC TUNA RESOURCES ...Commercial Fishing, Pacific Ocean-general, Population Dynamics, Size, ...5.0082
DEVELOP HIGH-SEA TUNA FISHERY ...Commercial Fishing, Fishing Gear, Pacific Ocean-general, Tropic, ...5.0084
INVESTIGATE TUNA RESOURCES OF THE TRUST TERRITORIES ...Caroline Islands, Commercial Fishing, Environmental Ecology, Population Dynamics, ...5.0085
SCHOOLING BEHAVIOR ...Alewife, menhaden, shad, herring, Anchovies, Behavioral Ecology, Environmental Ecology, ...5.0038
146 D EASTROPAC ...Marine Biology, Meteorological Studies, Pacific Ocean-east, Tropic, Vertical Distribution, ...4.0113
INVESTIGATE POPULATION DYNAMICS OF SKIPJACK TUNA IN HAWAIIAN WATERS ...Commercial Fishing, Economics, Environmental Ecology, Hawaii, Population Dynamics, ...5.0080
149A FISHERY SYSTEMS ANALYSIS ...California, Commercial Fishing, Nets, Production & Processing, Simulation, ...4.0175
TUNA PURSE SEINE NET ...Commercial Fishing, Fishing Gear, Nets, ...4.0119
REARING MARINE FISH ...Alewife, menhaden, shad, herring, Anchovies, Captive Rearing, Environmental Physiology, ...5.0041
SCRIPPS TUNA OCEANOGRAPHY RESEARCH PROGRAM ...Food Supply, Pacific Ocean-east, Temperature, Tropic, Water Temperature - non-specific, ...5.0200
CTFM SONAR ...Behavioral Ecology, Commercial Fishing, Locomotion - animal, Sonar and Echo Sounding, Telemetry, ...5.0058
THE PHYSIOLOGY OF TUNA AND OTHER PELAGIC FISH ...Blood - other, Environmental Physiology, Sharks, Thermonegulation, ...5.0272

Walleyes
THE EFFECTS OF ENVIRONMENTAL CONDITIONS ON THE SPAWNING AND SURVIVAL OF FRY OF THE WALLEYE ...Environmental Effects - geologic, Eutrophication, Lake Erie, Pollution - Effects of, Temperature, ...5.0299

Yellow Perch, Darters
THE ROLE OF CALCIUM IONS IN THE MOTILITY OF SEA URCHIN AND OTHER SPERMATOZOA ...Atpase, Calcium, Male Gametes, Motility and Migration, ...5.0622
LAKE ERIE INVESTIGATIONS - LIFE HISTORY AND ABUNDANCE OF THE YELLOW PERC ...Commercial Fishing, Environmental Ecology, Life History Studies, Nets, Population Dynamics, ...5.0134
CYTOLOGY OF VIRAL NEOLASMS OF FISH ...Dermal, Hypertrophy - Hypersia, Lymphocytosis, Neoplasms, ...5.0292

Fish & Wildlife Biology
Birds
Censusing
ECOLOGICAL STUDIES OF THE COPPER RIVER DELTA ...Alaska, Maps-general, Spawning & Nesting Sites, Waterfowl - non-specific, ...5.0855
Control of Nuisance Species
THE BIOLOGY OF THE LAYSAN AND BLACK-FOOTED ALBATROSSES ...Age, Albatrosses, Shearwaters, ...Animal Distr. (non-specific), Mark, Tag Or Capture - other, Spawning & Nesting Sites, ...5.0067
Food Supply
AVIFAUNAL ECOLOGY OF LIMANTOUR ESTERO ...Birds - non-specific, California, Game Reserves & Preserves, Habitat Studies, ...5.0534
WATERFOWL FOOD STUDIES ...Management, Plant Prod. (non-specific), South Carolina, Waterfowl - non-specific, ...5.0653
Game Reserves & Preserves
AVIFAUNAL ECOLOGY OF LIMANTOUR ESTERO ...Birds - non-specific, California, Food Supply, Habitat Studies, ...5.0534
EVALUATION OF ATLANTIC COAST ESTUARIES ...Atlantic Ocean-north, Estuaries, Habitat Studies, Life History Studies, Waterfowl - non-specific, ...5.0020
Mark, Tag Or Capture - other
SENSORY BASIS OF NAVIGATION IN HOMING PIGEONS ...Behavior, Biological Rhythms, Environmental Physiology, Locomotion - animal, Pigeon, ...4.0108
DISTANT GOAL ORIENTATION ...Biological Rhythms, Birds - non-specific, Locomotion - animal, Magnetic Impulses, Orientation, ...4.0109
ECOLOGY OF STORM PETRELS ...Albatrosses, Shearwaters, ...California, Islands, Spawning & Nesting Sites, Terrestrial Ecology, ...5.0852
THE BIOLOGY OF THE LAYSAN AND BLACK-FOOTED ALBATROSSES ...Age, Albatrosses, Shearwaters, ...Animal Distr. (non-specific), Control of Nuisance Species, Spawning & Nesting Sites, ...5.0607
TELEMETRY STUDIES ON MARINE BIRDS ...Albatrosses, Shearwaters, ...Bermuda, Pelicans, Cormorants, darters, Spawning & Nesting Sites, ...5.0531

Fish & Shellfish
Aquaria
NUTRITION AND PHYSIOLOGY OF MARINE FISH IN CONTROLLED GNOTOBOTIC ENVIRONMENTS ...Environmental Physiology, Fish - non-specific, Germ Free Animal, Nutrition - other, ...5.0317
Captive Rearing
COMPARATIVE BEHAVIOR OF HATCHERY-READED AND WILD SALMONIDS ...Atlantic Salmon, Sebago Salmon, Behavior, Environmental Physiology, Lake Trout, Brook Trout, ...5.0264
SHRIMP PRODUCTION IN LOUISIANA SALT-MARSH IMPOUNDMENTS UNDER EXISTING AND MANAGED CON-
SUBJECT INDEX

DICTIONS ...Aquaculture & Fish-farming, Lagoons, Louisiana, Shrimp ...Common, Water Movement, Currents, ...5.0435
GERMFREE FISH ...Fish -other, Germ Free Animal, Immunolo-

SHELLFISH EMBRYOLOGY AND LARVAE DEVELOPMENT

MANAGEMENT INVESTIGATIONS OF TWO SPECIES OF

TAG LOSS

POPULATION STUDIES OF ANADROMOUS FISH - UPPER

COOK INLET DRAINAGES ...Alaska, Censusing, Population

Dynamics, Salmon -coho,chinook,sockeye,..., Streams, ...5.0020

CONTROLLED REARING OF DUNGENESS CRAB LARVAE ...

...Crabs, Developmental Physiology, Maturity & Growth Stages, Oregon, ...5.0486

INSPECTION OF OYSTER SEED - NEW ASIAN SOURCES ...

...Commercial Fishing, Germ Free Animal, Japan, Oysters, ...5.0511

CHARTRUST OF SURTIDUAL OYSTER BEDS AND EXPERI-

MENTAL TRANSPLANTING OF SEED OYSTERS FROM

POLLUTED SEED OYSTER BEDS ...Commercial Fishing, Estuarine Oysters, South Carolina, Stocking of Fish & Shellfish, ...8.0011

TAG LOSS ...Salmon -coho,chinook,sockeye,..., Size, Tags, Washington ...5.0157

MANAGEMENT INVESTIGATIONS OF TWO SPECIES OF

SPINY LOBSTERS PANULUS JAPONICUS AND P.

PENCILLATUS ...Commercial Fishing, Lobsters, Management -other, Tags, ...5.0432

SHELLFISH EMBRYOLOGY AND LARVAE DEVELOPMENT

STUDY ...Basic Embryology, Crustacea -non-specific, Mollusks -other, Training Grants, Fellowships, ...5.0358

PRELIMINARY MODIFICATIONS AND CONTROL OF NATU-

RAL GROWING AREA ENVIRONMENTS ...Clams, Growth Rate, Mineral Content -water, Oysters, Predation, ...5.0495

RECOVERY OF MARKED COHO ...Data Acquisition, Salmon -

coho,chinook,sockeye,..., Tags, ...5.0163

MARKED COHO LIBERATION ...Columbia River, Mark, Tag Or Capture -other, Paget Sound, Salmon -coho,chin-

ook,sockeye,..., ...5.0164

FARMINGTON RIVER SHAD STUDIES ...Alewife,men-

haden,shad,herring, Bottom Sampling, Migration, Sampling, Streams, ...5.0203

CULTURE OF ATLANTIC CROAKER IN BRACKISH WATER

PONDS ...Aquaculture & Fish-farming, Brackish Water, Drums, Management, Ponds, Productivity (agricultural), ...5.0805

CULTURE OF RED SWAMP CRAWFISH, PROCAMBARUS

CLARKI, IN BRACKISH WATER PONDS ...Aquaculture &

Fish-farming, Aquatic Ecology, Brackish Water, Crawfish, ...5.0432

CULTURE OF BLUE, CHANNEL, AND WHITE CATFISH IN

BRACKISH WATER PONDS ...Aquaculture & Fish-farming, Blue Catfish, White Catfish, Brackish Water, Channel Catfish, Louisiana, ...5.0806

THE DEVELOPMENT OF HATCHERY TECHNIQUES TO AID

IN THE PRODUCTION OF ECONOMIC MOLLUSKS ...Aquaculture & Fish-farming, Fish, Clams, Food Supply, Oysters, Stocking & Nesting Sites, ...5.0483

NUTRITION OF SQUID FISHERIES ...Diet Or Ration -other, in Vivo- in vitro, Feed Rations, Purified Diets, Salmon & Trout - Non-specific, ...5.0384

REAR AND DESCRIBE LARVAE OF BIVALVES ...Clams, Developmental Physiology, Freshwater Mussels, Scallopis, Inverte-

brate Culture, ...5.0807

EXPLORATORY COLLECTION AND CARE OF AQUATIC

INVERTEBRATES FOR TESTING AT TIBURON ...Clams, Invertebrates -non-specific, Performance -in vitro, Specific, ...5.0500

METHODS OF Rearing EGGS AND LARVAE TO JU-

VILE STAGES ...Aquaculture & Fish-farming, Environmental

Physiology, Fish -non-specific, Specificity -in vitro, Specificity -in vivo, ...5.0010

CULTURE OF SHELLFISH IN ARTIFICIAL AND NATURAL

SALT PONDS ...Growth Rate, Oysters, Ponds, Stocking of Fish & Shellfish, Streams, ...5.0444

ESTUARINE BIOLOGY - RESPONSE OF LARVAE TO TEM-

PERATURE AND SALINITY ...Alewife,menhaden,shad,herring, Estuaries, Longevity, Low Temp, out Above 32f, Maturi-

ty & Growth Stages, Water Salinity, ...8.0013

BEHAVIOR OF LARVAL FISHES ...Behavior, Commercial Fish-

ing, Environmental Physiology, Fish -non-specific, Maturity & Growth Stages, ...5.0402

131.116B - LARVAL CULTURE (SHRIMP AQUACULTURE

PROGRAM) ...Algal Culture, Aquaculture & Fish-farming, Environ-

mental Physiology, Food Supply, Shrimps - Common, ...5.0500

EXPERIMENTAL SEEDING (SHRIMP AQUACULTURE

PROGRAM) ...Florida, Population Dynamics, Shrimps -coho,chin-

ook,sockeye,..., Stocking of Fish & Shellfish, ...5.0401

JUVENILE AND ADULT CULTURE (SHRIMP AQUACUL-

TURE PROGRAM) ...Aquaculture & Fish-farming, Growth Rate, Ponds, Shrimps - Common, ...5.0501

FOOD AND EXPERIMENTAL ENVIRONMENTS (SHRIMP

AQUACULTURE PROGRAM) ...Aquaculture & Fish-farming, Digestive System, Food Supply, Shrimps - Common, Water En-

vironment -other, ...5.0405

INCREASE EFFICIENCY OF HAWAIIAN SKIPJACK FISHERY

...Commercial Fishing, Food Supply, Hawaii, Tuna, Mackerel, Albacore, ...5.0077

DETERMINE ALTERNATE LIVEBACI SPECIES ...Anchovies, Commercial Fishing, Food Supply, Hawaii, Tuna, Mackerel, Al-

bacore, ...5.0080

REARING MARINE FISH ...Alewife,menhaden,herring,herring, Anchovies, Environmental Physiology, Tuna, Mackerel, Al-

bacore, ...5.0144

Censusing

POPULATION STUDIES OF ANADROMOUS FISH - UPPER

COOK INLET DRAINAGES ...Alaska, Captive Rearing, Popu-

lation Dynamics, Salmon -coho,chinook,sockeye,..., Streams, ...5.0020

CREEL CENSUS OF SUMMER FLOUNDER SPORT FISHERY

IN GREAT BAY, NEW JERSEY ...Bays, LeFaye Flounders, Legislation, Life History Studies, New Jersey, ...5.0124

ESTIMATION OF PARAMETERS OF STRIPED BASS POPU-

LATION AND DESCRIPTION OF THE FISHERY OF LOWER

CHESAPEAKE BAY ...Age, Basses -sea,white, White Perch, Chesapeake Bay, Fishing Gear, Population Dynamics, ...5.0151

STUDY ON THE DISTRIBUTION AND ABUNDANCE OF

PINK SHRIMP, Pandalus JONANI, IN THE PACIFIC

OCEAN OFF OREGON ...Fishing Gear, Life History Studies, Pacific Ocean,general, Population Dynamics, Shrimps - Com-

mon, ...5.0487

ESTIMATE OF STANDING CROP OF OYSTERS AND SUR-

VEY OF OYSTER PREDATORS IN GEORGIA ...Georgia, Oysters, Predation, ...5.0416

EXPANSION OF CURRENT AND DEVELOPMENT OF ADDI-

TIONAL COMMERCIAL FISHERIES CATCH, PRODUC-

TION AND GEAR STATISTICS ...Alaska, Commercial Fish-

ing, Fish -non-specific, Fish -other, Reliability Theory, ...5.0018

PRE-EMERGENT FRY PINK SALMON FORECAST -

SOUTHEASTERN ALASKA ...Alaska, Aquatic Ecology, Number Or Density, Salmon -coho,chinook,sockeye,..., Shrimps &

Fish & Wildlife Biology

...8.0113

INVESTIGATION OF SPANNING GROUND POTENTIALS

AND GROWTH AND SURVIVAL OF JUVENILE SOCKEYE

SALMON IN FRAZER LAKE SYSTEM ...Alaska, Lakes, Nets, Salmon -coho,chinook,sockeye,..., Stocking & Nesting Sites, Tags, ...5.0190

KOCHIKA RIVER TOTAL SMOLT ...Alaska, Fish -non-specific, Migration, Mortality Rates, Nets, Population Dynamics, ...5.0002

KING CRAB SAMPLING GEAR STUDY ...Alaska, Crabs, Fishing Gear, Population Dynamics, Stocking & Nesting Sites, ...8.0011

COOK INLET ESCAPEMENT ENUMERATION STUDY ...

Alaska, Migration, Organism Sampling Devices, Salmon -

coho,chinook,sockeye,..., Sonar, Sonar and Echo Sounding, ...8.0112

SOCKEYE SALMON MIGRATORY BEHAVIOR AND

BIOLOGICAL STATISTICS COLLECTION, SOUTHEAST-

ERN ALASKA ...Alaska, Aquatic Ecology, Migration, Salmon -

coho,chinook,sockeye,..., Streams, ...5.0027

SOCKEYE SALMON MIGRATORY BEHAVIOR AND

BIOLOGICAL STATISTICS COLLECTION, SOUTHEAST-

ERN ALASKA ...Alaska, Aquatic Ecology, Behavioral Ecology, Migration, Salmon -coho,chinook,sockeye,..., ...5.0016

OFFSHORE LOBSTER FISHERY ...Commercial Fishing, Lob-

sters, Massachusetts, Nets, ...5.0453

513
**SUBJECT INDEX**

### Fish & Wildlife Biology

**MANAGEMENT OF OREGON DUNGEON CRAB RESOURCE** ...Crabs, Legislation, Life History Studies, Oregon, Tugs, 5.0487

**FINANCING OF FISHING VESSELS** ...Economics, Fish & Shellfish, Rhode Island, Savings and Investment, ...4.0185

**MANAGEMENT OF COLUMBIA RIVER COMMERCIAL FISHERY** ...Aquatic Ecology, Columbia River, Legislation, Salmon ...8.0185

**UPGRADING CONVENTIONAL FISHING TECHNIQUES** ...Fishing Gear, Nets, Pacific Ocean-north, Sonar, Telemetry, ...5.0130

**MARINE INVERTEBRATE EXPLORATIONS** ...Freshwater Mussels, Scallops, Pacific Ocean-general, Shrimps - Common, Temporal Distribution, Vertical Distribution, ...5.0733

**BOTTOMFISH EXPLORATIONS** ...Fish - other, Nets, Pacific Ocean-east, Vertical Distribution, ...5.0168

**DEVELOPMENT OF NEW FISHING TECHNIQUES** ...Diving and Scuba, Fishing Gear, Geomorphology-topography, Mark, Tag Or Capture - other, Photography, Telemetry, ...5.0145

**POTENTIAL OYSTER SETTING CAPACITY - LOCAL AREAS** ...Chesapeake Bay, Mark, Tag Or Capture - other, Oysters, Spawning & Nesting Sites, Streams, ...5.0445

**SURF CLAM POPULATION DYNAMICS** ...Age, Clams, Continental Shelf, Population Dynamics, Size, ...5.0473

**FISH POPULATION STUDY** ...Chemical Measurements - water, Fish - non-specific, Food Supply, Population Dynamics, Water Temperature-non-specific, ...5.0747

**COLLECTION, COMPIATION, AND ANALYSIS OF GULF CATCH STATISTICS AND LOGBOOK DATA** ...Alewife, menhaden, herring, Computer Methods - general, Fish Studies - other, ...5.0136

**SAMPLING OF THE ATLANTIC COMMERCIAL CATCH** ...Alewife, menhaden, herring, Atlantic Ocean-general, Nets, Number Or Density, ...5.0162

**HISTORICAL CHARTS AND INTERPRETATION OF CHANGES IN SEA SURFACE TEMPERATURE IN THE NORTH PACIFIC OCEAN** ...Air-sea Boundary-general, Altimeter-maps, Circulation-general, Pacific Ocean-north, Temperature, ...5.0179

**INVESTIGATE SEASONAL VARIATIONS, SURFACE WATER TYPES, HAWAIIAN AREA (KOKO HEAD)** ...Hawaii, Heat and Radiation Transfer, Oceanic Fronts, Salinity, Temperature, Tuna, Mackerel, Albacore, ... Water Salinity, Water Temperature-non-specific, ...5.0167

**LAKE ERIE INVESTIGATIONS - LIFE HISTORY AND ABUNDANCE OF THE YELLOW PERCH** ...Environmental Ecology, Life History Studies, Perch, Population Dynamics, Yellow Perch, Darters, ...5.0134

**FLUCTUATIONS IN SPECIES COMPOSITION AND YEAR-CLASS STRENGTH OF COMMERCIAL LANDINGS** ...Lake Erie, Lakes, Scales, Size, Species, Comparison of, ...5.0135

**CHARACTERISTICS OF LAKE SUPERIOR WHITEFISH** ...Invertebiotic Relat.(non-specific), Lake Superior, Life History Studies, Whitefish, ...5.0183

**ASSESSMENT OF LAKE SUPERIOR LAKE TROUT** ...Aquatic Ecology, Lake Trout, Brook Trout, Lampreys, Life History Studies, Lakes, ...5.0736

**BEHAVIOR OF LARVAL FISHES** ...Behavior, Captive Rearing, Environmental Physiology, Fish - non-specific, Maturity & Growth Stages, ...5.0622

**POPULATION DYNAMICS OF ATLANTIC TUNAS** ...Atlantic Ocean-general, Censusing, Population Dynamics, Tuna, Mackerel, Albacore, ...5.0655

**GREAT LAKES GEAR RESEARCH** ...Fish - non-specific, Fishing Gear, Great Lakes, Lakes, Population Dynamics, ...8.0136

**LAKE SUPERIOR E’LORATIONS** ...Lake Superior, Management - other, Nets, Smelt, Suckers, ...5.0106

**INTERRELATIONS WITHIN THE PHYSICAL ENVIRONMENT** ...Density, Environmental Ecology, Sea Level Variation, Temporal Distribution, ...5.0078

**OCEAN ENGINEERING - Bathymetry, Fishing Gear, Instrumental Services, Telemetry-other, ...5.0152

**FISHING GEAR RESEARCH AND DEVELOPMENT** ...Fishing Gear, Meetings, Nets, ...5.0153

**SHELLFISH EXPLORATIONS** ...Benthic Fauna, Clams, Mark, Tag Or Capture - other, Population Dynamics, ...5.0514
### Subject Index

**Fish & Wildlife Biology**

<table>
<thead>
<tr>
<th>MARINE FISH BEHAVIOR</th>
<th>Behavioral Ecology, Fish - non-specific, Behavior, Cognition, ...</th>
<th>5.0176</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXPLORATION OF LATENT RESOURCES</td>
<td>On the Continental Shelf, Oceanography, Marine Biology, ...</td>
<td>5.0456</td>
</tr>
<tr>
<td>CONTINENTAL SHELF/SLOPE</td>
<td>Atlantic Ocean-north, Continental Shelf, Nests, Survey Studies, ...</td>
<td>5.0102</td>
</tr>
<tr>
<td>TECHNICAL ASSISTANCE AND LIAISON WITH FISHING INDUSTRIES</td>
<td>Fishing Gear, Management - other, Market, Tag Or Capture - other, ...</td>
<td>11.0026</td>
</tr>
<tr>
<td>COD WRECKS ...</td>
<td>Fishing Gear, Nets, ...</td>
<td>8.0133</td>
</tr>
<tr>
<td>MECHANIZATION OF TRAWL GEAR</td>
<td>Fishing Gear, Safety, ...</td>
<td>8.0135</td>
</tr>
<tr>
<td>SEA CLAM EXPLORATIONS</td>
<td>Animal Dias - non-specific, Atlantic Ocean - north, Clams, Population Dynamics, ...</td>
<td>5.0456</td>
</tr>
<tr>
<td>PROCESSING KING CRAB</td>
<td>Crabs, Fish &amp; Shellfish, Fish Meals, Freezing, Organoleptic Studies, ...</td>
<td>5.0083</td>
</tr>
<tr>
<td>LOBSTER RESEARCH</td>
<td>Environmental Ecology, Habitat Studies, Lobsters, Population Dynamics, ...</td>
<td>5.0436</td>
</tr>
<tr>
<td>MARINE BIOLOGICAL INVESTIGATIONS</td>
<td>JAPANESE FISHERY RIVERS PROJECT</td>
<td>Gulf of Alaska, Japan, Nets, Righteye Flounders, ...</td>
</tr>
<tr>
<td>TECHNICAL ASSISTANCE TO INDUSTRY</td>
<td>Alaska, Diffusion of Information, Fishing Gear, General Information Services, ...</td>
<td>5.0031</td>
</tr>
<tr>
<td>OCEAN ENGINEERING</td>
<td>Alaska, Design, Machinery, Equipment, Large Gear, Shrimp, ...</td>
<td>5.0081</td>
</tr>
<tr>
<td>BERING SEA KING CRAB STUDIES</td>
<td>Bering Sea, Crabs, Environmental Ecology, Migration, ...</td>
<td>5.0341</td>
</tr>
<tr>
<td>COMMERCIAL BENEFIT STUDIES</td>
<td>Fish &amp; Shellfish, ...</td>
<td>6.0037</td>
</tr>
<tr>
<td>GROUNDFISH INVESTIGATIONS (POSSIBLE YIELD OF UNDEVELOPED GROUNDFISH STOCKS)</td>
<td>Codfishes, Hake, Legislation, Number Or Density, Rockfish, Scraonfish, ...</td>
<td>5.0171</td>
</tr>
<tr>
<td>ANALYSIS OF JAPANESE CATCH STATISTICS</td>
<td>Japan, Number Or Density, Pacific Ocean - north, Salmon - coho, chinook, sockeye, ...</td>
<td>5.0166</td>
</tr>
<tr>
<td>DROPOUT OF SALMON FROM GILL NETS</td>
<td>Management - other, Mortality Rates, Nets, Salmon &amp; Trout - Non-specific, Water Salinity, ...</td>
<td>5.0177</td>
</tr>
<tr>
<td>CONTAINERIZATION OF FISHERY PRODUCTS</td>
<td>Fish - other, Packaging, Processing, Shrimp, ...</td>
<td>6.0049</td>
</tr>
<tr>
<td>PROCESSING AND PRODUCT DEVELOPMENT OF EDIBLE FISH AND SHELLFISH</td>
<td>Fish &amp; Shellfish, ...</td>
<td>6.0047</td>
</tr>
<tr>
<td>GREAT LAKES EXPLORATIONS</td>
<td>Fish - non-specific, Fishing Gear, Great Lakes-general, Population Dynamics, ...</td>
<td>5.0108</td>
</tr>
<tr>
<td>SPACE APPLICATIONS TO FISHERIES OCEANOGRAPHY</td>
<td>Gulf of Alaska, Oceanography Program, Computer Applications, Forecasting-prediction, Satellites, Water Environment - other, ...</td>
<td>4.0172</td>
</tr>
<tr>
<td>PREDICTING COMMERCIAL SHRIMP ABUNDANCE (SHRIMP DYNAMICS PROGRAM)</td>
<td>- Bays, Behavioral Ecology, Environmental Ecology, Population Dynamics, Shrimps - Common, ...</td>
<td>5.0499</td>
</tr>
<tr>
<td>EVALUATION OF ENGINEERING PROJECTS AND ESTUARINE DATA (ESTUARINE PROGRAM)</td>
<td>- Engineering Structures-general, Estuaries, Gulf of Mexico, Habitat Studies, Swamps-marshes, ...</td>
<td>5.0021</td>
</tr>
<tr>
<td>POPULATION DYNAMICS (SHRIMP DYNAMICS PROGRAM)</td>
<td>Gulf of Mexico, Mortality Rates, Nets, Population Dynamics, Shrimps - Common, ...</td>
<td>5.0503</td>
</tr>
<tr>
<td>INCREASE EFFICIENCY OF HAWAIIAN SKIPJACK FISHERY</td>
<td>Captive Rearing, Food Supply, Hawaii, Tuna, Mackeral, Albacore, ...</td>
<td>5.0077</td>
</tr>
<tr>
<td>DETERMINE ALTERNATE LIVESTOCK SPECIES</td>
<td>Anchovies, Captive Rearing, Food Supply, Hawaii, Tuna, Mackeral, Albacore, ...</td>
<td>5.0080</td>
</tr>
<tr>
<td>INVESTIGATE POPULATION DYNAMICS OF ALBACORE (CAPTIVE REARING PROGRAM)</td>
<td>- American Samoa, Population Dynamics, Tuna, Mackeral, Albacore, ...</td>
<td>5.0082</td>
</tr>
<tr>
<td>ASSESSMENT OF CENTRAL PACIFIC TUNA RESOURCES</td>
<td>Pacific Ocean - general, Population Dynamics, Sites, Tuna, Mackeral, Albacore, ...</td>
<td>5.0084</td>
</tr>
<tr>
<td>DEVELOP HIGH-SEA TUNA FISHERY</td>
<td>Fishing Gear, Pacific Ocean - general, Tropic, Tuna, Mackeral, Albacore, ...</td>
<td>5.0096</td>
</tr>
<tr>
<td>INVESTIGATE TUNA RESOURCES OF THE TRUST TERRITORIES</td>
<td>Caroline Islands, Environmental Ecology, Population Dynamics, Tuna, Mackeral, Albacore, ...</td>
<td>5.0082</td>
</tr>
<tr>
<td>DEVELOP FISHERIES FOR NON-TUNA RESOURCES</td>
<td>Fishing Gear, Hawaii, Pacific Ocean - general, Snappers, ...</td>
<td>5.0086</td>
</tr>
<tr>
<td>INCREASE EFFICIENCY OF HAWAIIAN LONGLINE FISHERY</td>
<td>- Fish &amp; Shellfish, Fishing Gear, Hawaii, Production &amp; Processing, Technic Development, Technological Development, ...</td>
<td>11.0026</td>
</tr>
<tr>
<td>LOCAL FISHERY SYSTEMS DEVELOPMENT</td>
<td>California, Sharks, Shrimps - Common, Swordfish, ...</td>
<td>5.0198</td>
</tr>
<tr>
<td>INVESTIGATE POPULATION DYNAMICS OF SKIPPACK TUNA IN HAWAIIAN WATERS</td>
<td>Economics, Environmental Ecology, Hawaii, Population Dynamics, Tuna, Mackeral, Albacore, ...</td>
<td>5.0083</td>
</tr>
<tr>
<td>NORTHERN SHRIMP EXPLORATIONS</td>
<td>- Atlantic Ocean-north, Censusing, Fishing Gear, Shrimps - Common, ...</td>
<td>5.0457</td>
</tr>
<tr>
<td>149A FISHERY SYSTEMS ANALYSIS</td>
<td>California, Nets, Production &amp; Processing, Simulation, Tuna, Mackeral, Albacore, ...</td>
<td>4.0175</td>
</tr>
<tr>
<td>TUNA PURSE SEINE NET</td>
<td>Fishing Gear, Nets, Tuna, Mackeral, Albacore, ...</td>
<td>8.0119</td>
</tr>
<tr>
<td>SUBPOPULATIONS</td>
<td>Anchovies, Pacific Ocean - general, Population Dynamics, ...</td>
<td>5.0042</td>
</tr>
<tr>
<td>DEVELOPMENT OF FISHERY BATHYKROMOGRAPH</td>
<td>Fishing Gear, Instrumental Services, Nets, Readout Systems, ...</td>
<td>5.0085</td>
</tr>
<tr>
<td>CTFM SONAR</td>
<td>Behavioral Ecology, Locomotion - animal, Sonar and Echo Sounding, Telemetry, Tuna, Mackeral, Albacore, ...</td>
<td>4.0172</td>
</tr>
<tr>
<td>MULTISPECIES FISHERIES MODELS</td>
<td>California, Economics, Model Studies, Oceanic - Pelagic, Pacific Ocean - east, Production &amp; Processing, ...</td>
<td>4.0065</td>
</tr>
<tr>
<td>OCEANOGRAPHIC STUDY OF NORTHEASTERN U. S. COASTAL WATERS FOR INTERNATIONAL COMMISSION FOR NORTHWEST ATLANTIC FISHERIES</td>
<td>... Gases, Salinity, Ships and Cruises, Temperature, ...</td>
<td>4.0123</td>
</tr>
<tr>
<td>Control of Nuisance Species</td>
<td>...</td>
<td>4.0172</td>
</tr>
<tr>
<td>SHARK RESEARCH</td>
<td>- Fish Repellents, Sharks, Tags, Temporal Distribution, ...</td>
<td>5.0047</td>
</tr>
<tr>
<td>BIOLOGY OF THE LARVAL SEA LAMPMIRE</td>
<td>Developmental Physiology, Environmental Ecology, Great Lakes-general, Lampreys, Life History Studies, ...</td>
<td>5.0631</td>
</tr>
<tr>
<td>NATURAL HISTORY OF PREDATORS AND COMPETITORS (PREDATOR CONTROL PROGRAM)</td>
<td>Behavioral Ecology, Competition, Environmental Ecology, Oysters, Predation, ...</td>
<td>5.0377</td>
</tr>
<tr>
<td>METHODS OF CONTROL OF PREDATORS AND COMPETITORS (PREDATOR CONTROL PROGRAM)</td>
<td>- Competition, Guttropods - slugs, conch, snails, Oysters, Predation, ...</td>
<td>5.0378</td>
</tr>
<tr>
<td>EFFECTS OF CHEMICALS ON THE PHYSIOLOGY OF SEA LAMPMIRE AMMOCETES (PETROMYZON MARINUS)</td>
<td>- Contamination - Water, Environmental Physiology, Lampreys, Maturity &amp; Growth Stages, ...</td>
<td>5.0631</td>
</tr>
<tr>
<td>LAKE SUPERIOR CHEMICAL CONTROL OF SEA LAMPMIRE</td>
<td>Aquatic Ecology, Lake Superior, Lampreys, Larvicides, Streams, ...</td>
<td>5.0628</td>
</tr>
<tr>
<td>LAKE MICHIGAN CHEMICAL CONTROL OF SEA LAMPMIRE</td>
<td>Animal Pollutant Sources, Evaluation, Lake Michigan, Lampreys, Larvicides, ...</td>
<td>5.0628</td>
</tr>
<tr>
<td>SEA LAMPMIRE AMMOCETE REESTABLISHMENT STUDIES</td>
<td>Aquatic Ecology, Great Lakes-general, Lampreys, Larvicides, Life History Studies, Population Dynamics, ...</td>
<td>5.0629</td>
</tr>
<tr>
<td>ELECTRIC BARRIER OPERATIONS</td>
<td>- Lake Michigan, Lake Superior, Lampreys, Migration, Population Dynamics, ...</td>
<td>5.0630</td>
</tr>
</tbody>
</table>

**Fish & Wildlife Biology**

| FISHES - OTHER \  \ Collection, compilation, and analysis of Gulf Catch Statistics and Logbook data | - Alewife, menhaden, shad, herring, Commercial Fishing, Computer Methods - general, ... | 5.0126 |
| FISHERY DEVELOPMENT - OTHER | - Sportfish Yield of Natural Reefs, ... | 5.0199 |
| EVALUATION, COORDINATION, AND PLANNING OF PACIFIC SALMON AND STEELHEAD RESEARCH AND MANAGEMENT ACTIVITIES | - Commercial Fishing, Management - other, Meetings, Rainbow Trout, Steelhead Trout, Salmon - coho, chinook, sockeye, ... | 5.0140 |
| FILM PROJECT (KELP FORESTS) | California, Cinematography, Habitat Studies, Laminariaceae (non-specific & other), ... | 5.0678 |
| THE ROLE OF THE SENORITA, OXYJULIS CALIFORNICA, AS A CLEANING ORGANISM | California, Ectoparasites, Fish - other, Interbiotic Relat.(non-specific), ... | 5.0193 |
SUBJECT INDEX

Fish & Wildlife Biology

Food Supply
THE STATUS AND POTENTIAL OF AQUACULTURE...Algal Culture, Aquaculture & Fish-farming, Fish -non-specific, Survey Studies,...5.0003

OYSTER SATNESS STUDY...Aquaculture & Fish-farming, Fats - Lipids & Oils, Growth Rate, Invertebrate Nutrition, Oysters,...5.0012

DETERMINATION OF THOSE MARINE SPECIES HAVING THE GREATEST KNOWN POTENTIAL FOR THE COMMERCIAL FISHERY...Ag Uses of Nat, resource-other, Alginates, Commercial Fishing, Fucus, Phaeophyta (non-specific & Or),...5.0009

FOOD HABIT STUDY OF ORGANISMS OF THE CALIFORNIA VIA CURRENT SYSTEM...Behavioral Ecology, California, California Current, Pacific Ocean-general,...5.0004

CULTURE OF PELAGIC IN BRACKISH WATER PONDS...Aquaculture & Fish-farming, Brackish Water, Louisiana, Pompanos, Scads, Jacks, Stocking of Fish & Shellfish,...8.0004

THE DEVELOPMENT OF HATCHERY TECHNIQUES TO AID IN THE PRODUCTION OF ECONOMIC MOLLUSKS...Aquaculture & Fish-farming, Captive Rearing, Clams, Oysters, Spawning & Nesting Sites,...5.0083

INFLUENCE OF UNLIMITED FOOD SUPPLY ON RHYTHMIC ACTIVITY OF BLUEFISH...Biological Rhythms, Bluefish, Predation,...5.0012

FISH POPULATION STUDY...Chemical Measurements -water, Commercial Fishing, Fish -non-specific, Population Dynamics, Water Temperature-non-specific,...5.0014

CHUM SALMON INVESTIGATIONS...Environmental Ecology, Eutrophies, Growth Rate, Life History Studies, Number Or Density, Salmon -coho,chinook,sockeye,...5.0007

INTEREST OF SMELT AS WILD NATIVE SPECIES...Competition, Lake Superior, Life History Studies, Number Or Density, Smelts,...5.0102

FEEDING HABITS OF ATLANTIC TUNAS AND NEKTON ECOLOGY...Atlantic Ocean-general, Plankton (non-specific), Food Productivity - Food Chain, Tuna, Mackerel, Albacore,...5.0008

RESEARCH ON THE MACROBENTHOS OF THE GREAT LAKES...Aquatic Ecology, Benthic Fauna, Earthworms, Great Lakes, Water Quality-general,...5.0012

INPEC BIOLOGICAL OCEANOGRAPHY...PHYTOPLANKTON AND ZOOPLANKTON RESEARCH...Pacific Ocean,...5.0043

131.116B - LARVAL CULTURE (SHRIMP AQUACULTURE PROGRAM)...Algal Culture, Aquaculture & Fish-farming, Captive Rearing, Environmental Physiology, Shrimps - Common, Common,...5.0500

BIOLOGICAL OCEANOGRAPHY (GULF OCEANOGRAPHY PROGRAM)...Environmental Ecology, Gulf of Mexico, Productivity - Food Chain, Shrimps - Common,...5.0038

FOOD AND EXPERIMENTAL ENVIRONMENTS (SHRIMP AQUACULTURE PROGRAM)...Aquaculture & Fish-farming, Captive Rearing, Digestive System, Shrimps - Common, Water Environment,...5.0005

DESIGN AND DEVELOPMENT OF NEKTON SAMPLER...Nektonic - Swimming, Organism Sampling Devices, Plankton Sampling, Tuna, Mackerel, Albacore,...5.0007

ECOLOGY AND TAXONOMY OF TROPICAL ATLANTIC SCOMBRID EGGS AND LARVAE...Animal Distri- (non-specific), Animal Taxonomy, Basic Embryology, Life History Studies,...5.0012

INCREASE EFFICIENCY OF HAWAIIAN SKIPJACK FISHERY...Captive Rearing, Commercial Fishing, Hawaii, Tuna, Mackerel, Albacore,...5.0077

DETERMINE ALTERNATE LIVEBATE SPECIES...Anchoives, Captive Rearing, Commercial Fishing, Hawaii, Tuna, Mackerel, Albacore,...5.0080

PHYSIOLOGY OF MARINE ORGANISMS...Energy, Environmental Physiology, Fish -non-specific,...5.0039

FEEDING BEHAVIOR...Alewife,menhaden,shad,hering, Anchoi- ves, Behavior, Environmental Physiology, Sensory Organs,...5.0004

SCRIPPS TUNA OCEANOGRAPHY RESEARCH PROGRAM...Pacific Ocean-east, Temperature, Tropic, Tuna, Mackerel, Albacore,...5.0005

EFFECTS OF HIGH TEMPERATURE, LIPID OXYGEN, AND PH EXPOSURES ON THE SURVIVAL OF AQUATIC INSECTS AND CRUSTACEA IMPORTANT AS TROUT FOOD...Aquatic Ecology, Eggs, Dissolved -water, High Temp., Or Above, Lake Superior, Ph, Acidity -water,...5.0044

517

Legislation
CREEL CENSUS OF SUMMER FLounder SPORT FISHERY IN GREAT BAY, NEW JERSEY...Boys, Censusing, Lefteye Flounders, Life History Studies, New Jersey,...5.0142

IDENTIFICATION OF WINTER FLounder SUBPOPULATION...Commercial Fishing, Nets, Population Dynamics, Righteye Flounders, Tags,...5.0106

SHELLFISH AND BOTTOMFISH DATA... Commercial Fishing, Crabs, Fish -other, Shrimps - Common,...5.0037

COASTAL LOBSTER FISHERY...Censusing, Commercial Fishing, Lobsters, Massachusetts,...5.0042

SHELLFISHERIES...Censusing, Commercial Fishing, Crustacea - non-specific, Mollusks - non-specific & Other,...5.0012

MANAGEMENT OF THE OREGON TRAWL FISHERY...Censusing, Commercial Fishing, Nets, Oregon, Rockfish, Scup-whiting,...5.0145

MANAGEMENT OF OREGON DUNGENESS CRAB RESOURCE... Commercial Fishing, Crabs, Life History Studies, Oregon, Tags,...5.0049

MANAGEMENT OF COLUMBIA RIVER COMMERCIAL FISHERY...Aquatic Ecology, Columbia River, Commercial Fishing, Salmon -coho,chinook,sockeye,...5.0015

GROUNDFISH INVESTIGATIONS (POTENTIAL YIELD OF UNDERUTILIZED GROUNDFISH STOCKS)...Codfishes, Hake, Commercial Fishing, Number Or Density, Rockfish, Scup-whiting,...5.0171

Management -other
LIFE HISTORY STUDY OF THE MOL POLYDACTYLCUS SEX-FILIS...Aquatic Ecology, Fish -other, Life History Studies, Tags,...5.0037

SEA SLED AND SCUBA RECONNAISSANCE OF INSHERE AND STUDIES ON EFFECT OF ARTIFICIAL SHELTERS ON STANDING CROP OF FISHES...Coastlines-shorelines, Diving and Scuba, Fish -non-specific, Geomorphology-topograph- istry, Hawaii,...5.0008

SILVER SALMON STUDIES IN THE RESURRECTION BAY AREA...Alaska, Aquatic Ecology, Bays, Environmental Ecology, Salmon -coho,chinook,sockeye,...5.0019

MANAGEMENT INVESTIGATIONS OF TWO SPECIES OF SPINY LOBSTERS PANULIRUS JAPONICUS AND P. PENICILLATUS...Captive Rearing, Commercial Fishing, Lobsters, Tags,...5.0042

LIFE-HISTORY AND BIOLOGICAL WORK IN THE RESTORATION AND MANAGEMENT OF SPECIES OF IMPORTANCE TO THE FISHERIES OF THE VIRGIN ISLANDS...Commercial Fishing, Diving and Scuba, Life History Studies, Population Dynamics, Virgin Islands,...5.0149

STREAM IMPROVEMENT PLANNING...Benefit-cost Analysis, Engineering, Structures-general, Fish -non-specific, Planning, Streams,...5.0020

EVALUATION, COORDINATION, AND PLANNING OF PACIFIC SALMON (SHAD, STEELHEAD) RESEARCH AND MANAGEMENT ACTIVITIES...Commercial Fishing, Development -other, Meetings, Rainbow Trout, Steelhead Trout, Salmon -coho,chinook,sockeye,...5.0140

MEASUREMENT OF SPAVING SUCCESS AND FRY QUALITY OF CHUM SALMON UTILIZING A SPAWNING CHANNEL AT BIG BEEF CREEK, WASHINGTON...Number Or Density, Quality -non-specific, Salmon -coho,chinook,sockeye,...5.0029

INVENTORY SURVEYS OF OREGON COASTAL STREAMS...Oregon, Rainbow Trout, Steelhead Trout, Salmon & Trout - Non-specific, Spawning & Nesting Sites, Streams,...5.0017

INVENTORY AND AATLAS OF GULF COAST SPORT FISHING FACILITIES...Atlas-maps, Fishing, Gulf of Mexico, Handbooks,...5.0006

RACIAL STUDIES OF HERRING...Alewife,menhaden,shad,hering, Animal Taxonomy, Atlantic Ocean-north, Biochemical Analysis, Blood Typing Studies,...5.0065

COLLECTION OF JUVENILE MIGRANTS FROM RIVERS AND STREAMS...Electric Power Plants, Engineering Structures-general, Fish -non-specific, Migration, Streams,...5.0013

ADULT MIGRATION RATES...Columbia River, Environmental Ecology, Migration, Pre-impoundment Sites, Salmon -coho,chinook,sockeye,...5.0017

LAKE SUPERIOR EXPLORATIONS...Commercial Fishing, Lake Superior, Nets, Smelts, Suckers,...5.0010

TECHNICAL ASSISTANCE AND LIAISON WITH FISHING INDUSTRIES...Commercial Fishing, Fishing Gear, Mark, Tag Or Capture -other,...11.0026
SUBJECT INDEX

Fish & Wildlife Biology

EPIDERMAL PAPILLOMAS IN PLEURONECTID FISHES ...Cancer, Papillomas of Animals, Puget Sound, Righteye Flounders ...5.0314

EPIZootICS IN EXPERIMENTAL MARINE SHELLFISH POPULATIONS ...Epizootic, Freshwater Mussels, Scallops, Mortality Rates, Oysters ...5.0220

STUDIES ON THE PROTEST: ...CAUSING MALPEQUE DISEASE ...Invertebrate Pathology, Myxomyces, Oysters, Plant Taxonomy, Range Or Territorial Dist ...5.0498

STUDIES ON THE DEVELOPMENT OF DERMOCYSTID MARMARUS ...Cell Cycle, Control and Prevention, Dermocystidium, Fungal Culture, Oysters ...5.0386

Stacking of Fish & Shellfish

INVESTIGATE THE FEASIBILITY OF INTRODUCING SOCKEYE SALMON INTO RESEVOIRS ...Aquatic Ecology, Captive Rearing, Oregon, Reservoirs and Impoundments, Salmon -coho,chinook,sockeye ...5.0314

INTRODUCTION OF MARINE GAME FISHES FROM AREAS IN THE PACIFIC ...Driving and Scuba, Hawaii, Pacific Ocean-north, ...5.0075

CHARTING OF SUBTIDAL OYSTER BEDS AND EXPERIMENTAL TRANSPLANTING OF SEED OYSTERS FROM POLLUTED SEED OYSTER BEDS ...Captive Rearing, Commercial Fishing, Estuaries, Oysters, South Carolina ...8.0011

PURCHASE OF MATERIALS FOR & CONSTRUCTION OF, FLOATS, RACKS, BAGS, AND TRAYS FOR THE SUSPENSION OF VARIOUS TYPES OF CULTCH - Biological Rhythms, Derivatives, Equipment Purchase Operation, Oysters, Spawning & Nesting Sites ...8.0008

STOCKING AND SURVIVAL OF STRIPED BASS FINGERLINGS ...Alabama, Basses -sea,white, White Perch, Commercial Fishing, Maturity & Growth Stages, Streams ...5.0001

COPPER RIVER SOCKEYE SALMON INVESTIGATIONS ...Alaska, Aquatic Ecology, Biological Rhythms, Migration, Population Dynamics, Salmon -coho,chinook,sockeye ...5.0025

THE PURCHASE AND INTRODUCTION OF BROOD STOCK ...Low Temp. -but Above 32f, Oysters, Ponds, Spawning & Nesting Sites, Warm Water ...8.0026

THE PURCHASE AND INTRODUCTION OF CULTCH MATERIALS ...Development,l Physiology, Oysters, Ponds, Spawning & Nesting Sites, ...8.0009

SAMPLING OF MARKED COHO ...-tag-using, Columbia River, Mark, Tag Or Capture -other, Number Or Density, Salmon -coho,chinook,sockeye ...5.0162

REPOPULATION OF DECIMATED SECTIONS OF WARM-WATER STREAMS BY LONGEAL SUNFISH, LEPOMIS MEGALOTIS (RAFINESQUE) ...Aquatic Ecology, Population Dynamics, Streams, Sunfish, Rock & Roanoke Bass ...Warm Water ...5.0097

CULTURE OF POMPANO IN BRACKISH WATER PONDS ...Aquadulture & Fish-farming, Brackish Water, Food Supply, Louisiana, Pompanos, Scads, Jacks ...5.8004

CULTURE OF SHELFISH IN ARTIFICIAL AND NATURAL SALT PONDS ...Captive Rearing, Growth Rate, Oysters, Ponds, Streams ...5.8044

EXPERIMENTAL SEEDING (SHRIMP AQUACULTURE PROGRAM) ...Captive Rearing, Florida, Population Dynamics, Shrimps - Common, Spawning & Nesting Sites ...5.8051

Tags

SHARK RESEARCH ...Control of Nuisance Species, Fish Repellents, Shark's, Tarpon, Ex-ribution ...5.0047

LIFE HISTORY STUDY OF THE MOL, POLYDACTYLYUS SEX-FILIS ...Aquatic Ecology, Fish -other, Life History Studies, Management -other ...5.0027

TAGGING ENGLISH SOLE, PETSOLE, SOLE, AND PACIFIC COD ...Codfishes, Hake, Commercial Fishing, Migration, Righteye Flounders, Size, Washington ...5.0158

TAG DETECTION ...Commercial Fishing, Number Or Density, Puget Sound, Salmon -coho,chinook,sockeye ...Streams ...5.0148

TAG LOSS ...Captive Rearing, Salmon -coho,chinook,sockeye ...Size, Washington, Weight ...5.0157

IDENTIFICATION OF WINTER FLOUNDER SUBPOPULATIONS ...Commercial Fishing, Legislation, Nets, Population Dynamics, Righteye Flounders ...5.0100

MANAGEMENT INVESTIGATIONS OF TWO SPECIES OF SPICY LOBSTERS PANULIRUS JAPONICUS AND P. PENICILLATUS ...Captive Rearing, Commercial Fishing, Lobsters, Management -other ...5.8042
Fish & Wildlife Biology

SUBJECT INDEX

PINK SALMON INVESTIGATIONS - INTERTIDAL ECOLOGY ...Alaska, Life History Study, Salmon -coho,chinook,sockeye... Tidal Streams, Water Salinity, ...5.0186

INVESTIGATE SYSTEMATICS AND ECOLOGY OF TUNA LARY, ANIMAL TAXONOMY, ARTIFICIAL SEED PRODUCTION, NUMBER & Density, Tests, Water Quality, ...5.0178

ALASKA, Animal Taxonomy, Artificial Insemination, Maturity & Growth Stages, Tuna, Mackeral, Al-bacore.......5.0079

PINK SALMON INVESTIGATIONS - FRESHWATER ECOLOGY ...Alaska, Aquatic Ecology, Salmon -coho,chinook,sockeye... Streams, Water Properties-general, ...5.0185

EXPERIMENTAL FEEDING (SHRIMP AQUACULTURE PRO-GRAM) ...Captive Rearing, Florida, Population Dynamics, Shrimps - Common, Stocking of Fish & Shellfish, ...5.0501

TELEMETRY STUDIES ON MARINE BIRDS ...Albatrosses, Shearwaters, ...Bermuda, Mark, Tag Or Capture -other, Pelmiscs Cormorants,dtarters....5.0531

Fish Repellents

SHARK RESEARCH ...Control of Nuance Species, Sharks, Tags, Temporal Distribution, ...5.0047

BEHAVIOR AND SENSORY PHYSIOLOGY OF SHARKS ...Au-ditory, Behavioral Ecology, Sharks, Tape Recording, Audio Visual Organs, ...5.0253

STUDIES OF SHARK REPELLENTS AND OTHER ANTI-SHARK MEASURES ...Shark Repellents, Sharks, ...5.0132

ELASMOBRANCH TOXINS ...Drug Evaluation, Mechanism of Action, Sharks, ...5.0119

MARINE ANIMAL TOXINS ...Mechanism of Action, Sharks, Toxins, ...5.0116

Fishing Gear

DESIGN STUDY - AN OPTIMUM FISHING VESSEL FOR THE GEORGES BANK GROUND FISHERY ...Atlantic Ocean-north, Commercial Fishing, Computer Applications, Naval Architecture-general, Other-design-and-construction, ...5.0188

ESTIMATION OF PARAMETERS OF STRIPPED BASS POPULA- TION, DESCRIPTION OF THE FISHERY OF LOWER CHEAPEAKE BAY ...Age, Bases -sea,white, White Perch, Censusing, Chesapeake Bay, Population Dynamics, ...5.0130

STUDY ON THE DISTRIBUTION AND ABUNDANCE OF PINK SHRIMP, PANDALUS JORDANI, IN THE PACIFIC OCEAN OFF OREGON ...Censusing, Life History Studies, Pacific Ocean-general, Population Dynamics, Shrimps - Common, ...5.0487

MARINE LABORATORY ...Laboratory Analysis, Louisiana, Nets, Organism Sampling Devices, Technique Development, ...5.0124

PRELIMINARY TESTING OF PELAGIC TRAWLS ON SMALL DRAGGERS ...Barges-towboats, Nets, Oceanic - Pelagic, ...5.0143

KING CRAB SAMPLING GEAR STUDY ...Alaska, Censusing, Crabs, Population Dynamics, Spawning & Nesting Sites, ...5.0113

MANAGEMENT OF THE OCEAN SALMON FISHERY WITH AN EMPHASIS ON THE BARBLESS HOOKS AS A MECHANISM TO OVERCOMEuntary Fishing, Salmon -coho,chinook,sockeye....5.0142

OPERATIONAL TESTING OF THE PELAGIC TRAWLS ON SMALL DRAGGERS ...Nets, ...5.0144

FISH POPULATION ON THE ISLAND OF TUTULIA, AMER- ICAN SAMOA ...American Samoa, Animal Taxonomy, Commercial Fishing, Fish -non-specific, Number Or Density, ...5.0302

FISH POPULATIONS OF AMERICAN SAMOA ...American Samoa, Crustaceans -non-specific, Fish -non-specific, Number Or Density, ...5.0033

GEAR EVALUATION ...American Samoa, Fish -non-specific, Nets, ...5.0114

WEIR, TRAP AND F TINE FISHERY ...Censusing, Commercial Fishing, Massachusetts, Nets, ...4.0010

FORECAST OF KODIAK ISLAND PINK SALMON RUNS FROM JUVENILES IN ESTUARIES ...Alaska, Estuaries, Maturity & Growth Stages, Migration, Number Or Density, Salmon -coho,chinook,sockeye....3.0179

UPGRADING CONVENTIONAL FISHING TECHNIQUES ...Commercial Fishing, Nets, Pacific Ocean-north, Sonar, Telemetry, ...5.0105

DEVELOPMENT OF NEW FISHING TECHNIQUES ...Commer- cial Fishing, Diving and Scuba, Geomorphology-topography, Mark, Tag Or Capture -other, Photography, Telemetry, ...5.0151

BRISTOL BAY ESTUARINE ECOLOGY ...Alaska, Estuaries, Life History Studies, Migration, Oceanic Fronts, Salmon -coho,chinook,sockeye....8.0004

GREAT LAKES GEAR RESEARCH ...Commercial Fishing, Fish -non-specific, Great Lakes-general, Lakes, Population Dynam- ics, ...5.0136

OCEAN ENGINEERING ...Bathymetry, Commercial Fishing, In- strumental Services, Telemetry-other, ...5.0152

FISHING GEAR RESEARCH AND DEVELOPMENT ...Com- mercial Fishing, Meetings, Nets, ...5.0153

MARINE FISH BEHAVIOR ...Behavioral Ecology, Commercial Fishing, Fish -non-specific, ...5.0176

TECHNICAL ASSISTANCE AND LIAISON WITH FISHING IN- DUSTRIES ...Commercial Fishing, Management -other, Mark, Tag Or Capture -other, ...5.0108

TRAWL DESIGN, MATERIALS AND METHODS ...Commercial Fishing, Nets, ...5.0133

MECHANIZATION OF TRAWL GEAR ...Commercial Fishing, Safety, ...5.0135

TECHNICAL ASSISTANCE TO INDUSTRY ...Alaska, Commer- cial Fishing, Diffusion of Information, General Information Ser- vices, ...5.0031

OCEAN ENGINEERING ...Alaska, Commercial Fishing, Design, Machinery, Equipment, Shrimp, ...5.0349

GREAT LAKES EXPLORATIONS ...Commercial Fishing, Fish -non-specific, Great Lakes-general, Population Dynamics, ...5.0108

DEVELOP HIGH-SEAS TUNA FISHERY ...Commercial Fishing, Pacific Ocean-general, Tropic, Tuna, Mackeral, Albacore,...5.0046

DEVELOP FISHING GEAR FOR NON-TUNA RESOURCES ...Com- mercial Fishing, Hawaii, Pacific Ocean-general, Snappers, ...5.0045

INCBBREASE EFFICIENCY OF HAWAIIAN LONGLINE FISHERY ...Commercial Fishing, Fish & Shellfish, Hawaii, Production & Processing, Technique Development, Technologi- cal Development, ...5.0122

NORTHERN SHRIMP EXPLORATIONS ...Atlantic Ocean-north, Censusing, Commercial Fishing, Shrimps - Common, ...5.0457

TUNA PURSE SEINE NETWORK ...Commercial Fishing, Nets, Tuna, Mackeral, Albacore,...5.0119

DEVELOPMENT OF FISHNET BATHYKROMOGRAPH ...Com- mercial Fishing, Instrumental Services, Nets, Readout Systems, ...5.0102

Flame Research

Combustion

Combustion Products

COMBUSTION OF RESIDUAL FUEL WITH MASSIVE RECIRCULATION ...Alleys, Atmospheric, Gas, Fuels, ...5.0026

A PILOT PLANT STUDY OF LOW EXCESS AIR COMBUSTION - ITS EFFECT ON FIRESIDE PROBLEMS IN OIL FIRED BOILERS ...Boilers, Combustion-other, Fuels, Main- tenance-system, ...5.0168

Combustion-other

A PILOT PLANT STUDY OF LOW EXCESS AIR COMBUSTION - ITS EFFECT ON FIRESIDE PROBLEMS IN OIL FIRED BOILERS ...Boilers, Combustion Products, Fuels, Main- tenance-system, ...5.0168

UNDERSEA PROPULSION AND POWER SOURCES ...Batte- ries, Generators, Marine Propulsion, ...5.0166

Florida

DEVELOPMENT OF TECHNIQUES FOR THE AQUACUL- TURE OF POMPANO ...Aquaculture & Fish-farming, Environ- mental Physiology, Mortality & Growth Stages, Pathology, Tuna, Mackeral, Albacore,...5.0007

AN ECOLOGICAL STUDY OF SOUTH BISCAYNE BAY IN THE VICINITY OF TURKEY POINT ...Applied Ecology,
Fluid Mechanics

Models, Optical, Optical Systems, Watersheds, Waves, ...2.0124

EXPERIMENTAL HYDRODYNAMICS ...Heat and Radiation Transfer, Hydrodynamics, Simulation Theory, Submembranes, Thermoclines, ...8.0161

HYDRODYNAMIC EFFECTS OF SUBMERGED BODY ...Airsea Boundary General, Model Studies, Theoretical Analysis, Water Tunnels Tables, ...8.0179

Body Theory

Drag

VISCO-ELASTIC DYNAMIC VIBRATION ABSORBER ...A study of, Close Channel, Energy Dissipators, Hydraulic Equipment, Vibration Systems-other, Viscous, ...8.0188

AN EXPERIMENTAL INVESTIGATION OF PARTIALLY SHROUDED POPPELLERS ...Control-systems, Lift, Marine Propulsion, Rotors-propellers, ...8.0305

PRELIMINARY CALCULATION OF THE LIFT AND DRAG AND ANGLE OF ATTACK FOR SUBMERGED HYDROFOILS ...Computer Applications, Hydrofoils, Lift, ...8.0278

MODEL FOR THE PRELIMINARY DESIGN OF SURFACE EFFECT SHIPS ...Computer Applications, Hydrofoils, Marine Propulsion, Other Models, Ships and Cruises, Waves, ...8.0279

Lift

AN EXPERIMENTAL INVESTIGATION OF PARTIALLY SHROUDED POPPELLERS ...Control-systems, Drag, Marine Propulsion, Rotors-propellers, ...8.0305

PRELIMINARY CALCULATION OF THE LIFT AND DRAG AND ANGLE OF ATTACK FOR SUBMERGED HYDROFOILS ...Computer Applications, Drag, Hydrofoils, ...8.0278

Boundary Layer

Boundary-layer-other

THERMALLY SUSTAINED PRESSURE OSCILLATIONS IN LIQUID HELIUM APPARATUS ...Boiling & Evaporation, Conduction, Engineering Studies-general, Heat-transfer-other, Model Apparatus-other, Pressure Gradient, ...8.0025

Laminar - Turbulent

A STUDY OF PROBLEMS RELATED TO WIND-GENERATED W/ WES ...Free Surface Waves, Theoretical Analysis, Waves, Wind-water Interaction, ...9.0038

EXPERIMENTAL FLUID DYNAMICS ...Model Studies, Rotating Fluids, Shear-flow, Thermodynamics, Wind-water Interaction, ...3.0021

Noise

TURBULENCE STRUCTURE AND NOISE STUDY ...Additives, Turbulent, ...1.0002

Non-steady Flow

COMPUTATION OF PERIODIC POPPELLER FORCES IN NON-UNIFORM FLOWS USING A LIFTING SURFACE MODEL ...Dimension-three, Marine Propulsion, Models, Rotors-propellers, Turbulent, ...8.0180

Pressure Gradient

THERMALLY SUSTAINED PRESSURE OSCILLATIONS IN LIQUID HELIUM APPARATUS ...Boiling & Evaporation, Boundary-layer-other, Conduction, Engineering Studies-general, Heat-transfer-other, Model Apparatus-other, ...8.0024

DETERMINATION OF FLOW IN AN AXIAL-TO-RADIAL DIFFUSER WITH SWIRL ...Configuration of Body, Impinging Jets, Model Apparatus-other, Rotors-propellers, Static, ...8.0187

Cavitation

Cavity Flow

VARIABLE PRESSURE WATER TUNNEL RESEARCH ...Facilities, Hydrofoils, Marine Propulsion, Shock-vibration, Sound Field, Water Tunnels Tables, ...8.0183

UNSTEADY TWO-DIMENSIONAL CAVITY FLOWS ...Boundary Problems, Concept, Dimension-two, Model Apparatus-other, Unsteady, ...8.0186

Sound Field

VARIABLE PRESSURE WATER TUNNEL RESEARCH ...Cavity Flow, Facilities, Hydrofoils, Marine Propulsion, Shock-vibration, Water Tunnels Tables, ...8.0183

Ventilated Cavities

EXPERIMENTAL INVESTIGATION OF VENTILATED CAVITIES ...Facilities, Pulsating, Rotors-propellers, Ventilated Flow, ...8.0185

Classification of Flow

Non Linear

INVESTIGATION OF THE NON-LINEAR CHARACTERISTICS OF FLUID-SUSPENDED VEHICLES ...Dimensionless-parameters, Other Hydrofoils, Non-linear, Simulation Theory, Stability, ...8.0184

Pulsating

EXPERIMENTAL INVESTIGATION OF VENTILATED CAVITIES ...Facilities, Rotors-propellers, Ventilated Cavities, Ventilated Flow, ...8.0185

Shear-flow

EXPERIMENTAL FLUID DYNAMICS ...Laminar - Turbulent, Model Studies, Rotating Fluids, Thermodynamics, Wind-water Interaction, ...3.0021

Stratified

RESEARCH ON TURBULENT CONVECTION ...Convection, Forced Convection, Laboratory Analysis, Turbulence, Turbulent, ...2.0058

Turbulent

TURBULENCE STRUCTURE AND NOISE STUDY ...Additives, Noise, ...1.0002

RESEARCH ON TURBULENT CONVECTION ...Convection, Forced Convection, Laboratory Analysis, Stratified, Turbulence, ...2.0058

COMPUTATION OF PERIODIC POPPELLER FORCES IN NON-UNIFORM FLOWS USING A LIFTING SURFACE MODEL ...Dimension-three, Marine Propulsion, Models, Non-steady Flow, Rotors-propellers, ...8.0180

Unsteady

BOTTOM CURRENTS AND THE MOVEMENT OF SEDIMENT ACROSS THE CONTINENTAL SHELF ...Bed Load, Columbia River, Continental Shelf, Puget Sound, Sediment Transport, ...2.0047

UNSTEADY TWO-DIMENSIONAL Cavitvity FLOWS ...Boundary Problems, Cavity Flow, Concept, Dimension-two, Model Apparatus-other, ...8.0186

Viscous

HYDRODYNAMIC FLOW FIELD STUDY ...Programming, Ship Resistance Stability, Wave, ...8.0170

VISCO-ELASTIC DYNAMIC VIBRATION ABSORBER ...Analysis, Close Channel, Drag, Energy Dissipators, Hydraulic Equipment, Vibrating Systems-other, ...8.0186

Vortex

VORTEX WAKE SHEDDING OF A HEAVING CIRCULAR CYLINDER ...Configuration of Body, Dimension-two, Reynolds Number, Ship Resistance Stability, Wake, ...8.0191

Conduit Flow

Close Channel

AN ANALYSIS OF THE RESPONSE OF CYLINDRICAL DUCTS TO INTERNAL ZERO MEAN FLOW, AIR-CARRIED ACOUSTIC EXCITATION ...Acoustic Field, Geometric Configuration, Response, ...8.0181

VISCO-ELASTIC DYNAMIC VIBRATION ABSORBER ...Analysis, Drag, Energy Dissipators, Hydraulic Equipment, Vibrating Systems-other, Viscous, ...8.0186

Conduit Flow-other

SALT WATER ENTRAINMENT FOR DILUTION IN SEWER OUTFALLS ...Dispersion-water, Fluid Flow-other, Fluid Mixing, Ocean, Outlet, Sewer, Two-phase-other, ...8.0329

Flexible

INVESTIGATION OF HEAT TRANSFER AUGMENTATION THROUGH USE OF INTERNALLY PINNED TUBES ...Convection, Heat Transfer Coefficient, Heat Transfer, Rotating Fluids, ...8.0189

Configuration of Body

DETERMINATION OF FLOW IN AN AXIAL-TO-RADIAL DIFFUSER WITH SWIRL ...Impinging Jets, Model Apparatus-other, Pressure Gradient, Rotors-propellers, Static, ...8.0187
**Fluid Mechanics**

<table>
<thead>
<tr>
<th>Mass Transfer</th>
</tr>
</thead>
<tbody>
<tr>
<td>GREAT LAKES RESEARCH - ENERGY TRANSFER AT THE AIR-WATER INTERFACE ...Data Analysis - General, Heat and Radiation Transfer, Heat-transfer-other, Lake Michigan, Towers, Wind-water Interaction, ...3.0029</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Two - Phase Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow of Dispersed Solids</td>
</tr>
<tr>
<td>SEDIMENT-FLUID INTERACTIONS ...Geomorphology-topography, Sedimentation, Textures-structures, Wave Action, Waves-internal, ...7.00248</td>
</tr>
<tr>
<td>Two-phase-other</td>
</tr>
<tr>
<td>SALT WATER ENTRAINMENT FOR DILUTION IN SEWER OUTFALLS ...Conduit flow-other, Dispersion-water, Fluid Flow-other, Fluid Mixing, Ocean, Outlet, Sewers, ...8.0329</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Wave Motion in Fluids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Free Surface Waves</td>
</tr>
<tr>
<td>A STUDY OF PROBLEMS RELATED TO WIND-GENERATED WAVES ...Laminar - Turbulent, Theoretical Analysis, Waves, Wind-water Interaction, ...4.0008</td>
</tr>
<tr>
<td>AN OPTICAL METHOD OF MEASURING THE FORM OF THE FREE SURFACE OF A FLUID ...Fluid Dynamics, Models, Optical, Optical Systems, Watersheds, Waves, ...2.0124</td>
</tr>
<tr>
<td>REALISTIC FREE SURFACE BOUNDARY CONDITIONS IN NUMERICAL HYDRODYNAMICS COMPUTATIONS ...Boundary Problems, Surface Phenomena, ...8.0173</td>
</tr>
<tr>
<td>Wave Motion in Fluids-other</td>
</tr>
<tr>
<td>COMPUTER SIMULATION OF THE PROPAGATION OF SURFACE WAVES ...Channel Roughness, Models, Partial, Velocity, Waves, ...4.0082</td>
</tr>
<tr>
<td>MECHANICS OF SAND MOVEMENT BY WAVES ...Model Studies, Ocean Waves - Currents, Shoreline Structures, Size, Waves, ...7.0017</td>
</tr>
<tr>
<td>Waves in Liquids</td>
</tr>
<tr>
<td>LOCALIZED SCOUR AROUND PILING SUBJECTED TO FIRST-ORDER STOKIAN WAVES ...Erosion Control, Model Studies, Scouring, Water Tunnels Tables, Wave Action, ...8.0043</td>
</tr>
</tbody>
</table>

**Flukes**

| AMINO ACID & PROTEIN METABOLISM IN SCHISTOSOMES ...Amino Acids -non-specific, Helminths, Metabolism, Proteins -non-specific, ...5.0621 |
| NATURAL HISTORY OF SALMON POISONING RICKETTSIAE ...Helminths, Invertebrates, Neorickettsiae Helminth, Reservoirs, ...5.0643 |
| EPIDEMIOLOGY OF SALMON POISONING DISEASE ...Helminths, Neorickettsiae Helminth, Pathology, Salmon & Trout - Non-specific, Vincence and Pathogenicity, ...8.0007 |

**Monogenea**

| THERMAL ACCLIMATION PATTERNS IN PARASITES AND HOSTS ...Adaptation, Host Resistance, Host Specificity, Life History Studies, Water Temperature-non-specific, ...5.0643 |

**Trematoda -other**

| TREVETACOS OF FISHES OCCURRING ON THE WEST COAST OF NORTH AMERICA ...Collections, Comparative Physiology, Nearctic, Pacific Ocean-general, ...5.0636 |
| SYSTEMATIC STUDIES OF A SEA TREMATODES ...Animal Taxonomy, Helminths, Organic Evolution, Vertical Distribution, ...5.0646 |
| SYSTEMATIC STUDIES OF CERTAIN MARINE PARASITIC WORMS ...Animal Taxonomy, Helminths, Life History Studies, Red Worms, Eye Works, ...5.0541 |
| BLOOD PARASITES OF NORTHWEST FISHES ...Blood Plasma and Serum, Codfishes, Hake, Helminths, Protozoa, Sculpins, ...5.0335 |

**Fluorescent**

| FURTHER STUDIES ON A FLUORESCENT COMPOUND IN THE DOGFISH LENS ...Sharks, Visual, Visual Organs, ...5.0271 |

**Fluoride**

| SIGNIFICANCE OF FLUORIDE VARIATIONS IN SEA WATER ...Atlantic Ocean-general, Chloride, Element Ratios, Estratives, Water Analysis-general, ...1.0103 |
| HUMIDITY SENSORS ...Barium, Humidity Instruments, Stability, Transducers, ...8.0083 |

**Foam, Porous**

| PASSIVE BUOYANCY SYSTEMS ...Buoyant, Flotation, Engineering Studies-general, Materials Used Undersea, Other-design-and-construction, Submersibles, ...8.0263 |

**Fog-haze-mist**

| LOOK-OUT ASSIST DEVICE ...Navigation, Navigation Communication, Radar, Visibility, Warning-systems, ...8.0146 |
| PROJECT FOG DROPS ...Condensation, Fog-mist "dissipation, Monolayers, Surfactants, ...3.0090 |
| VISUAL LANDING AIDS FIELD ...Atmosphere Optical Phenomena, Detectors, Electric Lighting Systems, Infrared Radiation, Lighting, ...4.0086 |
| VISUAL RANGE METERS ...Distance-measuring-device, Guidance, Landing, Meteorological Conditions, Visibility, ...8.0072 |
| AUDITORY DETECTION ...Interference, Spectral Distribution, Spectrum, Wave Analyzer, ...4.0095 |
| MISCELLANEOUS SERVICES FOR FEDERAL AVIATION AGENCY (VISUAL RANGE) ...Air-sea Boundary-general, Distance-measuring-device, Visibility, ...3.0011 |

**Food Chains, Animal And/or Man**

| MECHANISMS OF PESTICIDE ACCUMULATION IN AQUATIC ORGANISMS ...Chlorinated Hydrocarbons, Insecticides -non-specific, Pollution Effects, Productivity - Food Chain, ...6.0155 |
| PESTICIDE RESISTANT FISH IN NATURAL ECOSYSTEMS ...Animal Resistance -other, Edrin, Fish, Pollution Effects, Rates, Doses, Concentrations, ...8.0277 |

**Food Science and Technology**

<table>
<thead>
<tr>
<th>Cereal &amp; Grains</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOYBEANS</td>
</tr>
<tr>
<td>ANTIOXIDANT AND NUTRITIONAL POTENTIAL OF FERMENTED AND UNFERMENTED SOYBEANS IN COMBINATION WITH FISH ...Fermentation, Matling, Fish -non-specific, Food Spoilage Detection, Proteins, Rancidity, ...6.0023</td>
</tr>
<tr>
<td>FERMENTED PROTEIN-RICH FOODS ...Fermentation, Matling, Fish -non-specific, Fungal Toxins, Milk, Peanuts, ...6.0055</td>
</tr>
<tr>
<td>WHEAT</td>
</tr>
<tr>
<td>RADIOCHEMICAL TECHNIQUES ...Food Spoilage Detection, Mercury, Polonium, Radioactive Isotopes, Smoking, ...6.0008</td>
</tr>
</tbody>
</table>

**Cereal Products**

| WHEAT |
| FERMENTED PROTEIN-RICH FOODS ...Fermentation, Matling, Fish -non-specific, Fungal Toxins, Peanuts, ...6.0055 |

**Dairy Products**

| MILK |
| FERMENTED PROTEIN-RICH FOODS ...Fermentation, Matling, Fish -non-specific, Fungal Toxins, Peanuts, Soybeans, ...6.0055 |

**Eggs**

| ANALYSIS OF THE DEMAND FOR RED MEAT, POULTRY, EGGS, SEAFOOD, AND MEAT MIXTURES ...Consumer Pref & Consumption, Fish -non-specific, Meat -non-specific, Price & Value, ...6.0019 |
SUBJECT INDEX

Fats & Oils

Animal Fats -non-specific

EFFECTS OF IONIZING RADIATION ON FOOD LIPIDS
...Fats, Fish -non-specific, Organoleptic Studies, Radiation,...

Fats and Oils -other

CHEMISTRY OF FISH OILS AND THEIR UTILIZATION
...Fats, Fish & Shellfish, Fish -non-specific, Oiled Processing Technology,...

PROCESS ENGINEERING
...Design, Machinery, Equipment, Esters, Extraction, Fish Protein Concentrate, Industrial Operation, Legal Standards, Natural Occurring,...

LIPASE RESISTANT GLYCERIDES
...Fats, Fish -other, Lipids, Unsaturated Fats,...

Fish and Shellfish

Clams

THE EVALUATION OF WHOLESOMENESS OF RADIATION SUB-STERILIZED FOOD PRODUCTS USING RATS
...Animal Protein, Laboratory Rat, Quantitative & Qualitative, Radiation, Thiaminase,...

BACTERIAL INDICATORS OF THE SANITARY QUALITY OF DECAPITATED HARD CLAMS, MERCENARIA MERCENARIA
...Fish Spillage Detection, Microbiological, Sanitation,...

QUALITY STANDARDS TO DETERMINE RELEASE OF SHELLFISH FOR MARKETING PURPOSES
...Legal Standards, Microbiological, Sanitation, Shelf Life & Storage,...

THE RHODE ISLAND HARD CLAM - QUANHAUG - INDUSTRY
...Cost, Fish & Shellfish, Process & Processing, Rhode Island,...

ORGANISMS RESPONSIBLE FOR TOXICITY OF ALASKAN CLAMS, Alaska, Biological Pollutants -general, Food Spillage Detection, Microbiological, Pollutants-general,...

Crabs

THE EFFECT OF PROCESSING VARIABLES ON THE QUALITY OF MEAT FROM THE BLUE CRAB - CALLINECTES SAPIIDUS
...Fish Additives -other, Heat, Organoleptic Studies,...

ECONOMICS OF MARKETING DUNGENYES CRAB
...Marketing, Pacific Ocean-north, Price & Value,...

THE STORAGE LIFE OF ICED DEEP SEA RED CRABS - GERYON QUINQUELENS
...Iced Cooling and Storage, Microbiological, Organoleptic Studies, Shelf Life & Storage,...

PROCESS-INDUCED CHANGES IN CRUSTACEAN MUSCLE TISSUE NUCLEOTIDES -non-specific, Organoleptic Studies,...

PROCESSING KING CRAB
...Commercial Fishing, Fish & Shellfish, Process & Processing,...

COMPOSITION STUDIES OF FISH AND SHELLFISH AS RELATED TO STORAGE AND PROCESSING PROBLEMS
...Fish -other, Freezing, Mackerel, Packaging, Rancidity,...

INCIDENCE OF BACTERIA OF PUBLIC HEALTH SIGNIFICANCE IN FRESH COMMERCIAL SHELLFISH
...Coliforms -non-specific, Microbiological, Oysters, Radiation, Salmonella (non-specific & Ot), Staphylococcus (non-specific & Ot),...}

BACTERIOLOGICAL SURVEYS FOR MICROBIAL STANDARDS FOR FOOD
...Escherichia Coli, Food Spillage Detection, Legal Standards, Microbiological, Staphylococcus (non-specific & Ot),...}

SURVIVAL OF FOOD PATHOGENS IN RADIATION PASTEURIZATION SEAFOOD
...Cell env.(non-specific & Ot), Cobalt, Food Bacteria, Radiation, Radiation Sensitivity,...

Fish -non-specific

EFFECTS OF INGESTION OF RADIOACTIVE FISH AND THE NATURE AND BIOLOGY OF TOXINS IN CERTAIN FISHES
...Food (epidemiology), Food Chains, Radioactive Isotopes, Toxicological and Allergy,...

FUNDAMENTAL STUDIES IN THE FLAVOR AND ODOR CHEMISTRY OF FISH PRODUCTS
...Enzymes, Food Spillage,...

Food and Science and Technology

Detection, Microbiological, Organoleptic Studies, Radiation,...

OUTGROWTH OF CLOSTRIDIUM BOTULINUM TYPE E IN NONIRRADIATED AND IRRADIATED FISHERY PRODUCTS
...Clostridium Botulinum, Food (epidemiology), Microbiological, Radiation, Refrigeration,...

STABILITY OF FISH LIPIDS TO IONIZING RADIATION
...Fats, Radiation,...

STUDY OF THE BASIC MICROBIOLOGICAL AND BIOCHEMICAL FACTORS IN THE RADIATION PRESERVATION OF MARINE PRODUCTS
...Bacteria, Microbiological, Radiation, Refrigeration, Staphylococcus (non-specific & Ot),...}

RADIOPASTEURIZATION OF FISHERY PRODUCTS-OPERATION AND DEVELOPMENTAL INVESTIGATIONS
...Chemical Analysis, Microbiological, Organoleptic Studies, Radiation, Shelf Life & Storage,...

APPLICATION OF RADIATION PASTEURIZATION PROCESSES TO PACIFIC CRAB AND FLounder
...Clostridium Botulinum, Microbiological, Processing, Radiation, Toxicological and Allergy,...

RADIATION PRESERVATION OF FISHERY PRODUCTS
...Commercial Fishing, Fish & Shellfish, Organoleptic Studies, Radiation, Shelf Life & Storage,...

PREPARATION OF FISH PROTEIN HYDROLYSATES
...Analysis of Foods, Chemical Analysis, Fish Protein Concentrate, Heat, Protein,...

MARKET RESEARCH STUDIES ON THE EFFECTS OF THE FLORIDA MARKETING PROGRAM ON THE SALE OF FLORIDA SEAFOODS
...Florida, Institutional Management, Marketing, Retail,...

DETERMINATION OF THE STRUCTURE & ECONOMIC IMPORTANCE OF THE VARIOUS SEGMENTS OF THE SEAFOOD INDUSTRY
...Commercial Fishing, Consumer Pref. & Consumption, Fish & Shellfish, Georgia, Production & Processing, Regional Economic Impact, Shellfish -non-specific,...

CONSUMER EDUCATION AND MARKET DEVELOPMENT
...Atlantic Ocean-north, Fish & Shellfish, Northeast,...

REGIONAL DEMAND IN THE U.S. AND TRENDS IN THE FISHING AND SEAFOOD PROCESSING INDUSTRIES OF THE CHESAPEAKE BAY AREA
...Chesapeake Bay, Commercial Fishing, Consumer Pref. & Consumption, Consumption, Fish & Shellfish, Market Structure,...

ESTIMATING THE VALUE ADDED TO SEAFOOD PRODUCTS LANDED IN GEORGIA AT THE VARIOUS STAGES OF THE MARKETING CHANNEL
...Georgia, Processing, Quality -non-specific, Shellfish -non-specific,...

ANALYZING THE FACTORS AFFECTING THE DEMAND FOR SEAFOOD AND TO PROJECT THIS DEMAND TO FUTURE TIME PERIODS
...Consumer Pref. & Consumption, Food Needs and Demand, Trends,projections,...

CONSUMER EVALUATION OF FISH PRODUCTS
...Consumer Pref. & Consumption, Fish & Shellfish, Organoleptic Studies, Smoking,...

ANALYSES OF THE DEMAND FOR RED MEAT, POULTRY, EGGS, SEAFOOD, AND MEAT MIXTURES
...Consumer Pref. & Consumption, Eggs, Meat -non-specific, Price & Value,...

ANTIOXIDANT AND NUTRITIONAL POTENTIAL OF FERMENTED AND UNFERMENTED SOYBEANS IN COMBINATION WITH FISH
...Fermentation, Malting, Food Spillage Detection, Proteins, Rancidity, Soybeans,...

ECONOMIC ANALYSIS OF THE MARKET STRUCTURE OF THE COMMERCIAL FISHING INDUSTRY IN THE NORTHEAST
...Commercial Fishing, Consumer Pref. & Consumption, Market Structure, Northeast,...

BIOCHEMISTRY OF FISH AS RELATED TO HUMAN NUTRITION
...Amino Acids, Hypoxanthine, Northeast,...

BOTULINUM FOOD POISONING IN RELATION TO FISHERY PRODUCTS
...Antibiotics, Clostridium Botulinum, Great Lakes-general, Microbiological, Repression,...

A PROGRAM FOR THE TRAINING OF STAFF MEMBERS FROM THE SCHOOL OF FISHERIES OF THE CATHOLIC UNIVERSITY OF VALPARAISO CHILE
...Chile, Food Processing Industry, Marine Biology, Teaching and Research,...

STUDY OF THIAMINASE IN HAWAIIAN FISH
...Enzymatic, Enzyme Inhibitors, Hawaii, Thiaminase, Toxicological and Allergy,...
SUBJECT INDEX

FERMENTED PROTEIN-RICH FOODS ...Fermentation, Malting, Fungal Toxins, Milk, Peanuts, Soybeans, .6.0085

EFFECTS OF IONIZING RADIATION ON FOOD LIPIDS ...Animal Fats - non-specific, Fats, Organoleptic Studies, Radiation, .6.0030

ECOLOGY OF CLOSTRIDIUM BOTULINUM TYPE E IN GREEN BAY ...Great Lakes-general, Microbiological, .5.0840

ANAEROBIC BACTERIA IN THE MARINE ENVIRONMENT ...Food (epidemiology), Isolation From Nat. environ., Microbiological, .5.0846

LOW TEMPERATURE GROWTH OF BACTERIA ON FOODS ...Cryptoplic Bacteria, Growth (non-specific & Od), Poison, .6.0065

ISOLATION OF ANTI-THIAMINE FACTORS IN HAWAII FISH ...Food Spoilage Detection, Radiation, Thiamine, Thiamine Deficiency, Vitamin, .5.0461

Fish -other

EXPANSION OF CURRENT AND DEVELOPMENT OF ADDITIONAL COMMERCIAL FISHERIES CATCH, PRODUCTION AND GEAR STATISTICS ...Alaska, Censusing, Commercial Fishing, Fish (non-specific), Reliability Theory, .5.0018

UTILIZATION OF HAKE, DOGFISH, AND BY-PRODUCTS OF THE FILLET INDUSTRY FOR PROTEIN SUPPLEMENTS ...Anti-oxidants, Chemical and Spices, Fish Protein Concentrate, Heat, Nutritive Value, Supplements, .6.0067

UTILIZATION OF LATENT MARINE RESOURCES AND WASTE PRODUCTS ...Fish Meals, Fish Protein Concentrate, Proteins, Proteins and Amino Acids, Salmon & Trout - Non-specific, .6.0068

COMPOSITION STUDIES OF FISH AND SHELLFISH AS RELATED TO STORAGE AND PROCESSING PROBLEMS ...Crabs, Freezing, Mackerel, Packaging, Rancidity, .6.0046

CONTAINERIZATION OF FISH PRODUCTS ...Commercial Fishing, Packing, Processing, Shrimp, .6.0049

EFFECTS OF HANDLING AND PROCESSING PROCEDURES IN POTENTIAL PATHOGENS ON FISH ...Clostridium Botulinum, Legal Standards, Microbiological, Smoking, Toxicological and Allergy, .6.0044

INVESTIGATION OF FOOD PRESERVATION METHODS ...Chemical Analysis, Food Processing -other, Food Spoilage - other, Organoleptic Studies, Physical and Chemical Change, .6.0016

DIMETHYLITROSAMINE IN CURED, SMOKE-FISH FISH AND FLOUR BLEACHED WITH OXIDES OF NITROGEN ...Ethylene, Fish Protein Concentrate, Flour, Nitrogen Compounds, Nitrous Oxide, .6.0007

LIPASE RESISTANT GLYCERIDES ...Fats, Fats and Oils - other, Lipids, Un saturated Fats, .5.1029

Fish Protein Concentrate

RESEARCH AND GRADUATE TRAINING IN FOOD AND DRUGS FROM THE SEA. AND MARINE POLLUTION ...Antimicrobial, Carcinostatic, Chemistry, Pollution Sources-General, Training Grants, Fellowships, .6.0050

PREPARATION OF FISH PROTEIN HYDROLYSATES ...Analysis of Foods, Chemical Analysis, Fish (non-specific), Heat, Protein, .6.0066

UTILIZATION OF HAKE, DOGFISH, AND BY-PRODUCTS OF THE FILLET INDUSTRY FOR PROTEIN SUPPLEMENTS ...Anti-oxidants, Chemical and Spices, Fish -other, Heat, Nutritive Value, Supplements, .6.0067

UTILIZATION OF LATENT MARINE RESOURCES AND WASTE PRODUCTS ...Fish Meals, Fish, Proteins, and Amino Acids, Salmon & Trout - Non-specific, .6.0068

FISH SCIENCE AND TECHNOLOGY

EFFECT OF STORAGE ON FISH MUSCLE PROTEINS ...Fish & Shellfish, Food Raw Quality, Muscle Proteins, Organoleptic Studies, Protein, .6.0062

NUTRITIVE VALUE OF FISH AND OTHER MARINE PRODUCTS ...Ascorbic Acid, Nutritive Value, Paper Chromatography -non-specific, Tannin, .6.0054

LIPID OXIDATION AND ASSOCIATED BIOCHEMICAL CHANGES OCCURRING DURING THE PROCESSING AND STORAGE OF FISHERY PRODUCTS ...Anti-oxidants, Chemical Analysis, Fats, Food Spoilage Detection, Rancidity, .6.0071

DEVELOPMENT OF RADIATION STERILIZED FISH ITEMS FOR ARMED FORCES FEEDING ...Anti-oxidants, Chemical Analysis, Consumer Freq. & Consumption, Military Rations, Radiation, .6.0073

THE COMPOSITION, NUTRITIVE VALUE AND QUALITY OF FISHERY PRODUCTS WITH SPECIAL EMPHASIS ON LIPID AND ITS FUNCTION ...Anti-oxidants, Fats, Fats & Lipids, Radiation, Un saturated Fats, .6.0076

SURVIVAL MECHANISM OF IRRADIATED BACTERIA IN FOODS ...Bacterial Spores, Antibiotics, Cell Injury and Autolysis, Mutagens, Radiation, .6.0069

STORAGE STABILITY STUDIES ON RADIATION STERILIZED FISH PRODUCTS ...Carbohydrates, Fats, Freezing, Protein, Radiation, .6.0074

OPERATION AND MAINTENANCE OF THE OREGON STATE UNIVERSITY SEAFOODS LABORATORY ...Facilities, Fish & Shellfish, Industry Land Use Effects, Oregon, .12.0042

THE STRUCTURE OF DECISION MAKING IN MAJOR MARKETING AREAS OF FRESH AND FROZEN FISH IN THE U.S. UNITED STATES ...Marketing, Northeast, Price & Value, Production & Processing, Shelf Life & Storage, .6.0078

MARKETING EFFICIENCY IN A COOPERATIVE FROZEN-FISH PROCESSING PLANT, A CASE STUDY ...Design, Machinery, Equipment, Fish & Shellfish, Freezing, Processing, Shelf Life & Storage, .6.0079

DISTRIBUTION OF C. BOTULINUM IN COMMERCIAL SMOKED FISH ...Bacterial Pollutant Sources, Clostridium Botulinum, Food (epidemiology), Microbiological Smoking, .5.0337

CHEMISTRY OF FISH OILS AND THEIR UTILIZATION ...Fats, Fats & Oils - other, Fish & Shellfish, Oiled Pro-cressing Technology, .6.0082

BIOCHEMISTRY OF FISH MUSCLE AND QUALITY CHANGES DURING FROZEN STORAGE ...Fish & Shellfish, Food Raw Quality, Muscle, Organoleptic Studies, .5.1035

PRESERVATION AND DEVELOPMENT OF FOOD PRODUCTS ...Fish & Shellfish, Food Raw Quality, Food Transport - other, Packaging, Processed Product Quality, .6.0084

IRRADIATION SERVICES AND STUDIES ...Fish & Shellfish, Instrumental Services, Radiation, .6.0036

COMMERCIAL BENEFIT STUDIES ...Commercial Fishing, Fish & Shellfish, .6.0037

SHIPBOARD IRRADIATION STUDIES ...Food Raw Quality, Medical Studies, Microbiological, Radiation, Shelf Life & Storage, .6.0039

FUNDAMENTAL RADIATION CHEMISTRY RESEARCH ...Antibiotics, Chemical Analysis, Packaging, Radiation, Radiochemical Analysis, .6.0040

INVESTIGATION OF FEASIBILITY OF STERILIZING FISH BY RADIATION ...Enzymatic Inactivation, Organoleptic Studies, Radiation, Shelf Life & Storage, .6.0041

PROCESSING AND PRODUCT DEVELOPMENT OF EDIBLE FISH AND SHELLFISH ...Commercial Fishing, Fish & Shellfish, .6.0047

PRODUCT/PROCESS DEVELOPMENT RESEARCH ...Design, Machinery, Equipment, Fish & Shellfish, Freezing, Radiation, Refrig eration, .5.0988

GROWTH AND TOXICOGENESIS OF C. BOTULINUM IN FISH AND FISH PRODUCTS ...Antibiotics -non-specific, Bacterial Exotoxins, Clostridium Botulinum, Growth (non-specific & Od), Medical Studies, Microbiological, .6.0043

CONTROL OF OXIDATIVE CHANGES IN FRESHWATER FISH ...Chemical Analysis, Freezing, Fresh Water, Organoleptic Study, Rancidity, .6.0045

ELECTROPHORETIC PROFILES FOR THE IDENTIFICATION OF FISH SPECIES ...Diel Electrophoresis, Gel Electrophoresis, Infection, Intoxication & Pois, Legal Standards, .6.0014

COMPOSITION OF BREADED FISH PRODUCTS ...Food Preparation, Heat, Legal Standards, .6.0061

528
Food Science and Technology

SUBJECT INDEX

Carbohydrates
STORAGE STABILITY STUDIES ON RADIATION STERILIZED FISH ITEMS...Fats, Fish -non-specific, Freezing, Protein, Radiation, ...6.0074

Enzymes
FUNDAMENTAL STUDIES IN THE FLAVOR AND ODOR CHEMISTRY OF FISH PRODUCTS...Fish -non-specific, Food Spoilage Detection, Microbiological, Organoleptic Studies, Radiation, ...6.0042

Fats
STABILITY OF FOOD LIPIDS TO IONIZING RADIATION... Radiation, ...6.0029
LIPID OXIDATION AND ASSOCIATED BIOCHEMICAL CHANGES OCCURRING DURING THE PROCESSING AND STORAGE OF FISHERY PRODUCTS...Antioxidants, Chemical Analysis, Fish -non-specific, Food Spoilage Detection, Radiation, ...6.0071
THE COMPOSITION, NUTRITIVE VALUE AND QUALITY OF FISHERY PRODUCTS WITH SPECIAL EMPHASIS ON LIPID AND ITS INTERACTION...Antioxidants, Lipids, Fish -non-specific, Radiation, Unstabilized Fats, ...6.0076
STORAGE STABILITY STUDIES ON RADIATION STERILIZED FISH ITEMS...Carbohydrates, Fish -non-specific, Freezing, Protein, Radiation, ...6.0074
CHEMISTRY OF FISH OILS AND THEIR UTILIZATION...Fats and Oils -other, Fish & Shellfish, Fish -non-specific, Oils and Oils Processing Technology, ...6.0082
EFFECTS OF IONIZING RADIATION ON FOOD LIPIDS...Animal Fats -non-specific, Fish -non-specific, Organoleptic Studies, Radiation, ...6.0039

Physical and Chemical Change
INVESTIGATION OF FOOD PRESERVATION METHODS...Chemical Analysis, Fish -other, Food Processing -other, Food Spoilage -other, Organoleptic Studies, ...6.0016

Protein
PREPARATION OF FISH PROTEIN HYDROLYSATES...Analysis of Foods, Chemical Analysis, Fish -non-specific, Fish Protein Concentrate, Heat, ...6.0066
EFFECT OF STORAGE ON FISH MUSCLE PROTEINS...Fish & Shellfish, Fish -non-specific, Food Raw Quality, Muscle Proteins, Organoleptic Studies, ...6.0062
STORAGE STABILITY STUDIES ON RADIATION STERILIZED FISH ITEMS...Carbohydrates, Fats, Fish -non-specific, Freezing, Radiation, ...6.0074
CHEMICAL REACTIONS IN PROCESSED SEAFOODS...Enzymatic, Iced Cooling and Storage, Organoleptic Studies, Shrimp, ...6.0048

Vitamins
ISOLATION OF ANTI-THIAMINE FACTORS IN HAWAII FISH...Fish -non-specific, Food Spoilage Detection, Radiation, Thiamine, Thiamine Compounds, ...6.0021

Food Engineering & Technology
Design, Machinery, Equipment
MARKETING EFFICIENCY IN A COOPERATIVE FOOD-FISH PROCESSING PLANT, A CASE STUDY...Fish & Shellfish, Fish -non-specific, Freezing, Processing, Shelf Life & Storage, ...6.0079
PROCESS ENGINEERING...Extraction, Extraction, Fats and Oils -other, Fish Protein Concentrate, Industrial Operation, Legal Standards, Natural Occurring, ...6.0089
PROCESSING ALASKA SHRIMP...Carotenoid Pigments, Heat, Organoleptic Studies, Shrimp, Temperature Control, ...6.0062
OCEAN ENGINEERING...Alaska, Commercial Fishing, Fishing Gear, Shrimp, ...6.0349
CHEMICAL AND MICROBIOLOGICAL APPLICATIONS TO PRODUCT ENGINEERING...Freezing, Iced Cooling and Storage, Microbiological, Oysters, Shrimp, ...6.0050
DEVELOPMENT OF MECHANIZATION DEVICE PROTOTYPES...Fish Meals, Fish Protein Concentrate, Shrimp, ...6.0051
PRODUCT/PROCESSING DEVELOPMENT RESEARCH...Fish & Shellfish, Fish -non-specific, Freezing, Radiation, Refrigeration, ...5.0988

Packaging
EVALUATION OF PRESENT AND PROPOSED LAWS REGULATING THE PROCESSING AND PACKING OF OYSTERS...Food Processing -other, Legal Standards, Louisiana, Oysters, ...6.0027
PRESEVERATION AND DEVELOPMENT OF FOOD PRODUCTS...Fish & Shellfish, Fish -non-specific, Food Raw Quality, Food Transport -other, Processed Product Quality, ...6.0084
COMPOSITION STUDIES OF FISH AND SHELLFISH AS RELATED TO STORAGE AND PROCESSING PROBLEMS...Crabs, Fish -other, Freezing, Mackerel, Radiation, ...6.0046
FUNDAMENTAL RADIATION CHEMISTRY RESEARCH...Antioxidants, Chemical Analysis, Fish -non-specific, Radiation, Radiochemical Analysis, ...6.0040
CONTAINMENT OF FISHERY PRODUCTS...Commercial Fishing, Fish -other, Processing, Shrimp, ...6.0049
PROCESSING AND PRODUCT DEVELOPMENT OF EDIBLE FISH AND SHELLFISH...Commercial Fishing, Fish & Shellfish, ...6.0047

Food Needs and Demand
ANALYZING THE FACTORS AFFECTING THE DEMAND FOR SEAFOOD AND TO PROJECT THIS DEMAND TO FUTURE TIME PERIODS...Consumer Pref. & Consumption, Fish -non-specific, Trends, projections, ...6.0021

Infection, Intoxication & Pois
OIL CONTAMINATION OF OYSTERS FROM OIL WELL DRILLING MUDS...Fluid Properties, Oil, Oil and Natural Gas -Sulfur, Organoleptic Studies, Oysters, ...5.0451
TOXIC IMPURITIES IN MARINE PROTEIN CONCENTRATE...Fish Protein Concentrate, Fish Spoilage -other, Toxics Substances -non-specific, Toxicological and Allergy, ...6.0009
ELECTROPHORETIC PROFILES FOR THE IDENTIFICATION OF FISH SPECIES...Disc Electrophoresis, Fish -non-specific, Gel Electrophoresis, Legal Standards, ...6.0014
PROGRAM PROJECT - FOOD MICROBIOLOGY...Clostridia (non-specific & Ot), Food (epidemiology), Microbiological, Salmonella (non-specific & Ot), Toxicological and Allergy, ...6.0005

Meats and Meat Product
Beef
INVESTIGATION OF THE PRESERVATION OF FOODS BY FREEZE DRYING...Food Spoilage Detection, Freeze Drying, Legal Standards, Physical Decomposition, Shrimp, ...6.0012
Meat -non-specific
ANALYSIS OF THE DEMAND FOR RED MEAT, POULTRY, EGGS, SEAFOOD, AND MEAT MIXTURES...Consumer Pref. & Consumption, Eggs, Fish -non-specific, Price & Value, ...6.0019

Sausage and Variety Meats
DEVELOPMENT OF NEW HUMAN FOOD PRODUCTS FROM SHAD...Fish & Shellfish, Processing, Shad, Shelf Life & Storage, Smoking, ...6.0065

Military Rations
DEVELOPMENT OF RADIATION STERILIZED FISH ITEMS FOR ARMED FORCES FEEDING...Anti-oxidants, Chemical Analysis, Consumer Pref. & Consumption, Fish -non-specific, Radiation, ...6.0073

Nuts & Nutmeats
Peanuts
FERMENTED PROTEIN-RICH FOODS...Fermentation, Malting, Fish -non-specific, Fungal Toxins, Milk, Soybeans, ...6.0055

Processing & Preservation
Antibiotics
BOTULINUM FOOD POISONING IN RELATION TO FISHERY PRODUCTS...Clostridium Botulinum, Fish -non-specific, Great Lakes -general, Microbiological, Repression, ...6.0087
SURVIVAL MECHANISM OF IRRADIATED BACTERIA IN FOODS...Achromobacter Sp, Cell Injury and Autolysis, Fish -non-specific, Mutagens, Radiation, ...6.0069
SUBJECT INDEX

Food Science and Technology

PROCESS-INDUCED CHANGES IN CRUSTACEAN MUSCLE TISSUE ...Crabs, Nucleotides -non-specific, Organoleptic Study... ,.6.0350
COMPOSITION OF BREADED FISH PRODUCTS ...Fish -non-specific, Food Preparation, Legal Standards, ...6.0015
Iced Cooling and Storage
RADIATION PASTEURIZATION OF SHRIMP AND OYSTERS ...Organoleptic Studies, Oysters, Radiation, Residues in Foods, ...6.0024
THE STORAGE LIFE OF ICED DEEP SEA RED CRABS - GERONY QUINQUEDENS ...Crabs, Microbiological, Organoleptic Studies, Shelf Life & Storage, ...6.0077
CHEMICAL REACTIONS IN PROCESSED SEAFOODS ...Enzymatic, Organoleptic Studies, Protein, ...6.0048
CHEMICAL AND MICROBIOLOGICAL APPLICATIONS TO PRODUCT ENGINEERING ...Design, Machinery, Equipment, Freezing, Microbiological, Oysters, Shrimp, ...6.0050
Oilseed Processing Technology
CHEMISTRY OF FISH OILS AND THEIR UTILIZATION ...Fats, Fats and Oils -other, Fish & Shellfish, Fish -non-specific, ...6.0002

Radiation
FUNDAMENTAL STUDIES IN THE FLAVOR AND ODOR CHEMISTRY OF FISH PRODUCTS ...Enzymes, Fish -non-specific, Food Spoilage Detection, Microbiological, Organoleptic Studies, ...6.0042
OUTGROWTH OF CLOSTRIDIUM BOUTULINUM TYPE E IN NONIRRADIATED AND IRRADIATED FISHERY PRODUCTS ...Bacteria, Clostridium, Fish -non-specific, Food (epidemiology), Microbiological, Refrigeration, ...6.0081
THE EVALUATION OF WHOLENESSNESS OF RADIATION SUB-STERILIZED FISH PRODUCTS USING RATS ...Animal Protein, Crabs, Laboratory Rat, Quantitative & Qualitative, Thiaminase, ...6.0031
GROWTH CHARACTERISTICS OF TYPE E CLOSTRIDIUM BOULULINUM IN THE TEMPERATURE RANGE 34 TO 50 F ...Clostridium Botulinum, Food (epidemiology), Haddock, Microbiological, Temperature-Control, ...6.0022
STABILITY OF FOOD LIPIDS TO IONIZING RADIATION ...Fats, ...6.0079
STUDY OF THE BASIC MICROBIOLOGICAL AND BIOCHEMICAL FACTORS IN THE IRRADIATION PRESERVATION OF MARINE PRODUCTS ...Bacteria, Fish -non-specific, Microbiological, Refrigeration, Staphylococcus (non-specific & Ot), ...6.0083
INOCULATED PACK STUDIES ON LOW-DOSE IRRADIATED MARINE PRODUCTS - SHRIMP ...Clostridium Botulinum, Microbiological, Oysters, Shrimp, ...6.0017
RADIOPASTEURIZATION OF FISHERY PRODUCTS-OPERATION AND DEVELOPMENTAL INVESTIGATIONS ...Chemical Analysis, Fish -non-specific, Microbiological, Organoleptic Studies, Shelf Life & Storage, ...6.0033
RADIATION PASTEURIZATION OF SHRIMP AND OYSTERS ...Iced Cooling and Storage, Organoleptic Studies, Oysters, Residues in Foods, Shrimp, ...6.0024
COMMERCIAL IRRADIATION OF SHELLFISH WITH A PORTABLE SHIPBOARD IRRADIATOR ...Chemical Analysis, Microbiological, Organoleptic Studies, Shelf Life & Storage, Shrimp, ...6.0025
APPLICATION OF RADIATION PASTEURIZATION PROCESSES TO PACIFIC CRAB AND FLOUNDER ...Clostridium Botulinum, Fish -non-specific, Microbiological, Processing, Toxico-Biological and Allergy, ...6.0083
RADIATION PRESERVATION OF FISHERY PRODUCTS ...Commercial Fishing, Fish & Shellfish, Fish -non-specific, Organoleptic Studies, Shelf Life & Storage, ...6.0034
CAUSES AND PREVENTION OF UNDESIRABLE CHANGES IN THE QUALITY OF FRESH AND FROZEN GULF SHRIMP IN REFRIGERATED STORAGE ...Effect of Processing Variables on the Quality of Meat from the Blue Crab - CALLINECTES SAPIDUS ...Crabs, Food Additives -other, Organoleptic Studies, ...6.0061
MICROFLORA OF RADIATION PASTEURIZED SEAFOODS ...Microbiological, Organoleptic Studies, Radiation Sensitivity, ...Refrigeration, Shellfish -non-specific, ...6.0171
INVESTIGATE THE EFFECT OF IRRADIATION ON THE MICROBIAL FLORA SURVIVING IRRADIATION PASTEURIZATION OF SEAFOODS ...Consumer Prof & Consumption, Food Spoilage Detection, Microbiological, Radiation Protectors, Shellfish -non-specific, ...6.0072

Heat
PREPARATION OF FISH PROTEIN HYDROLYSATES ...Analysis, Fish Protein Concentrate, Protein, ...6.0066
THE EFFECT OF PROCESSING VARIABLES ON THE QUALITY OF MEAT FROM THE BLUE CRAB - CALLINECTES SAPIDUS ...Crabs, Food Additives -other, Organoleptic Studies, ...6.0061
UTILIZATION OF HAKE, DOGFISH, AND BY-PRODUCTS OF THE FILLET INDUSTRY FOR PROTEIN SUPPLEMENTS ...Anti-oxidants, Chemical and Spices, Fish -other, Fish Protein Concentrate, Nutritive Value, Supplements, ...6.0067
PROCESSED ALASKA SHRIMP ...Carotenoid Pigments, Design, Machinery, Equipment, Organoleptic Studies, Shrimp, Temperature Control, ...6.0002

351
SUBJECT INDEX

DEVELOPMENT OF RADIATION STERILIZED FISH ITEMS FOR ARMED FORCES FEEDING ...Antioxidants, Chemical Analysis, Consumer Pref. & Consumption, Fish -non-specific, Military Rations, ...6.0072

THE COMPOSITION, NUTRITIVE VALUE AND QUALITY OF FISHERY PRODUCTS WITH SPECIAL EMPHASIS ON LIPID AND ITS INTERACTION ...Anti-oxidants, Fats, Fats - Lipid, Fish -other, Immunological, Microbiological, ...6.0076

SURVIVAL MECNHANISM OF IRRADIATED BACTERIA IN FOODS ...Achromobacter Sp, Antibiotics, Cell Injury and Autolysis, Fish -non-specific, Muragens, ...6.0069

STORAGE STABILITY STUDIES ON RADIATION STERILIZED FISH ITEMS ...Carbohydrates, Fats, Fish -non-specific, Freezing, Protein, ...6.0074

LABORATORY SCALE INVESTIGATION INTO THE FEASIBILITY OF RADIOPASTEURIZING FISH PRODUCTS ...Chemical Analysis, Microbiological, Organoleptic Studies, Shelf Life & Storage, Shelffish -non-specific, ...6.0035

IRRADIATION SERVICES AND STUDIES ...Fish & Shellfish, Fish -non-specific, Instrumental Services, ...6.0036

COMMERCIAL BENEFIT STUDIES ...Commercial Fishing, Fish & Shellfish, ...6.0037

INCIDENCE OF BACTERIA OF PUBLIC HEALTH SIGNIFICANCE IN FRESH COMMERCIAL SHELLFISH ...Cholera (non-specific), Crabs, Microbiological, Oysters, Salmonella (non-specific & Ot), Staphylococcus (non-specific & Ot), ...6.0038

SHIPBOARD IRRADIATION STUDIES ...Fish -non-specific, Food Raw Quality, Medical Studies, Microbiological, Shelf Life & Storage, ...6.0039

FUNDAMENTAL RADIATION CHEMISTRY RESEARCH ...Antibiotics, Chemical Analysis, Fish -non-specific, Packaging, Radiochemical Analysis, ...6.0040

INVESTIGATION OF FEASIBILITY OF STERILIZING FISH BY RADIATION ...Enzymatic, Fish -non-specific, Inactivation, Organoleptic Studies, Shelf Life & Storage, ...6.0041

PROCESSING AND PRODUCT DEVELOPMENT OF EDIBLE FISH AND SHELFISH ...Commercial Fishing, Fish & Shellfish, ...6.0047

PRODUCT/PROCESS DEVELOPMENT RESEARCH ...Design, Machinery, Equipment, Fish & Shellfish, Fish -non-specific, Freezing, Refrigeration, ...6.0088

SURVIVAL OF FOOD PATHOGENS IN RADIATION PASTEURIZATION SEAFOOD ...Cell env. (non-specific & Ot), Cobalt, Crabs, Food Bacteria, Radiation Sensitivity, ...6.0063

SURVIVAL MECHANISM OF IRRADIATED MICROORGANISMS IN FOOD ...Antibiotics, Cell Injury and Autolysis, Preservation, Radiation Protectors, Salmonella (non-specific & Ot), ...6.0070

EFFECTS OF IONIZING RADIATION ON FOOD LIPIDS ...Animal Fats -non-specific, Fats, Fish -non-specific, Organoleptic Studies, ...6.0090

ISOLATION OF ANTI-THIAMINE FACTORS IN HAWAII FISH ...Fish -non-specific, Food Spoilage Detection, Thiamine, Thiamine Compounds, Vitamins, ...6.0261

Refrigeration

OUTGROWTH OF CLOSTRIDIUM BOTULINUM TYPE E IN NONIRRADIATED AND IRRADIATED FISHERY PRODUCTS ...Clostridium Botulinum, Fish -non-specific, Food (epidemiology), Microbiological, Radiation, ...6.0081

STUDY OF THE BASIC MICROBIOLOGICAL AND BIOCHEMICAL FACTORS IN THE IRRADIATION PRESERVATION OF MARINE PRODUCTS ...Bacteria, Fish -non-specific, Microbiological, Radiation, Staphylococcus (non-specific & Ot), ...6.0085

MARKET STRUCTURE OF COMMERCIAL FISHING INDUSTRY IN THE NORTHEAST ...Commercial Fishing, Consumption, Haddock, Market Structure, Northeast, ...4.0186

CAUSES AND PREVENTION OF UNDESIRABLE CHANGES IN THE QUALITY OF FRESH AND FROZEN GULF SHRIMP IN REFRIGERATED STORAGE ...Freezing, Radiation, Shelf Life & Storage, Shrimp, ...6.0026

MICROFLORA OF RADIATION PASTEURIZED SEAFOODS ...Microbiological, Organoleptic Studies, Radiation, Radiation Sensitivity, Shellfish -non-specific, ...6.0171

PRODUCT/PROCESS DEVELOPMENT RESEARCH ...Design, Machinery, Equipment, Fish & Shellfish, Fish -non-specific, Freezing, Radiation, ...5.0988

LOW TEMPERATURE GROWTH OF BACTERIA ON FOODS ...Cryptobacterium Bacteria, Fish -non-specific, Growth (non-specific & Ot), Lactobacillus, Microbiological, Temperature, ...6.0066

SmokIng

DEVELOPMENT OF NEW HUMAN FOOD PRODUCTS FROM SHAD ...Fish & Shellfish, Processing, Sausage and Variety Meats, Shad, Shelf Life & Storage, ...6.0065

CONSUMER EVALUATION OF FISH PRODUCTS ...Consumer Pref. & Consumption, Fish & Shellfish, Fish -non-specific, Organoleptic Studies, ...6.0004

DISTRIBUTION OF B. COTULINUM IN COMMERCIAL SMOKED FISH ...Bacterial Pollutant Sources, Clostridium Botulinum, Fish -non-specific, Food (epidemiology), Microbiological, ...5.0337

EFFECTS OF HANDLING AND PROCESSING PROCEDURES IN POTENTIAL PATHOGENUS ON FISH ...Cladostereum Botulinum, Fish -other, Legal Standards, Microbiological, Toxicological and Allergy, ...6.0044

RADIOCHEMICAL TECHNIQUES ...Food Spoilage Detection, Mercury, Polonium, Radioactive Isotopes, Wheat, ...6.0008

Temperature Control

GROWTH CHARACTERISTICS OF TYPE E CLOSTRIDIUM BOTULINUM IN THE TEMPERATURE RANGE 34 TO 50 F. ...Clostridium Botulinum, Fish -non-specific, Food (epidemiology), Haddock, Salmonella (non-specific & Ot), ...6.0022

PROCESSING ALASKA SHRIMP ...Carotenoid Pigments, Design, Machinery, Equipment, Heat, Organoleptic Studies, Shrimp, ...6.0002

Proteins

Animal Protein

THE EVALUATION OF WHOLESOMENESS OF RADIATION SUB-STERILIZED FOOD PRODUCTS USING RATS ...Clams, Laboratory Rat, Quantitative & Qualitative, Radiation, Thiaminase, ...6.0031

Quality Control and Standards

FOOD RAW QUALITY

EFFECT OF STORAGE ON FISH MUSCLE PROTEINS ...Fish & Shellfish, Fish -non-specific, Muscle Proteins, Organoleptic Studies, Protein, ...6.0062

BIOCHEMISTRY OF FISH MUSCLE AND QUALITY CHANGES ...Enzymatic, Fish -non-specific, Muscle, Organoleptic Studies, ...5.0135

PRESERVATION AND DEVELOPMENT OF FOOD PRODUCTS ...Fish & Shellfish, Fish -non-specific, Food Transport -other, Packaging, Processed Product Quality, ...6.0084

SHIPBOARD IRRADIATION STUDIES ...Fish -non-specific, Medical Studies, Microbiological, Radiation, Shelf Life & Storage, ...6.0039

Legal Standards

QUALITY STANDARDS TO DETERMINE RELEASE OF SHELLFISH FOR MARKETING PURPOSES ...Clams, Microbiological, Sanitation, Shelf Life & Storage, ...6.0166

EVALUATION OF PRESENT AND PROPOSED LAWS REGULATING THE PROCESSING AND PACKING OF OYSTERS ...Food Processing -other, Louisiana, Oysters, Packaging, ...6.0027

PROCESS ENGINEERING ...Design, Machinery, Equipment, Externs, Extraction, Fats and Oils -other, Fish Protein Concentrate, Industrial Operation, Natural Occurring, ...6.0090

EFFECTS OF HANDLING AND PROCESSING PROCEDURES IN POTENTIAL PATHOGENUS ON FISH ...Cladostereum Botulinum, Fish -other, Microbiological, Smoking, Toxicological and Allergy, ...6.0044

CHARACTERISTICS OF CANNED SALMON ...Organoleptic Studies, Salmon, ...6.0013

ELECTROPHORETIC PROFILES FOR THE IDENTIFICATION OF FISH SPECIES ...Diet Electrophoresis, Fish -non-specific, Gel Electrophoresis, Infection, Intoxication & Poison, ...6.0014

COMPOSITION OF BREADED FISH PRODUCTS ...Fish -non-specific, Food Preparation, Heat, ...6.0015

BACTERIOLOGICAL SURVEYS FOR MICROBIAL STANDARDS FOR FOOD ...Crabs, Escherichia Coli, Food Spoilage Detection, Microbiological, Staphylococcus (non-specific & Ot), ...6.0010

532
SUBJECT INDEX

Food Science and Technology

INVESTIGATION OF FOOD PRESERVATION METHODS ...Chemical Analysis, Fish -non-specific, Food Processing -other, Food Spoilage -other, Physical and Chemical Change, ...6.0016

CHARACTERISTICS OF CANNED SALMON ...Legal Standards, Salmon, ...6.0013

EFFECTS OF IONIZING RADIATION ON FOOD LIPIDS ...Animal Fats -non-specific, Fats, Fish -non-specific, Radiation, ...6.0030

Processed Product Quality

EFFECT OF PROCESS ON SHELLFISH ...Clams, Processing, Sanitation, Shell Life & Storage, Winter, ...6.0059

PRESERVATION AND DEVELOPMENT OF FOOD PRODUCTS ...Fish & Shellfish, Fish Raw Quality, Food Transport -other, Packaging, ...6.0084

Shell Life & Storage

RADIOPISTEURIZATION OF FISHERY PRODUCTS-OPERATION AND DEVELOPMENTAL INVESTIGATIONS ...Chemical Analysis, Fish -non-specific, Microbiological, Organoleptic Studies, Radiation, ...6.0033

COMMERCIAL IRRADIATION OF SHELLFISH WITH A PORTABLE SHIPBOARD IRRADIATOR ...Chemical Analysis, Microbiological, Radiation, Shelf Life & Storage, ...6.0025

RADIATION PRESERVATION OF FISHERY PRODUCTS ...Commercial Fishing, Fish & Shellfish, Fish -non-specific, Radiation, Shelf Life & Storage, ...6.0034

CONSUMER EVALUATION OF FISH PRODUCTS ...Consumer Pref. & Consumption, Fish & Shellfish, Fish -non-specific, Smoked, ...6.0004

OIL CONTAMINATION OF OYSTERS FROM OIL WELL DRILLING MUDS ...Fluid Properties, Infection, Intoxication & Poisoning, Oysters, Raw, Natural Gas - Sulfur, Oysters, ...5.0431

THE EFFECT OF PROCESSING VARIABLES ON THE QUALITY OF MEAT FROM THE BLUE CRAB - CALLINECTES SAPIDUS ...Crabs, Food Additives -other, Heat, ...6.0061

EFFECT OF STORAGE ON FISH MUSCLE PROTEINS ...Fish & Shellfish, Fish -non-specific, Food Raw Quality, Muscle Proteins, Protein, ...6.0062

MICROFLORA OF RADIATION PASTEURIZED SEAFADOWS ...Microbiological, Radiation, Radiation Sensitivity, Refrigeration, Shelf Life -non-specific, ...6.0171

DEVELOPMENT OF THE SHAD INDUSTRY ...Fish & Shellfish, ...6.0064

UTILIZATION AND PREPARATION OF FISH PROTEIN CONCENTRATE ...Chemical Analysis, Fish -non-specific, Microbiological, Radiation, Shelf Life & Storage, ...6.0103

PROCESSING ALASKA SHRIMP ...Carotenoid Pigments, Design, Machinery, Equipment, Heat, Shrimp, Temperature Control, ...6.0002

PROCESS-INDUCED CHANGES IN CRUSTACEAN MUSCLE TISSUE ...Crabs, Heat, Nucleotides -non-specific, ...5.0350

PROCESSING KING CRAB ...Commercial Fishing, Crabs, Fish & Shellfish, Fish Meats, Freezing, ...6.0063

LABORATORY SCALE INVESTIGATION INTO THE FEASIBILITY OF RADIOPASTEURIZING FISH PRODUCTS ...Chemical Analysis, Microbiological, Radiation, Shelf Life & Storage, ...6.0077

LABORATORY SCALE INVESTIGATION INTO THE FEASIBILITY OF RADIOPASTEURIZING FISH PRODUCTS ...Chemical Analysis, Microbiological, Organoleptic Studies, Radiation, Shelf Life -non-specific, ...6.0035

COMMERCIAL BENEFIT STUDIES ...Commercial Fishing, Fish & Shellfish, ...6.0004

SHIPBOARD IRRADIATION STUDIES ...Fish -non-specific, Food Raw Quality, Medical Studies, Microbiological, Radiation, ...6.0039

INVESTIGATION OF FEASIBILITY OF STERILIZING FISH BY RADIATION ...Enzymatic, Fish -non-specific, Inactivation, Organoleptic Studies, Radiation, ...6.0041

Spoilage

Enzymatic

STUDY OF THIAMINASE IN HAWAII FISH ...Enzyme Inhibitors, Fish -non-specific, Hawaii, Thiaminate, Toxicological and Allergy, ...5.0260

CHEMICAL REACTIONS IN FROZEN SEAFISH ...Rancidity, ...5.0468

BIOCHEMISTRY OF FISH MUSCLE AND QUALITY CHANGES ...Fish -non-specific, Food Raw Quality, Muscle, Organoleptic Studies, ...5.0103

INVESTIGATION OF FEASIBILITY OF STERILIZING FISH BY RADIATION ...Fish -non-specific, Inactivation, Organoleptic Studies, Radiation, Shelf Life & Storage, ...6.0041

Food Spoilage -other

INVESTIGATION OF FOOD PRESERVATION METHODS ...Chemical Analysis, Fish -other, Food Processing -other, Organoleptic Studies, Physical and Chemical Change, ...6.0016
Food Science and Technology

SUBJECT INDEX

TOXIC IMPURITIES IN MARINE PROTEIN CONCENTRATE...
Fish Protein Concentrate, Infection, Intoxication & Poi, Toxic Substances -non-specific, Toxicological and Allergy, 6.0065

Food Spoilage Detection
FUNDAMENTAL STUDIES IN THE FLAVOR AND ODOR CHEMISTRY OF FISH PRODUCTS...
Enzymes, Fish -non-specific, Microbiological, Organoleptic Studies, Radiation, 6.0042

BACTERIAL INDICATORS OF THE SANITARY QUALITY OF DEPURATED HARD CLAMS, MERCENARIA MERCENARIA...
Clams, Microbiological, Sanitation, 6.0056

ANTIOXIDANT AND NUTRITIONAL POTENTIAL OF FERMENTED AND UNFERMENTED SOYBEANS IN COMBINATION WITH PROTEINS, Ranciditly, Soybeans, 6.0023

LIPID OXIDATION AND ASSOCIATED BIOCHEMICAL CHANGES OCCURRING DURING THE PROCESSING AND STORAGE OF FISHERY PRODUCTS...
Anti-oxidants, Chemical Analysis, Fish -non-specific, Rancidity, 6.0071

INVESTIGATE THE EFFECT OF IRRADIATION ON THE MICROBIAL FLORA SURVIVING IRRADIATION PASTEURIZATION OF SEAFOOD...
Consumer Pref. & Consumption, Microbiological, Radiation, Radiation Protectors, Shellfish -non-specific, 6.0072

RADIOCHEMICAL TECHNIQUES...
Mercury, Polonium, Radiative Isotopes, Smoking, Wheat, 6.0008

BACTERIOLOGICAL SURVEYS FOR MICROBIAL STANDARDS FOR FOOD...
Crabs, Escherichia Coli, Legal Standards, Microbiological, Staphylococcus (non-specific & Ot), 6.0010

INVESTIGATION OF DECOMPOSITION IN SHRIMP...
Ammonium, Physical Decomposition, Shrimp, 6.0011

INVESTIGATION OF THE PRESERVATION OF FOODS BY FREEZE DRYING...
Beef, Freeze Drying, Legal Standards, Physical Decomposition, Shrimp, 6.0012

ORGANISMS RESPONSIBLE FOR TOXICITY OF ALASKAN CLAMS...
Alaska, Biological Pollutants -general, Clams, Microbiological, 5.0336

ISOLATION OF ANTI-TIAMINE FACTORS IN HAWAII FISH...
Fish -non-specific, Radiation, Thiamine, Thiamine Compounds, Vitamins, 5.08261

Microbiological
FUNDAMENTAL STUDIES IN THE FLAVOR AND ODOR CHEMISTRY OF FISH PRODUCTS...
Enzymes, Fish -non-specific, Food Spoilage Detection, Organoleptic Studies, Radiation, 6.0042

OUTGROWTH OF CLOSTRIDIUM BOTULINUM TYPE E IN NONIRRADIATED AND IRRADIATED FISHERY PRODUCTS...
Clostridium Botulinum, Swarming, 6.0081

GROWTH CHARACTERISTICS OF TYPE E CLOSTRIDIUM BOTULINUM IN THE TEMPERATURE RANGE 34 TO 50 F...
Clostridium Botulinum, Food (epidemiology), Haddock, Radiation, Temperature Control, 6.0022

STUDY ON THE BASIC MICROBIOLOGICAL AND BIOCHEMICAL FACTORS IN THE IRRADIATION PRESERVATION OF MARINE PRODUCTS...
Bacteria, Fish -non-specific, Radiation, Staphylococcus (non-specific & Ot), 6.0058

INOCULATED PACK STUDIES ON LOW-F-56E IRRADIATED MARINE PRODUCTS - SHRIMP...
Clostridium Botulinum, Oysters, Radiation, Shrimp, 6.0017

RADIOPESTURIZATION OF FISHERY PRODUCTS-OPERATION AND DESIGN FISHERMAN INVESTIGATIONS...
Chemical Analysis, Fish -non-specific, Organoleptic Studies, Radiation, Shellfish -Life & Storage, 6.0033

COMMERCIAL IRRADIATION OF SHELLFISH WITH A PORTABLE SHIPBOARD Irradiator...
Chemical Analysis, Organoleptic Studies, Radiation, Shelf Life & Storage, Shrimp, 6.0025

APPLICATION OF RADIATION PASTEURIZATION PROCESSES TO PACIFIC CRAB AND FLounder...
Clostridium Botulinum, Fish -non-specific, Processing, Radiation, Toxicological and Allergy, 6.0083

BACTERIAL INDICATORS OF THE SANITARY QUALITY OF DEPURATED HARD CLAMS, MERCENARIA MERCENARIA...
Clams, Food Spoilage Detection, Sanitation, 6.0056

QUALITY STANDARDS TO DETERMINE RELEASE OF SHELLFISH FOR MARKETING PURPOSES...
Clams, Legal Standards, Sanitation, Shelf Life & Storage, 6.0166

BOTULINUM FOOD POISONING IN RELATION TO FISHERY PRODUCTS...
Antibiotics, Clostridium Botulinum, Fish -non-specific, Great Lakes-general, Repression, 6.0087

MICROFLORA OF RADIATION PASTEURIZED SEAFOODS...
Organoleptic Studies, Radiation, Radiation Sensitivity, Refrigeration, Shellfish -non-specific, 6.0017

VITAMIN K3 AS A FOOD PRESERVATIVE...
Food Bacteria, Food Processing-other, Repression, Vitamin K, 6.0075

INVESTIGATE THE EFFECT OF IRRADIATION ON THE MICROBIAL FLORA FOR RADIATION PASTEURIZATION OF SEAFOODS...
Consumer Pref. & Consumption, Food Spoilage Detection, Radiation, Radiation Protection, Shellfish -non-specific, 6.0072

THE STORAGE LIFE OF ICED DEEP SEA RED CRABS - GERYON QUINQUEDENSI...
Crabs, Iced Cooling and Storage, Organoleptic Studies, Shelf Life & Storage, 6.0077

DISTRIBUTION OF C. BOTULINUM IN COMMERCIAL SMOKED FISH...
Bacterial Pollutant Sources, Clostridium Botulinum, Fish -non-specific, Food (epidemiology), Smoking, 5.0337

CHEMICAL AND MICROBIOLOGICAL APPLICATIONS TO PRODUCT ENGINEERING...
Design, Machinery, Equipment, Freezing, Iced Cooling and Storage, Oysters, Shrimp, 6.0065

LABORATORY SCALE INVESTIGATION INTO THE FEASIBILITY OF RADIOPASTEURIZING FISH PRODUCTS...
Chemical Analysis, Organoleptic Studies, Radiation, Shelf Life & Storage, Shellfish -non-specific, 6.0033

SHIPBOARD IRRADIATION STUDIES...
Fish -non-specific, Food Raw Quality, Medical Studies, Radiation, Shelf Life & Storage, 6.0039

GROWTH AND TOXICOCENESIS OF C. BOTULINUM IN FISHERY PRODUCTS...
Antimetabolites -non-specific, Bacillus Toxidermus, Clostridium Botulinum -non-specific, Growth (non-specific & Ot), Medical Studies, 6.0043

EFFECTS OF HANDLING AND PROCESSING PROCEDURES IN POTENTIAL PATHOGENUS ON FISH...
Clostridium Botulinum, Fish -other, Legal Standards, Smoking, Toxicological and Allergy, 6.0044

BACTERIOLOGICAL SURVEYS FOR MICROBIAL STANDARDS FOR FOOD...
Crabs, Escherichia Coli, Food Spoilage Detection, Legal Standards, Staphylococcus (non-specific & Ot), 6.0010

THERMAL DESTRUCTION OF TYPE E CLOSTRIDIUM BOTULINUM...
Clostridium Botulinum, Differentiation Mechanism, Food (epidemiology), Heat Resistance, Spore Studies, 6.0006

ECOLOGY OF CLOSTRIDIUM BOTULINUM TYPE E IN GREEN BAY...
Fish -non-specific, Great Lakes-general, 6.0580

PROGRAM PROJECT - FOOD MICROBIOLOGY...
Clostridia (non-specific & Ot), Food (epidemiology), Infection, Intoxication & Poi, Salmonella (non-specific & Ot), Toxicological and Allergy, 6.0005

ANAEROBIC BACTERIA IN THE MARINE ENVIRONMENT...
Fish -non-specific, Food (epidemiology), Isolation From Nat. Environ, 5.0846

STUDIES ON VIBrio FISH POISONING...
Bacteria, Bacterial Endotoxins, Food (epidemiology), Toxicological and Allergy, 6.0014

LOW TEMPERATURE GROWTH OF BACTERIA ON FOODS...
Cryophible Bacteria, Fish -non-specific, Growth (non-specific & Ot), Isoenzymes, Refrigeration, Temperature, 6.0086

ORGANISMS RESPONSIBLE FOR TOXICITY OF ALASKAN CLAMS...
Alaska, Biological Pollutants -general, Clams, Food Spoilage Detection, Pollutants-general, 5.0344

Physical Decomposition
INVESTIGATION OF DECOMPOSITION IN SHRIMP...
Ammonium, Food Spoilage Detection, Shrimp, 6.0011

INVESTIGATION OF THE PRESERVATION OF FOODS BY FREEZE DRYING...
Beef, Food Spoilage Detection, Freeze Drying, Legal Standards, Shrimp, 6.0012

Radioactive Isotopes
EFFECTS OF INGESTION OF RADIOACTIVE FISH AND THE NATURE AND BIOLOGY OF TOXINS IN CERTAIN FISHES...
Fish -non-specific, Food (epidemiology), Food Chains, Toxicological and Allergy, 6.0108

534
SUBJECT INDEX

RADIOCHEMICAL TECHNIQUES ...Food Spoilage Detection, Mercury, Polonium, Smoking, Wheat, ...6.0068

Rancidity
ANTIOXIDANT AND NUTRITIONAL POTENTIAL OF FERMENTED AND UNFERMENTED SOYBEANS IN COMBINATION WITH FISH ...Fermentation, Mailing, Fish - non-specific, Food Spoilage Detection, Proteins, Soybeans, ...6.0023

LIPID OXIDATION AND ASSOCIATED BIOCHEMICAL CHANGES OCCURRING DURING THE PROCESSING AND STORAGE OF FISH AND SHELLFISH PRODUCTS ...Antioxidants, Chemical Analysis, Fats, Fish - non-specific, Food Spoilage Detection, ...6.0071

COMPOSITION STUDIES OF FISH AND SHELLFISH AS RELATED TO STORAGE AND PROCESSING PROBLEMS ...Crustaceans, Fish - other, Freezing, Mackerel, Packaging, ...6.0046

CONTROL OF OXIDATIVE CHANGES IN FRESHWATER FISH ...Chemical Analysis, Fish - non-specific, Freezing, Fresh Water, Organoleptic Studies, ...6.0045

Supplements
UTILIZATION OF HAKE, DOGFISH, AND BY-PRODUCTS OF THE FISHERY INDUSTRY FOR PROTEIN SUPPLEMENTS ...Antioxidants, Chemical and Spices, Fish - other, Fish Protein Concentrate, Heat, Nutritive Value, ...6.0067

Transportation and Marketing
Food Transport - other
PRESERVATION AND DEVELOPMENT OF FOOD PRODUCTS - Fish & Shellfish, Fish - non-specific, Food Raw Quality, Packaging, Processed Product Quality, ...6.0084

Forecasting-prediction
PREDICTION OF EXTREME ENVIRONMENTAL FACTORS ...Meteorology, Statistics-general, Technique Development, Waves, Wind-general, ...6.0048

STUDY OF RELATIONSHIP BETWEEN EARTHQUAKES AND TECTONIC MOVEMENTS IN ALASKAN FAULT ZONE ...Alaska, Crustal Fracturing, Deformation, Earthquakes, Fault Complexes, ...7.0139

HIGH FREQUENCY OCEAN WAVES ...Aircraft, Photography, Fish - other, Waves, Wind-water Interaction, ...6.0121

HIGH FREQUENCY WAVES ...Heat and Radiation Transfer, Hydrodynamics, Water Motion Testers, Waves, ...3.0113

TSUNAMI RUNUP EXPERIMENTS ON A SCALE MODEL OF OAHU ...Hawaii, Model Studies, Tsunamis, ...6.0111

WAVE, CURRENT AND STORM SURGE RESPONSE TO EXTREME WIND CONDITIONS ...Currents-ocean, Model Studies, Storms-general, Waves, Wind-water Interaction, ...6.0070

DETERMINATION OF TIDES IN THE REAL OCEANS ...Numerical Analysis-other, Partial, Tides, ...6.0095

THEORETICAL STUDY OF TSUNAMI PROPAGATION ...Depth, Environmental Effects-geologic, Geomorphology-topography, Tsunamis, Waves, ...7.0122

AIR-SEA INTERACTION ...Heat and Radiation Transfer, Meteorological Studies, Thermal, Wind-water Interaction, ...6.0023

CHARACTERISTICS, CAUSES, AND PREDICTION OF UPWELLING WATER MASSESS OFF ORIFCAS ...Mixing, Oceanic Fronts, Oregon, Pacific Ocean-east, Water Motion Recorders, ...2.0063

THEORETICAL STUDY OF OCEAN TIDES FOR PURPOSES OF WORLDWIDE PREDICTION ...Earth Tides, Mediterranean Sea-ocean, Tides, Waves, ...6.0090

PROPAGATION AND REFRACTION OF OCEAN WAVES IN NEAR SHORE REGIONS ...Mathematical Analysis, Operational Aspects, Surface Environments, Waves, ...2.0117

AIR-SEA INTERACTION (WAVES) ...British West Indies, Heat and Radiation Transfer, Surface Environments, Wav-v, Wind-water Interaction, ...6.0006

THEORETICAL AND LABORATORY MODEL STUDIES OF LARGE-SCALE OCEAN CIRCULATION ...Circulation-general, Currents-ocean, Gulf Stream, Model Studies, Tuns, ...2.0033

SATELITE COMMUNICATION TESTS ...Buoy, Marine Environments-general, Satellites, Telemetry-other, Very High Frequency, ...4.0001

MEASUREMENT AND INTERPRETATION OF MOTIONALLY-INDUCED ELECTRIC FIELDS IN THE SEA ...Currents-ocean, Electrical, Marine Environments-general, Model Studies, Moorings, Water Motion Recorders, ...1.0139

Fouling
RADIANT ENERGY FLUX ACROSS THE AIR-SEA INTERFACE AND HEAT BUDGET OF THE OCEANS ...Air-sea Boundary-general, Heat and Radiation Transfer, Heat Exchange, Radiation-general, Thermal, ...3.0032

MODEL STUDIES OF REFRACTION OF SHOALING OCEAN WAVES ...Model Apparatus-other, Model Studies, Shoals, Wave, Waves, ...6.0194

NUMERICAL OCEANOGRAPHIC MODEL DEVELOPMENT FOR ENVIRONMENTAL PREDICTION ...Marine Environments-general, Meteorological Studies, Model Studies, Oceanic Fronts, Weather Forecasting, ...4.0077

SEA ICE MOVEMENT DYNAMICS ...Charts, Mapping, Model Studies, Polar, Sea Ice, ...3.0087

TURBULENCE OVER WAVES ...Heat and Radiation Transfer, Heat Exchange, Meteorological Studies, Thermal, Turbulence, Waves, ...3.0027

SPECTRAL ANALYSIS ...Data Reduction and Analysis, Handbooks, Oceanography-general, Spectral Analysis, ...6.0032

OCEANOGRAPHIC RESEARCH ...Acoustical, Submersibles, Temperature, ...6.0161

OCEAN CIRCULATION ...California Current, Circulation-general, Hydrodynamics, Model Studies, Submarine Canyons, ...2.0002

EARTHQUAKE HAZARD - A PUBLIC POLICY PROBLEM IN THE SAN FRANCISCO BAY AREA ...California, Earthquakes, Faults, Intergovernmental Relations, Policy Making, San Francisco Bay, ...9.0002

FLUID MECHANICS RESEARCH ...Hydrodynamics, Industrial Engineering, Ship Resistance Stability, Waves, ...8.0176

OCEANOGRAPHIC RESEARCH - INVESTIGATIONS WITH THERMISTORS ...Acoustical, Temperature, Thermal, Transmission, Water Properties-general, Waves-internal, ...1.0143

OCEANOMETRICS ...Acoustical, Statistics-general, Transmission, Velocity, ...1.0006

SHALLOW WATER OCEANOGRAPHY ...Continental Shelf, Environmental Effects-geologic, Pressure, Subsurface Environments, Waves, ...6.0172

NUMERICAL WAVE PREDICTION ...Development of Models, Model Studies, Numerical Analysis-other, Waves, ...2.0104

ADVANCED TECHNOLOGY AND BOTTOM PREDICTIONS ...Acoustical, Benthos-bottom, Data Acquisition, Data Analysis - General, Model Studies, Seismic Studies, ...1.0045

PREDICTION OF POLAR ICE BEHAVIOR AND DISTRIBUTION ...Arctic Ocean, Data Acquisition, Hydrodynamics, Ice-general, Sea Ice, Weather Forecasting, ...3.0078

PREDICTIVE OCEAN ACUSTICS ...Acoustical, Velocity, ...6.0033

PREDICTIVE OCEAN ACOUSTICS ...Acoustical, Environmental Effects-geologic, Transmission, Velocity, ...6.0034

UNDERWATER ACOUSTIC ANALYSIS ...Acoustical, Phase Relationships, Signal Analysis-other, Transmission, Water Propagation, ...2.0107

MEASUREMENT OF UNDERWATER ACOUSTIC PROPAGATION ...Acoustical, Depth, Intensity, Transmission, ...1.0014

GREAT LAKES RESEARCH - MONITORING OF WATER CHARACTERISTICS ...Data Acquisition, Geophysical Analysis, Great Lakes-general, Instrumentation-general, Temperature, ...6.0185

SPACE APPLICATIONS TO FISHERIES OCEANOGRAPHY (GULF OCEANOGRAPHY PROGRAM) ...Commercial Fishing, Computer Applications, Satellites, Water Environment-other, ...4.0017

Fouling
ANTI-FOULING MEANS FOR MARINE PROPELLERS ...Corrosion Prevention-other, Marine Propulsion, Materials Used Undersea, ...6.0114

NEW PROGRESS TO BIOFOULING ASSAY ...Bioassays, Corrosion Prevention-other, Marine Biology (non-specific), ...6.0028

FORESTRY
EFFECTS OF LOG RAFTING ON DUNGEONS CRAB ...Contaminants - Water, Crabs, Diving and Scuba, Marine Activities, Pulp, Paper, and Logging, ...5.0037

MOBILITY OF OIL-TYPE PRESERVATIVES IN IMMERSED WOOD ...Creosote, Evaluation, Liquid - Solid Interactions, Marine Biology (non-specific), Wood Preservatives-non-specific, ...6.0028

FORESTRY
EFFECTS OF LOG RAFTING ON DUNGEONS CRAB ...Contaminants - Water, Crabs, Diving and Scuba, Marine Activities, Pulp, Paper, and Logging, ...5.0037

MOBILITY OF OIL-TYPE PRESERVATIVES IN IMMERSED WOOD ...Creosote, Evaluation, Liquid - Solid Interactions, Marine Biology (non-specific), Wood Preservatives-non-specific, ...6.0028

535
<table>
<thead>
<tr>
<th>SUBJECT INDEX</th>
<th>Fouling</th>
</tr>
</thead>
<tbody>
<tr>
<td>EVALUATION OF EFFECTS OF SATURATED HYDROCARBONS ON PRESERVATIVE QUALITY OF CREOSOTE</td>
<td>FOULING RESEARCH - Corrosion Prevention-Other, Materials Used Undersea, Water, 8.8020</td>
</tr>
<tr>
<td>BIOCHEMISTRY OF MARINE ORGANISMS</td>
<td>MICROBIAL CORROSION AND DETERIORATION OF NAVAL MATERIALS - Biological, Classification Or Taxonomy, Ionic Effect, Marine Bacteria, Materials Used Undersea, 8.8020</td>
</tr>
<tr>
<td>PRESERVATION OF WOODS IN THE MARINE ENVIRONMENT</td>
<td>DEEP-WATER FOULING - Biological, Classification Or Taxonomy, Ionic Effect, Marine Bacteria, Materials Used Undersea, 8.8020</td>
</tr>
<tr>
<td>CIVIL ENGINEERING STRUCTURES IN THE OCEANS</td>
<td>PILING PRESERVATIVE THRESHOLD STUDIES - Biological, Classification Or Taxonomy, Ionic Effect, Marine Bacteria, Materials Used Undersea, 8.8020</td>
</tr>
<tr>
<td>BOTANICAL STUDIES ON MOLTING, GROWTH, AND DEVELOPMENT IN BENTHIC BIOLOGY</td>
<td>PHYLOGENETIC RELATIONS OF FOSSIL AND LIVING GYMNOLEMATES</td>
</tr>
<tr>
<td>BENTHIC BIOLOGICAL COMMUNITIES</td>
<td>BENTHIC COMMUNITIES - Behavioral Ecology, Benthic Fauna, Bottom Sampling Device, Developmental Physiology, Metabolism, Productivity - Food Chain, 5.0561</td>
</tr>
<tr>
<td>ECOLOGICAL SUCCESSION ON SURTSEY</td>
<td>THE ROLE OF SULFUR BACTERIA IN CORROSION AND DETERIORATION</td>
</tr>
<tr>
<td>MARINE-BACTERIA CULTURE</td>
<td>MICROBIAL CORROSION IN THE MARINE ENVIRONMENT - Biodegradation, Biological, Carbon, Marine Fungi (non-specific), 5.0561</td>
</tr>
<tr>
<td>MARINE-BACTERIA CULTURE</td>
<td>MICROBICAL CONTROL IN NAVY AND MARINE OPERATING ENVIRONMENTS - Medical Studies, Microorganisms (non-specific), Oxygen, 5.0561</td>
</tr>
<tr>
<td>MARINE-BACTERIA CULTURE</td>
<td>MECHANISMS OF CALCIUM CARBONATE DEPOSITION - Bacteria, Biogeochemical Process, Calcium, Chemical Reactions, Derivatives, 5.0561</td>
</tr>
<tr>
<td>MARINE-BACTERIA CULTURE</td>
<td>MARINE FUNGI DEGRADATION - Cellulose, Growth and Differentiation, Marine Fungi (non-specific), Nutrition Studies, 5.0561</td>
</tr>
<tr>
<td>MARINE-BACTERIA CULTURE</td>
<td>MICROBES AND CORROSION - Calcium, Organisms (non-specific), 5.0561</td>
</tr>
<tr>
<td>MARINE-BACTERIA CULTURE</td>
<td>OCEANOGRAPHIC RESEARCH - Abyssal, Benthonic-bottom, Geomorphology-topography, Marine Soils, Tables, Compilations, Catalogs, 5.0561</td>
</tr>
<tr>
<td>MARINE-BACTERIA CULTURE</td>
<td>DEGRADATION OF MARINE SURFACES BY SALT REQUIRING BACTERIA - Control and Regulation, Dna-satellite, Halophilic Bacteria, Isolation From Natural Environments, Halophilic-biochemical Genetics, 5.0561</td>
</tr>
<tr>
<td>MARINE-BACTERIA CULTURE</td>
<td>MECHANISMS OF ATTACHMENT OF MARINE BACTERIA TO MARINE SURFACES - Adhesion &amp; Interface, Biological, Corrosion Prevention-Other, Marine Bacteria, 5.0561</td>
</tr>
<tr>
<td>MARINE-BACTERIA CULTURE</td>
<td>FOULING OF SENSORS - Inhibitors, Instrumentation-general, Marine Bacteria, Organometallics, 5.0561</td>
</tr>
<tr>
<td>MARINE-BACTERIA CULTURE</td>
<td>DEEP-WATER FOULING - Biological, Fish (non-specific), Predation, Vertical Distribution, 5.0561</td>
</tr>
<tr>
<td>MARINE-BACTERIA CULTURE</td>
<td>BIOLOGICAL EVALUATION OF EACH EXISTING SEED OYSTERS OF DELAWARE BAY - Number Or Density, Oysters, Spawning &amp; Nesting Sites, 5.0561</td>
</tr>
<tr>
<td>MARINE-BACTERIA CULTURE</td>
<td>STEEL PILING - Corrosion Prevention-Other, Low Alloy Steels, Polarization, Soils, Water, 5.0561</td>
</tr>
<tr>
<td>MARINE-BACTERIA CULTURE</td>
<td>MICROBIAL CORROSION - Alloys, Biological, Marine Bacteria, Sulfur Bacteria, Water, 5.0561</td>
</tr>
<tr>
<td>MARINE-BACTERIA CULTURE</td>
<td>CHEMICAL WOOD PRESERVATIVE TREATMENTS - Biological, Corrosion Prevention-Other, Creosote, Wood Preservatives (non-specific), 5.0561</td>
</tr>
<tr>
<td>MARINE-BACTERIA CULTURE</td>
<td>DRUG-REDUCING ALGAE - Algae - General, Coatings-general, Marine Bacteria, Natural Occurring, Secretions and Products, Wear, Friction, 5.0561</td>
</tr>
</tbody>
</table>

536
SUBJECT INDEX

Frequency Standards
WWWVB-WWVL BROADCASTS ...Low Frequency, Navigation, Radio, Signal Generators, Standards, Specifications, Time Measurements, Very Low Frequency, ...4.0090

Radio Frequencies
Low Frequency
WWWVB-WWVL BROADCASTS ...Frequency Standards, Navigation, Radio, Signal Generators, Standards, Specifications, Time Measurements, Very Low Frequency, ...4.0090

Very High Frequency
VHF SATELLITE COMMUNICATIONS ...Navigation, Range and Tracking-other, Space Crafts, ...4.0105
SATELLITE COMMUNICATION TESTS ...Buoys, Forecasting-prediction, Marine Environments-general, Satellites, Telemetry-other, ...4.0001

Very Low Frequency
FREQUENCY TIME RESEARCH ENGINEERING ...Amplifiers, Electronic apparatus, Transmission, Frequencies-other, Frequency Conversion, Time Measurements, ...8.0068
WWWVB-WWVL BROADCASTS ...Frequency Standards, Low Frequency, Navigation, Radio, Signal Generators, Standards, Specifications, Time Measurements, ...4.0090
VLF TIMING STUDIES ...Atenuation, Absorption, Electromagnetic Transmission, Navigation, Standards, Specifications, Time Measurements, ...4.0092

Fresh Water
STUDIES OF FISH ENDOCRINOLOGY ...Environmental Physiology, Hormone, Killifish - Cyprinodon, Testes, Thyroid, ...5.0346
FISH COLLECTION OF NORTH CAROLINA AND WESTERN ATLANTIC FISHES ...Atlantic Ocean-north, Collections, Fish - non-specific, North Carolina, ...5.0133
OREGON FISHES - THEIR CLASSIFICATIONS, DISTRIBUTIONS AND LIFE HISTORIES ...Animal Taxonomy, Life History Studies, Oregon, Vertical Distribution, ...5.0137
OREGON FISHES - THEIR CLASSIFICATION, DISTRIBUTION AND BIOLOGY ...Animal Taxonomy, Fish - non-specific, Oregon, Vertical Distribution, ...5.0138
FLOW AND SALINITY IN THE HUDSON ESTUARY, NEW YORK ...Estuaries, Inflow, Management, Salinity, Tides, ...2.0075
REMOTE SENSING, GULF COASTAL AREA, CENTRAL FLORIDA ...Aircraft, Aquifers, Saline Water Systems, Temperature, Tides, ...4.0160
MARINE BIOLOGICAL INVESTIGATIONS - TAXONOMIC COLLECTION OF THE FRESH AND SALTWATER FISHES OF ALASKA ...Alaska, Animal Taxonomy, Collections, Fish - non-specific, ...5.0100
CONTROL OF OXIDATIVE CHANGES IN FRESHWATER FISH ...Chemical Analysis, Fish - non-specific, Freezing, Organosillicic Starches, Rancidity, ...6.0045

Fuels
COMBUSTION OF RESIDUAL FUEL WITH MASSIVE RECIRCULATION ...Alloys, Atmospheric, Gases, Combustion Products, ...8.0026
A PILOT PLANT STUDY OF LOW EXCESS AIR COMBUSTION - ITS EFFECT ON FIRESIDE PROBLEMS IN OIL FIRED HEATERS ...Boilers, Combustion Products, Combustion-other, Maintenance-system, ...8.0168

Fungal Physiology
Growth and Differentiation
MARINE FUNGI DEGRADATION ...Cellulose, Fouling, Marine Fungi (non-specific), Nutrition Studies, ...8.0225

Metabolism
Nutrition Studies
MARINE FUNGI DEGRADATION ...Cellulose, Fouling, Growth and Differentiation, Marine Fungi (non-specific), ...8.0225

Pathological Physiology
BIOLOGICAL ACTIVITIES OF MARINE FUNGI ...Endoparasites -other, Host-parasite Interactions, Invertebrate Pathology, Marine Fungi (non-specific), Oysters, Plant Developmental Biology, ...5.0699

Fungi
Aquatic Fungi (non-specific)
SYSTEMATICS, MORPHOLOGY, AND ECOLOGICAL DISTRIBUTION OF ALGAL AND WOOD-INHABITING MARINE AND FRESHWATER FUNGI OF SURTSEY AND ICELAND ...Iceland, Islands, Marine Fungi (non-specific), Plant Taxonomy, Range Or Territorial Distri, ...5.0714
LACUSTRINE AND ESTUARINE FUNGI ...Host-parasite Interactions, Marine Fungi (non-specific), Phytoplankton, Plant Morphology, Plant Taxonomy, Range Or Territorial Distri, ...5.0731

Dermocystidium
STUDIES ON THE DEVELOPMENT OF DERMOCYSTIDII MARINUM ...Cell Cycle, Control and Prevention, Fungal Culture, Oysters, Pathology, ...5.0856

Marine Fungi (non-specific)
SYSTEMATICS, MORPHOLOGY, AND ECOLOGICAL DISTRIBUTION OF ALGAL AND WOOD-INHABITING MARINE AND FRESHWATER FUNGI OF SURTSEY AND ICELAND ...Aquatic Fungi (non-specific), Iceland, Islands, Plant Taxonomy, Range Or Territorial Distri, ...5.0714

MICROBIOLOGICAL INVESTIGATIONS OF THRESHOLD PANELS ...Catabolism and Degradation, Degradation, Freshwater Mussels, Scallops, Marine Bacteria, Wood, Wood Preservatives-non-specific, ...8.0243
MORPHOLOGY AND TAXONOMY OF MARINE FUNGI ...Habitat Studies, Mangroves, Plant Morphology, Plant Taxonomy, Sub - Tropic, Tropic, ...5.0716
LACUSTRINE AND ESTUARINE FUNGI ...Aquatic Fungi (non-specific), Host-parasite Interactions, Phytoplankton, Plant Morphology, Plant Taxonomy, Range Or Territorial Distri, ...5.0731

DISTRIBUTION OF ANTARCTIC MARINE FUNGI ...Antarctica, Phycomycetes, Plant Taxonomy, Range Or Territorial Distri, ...5.0791
MICROBIAL CORROSION IN THE MARINE ENVIRONMENT ...Biodegradation, Biological, Carbon, Fouling, Water, ...5.0769
MARINE FUNGI DEGRADATION ...Cellulose, Fouling, Growth and Differentiation, Nutrition Studies, ...8.0225
EXPERIMENTAL ECOLOGY OF LOWER MARINE FUNGI ...Habitat Studies, Phycomycetes, Plant Developmental Biology, ...5.0808
PRESEVATION OF WOODS IN THE MARINE ENVIRONMENT ...Biological, Fouling, Habitat Studies, Materials Used Underwater, Preservatives, Wood, ...8.0216
COMPARATIVE BIOCHEMICAL AND MORPHOLOGICAL CHARACTERISTICS OF MARINE FUNGI FROM SHELLFISH ...Endoparasites -other, Fungal Culture, Histochemistry - Cytochemistry, Histology and Cytology, Plant Taxonomy, ...5.0791
WATER QUALITY AND FUNG NIEMATODE-SEAGRASS RELATIONSHIPS ...Elodea, Waterweed, Thalassia, Florida, Habitat Studies, Nematomata -other, ...5.0878
BIOLOGICAL ACTIVITIES OF MARINE FUNGI ...Endoparasites -other, Host-parasite Interactions, Invertebrate Pathology, Oysters, Pathological Physiology, Plant Developmental Biology, ...5.0699

Mycorrhiza
SUPPORT FOR THE PHYSIOLOGICAL RESEARCH SHIP, R/V Alpha Helix ...Insecticides -non-specific, Nerve Effects, Rain Forests, Regulation, Tropic, ...12.0011

Myxomycetes
ULTRASTRUCTURAL STUDIES OF PARASITIC AND SAProphytic FUNGI AND PROTOZOA ASSOCIATED WITH MARINE INVERTEBRATES ...Cell Cycle, Electron Microscopy, Host-parasite Interactions, Protozoa, ...5.0839
STUDIES ON THE PROTISTAN CAUSING MALPEQUE DISEASE ...Invertebrate Pathology, Oysters, Pathology, Plant Taxonomy, Range Or Territorial Distri, ...5.0498

537
Geochemistry

Mineral Equilibria
MINEAL-WATER CHEMISTRY, GREAT LAKES ...Chemical Reactions, Great Lakes, Geochemical Equilibrium, ...1.0117

Phase Relationships
MINERAL-WATER CHEMISTRY, GREAT LAKES ...Chemical Reactions, Great Lakes, Geochemical Equilibrium, ...1.0117

Solution Chemistry
ALTERATION OF MINERALS ...Aragonite ...3.0054
Mineralogy, Saline Water Systems, Silicates, ...7.0085
SOLUTION-SILICATE REACTIONS AND ...REACTION ...7.0260
Chemical Reactions, Chemistry, Equilibrium, Groundwater, Reaction-general, Silicate-gene ...1.0079

CHEMICAL EXCHANGES ACROSS SEDIMENT-WATER INTERFACES ...Chemical, Chemical-general, Estuaries, Exchange Capacities, ...7.0089

MINERAL-WATER CHEMISTRY, GREAT LAKES ...Chemical Reactions, Great Lakes, Geochemical Equilibrium, ...1.0117

Stability Fields
ROCKS OF OCEANIC CRUST AND UPPER MANTLE EQUILIBRIUM ...atlantic Ocean-general, Earth Energetics, Ocean Basins, Petrogenesis-general, Petrology, ...7.0059

Geochemical Investigations
Element Ratios
THE GEOCHEMISTRY OF RADIOACTIVE ELEMENTS IN THE MARINE ENVIRONMENT ...7.0055
GEOCHEMISTRY OF LANDLOCKED SEAS ...Distribution, Oceans, Sea Water, Radioactive Dating, Sedimentation, Uranium, ...1.0085

GEOCHEMICAL STUDIES OF CONTINENTAL WATERS ...Authigenesis, Geochemical Analysis, Isotope, Isotope Trace, other, Location, Pore Fluids, Radiotopes, Water Analysis, ...1.0121

DEPOSITION RATES BY THE PROTECTINUM METHOD ...Chemical, Distribution, Manganeous, Sedimentary Petrogenesis, Thermal, Thromism, Uranium, ...7.0260

AZORES VOLCANIC STUDY ...Atlantic Ocean-general, Azores, Igneous Activity - Volcanism, Ridges, Volcanic, ...8.0195

STABLE CARBON AND OXYGEN ISOTOPE RATIO VARIATIONS IN THE FLOW TO CARBON AND OXYGEN THROUGH NORMAL AND POLLUTED AQUATIC SYSTEMS ...Carbon, Organic-general, Oxygen, Pollutants - Path of, Serratage System-in-other, Water Analysis, ...1.0132

RARE GAS STUDY OF INTERPLANETARY MATERIAL IN PELAGIC SEDIMENTS ...Chemistry, Cosmogenous, Equipment Purchase Operation, Mass Spectroscopy, Mineralogy, X-ray, ...7.0081

SIGNIFICANCE OF FLUORIDE VARIATIONS IN SEA WATER ...Atlantic Ocean-general, Chloride, Extrusives, Fluoride, Water Analysis-general, ...1.0105

TRACE ELEMENT AND STABLE ISOTOPE STUDIES OF CORAL REEF CARBONATES ...Diagenesis, Fossil Limestone, Paleoenvironments, Rocks, Trace Element Analysis, ...7.0086

ELEMENT CHEMISTRY ...Atomic Absorption, Industrial Wastes, Oceanic Fronts, Water Chemistry-other, ...1.0113

GEOLOCIC INVESTIGATIONS IN PUERTO RICO & THE CARIBBEAN ...Caribbean Sea, Plutonic, Pacific, Petrology, ...7.0042

DISTRIBUTION OF ELEMENTS IN FLUVIAL AND BRACKISH ENVIRONMENTS ...Adsorption, Adsorption Capacity, Brackish Water, Chemical Reactions, Exchange Capacity, Sediment, ...7.0221

Genetic Relationships
STABLE ISOTOPE STUDIES ON COEXISTING MINERALS IN MARINE SEDIMENTS ...Coring and Dredging, Diagenesis, Mineralogy, Red Sea, Salinity, Thermal, ...1.0106

KAOLINITE AS RELATED TO DEPOSITION OF DEPOSITION ...Diagenesis, Environment, Kaolinite, Mineral Type, ...7.0239

Geologic Age Relations
POTASSIUM-ARGON DATING OF DEEP-SEA SAMPLES ...Abysmal, Argon-potassium, Microfossils, Radiocative Dating, Sea Floor Spreading, Tertiary Period, ...7.0066
### SUBJECT INDEX

#### Geochronology

- Geochronology-general
  - Geologic History of Pacific Faunas, Evolutionary Studies-general, Pacific Oceans-General, Paleontology, Sea Level Changes, ...7.0116
  - Geochemistry of Mid-Atlantic Ridge Sediments, Atlantic Ocean-General, Chemistry, Core Analysis, Correlation, Ridges, ...7.0071

#### Geodec Instrumentation

- Geodic Instrumentation
  - Collection of the Varved Sediments in Saanich Inlet, Canada, Geologic and Dredging, Local Stratigraphy, Pacific Ocean-east, Varves, ...7.0282
  - Correlation of Submarine Volcanic Ash by Cathode-Luminescence, Correlation, Extrusive, Luminescence, Qualitative, Size, ...7.0255
  - University of Southern California Contract, Channel Islands and Basins Southern California, Continental Margin, California, Continental Shelf, Continental General Mineralogic Properties, Mineralogy, ...7.0225

#### Radioactivity Methods

- Argon-potassium
  - Neutron Activation Analysis of Iron Meteorites, Activation Analysis, Aluminum, Carbon, Cosmogenic, Iron, Neutron Activation, ...7.0065
  - Dating Marine Sediments, Least, Optical, Origin, Radiocarbon Dating, Rate of Deposition, Terrigenous, ...7.0201
  - Potassium/Argon Dating of Deep-Sea Samples, Abyssal, Geologic Age Relations, Neutron Activation, Ocean-floor Spreading, Tertiary Period, ...7.0225
  - Petrology and Geochemistry of Igneous Rocks from the Ocean Floor, Extrusive, Pacific Ocean-eat, Petrography, Petrology, Ridges, Soma, ...7.0064

#### Carbon-14

- Chemical Oceanography, Carbon, Chemical Reactions, Gulf of Mexico, Origins, Reaction-General, ...1.0131
  - Carbon-14 Age Profile of a Hawaiian Reef, Anhozhou, Coral and Dredging, Growth Rate, Hawaii, Reefs, Sea Level Variations, ...7.0051
  - Investigation of Quaternary Sea Level Changes in the Caroline and Marshall Islands, Emergent, Pacific Ocean-south, Quaternary Period, Reefs, Sea Level Variations, ...7.0159
  - Radiocarbon Dating of a Hawaiian Reef Profile, Hawaii, Radiocarbon Dating, Reefs, Sea Level Variations, ...7.0087
  - An Investigation of the Mass Physical Properties of Carbonate Mud Sediments, Carbonates-other, Core Analysis, Density, Physical Properties, Porosity, ...7.0225
  - Natural RadioCarbon Measurements, Facililities, Mixing, Oceanic Fronts, Pacific Ocean-general, Radioactivity, ...1.0084
  - Properties and Origin of Sediments in the Northeast Pacific Ocean-General, Core Analysis, Origin, Pacific Ocean-east, Physical Properties, Washington, ...7.0287
  - Rectile Coepods from Lake Tungur, Ellesmere Island, ...Brackish Water, Canada, Copepods, Lakes, Plankton Sampling, ...5.0388

#### Uranium

- Investigations of Uranium and Thorium Series Isotope Disequilibrium in the Ocean and in Pleistocene Sediments, Chemistry, Glacial History, Quaternary Period, Radioactivity, Radium, Thorium, ...7.0120
  - The Geochemistry of Radioactive Elements in the Marine Environment, The Geochemistry of Landlocked Seas, Distribution, Element Ratios, Ocean - Sea Water, Radioactive Dating, Sedimentation, ...1.0095

#### Geodesy

- Geodesy
  - Geodetic Surveys
    - Gravity Survey Arctic Ocean, Bathymetry, Beaufort Sea, Continental Shelf, Gravity Studies, Seismic Studies, Structural Studies, ...7.0114

#### Standard Geod

- Standard Geod
  - Marine Physical Geodesy, Aquatspal, Caribbean Sea, Gravity Studies, Navigation, Sea Level Variations, ...4.0058

#### Geodetic Instrumentation

- Geodetic Instrumentation
  - New Sea Gravity Meter, Capacitance, Geophysical Equipment, Gravity Studies, Instrumental Services, Transducers, ...8.0067

---

**Table:**

- **Geochronology**
  - Magsas...
  - Lithosphere
  - Meteorites
  - Ocean Bottom
  - Meteorites-general
  - Organic Geochemistry
  - Biogeochemical Process
  - Biogeochemistry of Nucleic Acids
  - Biogeochemistry of Terrestrial & Extraterrestrial Organic Matter
  - Uranium Geochemistry in (Modern) Carbonates
  - Chemical Oceanography
  - Biogeochemistry of Carbonate S...
SUBJECT INDEX

Geophysical Oceanography

A STUDY OF THE TEMPERATURE MICROSTRUCTURE AND EDDY TRANSPORT IN THE OCEAN FLOOR BOUNDARY LAYER...Benthic-bottom, Geothermal, Physical Analysis, Temperature, Thermodynamics, 1.0189

ATLANTIC OCEAN CRUSTAL STUDIES...Atlantic Ocean-general, Basin, Bathymetry, Coring and Dredging, Crust, Seismic Reflection, 7.0116

GEOPHYSICAL INVESTIGATIONS IN THE TAIWAN-PHILIPPINE-NEW GUINEA REGION...Basin, Gravity Surveys, Magnetic Surveys, Seismic Reflection, 7.0129

GEOTHERMAL INVESTIGATIONS IN OCEAN REGIONS...Atlantic Ocean-general, Geothermal, Model Studies, Regional Structure, Technique Development, 7.0121

THE GEOCHEMISTRY, MINERALOGY AND ORIGIN OF PELAGIC SEDIMENTS IN AREAS OF HIGH HEAT FLOW AND FRACTURE ZONES...Chemistry, Diagenesis, Geochemistry, Mineralogy, Origin, Sedimentation, 7.0227

HEAT FLOW MEASUREMENTS...Atlantic Ocean-general, Geophysical Equipment, Photography, Technique Development, Water Motion Recorders, 7.0138

HEAT FLOW MEASUREMENTS...Basin, Melanesia, Philippines, Ridges, Temperature, 7.0109

GEOTHERMAL STUDIES IN DEEP-SEA DRILL HOLES...Abyssal, Bathyal, Borehole Geophysics, Core Temperature, Earth Interior, Geothermal, Heat Flows, Sediments-general, Technique Development, 7.0122

GEOTHERMAL INVESTIGATIONS IN OCEAN REGIONS...Atlantic Ocean-general, Oceanic - Pelagic, Ridges, Sediments-other, Temperature, 7.0123

Magnetic Studies

PARTIAL SUPPORT OF A PROGRAM OF EDUCATION & RESEARCH IN MARINE SEISMOLOGY AND GEOMAGNETICS...Seismic Studies, Training Grants, Fellowships, 7.0127

RESEARCH IN MARINE GEOLOGY...Bathymetry, Data Analysis - General, Gravity Studies, Seismic Studies, Ships and Cruises, 7.0027

SEARCH FOR FERROMAGNETICALLY TRAPPED MAGNETIC MOMENTS OF LAMINATED RAY ORIGIN...Field Reversals, Magnetic Monopole, Paleomagnetism, Physical Properties, 7.0114

MARINE GEOLOGY...Acoustical, Bathymetry, Geomorphology-topography, Mapping, Sea Floor Spreading, 7.0041

EARTH CURRENT STUDIES...Aurora, Earth-telluric Current, 4.0085

ARCTIC RESEARCH...Acoustical, Arctic Ocean, Currents-ocean, Geomorphology-topography, Sea Ice, 4.0049

MARINE GEOPHYSICS...Caribbean Sea, Geomorphology-topography, Geophysical Equipment, Heat Flow Measurements, Structural Studies, 7.0115

MARINE SEDIMENTS...Atlantic Ocean-south, Bathymetry, Ridges, Sea Floor Spreading, Textures-structures, 7.0203

HEAT FLOW AND MAGNETICS IN THE PHILIPPINE SEA...Arcs, Heat Flow Measurements, Philippine Sea, Sea Floor Spreading, Trenches, 7.0137

ACQUISITION, REDUCTION AND INTERPRETATION OF MARINE MAGNETIC DATA...Anomalies, Data Acquisition, Data Reduction and Analysis, Ridges, 4.0032

GRAVITY AND MAGNETIC DATA COLLECTED DURING THE INTERNATIONAL INDIAN OCEAN EXPEDITION AND IN THE CARIBBEAN SEA...Data Analysis - General, Data Reduction and Analysis, Digital Computer Applications, Gravity Studies, Indian Ocean-general, Research - Development, 4.0039

GEODELIC AND GEOPHYSICAL INVESTIGATION OF THE BAHAMA BANK...Banks, Bathymetry, British West Indies, Crust, Seismic, 7.0110

GEOPHYSICAL AND GEOSCIENCE STUDY OF THE DARN-WIN RISE...Bathymetry, Coring and Dredging, Geophysical-studies, Island-arcs, Ocean Basins, Pacific Ocean-oest, Photography, Refraction, Ridges, Seamounts-guyots, 7.0112

MARINE GEOPHYSICAL STUDIES IN THE PACIFIC OCEAN...Crust, Gravity Studies, Ocean Basins, Seismic Studies, Solomon Islands, 7.0113

THE MAGNETIZATION OF SUBMARINE BASALTS AND ITS EFFECT ON MARINE MAGNETIC ANOMALIES...Anomalies, Extrusives, Field Reversals, Paleomagnetism, Seamounts-guyots, 7.0113

SEA FLOOR ROUGHNESS...Acoustical, Attenuation, Benthic-bottom, Bottom Sampling Device, Propagation, Transmission, 7.0033

WOODS HOLE SHIPBOARD DATA PROCESSING...Data Reduction and Analysis, Digital Computer Applications, Gravity Studies, Navigation, Real-Time Systems, 4.0031

SEAMOUNT INVESTIGATION...Anomalies, Data Analysis - General, Geothermal, Ocean Mining, Seamounts-guyots, Sonar, 7.0107

MAGNETIC AND GRAVITY PREDICTION...Geomagnetic Field, Magnetic Sensor, Noise, 4.0044

EVALUATION OF CONTEMPORARY ACOUSTIC, MAGNETIC AND GRAVIMETRIC METHODS FOR DETERMINING SIZE AND SHAPE OF DEPOSITS...Geophysical Equipment, Gravity Studies, Instrumental Services, Sonar, Survey Studies, 7.0007

TESTING AND EVALUATION OF MAGNETER/GRADIOMETER AND TOW VEHICLE SYSTEM...Evaluation Other, Field Testing, Instrumental Services, Ore Deposits, Placer, 8.0116

Seismic Studies

PARTIAL SUPPORT OF A PROGRAM OF EDUCATION & RESEARCH IN MARINE SEISMOLOGY AND GEOMAGNETICS...Magnetic Studies, Training Grants, Fellowships, 7.0127

HIGH-POWER HYDROACOUSTIC VIBRATOR DEVELOPMENT...Generation, Liquids, Sonar, 8.0015

A SHIPBOARD DIGITAL DATA ACQUISITION SYSTEM...Data Acquisition, System Analysis, Tape Storage, 4.0036

SUBMARINE GEOLOGY OF GASTINEAU CHANNEL JU- NEAU, ALASKA...Alaska, Basins, Distribution, Size, Subbottom, 7.0191

SUBMARINE SEISMIC PROFILES OF THE WORLDS OCEANS...Atlantic Ocean-general, Cables and Transmission Lines, Data Analysis - General, Indian Ocean-general, Subbottom, 7.0050

LOW NOISE MULTI-CHANNEL HYDROPHONE CABLE...Amplifiers, Bathymetry, Cables and Transmission Lines, Telephone, Transmission Lines, 8.0014

SEISMICAL AND GEOPHYSICAL DATA...Earthquakes, Propagation, Rift Structure, Location, Surface, 7.0141

RESEARCH IN MARINE GEOLOGY...Bathymetry, Data Analysis - General, Gravity Studies, Magnetic Studies, Ships and Cruises, 7.0027

STUDY OF EARTH NOISE ON LAND AND SEA BOTTOM...Microseisms - Background, Ocean Basins, Propagation, Structural Studies, 7.0094

MARINE GEOPHYSICS...Crust, Field Characteristics-general, Gravity Studies, Gulf of Mexico, Physical Properties, 7.0149

STUDY OF SEISMIC STRUCTURE OF ELLIOTT PIL- SBURY, GERDA, TURSIOPS...Microfossils, Micropaleontology, Paleotemperature, Pteridology, Seabed and Crusts, 12.0024

MOHOLE SITE STUDIES...Coring and Dredging, Earth Interior, Hawaii, Pacific Ocean-north, Structure Location, 7.0097


DIGITIZING SYSTEM FOR OCEANOGRAPHIC DATA...Analogue-digital Converters, Applied Electronics, Bathymetry, Digital Computers, Instrumental Services, Spectroscopy, 4.0039

DEEP EARTHQUAKES AND ISLAND-ARC TECTONICS AND STRUCTURE...American Samoa, Attenuation, Earthquake Location, Earthquakes, Island-arcs, Velocity Variations, 7.0140

SUPPORT OF RESEARCH VESSEL AT LAMONT GEOLOGICAL OBSERVATORY...Subbottom, Marine Biology, Patterns, Ridges, Ships and Cruises, 12.0037

GEODELIC AND GEOPHYSICAL INVESTIGATION OF THE BAHAMA BANK...Banks, Bathymetry, British West Indies, Crust, Magnetic Studies, 7.0110

COLLECTION, REDUCTION, AND INTERPRETATION OF SEISMOLOGIC AND PHOTOGRAPHIC DATA...Data Analysis - General, Distribution, Earthquakes, Sonar, 7.0013

LAKE SUPERIOR CORING...Core Analysis, Lake Superior, Sedimentology-general, Subsurface, Textures-structures, 7.0247
SUBJECT INDEX

CHEMICAL OCEANOGRAPHY...Carbon, Carbon-14, Chemical Reactions, Organic Reactions-general...1.0131
AIR-SEA INTERACTION...Air-sea Boundary-general, Currents-ocean, Thermal, Tropical Cyclones, Weather Forecasting, 3.0042
MARINE GEOPHYSICS...Crust, Field Characteristics-general, Gravity Studies, Physical Properties, Seismic Studies, 7.0149
HETEROPTERTIC ACTIVITY AND PRIMARY REGENERATION IN THE OCEAN...Atlantic Ocean-south, Biodegrada-
tion, Carbon, Organics, Organics-general, 1.0114
ECOLOGICAL EFFECTS OF ENVIRONMENTAL & LOW LEVEL POLLUTANT STRESSES ON METABOLIC
REQUIREMENTS FOR GROWTH OF GULF COAST FISHES...Environmental Ecology, Metabolism, Pollution - Effects of, Pollu-

tion Effects, Pollution Sources-general, Stress, 5.0328
COLLECTION AND INTERPRETATION OF OCEANIC THER-
MAL GRADIENTS...Bathythermographs, Heat Flow Measure-
ments, Pacific Ocean-est, Temperature, 1.0187
SEA BREEZE INVESTIGATION...Analysis - General, Energy-general, Heat and Radiation Transfer, Land-sea
Breezes, Texas, 3.0040
LIPID COMPOSITION OF ANTARCTIC MARINE ORGANISMS AND SEA WATER...Antarctic Ocean, Fish -non-
specific, Lipids, Low Temp. -but Above 32f, Phytoplankton, Productivity - Food Chain, Zooplankton, 3.1031
SYMPOSIUM ON RESEARCH NEEDS AND PRIORITIES FOR MARINE GEOLOGY OF THE GULF OF MEXICO...Contin-
tinal Shelf, Instrumentation-general, Mechanical Properties, Meets, Sedimentation, Structural Studies, Distribution, 9.0040
OPERATION OF R/V ALAMINOS...Carbon, Caribbean Sea, Gulf Stream, Ships and Cruises, Textures-structures, 12.0046
CIRCULATION IN THE GULF OF MEXICO...Circulation-
general, Currents-ocean, Infrared Radiation, Mapping, Oceanic Fronts, 2.0022
DEEP SEA BENTHOS OF THE GULF OF MEXICO...Benthic Fauna, Benthic-bottom, Biology, Population Dynamics, 3.0655
REMOTE SENSOR OCEANOGRAPHY...Aerial Photography, Cloud Temperature, Correlated Radiation, Satellites, Surface En-
vironments, Temperature, 4.0170
BOTTOM ENVIRONMENT-GULF OF MEXICO...Benthonic-
bottom, Biology, Chemistry, Ocean Currents-other, Physical Properties, 2.223
CIRCULATION STUDIES...Circulation-general, Currents-ocean, Model Studies, Thermal, Tropical Cyclones, 2.0044
GEOPHYSICS, GULF OF MEXICO...Ocean Basins, Regional
Structure, Seismic Studies, Structural Studies, Trenches, 7.0148
OYSTER LEASE CONTROL MONUMENTS - BAY ADAM, BASTIAN BAY AND SANDY POINT BAY AREAS...Com-
mercial Fishing, Louisiana, Oysters, Plane, Tides, 4.0057
LAKE BORINGO - CHANDELEUR SOUND SYSTEM...Data Acquisition, Maturity, Growth, Net, Plankton Sampling, Population Dynamics, Shrims - Common, 5.0343
HORIZONTAL DISPERSION IN SHALLOW ESTUARIES OF IRREGULAR SURFACE...Circulation-water, Estuaries, Model Studies, Water Quality-general, 2.0064
REFERENCE COLLECTION OF GULF MARINE ANIMALS...Animal Taxonomy, Collections, Invertebrates -non-specific, Vertebrates -non-specific, 5.0657
STUDY OF LIFE HISTORY AND ECOLOGY OF SERPUL-
IDAE IN TEXAS COASTAL WATERS...Life History Studies, 5.0656
 DISTRIBUTION OF HEAVY METALS, WESTERN GULF OF MEXICO...Chemistry, Dimensions-distribution, Geophys-
ics-general, Heavy Minerals, Ocean Mining, 7.0013
MARINE GEOLOGY STUDIES, GULF OF MEXICO-CARIB-
BEAN REGION...Dimensions-distribution, Distribution, Geology-
general, Ocean Mining, Tectonics-general, 7.0103
ECOLOGICAL STUDIES OF ATLANTIC AND GULF COAST ESTUARIES OF IMPORTANCE TO WATER-
FOWL...Agricultural Land Use Effects, Atlantic Ocean-general, Construction Land Use Effects, Estuaries, Habitat Studies, Waterfowl -non-specific, 5.0096
INVENTORY AND ATLAS OF GULF COAST SPORT FISH-
ING FACILITIES...Atlases-maps, Fishing, Handbooks, Management-other, 9.0006
ENVIRONMENTAL EFFECTS ON ISTIOPHORID FISH DIS-
TRIBUTION...Environmental Ecology, Marlin, Billfishes, Saffish, Ships and Cruises, Temporal Distribution, 5.0070
INVENTORY OF THE GULF ESTUARY SYSTEM...Bays, Data Acquisition, Estuaries, Fishing, Sedimentology-general, 4.0047
INVESTIGATION OF THE BIOLOGY AND POPULATION
STRUCTURE OF GULF MENHADEN...Alewife, men-
haden,shad,herring, Bone, Handbooks, Population Dynamics, Vertetate Anatomy, 5.0138
ESTIMATION OF JUVENILE ABUNDANCE IN ESTUARINE NURSERIES...Alewife, menhaden,shad,herring, Aquatic Ecolo-
y, Estuaries, Maturity & Growth Stages, Number Or Density, 5.0131
CIRCULATION DYNAMICS (GULF OCEANOGRAPHY PRO-
GRAM)...Circulation-general, Environmental Changes, Shrimp, Common, Thermodynamics, 2.0045
BIOLOGICAL OCEANOGRAPHY (GULF OCEANOGRAPHY PRO-
GRAM)...Environmental Ecology, Food Supply, Productiv-
ity - Food Chain, Shrims - Common, 4.0057
EVALUATION OF ENGINEERING PROJECTS AND
ESTUARINE DATA (ESTUARINE PROGRAM)...Commer-
cial Fishing, Engineering Studies, Estuaries, Habitat, 1 studies, Swamps-marshes, 9.0021
POPULATION DYNAMICS (SHRIMP DYNAMICS PRO-
GRAM)...Commercial Fishing, Mortality Rates, Nets, Popula-
tion Dynamics, Shrims - Common, 5.0653
ECOLOGY OF WESTERN GULF ESTUARIES (ESTUARINE
PROGRAM)...Coastal Engineering-other, Estuaries, Habitat Studies, Mass Activities, Pollution - Effects of, 5.0692
LABORATORY STUDIES OF TOXIC DINOFLAGELLATES...Algal Culture, Algal Toxins, Gonyaulax, Gymnodinium, Plant Orin, 5.0287

Harbors

GENERATION, PROPAGATION, AND COASTAL EFFECTS OF TSUNAMIS...Earthquakes, Propagation, Shoreline - Coast-
line, Shoreline Studies, Tsunami, 7.0095
CRITERIA FOR THE DESIGN OF SMALL CRAFT HARBORS...Breakwaters, Coastal Engineering-other, Marinas, Seiches, 8.0036
MEASUREMENT OF SURGING IN KUHIO BAY, HILO HAWAI
I...Gaging, Hawaii, Tsunami, Water Motion Recorders, Waves, 8.0037
BARBERS POINT HARBOR MODEL STUDY...Hawaii, Model Studies, 4.0104
DESIGN OF RUBBLE WAVE-ABSORBER...Beaches, Energy
Dissipators, Measuring Devices-other, Shoreline Studies, Waves, 8.0037
BACTERIOLOGICL AND ESTHETIC OF PLEASURE BOAT
WASTE DISCHARGE ON SMALL MARINE HARBORS...Bacterial Pol-
tant Sources, Beautification, Marinas, Ship Wastes, Water Analysis, 6.0191
THE POPULATION ECOLOGY OF GEMMA GEMMA (PELECYPODA, VENERIDAE), A DOMINANT SPECIES IN
BARNSTABLE HARBOR, MASS...Clams, Massachusetts, Population Dynamics, 5.0640
FORAMINIFERA FROM HEDLEY HARBOR, MAS-
SACHUSETTS...Environmental Ecology, Foraminifera, Mas-
sachusetts, Number Or Density, Vertical Distribution, 5.0663
TIDAL FLOWS IN RIVERS AND HARBOURS...Committee-sup-
port, Hydraulicities-general, Streams, Tides, 2.0087
HARBOR DESIGN STUDIES...Navigation, Waves, 8.0046
EFFECTS OF SCALE AND OPERATING TECHNIQUE ON
HARBOR MODELS...Synthetic Hydrology, 4.0074
GREAT LAKES RESEARCH - HARBOR CURRENTS...Great
Lakes-general, Model Studies, Ocean Currents-other, Pressure-
density, Water Level Fluctuation, Wind-water Interaction, 2.0074
HISTORICAL STUDY ON EFFECT OF HARBOR DREDGING ON THE ENVIRONMENT (ENVIRONMENTAL FACTORS
PERTINENT TO EFFECTS ON MARINE ENVIRONMENTS)...Dredging, Environmental Effects-geologic, Excavation, 6.0135
TRACERS STUDIES IN ALASKAN HARBORS...Estuaries, Flow Augmentation, Industrial Wastes, Tides, Trawlers-general, 2.0609

551
SUBJECT INDEX

Hawaii

HAWAIIAN OCEANOGRAPHY ...Circulation-general, Environmental Effects-geology, Hydrodynamics, Islands, Ocean Currents-other... 1.2001

PHYSICAL OCEANOGRAPHY ...Convection, Heat and Radiation Transfer, Mixing, Thermal, Wind-water Interaction,... 1.2003

THE SYSTEMATICS AND ZOOGEOGRAPHY OF THE BRYOZOAN FAUNA OF THE HAWAIIAN ISLANDS ...Animal Taxonomy, Australian, Bryozoa, Collections, Range Or Territorial Dist,... 1.2004

POPULATION GENETICS AND LARVAL ECOLOGY OF HAWAIIAN LITTORINA ...Derivatives, Gastropods - slugs,conch,snails, Maturity & Growth Stages, Polymorphism,... 1.2005

RECENT AND ANCESTRAL FAUNAS OF A DROWNED ISLAND CHAIN (MID-PACIFIC MOUNTAINS) ...Benthic Fauna, Biofacies, Coring and Dredging, Seamounts-guyots,... 1.2006

TSUNAMI RUNUP EXPERIMENTS ON A SCALE MODEL OF OAHU ...Forecasting-prediction, Model Studies, Tsunami,... 1.2007

MOHOLE SITE STUDIES ...Coring and Dredging, Earth Interior, Pacific Ocean-north, Seismic Studies, Structure Location,... 1.2008

CARBON-14 AGE PROFILE OF A HAWAIIAN REEF ...Anthozoa, Carbon-14, Coring and Dredging, Growth Rate, Reefs, Sea Level Variations,... 1.2009

RADIOCARBON DATING OF A HAWAIIAN REEF PROFILE ...Carbon-14, Radioactive Dating, Reefs, Sea Level Variations,... 1.2010

DEVELOPMENT OF A SIMPLE UNATTENDED PYCNOCLINE FOLLOWER ...Density, Heat and Radiation Transfer, Wind-water Interaction,... 1.2011

OPERATIONAL SUPPORT OF OCEANOGRAPHIC RESEARCH VESSELS ...Facilities, Geophysics-general, Sediments-general, Structural Studies,... 1.2012

MEASUREMENT OF SURGING IN KUHIO BAY, OAHU ...Bays, Harbors, Tsunami, Water Motion Recorders, Waves,... 1.2013

BARBERS POINT HARBOR MODEL STUDY ...Harbors, Model Studies,... 1.2014

INTRODUCTION OF MARINE GAME FISHES FROM AREAS IN THE PACIFIC ...Diving and Scuba, Pacific Ocean-north, Stocking of Fish & Shellfish,... 1.2015

SEA SLED AND SCUBA RECONNAISSANCE OF INSHORE AND STUDIES ON EFFECT OF ARTIFICIAL SHELTERS ON STANDING CROP OF FISHES ...Coastlines-shorelines, Diving and Scuba, Fish -non-specific, Geomorphology-topography, Management-other,... 1.2016

HAWAII STATE COMPREHENSIVE OUTDOOR RECREATION PLAN ...Inventories, Methods, Projected Demand, Recreation, Survey, Use Characteristics,... 1.2017

BACTERIOLOGICAL STUDY OF THE POLLUTION OF KANEHOE BAY, OAHU ...Bays, Biodicators, Coliforms (non-specific), Nitrogen, Sewage, Streptococcus Fecalis,... 1.2018

SPECTRAL ANALYSIS OF TIDAL CURRENTS ...Currents-other, Integral Transforms, Prediction, Tides, Time Series Analysis,... 1.2019

ALPINE LIMNOLOGY PROJECT ...Core Analysis, Dust - Particulate Matter, Extratropics, Lakes, Mountains-alpine, Volcanoes,... 1.2020

STUDY OF THE THINNASE IN HAWAII FISH ...Enzymatic, Enzyme Inhibitors, Fish -non-specific, Thiaminase, Toxicological and Allergy,... 1.2021

WESTERN PACIFIC ISLANDS ...Igneous Activity, Volcanism, Lava, Mapping, Petrology, Sea Level Changes,... 1.2022

INVESTIGATE FACTORS DETERMINING DISTRIBUTION OF PHYSICAL AND CHEMICAL PROPERTIES OF THE PACIFIC OCEAN ...Currents-ocean, Mathematical Models, Ocean Studies, Oceanic Fronts, Pacific Ocean-general,... 1.2023

STUDY ASSOCIATION BETWEEN TRADE WIND SYSTEM AND NORTH PACIFIC OCEANOGRAPHIC CLIMATE ...Meteorological Studies, Ocean-Lakes, Temperature, Waves, Wind-water Interaction,... 1.2024

INVESTIGATE SEASONAL VARIATIONS, SURFACE WATER TYPES, HAWAIIAN AREA (KOKO HEAD) ...Commercial Fishing, Fish-and-Radiation Transfer, Oceanic Fronts, Salinity, Temperature, Tuna, Mackarel, Albacore,... 1.2025

PROVIDE FOR ACTIVITIES OF TUNA BLOOD GROUP CENTER ...Blood Plasma and Serum, Blood Typing Studies, Immunology Methods, Tuna, Mackrel, Albacore,... 2.0001

INCREASE EFFICIENCY OF HAWAIIAN SKIPJACK FISHERY ...Captive Rearing, Commercial Fishing, Food Supply, Tuna, Mackrel, Albacore,... 2.0002

DETERMINE ALTERNATE LIVEBAIT SPECIES ...Anchovies, Captive Rearing, Commercial Fishing, Fish Gear, Production & Processing, Technique Development, Technological Development,... 2.0003

DEVELOP FISHERIES FOR NON-TUNA RESOURCES ...Commercial Fishing, Fish & Shellfish, Fishing Gear, Production & Processing, Technique Development, Technological Development,... 2.0004

INCREASE EFFICIENCY OF HAWAIIAN LONGLINE FISHERY ...Commercial Fishing, Fish & Shellfish, Fishing Gear, Production & Processing, Technique Development, Technological Development,... 2.0005

INVESTIGATE POPULATION DYNAMICS OF SKIPJACK TUNA IN HAWAIIAN WATERS ...Commercial Fishing, Economics, Environmental Ecology, Population Dynamics, Tuna, Mackrel, Albacore,... 2.0006

SENSORY PROCESSES ...Basic Studies, Pathways,... 2.0007

Heat Transmission

Boiling & Evaporation

THERMALLY SUSTAINED PRESSURE OSCILLATIONS IN LIQUID HELIUM APPARATUS ...Boundary-layer-other, Conduction, Engineering Studies-general, Heat-transfer-other, Model Apparatus-other, Pressure Gradient,... 2.0008

Conduction

THERMAL PROPERTIES OF SEA WATER AT LOW TEMPERATURE AND HIGH PRESSURE ...Acoustical, Expansion, Hydrodynamics, Physical Analysis, Thermal,... 2.0009

THERMALLY SUSTAINED PRESSURE OSCILLATIONS IN LIQUID HELIUM APPARATUS ...Boiling & Evaporation, Boundary-layer-other, Engineering Studies-general, Heat-transfer-other, Model Apparatus-other, Pressure Gradient,... 2.0010

Convection

INVESTIGATION OF HEAT TRANSFER AUGMENTATION THROUGH USE OF INTERNALLY FINNED TUBES ...Flexible, Heat Trans Coefficient, Heat Transfer, Rotating Fluids,... 2.0011

Heat Transfer

INVESTIGATION OF HEAT TRANSFER AUGMENTATION THROUGH USE OF INTERNALLY FINNED TUBES ...Convection, Flexible, Heat Trans Coefficient, Rotating Fluids,... 2.0012

HELIUM - HEAT TRANSFER ...Air, Diving and Scuba, Helium, Suomisers, Temperature Effects,... 2.0013

ADVANCES HEAT SOURCES AND THERMAL INSULATION MATERIALS FOR SWIMMER HEATING ...Diving and Scuba, Diving-system, Heating, Thermal, Thermal Insulators,... 2.0014

Radiation

REFLECTIVITY AND EMISSIVITY STANDARDS ...Atmosphere Radiation, Infrared Radiation, Interferometry, Radiation-general, Standards, Specifications,... 2.0015

Heavy Elements

MARINE GEOLOGY OF THE CALIFRonia CONTINENTAL BORDERLAND WITH EMPHASIS ON FUTURE ECONOMIC DEVELOPMENT AND GENERAL RESOURCE VALUE ...California, Clay Minerals-general, Continental Shelf, Mineralogy, Ocean Mining,... 2.0016

MARINE HEAVY-METALS PRODUCTION INFORMATION, ON WORLDWIDE BASIS ...Apparatus-general, Beneficiation, Deposits-ores, Documents & Literature, Ocean Mining,... 2.0017

Heavy Mineral Analysis

OREGON-CALIFORNIA BLACK SANDS ...Beaches, California, Heavy Minerals, Mineralogy, Ocean Mining, Potential of Deposit,... 2.0018
SUBJECT INDEX

Helium

UNDERWATER WELDING ...Inert Gas, Materials Used Undersea, Safety, Scientific-service-support, Subsurface Environments, ...8.0344

HELIUM - HEAT TRANSFER ...Air, Diving and Scuba, Heat Transfer, Submersibles, Temperature Effects, ...8.0201

Histochemical Test

IMMUNE MECHANISMS AND RESISTANCE FACTORS IN MARINE ANIMALS ...Antigen, Fish -other, Serology and Immunology, ...5.0255

Home Economics

Consumer Pref. & Coasumption

DETERMINATION OF THE STRUCTURE & ECONOMIC IMPORTANCE OF THE VARIABLES OF THE SEAFISH INDUSTRY ...Commercial Fishing, Fish & Shellfish, Fish -non-specific, Georgia, Production & Processing, Regional Economic Impact, Shellfish -non-specific, ...4.0180

REGIONAL DEMAND IN THE U.S. AND TRENDS IN THE FISHING AND SEAFOOD PROCESSING INDUSTRIES OF THE CHESAPEAKE BAY AREA ...Chesapeake Bay, Commercial Fishing, Consumption, Fish & Shellfish, Fish -non-specific, Market Structure, ...6.0028

ANALYZING THE FACTORS AFFECTING THE DEMAND FOR SEAFOOD AND TO PROJECT THIS DEMAND TO FUTURE TIME PERIODS ...Fish -non-specific, Food Needs and Demand, Trends, projections, ...6.0021

CONSUMER EVALUATION OF FISH PRODUCTS ...Fish & Shellfish, Fish -non-specific, Organoleptic Studies, Smoking, ...6.0004

ANALYSIS OF THE DEMAND FOR RED MEAT, POUlTRY, EGGS, SEAFOOD, AND MEAT MIXTURES ...Eggs, Fish -non-specific, Meat -non-specific, Price & Value, ...6.0019

ECONOMIC ANALYSIS OF THE MARKET STRUCTURE OF THE COMMERCIAL FISHING INDUSTRY IN THE NORTHEAST ...Commercial Fishing, Fish -non-specific, Market Structure, Northeast, ...4.0183

INVESTIGATE THE EFFECT OF IRRADIATION ON THE MICROBIAL FLORA SURVIVING IRRADIATION PASTEURIZATION OF SEAFOODS ...Food Spoilage Detection, Microbiological, Radiation, Radiation Protectors, Shellfish -non-specific, ...6.0072

DEVELOPMENT OF RADIATION STERILIZED FISH ITEMS FOR ARMED FORCES FEEDING ...Anti-oxidants, Chemical Analysis, Fish -non-specific, Military Rations, Radiation, ...6.0073

Food Preparation

COMPOSITION OF BREADED FISH PRODUCTS ...Fish -non-specific, Heat, Legal Standards, ...6.0015

Institutional Management

MARKET RESEARCH STUDIES ON THE EFFECTS OF THE FLORIDA MARKETING PROGRAM ON THE SALE OF FLORIDA SEAFOODS ...Fish -non-specific, Florida, Marketing, Retail, ...6.0018

Hormones

Hormones - Other

MARINE ANIMAL USE IN THE STUDY OF HEALTH PROBLEMS ...Hormones, Life History Studies, Metabolism, ...6.0126

Intermedin

NEUROSECRETION AND ENDOCRINE PHYSIOLOGY ...Configuration, Crucianca -non-specific, Diabetogenic, Ns, Endocrine System, Hormones, ...5.1023

Luteotropic Hormone

PHYSIOLOGY AND ASSAY OF PROLACTIN IN FISH ...Biologicals, Biochemical, Gambusia, Molly, Immunology, Pituitary, ...5.0329

Hydraulic Engineering

Testosterone

STUDIES ON GAMETOGENESIS IN HYDROMEDUSAE ...Basic Embryology, Developmental Physiology, Differentiation Mechanism, Hydras, Portuguese Man-of-war, Reproduction, Reproductive System, ...5.1040

Hudson River

QUATERNARY OF THE HUDSON RIVER ESTUARY ...Estuaries, Fjords, Paleoenvironments, Quaternary Period, Valleys and Canyons, ...7.0256

Humic Acid

ALGAL SUBSTANCES IN THE MARINE FOOD WEB ...Food Chains, Food Webs, Marine Plants, Phaeophyta (non-specific & Ot), Phenols, Secretions and Products, ...5.0725

Humidity Instruments

HUMIDITY STANDARDS AND MEASUREMENTS ...Evaporation, Humidity, Pressure-density, Standards, Specifications, Streams, ...8.0081

AEROLOGICAL INSTRUMENTS ...Amplifiers, Field Testing, Instrumental Services, Microwave Techniques, Technique Development, ...8.0082

HUMIDITY SENSORS ...Barium, Fluoride, Stability, Transducers, ...8.0083

HUMIDITY CALIBRATION ...Humidity, Standards, Specifications, ...8.0084

NUMERICAL CODE CONVERTER ...Air Temperature Instruments, ...8.0078

EVAPORATION OF WATER ...Evaporation, Humidity, Particle-gas Transfer, ...3.0012

Hydra, Portuguese Man-of-war

AGING IN HYDROIDS ...Aging, Cell Injury and Autolysis, Developmental Physiology, Environmental Physiology, Senescence, ...5.0597

STUDIES ON GAMETOGENESIS IN HYDROMEDUSAE ...Basic Embryology, Developmental Physiology, Differentiation Mechanism, Regeneration and Wound, Reproductive System, Testosterone, ...5.1040

CORRELATION BETWEEN ELECTRICAL PATTERNS AND MORPHOGENETIC PATTERNS DURING REGENERATION ...Developmental Physiology, Electrical Fields, Regeneration and Wound, ...5.0602

GROWTH, DIFFERENTIATION AND NERVE TRANSMISSION IN THE HYDROID, CAMPANULARIA ...Basic Embryology, Developmental Physiology, Growth Rate, Nervous System, ...5.0601

COMPUTER SIMULATION OF HYDROID COLONIES ...Computer Applications, Growth Rate, ...5.0651

CONDUCTION AND INTEGRATION ...Behavior, Cellular Physiology, Katydids, Musculoskeletal System, Nervous System, ...5.1018

Hydraulic Engineering

Engineering Studies

Breakwaters

WAVE DAMPING SYSTEMS ...Energy Dissipators, Model Studies, Shoreline Structures, Wave Action, Waves, ...8.0047

CRITERIA FOR THE DESIGN OF SMALL CRAFT HARBORS ...Coastal Engineering-other, Harbors, Marinas, Seiches, Waves, ...8.0036

WAVE FORCES ON BREAKWATERS ...Hydrodynamics, Model Studies, Shoreline Structures, Wave Action, Waves, ...8.0044

WAVE FORCES ON BREAKWATERS ...Ext Pressure on Structure, Shoreline Structures, Wave Action, Waves, ...8.0034

STABILITY OF RUBBLE-MOUND BREAKWATERS ...Design Criteria, Engineering Structures-general, Hydrodynamics, Shoreline Structures, Wave Action, Waves, ...8.0045

COASTAL WORKS EVALUATION FOR CHECKING, IMPROVING AND DEVELOPING DESIGN RELATIONSHIPS AND CONSTRUCTION TECHNIQUE ...Coastal Engineering-other, Design Criteria, Green, Jetty, Shoreline Structures, ...8.0039

553
SUBJECT INDEX

Water Control Works
Design Criteria
STABILITY OF RUBBLE-MOUND BREAKWATERS...Breakwaters, Engineering Structures-general, Hydrodynamics, Shoreline Structures, Wave Action, Waves,...8.0045
HARBOR DESIGN STUDIES...Harbors, Navigation, Waves,...8.0046
COASTAL WORKS EVALUATION FOR CHECKING, IMPROVING AND DEVELOPING DESIGN RELATIONSHIPS AND CONSTRUCTION TECHNIQUE...Breakwaters, Coastal Engineering-other, groin, jetty, Shoreline Structures,...8.0039
DEVELOPMENT OF CRITERIA FOR ARTIFICIAL BEACHES...Beach, Beaches, Coastal Engineering-other, Shoreline Structures, Statistics-general,...8.0041

Gruin
ANALYSIS OF AN ATTEMPT TO CONTROL BEACH EROSION AT SCIENTISTS CLIFFS, MARYLAND...Beaches, Chesapeake Bay, Engineering Studies-other, Erosion, Maryland,...8.0038
COASTAL WORKS EVALUATION FOR CHECKING, IMPROVING AND DEVELOPING DESIGN RELATIONSHIPS AND CONSTRUCTION TECHNIQUE...Breakwaters, Coastal Engineering-other, Design Criteria, Jetty, Shoreline Structures,...8.0039

Jetty
COASTAL WORKS EVALUATION FOR CHECKING, IMPROVING AND DEVELOPING DESIGN RELATIONSHIPS AND CONSTRUCTION TECHNIQUE...Breakwaters, Coastal Engineering-other, Design Criteria, Groin, Shoreline Structures,...8.0039
RUBBLE-MOUND PROTOTYPE STUDIES...Breakwaters, Shoreline Structures, Water Motion Recorders, Wave Action, Waves,...8.0042

Hydraulics-general
APOLLO TEST SITE EXPERIMENT...Aircraft, Estuaries, Hydrology-general, Recognition Systems, Remote Sensing-general,...4.0146
DYNAMIC MODEL STUDY OF LAKE ERIE...Inflow, Lake Erie, Model Studies, Synthetic Hydrology,...4.0075
HYDRAULIC BULLETIN...Current Research Projects, Hydraulic Engineering-other, Table, Compilations, Catalogs,...8.0177
TIDAL FLOWS IN RIVERS AND HARBORS...Committee-support, Harbors, Streams, Tides,...2.0087

Hydrazine
ENERGY CONVERSION MATERIALS AND COMPONENTS...Durability, Deterioration, Electrode, Fuel Cell-other, Hydrocarbon, Pressure,...8.0223

Hydrodynamics
OCEANOGRAPHIC DATA SYSTEMS...Acoustical, Data & Statistics Storage, Engineering Studies-other, Instrumentation-general, Pollution Sources-general,...4.0013
WATER PHYSICS AND CHEMISTRY...Chemical-general, Infrarad Radiation, Lasers-masers, Satellites, Thermal Pollution,...4.0147
GULF STREAM EDDIES...Data Analysis - General, Data Reduction and Analysis, Gulf Stream, Temperature, Water Motion,...2.0028
KINETICS OF SEDIMENTS IN BREAKERS...Coastal Engineering-other, Development, Sedimentation, Suspension, Waves,...7.0227
LONG PERIOD WAVES...Fjords, Iceland, Seiches, Tides, Waves,...2.0108
HAWAIIAN OCEANOGRAPHY...Circulation-general, Environmental Effects-geology, Hawaii, Islands, Ocean Currents-other,...2.0021
OCEAN CIRCULATION STUDIES...Acoustical, Atlantic Ocean-north, Currents-ocean, Statistics-general, Water Motion Recorders, Waves-internal,...2.0040
CIRCULATION STUDIES...Circulation-general, Currents-ocean, Gulf of Alaska, Mixing, Pacific Ocean-north,...2.0042
HIGH FREQUENCY WAVES...Forecasting-prediction, Heat and Radiation Transfer, Water Motion Recorders, Waves,...2.0113

INERTIAL TECHNIQUES...Acoustical, Currents-ocean, Physical An. lysis,...8.0099
VERTICAL MOTIONS...Convection, Gulf Stream, Water Motion Recorders,...2.0060
NORTH ATLANTIC CIRCULATION...Atlantic Ocean-north, Circulation-general, Geomorphology-topography, Gulf Stream, Oceanic Fronts,...2.0031
STUDY OF OCEANIC TURBULENCE...Energy, Mixing, Sub-surface Environments, Turbulence - Sea Water, Water Motion,...2.0055
FORMATION OF ANTARCTIC BOTTOM WATERS...Buoy, Oceanic Fronts, Salinity, Temperature, Weddell Sea,...1.0152
EXPERIMENTAL STUDY OF THE INTERRELATIONS BETWEEN WIND-WAVE PROPERTIES...Mixing, Pressure, Turbulence - Sea Water, Waves, Wind-water Interaction,...2.0123
GULF STREAM TRANSPORT...Automatic Stations, Gulf Stream, Ships and Cruises, Water Motion Recorders,...2.0029
STUDY OF INFLUENCE OF STRATIFICATION ON CURRENT STRUCTURE...Circulation-general, Currents-other, Lake Michigan, Stratified Flow,...7.0237
PHYSICAL OCEANOGRAPHY IN OREGON SHELF AND SLOPE WATERS...Continental Shelf, Continental Slope, Moe, Oregon, Thermodynamics,...2.0076
EXPERIMENTAL HYDRODYNAMICS...Fluid Dynamics, Heat and Radiation Transfer, Simulation Theory, Submersibles, Thermocline,...8.0192
COASTAL ENGINEERING...Alaska, Estuaries, Fjords, Model Studies, Simulation Theory,...4.0040
THERMAL PROPERTIES OF SEA WATER AT LOW TEMPERATURE AND HIGH PRESSURE...Acoustical, Conductivity, Expansion, Physical Analysis, Thermal,...1.0177
OCEAN CIRCULATION...California Current, Circulation-general, Forecasting-prediction, Model Studies, Submarine Canyons,...2.0002
WAVE FORCES ON BREAKWATERS...Breakwaters, Model Studies, Shoreline Structures, Water Action, Waves,...8.0044
FLUID MECHANICS RESEARCH...Forecasting-prediction, Industrial Engineering, Ship Resistance Stability, Waves,...8.0176
FUNDAMENTAL PROBLEMS IN HYDRODYNAMICS...Convection, Ordnance, Survey Studies, Waves, Waves-inter nal,...2.0102
SEA-AIR INTERACTION RESEARCH...Acoustical, Heat and Radiation Transfer, Salinity, Waves,...3.0039
OCEAN DYNAMICS SEA AIR INTERACTION MODELS-MEDITERRANEAN...Acoustical, Mediterranean Sea-general, Model Studies, Surface Environments, Wind-water Interaction,...3.0002
OCEAN DYNAMICS IN THE STRAITS OF GIBRALTAR AND ADJACENT AREAS...Acoustical, Anti-submarine-warfare, Computer Applications, Model Studies, Strait of Gibraltar, Submerged Ships,...1.0141
OCEAN DYNAMICS - OCEANOGRAPHIC ANALYSES AND FORECASTING MODELS...Acoustical, Air-sea Boundary-general, Model Studies, Surface Environments, Temperature,...1.0004
OCEANOGRAPHIC RESEARCH...Acoustical, Instrumentation-general, Moorings, Naval Architecture-general, Water Motion Recorders,...1.0052
SHALLOW WATER OCEANOGRAPHY...Acoustical, Continental Shelf, Rhode Island, Surface Environments, Transmission,...1.0030
PREDICTION OF POLAR ICE BEHAVIOR AND DISTRIBUTION...Arctic Ocean, Data Acquisition, Forecasting-prediction, Ice-general, Sea Ice, Weather Forecasting,...3.0078
STABILITY OF RUBBLE-MOUND BREAKWATERS...Breakwaters, Design Criteria, Engineering Structures-general, Shoreline Structures, Wave Action, Waves,...8.0045

Hydrogen
HYDROGEN PROPERTIES...Density, Dielectric Properties, Cell-other, Marine Propulsion, Refraction,...8.0157
RESEARCH AND COMPUTATIONS ON THE THERMO-DYNAMICS PROPERTIES OF AIR AND RELATED GASES...Air, Critical, Free Energy, Virial Coefficient,...3.0014

555
SUBJECT INDEX

Hydrology-general

APOLLO TEST SITE EXPERIMENT ...Aircraft, Estuaries, Hydraulic-regional, Recognition Systems, Remote Sensing-regional, ...4.0146

SIMULATION MODELS OF SHALLOW-WATER AND COASTAL ENVIRONMENTS ...Computer Applications, Gulf of Mexico, Model Studies, Sedimentation, Shoreline-Coastline, ...4.0066

HYDROLOGY OF UPPER OLD TAMPA BAY, FLORIDA ...Bays, Groundwater Movement, Lakes, Permeability, Water Harvesting, Water Quality-general, ...2.0067

Hypophysectomy

ENDOCRINE REGULATED PROCESSES IN TELEOST FISHES ...Comparative Physiology, Environment Resistance, Fish - other, Osmoregulation, Pituitary, ...5.0288

Hypoxanthine

BIOCHEMISTRY OF FISH AS RELATED TO HUMAN NUTRITION ...Amino Acids, Nor east, ...6.0053

Ice Studies

Alteration

SPECIALIZED RESEARCH EQUIPMENT FOR SEA ICE STUDIES ...Equipment Purchase Operation, Sea Ice, ...3.0086

GREAT LAKES RESISTANCE - ICE COVER DISTRIBUTION ...Aerial Photography, Aerospacial, Great Lakes-general, Petrofabrics, Sea Ice, ...3.0083

GREAT LAKES RESEARCH - GREAT LAKES DEICING ...Bibliography, Great Lakes-general, Ice Properties-general, Origin, Sea Ice, ...3.0084

Composition

CARBON MONOXIDE CONTENT OF GLACIAL ICE AND THE NATURAL ATMOSPHERE ...Carbon, Dispersion - Transportation, Gaseous, Mono-oxide, ...3.0066

Ice Jam

GREAT LAKES RESEARCH - RIVER ICE JAMS ...Great Lakes-general, Streams, Survey Studies, Water Motions, ...3.0081

Ice-general

ENVIRONMENTAL APPLICATIONS OF PASSIVE MICROWAVE SENSORS ...Beaches, Microwave Radiation, Sea Ice, Sedimentology-general, Snow-general, Soil Engineering Investigation, ...4.0136

PREDECTION OF POLAR ICE BEHAVIOR AND DISTRIBUTION ...Arctic Ocean, Data Acquisition, Forecasting-prediction, Hydrodynamics, Sea Ice, Weather Forecasting, ...3.0078

Origin

GREAT LAKES RESEARCH - ICE CHARACTERISTICS ...Aerial Photography, Lake Superior, Micrometeorology, Petrofabrics, Radiation-terrestrial, Sea Ice, ...3.0082

GREAT LAKES RESEARCH - GREAT LAKES DEICING ...Alteration, Bibliography, Great Lakes-general, Ice Properties-general, Sea Ice, ...3.0084

Petrofabrics

GREAT LAKES RESEARCH - ICE CHARACTERISTICS ...Aerial Photography, Lake Superior, Micrometeorology, Origin, Radiation-terrestrial, Sea Ice, ...3.0082

GREAT LAKES RESEARCH - ICE COVER DISTRIBUTION ...Aerial Photography, Aerospacial, Alteration, Great Lakes-general, Sea Ice, ...3.0083

Properties

Electrical

ELECTRICAL PROPERTIES OF ICE ...Audio Frequency, Phase Relationships, Sea Ice, ...3.0072

Ice Acoustics

HF AUDIO ABSORPTION IN ICE ...Acoustical, Attenuation, Reverberation, Salinity, Sea Ice, ...3.0073

556
<table>
<thead>
<tr>
<th>SUBJECT INDEX</th>
<th>Industries</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TAXONOMY OF CALCAREOUS GREEN ALGAE</strong> ...Chlorophyceae (non-specific), Plant Taxonomy, Range Or Territorial Distir, Reproductive Physiolog-</td>
<td><strong>Industries</strong></td>
</tr>
<tr>
<td>y,...5.0178</td>
<td>PROCESS ENGINEERING ...Design, Machinery, Equipment, Extract, Fats and Oils-</td>
</tr>
<tr>
<td><strong>MARINE PHYTOPLANKTON RESEARCH</strong> ...Algal Culture, Nutrition Studies, Pacific Ocean-general, Phytoplankton, Symbiotio,</td>
<td>...other, Fish Protein Concentrato, Legal Standards, Natural Occurring,...5.0009</td>
</tr>
<tr>
<td><strong>INTERNATIONAL INDIAN OCEAN EXPEDITION PHYSICAL AND CHEMICAL ATLAS</strong> ...Data &amp; Statistics Storage, Data Analysis General, General Sea Water Chemistry, Tables, Compilations, Catalog, Water Properties-general,</td>
<td><strong>Industrial Wastes</strong></td>
</tr>
<tr>
<td><strong>ANALYSIS OF SEISMIC DATA COLLECTED DURING THE INTERNATIONAL INDIAN OCEAN EXPEDITION AND IN THE CARIBBEAN SEA</strong> ...Basins, Data Analysis General, Data Reduction and Analysis, Digital Computer Applications, Gravity Studies, Magnetic Studies, Research Development,</td>
<td><strong>Desalination Wastes</strong></td>
</tr>
<tr>
<td><strong>GRAVITY AND MAGNETIC DATA COLLECTED DURING THE INTERNATIONAL INDIAN OCEAN EXPEDITION AND IN THE CARIBBEAN SEA</strong> Data Analysis General,</td>
<td>BRACKISH WATER PURIFICATION BY BIOLOGICAL FUEL CELL POWERED ELECTRODIALYSIS Biological, Brackish</td>
</tr>
<tr>
<td><strong>INDIAN OCEAN FORAMINIFERA AND SEDIMENTS</strong> ...Bioseries, Geographical Relations, Order, Foraminifera, Pacific Ocean-south, Sedimentology-general,</td>
<td>Water, Desalination, Electrolysis, Material Recovery Wastes, Water Costs,...6.0161</td>
</tr>
<tr>
<td><strong>STUDIES IN THE INDIAN OCEAN</strong> ...Circulation-general, Data Analysis General,</td>
<td><strong>Material Recovery Wastes</strong></td>
</tr>
<tr>
<td><strong>BATHYMETRY, DATA ANALYSIS</strong> ...Diagnostic Aids, Diagnostic Aids ...Gases, Radium, Sampling, Trace Elements,</td>
<td>BRACKISH WATER PURIFICATION BY BIOLOGICAL FUEL CELL POWERED ELECTRODIALYSIS Biological, Brackish</td>
</tr>
<tr>
<td><strong>INTERACTIONS BETWEEN TURBULENCE, CLOUDS, SEA TEMPERATURE</strong> ...Data Analysis General,</td>
<td>Water, Desalination, Desalination Wastes, Electrolysis, Water Costs,...6.0161</td>
</tr>
<tr>
<td><strong>DISTRIBUTION OF CARBON AND RADIUM IN THE ANTARCTIC WATERS</strong> ...Carbon, Gases, Radium, Sampling, Trace Elements</td>
<td><strong>MODEL ADVANCED WASTE-TREATMENT PLANT</strong> ...Activated Carbon, Lime Treatment</td>
</tr>
<tr>
<td><strong>INDIAN OCEAN DATA REDUCTION</strong> ...Bathymology, Data Analysis General, Geophysics-general, Ocean Basins, Sedimentology-general,</td>
<td>Pilot Plant, Process Design, Solid Waste,...8.0326</td>
</tr>
<tr>
<td><strong>BIOD-ACOUSTIC AND BIOLOGICAL SAMPLING GEAR STUDIES</strong> ...Acoustical, Mapping, Organism Sampling Devices, Plankton (non-specific),</td>
<td><strong>Pulp and Paper Wastes</strong></td>
</tr>
<tr>
<td><strong>TAXONOMY AND DISTRIBUTION OF CLUPEOIDS AND REVISION OF THE GENUS ILISHA OF THE FAMILY CLUPEIDAE</strong> ...Alewife, menhaden,shad,herring,</td>
<td><strong>COASTAL DIFFUSION OF POLLUTANTS</strong> ...Currents-other, Model Studies, Ocean, Oregon, Outlet,...6.0174</td>
</tr>
<tr>
<td><strong>MONTVILLE STATION TEMPERATURE SURVEY</strong> ...British Isles, Estuaries, Maps-other, Temperature, Thermal Pollution,...1.0182</td>
<td></td>
</tr>
<tr>
<td><strong>A UNIFIED APPROACH TO WATER, FOOD AND POWER IN A COASTAL DESERT COMMUNITY</strong> Arid and Desert, Desalination, Deserts, Diesel, Distilling Units, Greenhouse, Use of Impaired Water,</td>
<td>ECOLOGICAL STUDY OF SOUTH BISCAYNE BAY IN THE VICINITY OF TURKEY POINT ...Applied Ecology, Balance of Nature, Bays, Environmental Ecology, Florida, Phytoplankon, Thermal Pollution,...5.0077</td>
</tr>
<tr>
<td><strong>A PROGRAM FOR THE TRAINING OF STAFF MEMBERS FROM THE SCHOOL OF FISHERIES OF THE CATHOLIC UNIVERSITY OF VALPARAISO CHILE</strong> ...Arid and Desert, Desalination, Deserts, Diesel, Distilling Units, Greenhouse, Use of Impaired Water,</td>
<td><strong>Industrial Wastes</strong></td>
</tr>
<tr>
<td><strong>COLLECTION OF JUVENILE MIGRANTS FROM RIVERS AND STREAMS</strong> ...Engineering Structures-general, Fish-non-specific, Management-other, Migration, Streams,...5.0513</td>
<td></td>
</tr>
<tr>
<td><strong>FLUSHING PATTERN OF CERTAIN TIDAL STREAMS IN DELAWARE</strong> ...Aquatic Ecology, Cultivation-water, Delaware, Discharge, Tidal Streams,...2.0013</td>
<td></td>
</tr>
<tr>
<td><strong>SALT-WATER ENCROACHMENT IN NORTH CAROLINA ESTUARIES</strong> ...Chemical-general, Estuaries, Flow Characteristics-water, Saline Water Intrusion, Sampling,...6.0168</td>
<td></td>
</tr>
</tbody>
</table>
Industries
Pulp, Paper, and Logging
ECOLOGICAL SURVEY OF EFFLUENT DISCHARGE AT TWO PULP MILLS IN HUMBOLDT COUNTY, CALIFORNIA...California, Chemical Analysis (water), Effluents-waste Water, Pollution - Effects of, Pollution Effects, ...0.0055
MONITORING THE EFFECTS OF LAND USE ON SALMON PRODUCTION...Alaska, Environmental Ecology, Land Use, Salmon & Trout - Non-specific, Streams, ...0.0056
EFFECTS OF LOG RAFTING ON DUNGENESS CRAB...Contamination - Water, Crabs, Diving and Scuba, Forestry, Mans Activities, ...0.0047
ESTUARINE WATER QUALITY AND FISH DISTRIBUTION...Contamination - Water, Environmental Physiology, Estuaries, Pollution Effects, Salmon & Trout - Non-specific, ...0.0058
ECOLOGY OF KRAFT PAPER MILL EFFLUENT IN SAPELO & ST. CATHERINES SOUNDS, GA...Aquatic Ecology, Georgia, Pollution - Effects of, Pollution Effects, Streams, ...0.0059
FLOW AND SALINITY IN THE HUDSON FSTUARY, NEW YORK...Estuaries, Fresh Water, Management, Salinity, Tides, ...0.0057
Information Centers & Services
Critically Evaluated Data
BATHYTERMGRAPH ANALYSIS...BathytHERmographs, Data Analysis - General, Model Studies, Salinity, Surface Environments, Temperature, ...0.0018
Current Research Projects
HYDRAULIC BULLETIN...Hydraulic Engineering-other, Hydraulics-general, Tables, Compilations, Catalogs, ...0.0077
Data & Statistics Storage
OCEANOGRAPHIC DATA SYSTEMS...Acoustical, Engineering Studies-other, Hydrodynamics, Instrumentation-General, Pollution Sources-general, ...0.0013
SUPPORT OF THE NATIONAL OCEANOGRAPHIC DATA CENTER...Documents & Literature, Oceanography-general, ...0.0012
INTERNATIONAL INDIAN OCEANIC DATA SYSTEMS...Acoustical, Engineering Studies-other, Oceanography-General, ...0.0014
SUPPORT OF THE NATIONAL OCEANOGRAPHIC DATA CENTER...Documents & Literature, Oceanography-general, ...0.0013
USE OF STATISTICAL INFERENCE AND EXPERIMENTAL DESIGN FOR EFFICIENT COLLECTION OF OCEAN DATA...Data & Statistics Storage, Sampling, ...0.0015
OCEANOGRAPHIC INFORMATION PROCESSING TECHNOLOGY...Computer Applications, Data & Statistics Storage, Data Reduction and Analysis, Information Storage and File, Oceanography-general, Real Time Systems, ...0.0023
Inflow
HYDROLOGIC SYSTEMS ANALYSIS OF THE GREAT LAKES...Discharge, Great Lakes-general, Water Storage, ...0.0076
DYNAMIC MODEL STUDY OF LAKE ERIE...Hydraulics-general, Lake Erie, Model Studies, Synthetic Hydrology, ...0.0077
FLOW AND SALINITY IN THE HUDSON FSTUARY, NEW YORK...Estuaries, Fresh Water, Management, Salinity, Tides, ...0.0075
Information Systems
Bioscience Applications
Biology
SURVEY, EVALUATION & SUMMARIZATION OF LITERATURE ON ENVIRONMENTAL REQUIREMENTS OF MARINE ORGANISMS LEVELS OF POTENTIAL TOXICANTS (ABBREVIATION: BIBLIOGRAPHY, ...Chemical, Environmental Effects-geologic, Geosciences, Marine Biology, Marine Environments-general, Survey Studies, ...0.0037
Information Retrieval Methods
USES OF STATISTICAL INFERENCE AND EXPERIMENTAL DESIGN FOR EFFICIENT COLLECTION OF OCEAN DATA...Data & Statistics Storage, Sampling, ...0.0015
OCEANOGRAPHIC INFORMATION PROCESSING TECHNOLOGY...Computer Applications, Data & Statistics Storage, Data Reduction and Analysis, Information Storage and File, Oceanography-general, Real Time Systems, ...0.0023
Physical Sciences Applications
Geosciences
SURVEY, EVALUATION & SUMMARIZATION OF LITERATURE ON ENVIRONMENTAL REQUIREMENTS OF MARINE ORGANISMS LEVELS OF POTENTIAL TOXICANTS (ABBREVIATION: BIBLIOGRAPHY, ...Chemical, Environmental Effects-geologic, Geosciences, Marine Biology, Marine Environments-general, Survey Studies, ...0.0037
Tape Storage
A SHIPBOARD DIGITAL DATA ACQUISITION SYSTEM...Data Acquisition, Seismic Studies, Systems Analysis, ...0.0036
Writing & Editing
SUPPORT OF WORLD DATA CENTER - A (OCEANOGRAPHY)...Data & Statistics Storage, Data Reduction and Analysis, Facilities, Oceanography-general, ...0.0018
Insects
Aedes Mosquitoes
THE EFFECT OF CONTROLLING SALT-MARSH MOSQUITOES ON BEEF CATTLE PRODUCTION, PLAN ECOLOGY, SOIL PRODUCTIVITY, AND ESTUARINE ANIMALS...Cultural Control of Insects, Ectoparasite Insects, Management, Wetlands, ...0.0027
Intrumentation Design

Mathematical Models
WATER-TO-AIR RETRIEVA ...Aircraft, Recovery Operations, Suspension-release, 8.0076
ANALYSIS OF INLAND CARGO CONSOLIDATION CENTERS ...Data Reduction and Analysis, Development of Models, Freight, Loading/unloading, Warehouses, 8.0032

Measuring Devices
Distance-measuring-device
VISUAL RANGE METERS ...Fog-haze-mist, Guidance, Landing, Meteorological Conditions, Visibility, 8.0072
MISCELLANEOUS SERVICES FOR FEDERAL AVIATION AGENCY (VISUAL RANGE) ...Air-sea Boundary-general, Fog-haze-mist, Visibility, 3.0014

Fluids
AUTOMATED FLOW SYSTEM CALIBRATION ...Aircraft, Controls, Digital Computer Applications, Transducers, 8.0071

Force
MECHANICAL TESTS AND FORCE CALIBRATIONS ...Standards, Specifications, 8.0073

Humidity
HUMIDITY CALIBRATION ...Humidity Instruments, Standards, Specifications, 8.0084

Measuring Devices-other
DESIGN OF BUBBLE WAVE-Absorber ...Beaches, Energy Dissipators, Harbors, Shoreline Structures, Waves, 8.0037
ESTIMATION OF HULL STEEL WEIGHTS FROM MIDSHIP SECTION CHARACTERISTICS ...Bulkheads, Engineering Studies-other, Naval Architecture-general, 8.0303
WEIGHT ANALYSIS IN FISHING BOATS ...Approximations, Hull, Low Alloy Steels, Pressure Effects, 8.0295

Pressure
OCEAN PRESSURE RESEARCH ...Military Aspects, Ordnance, Underwater Warfare, 3.0173
LABORATORY MODEL STUDIES ON PRESSURE DISTRIBUTION IN DENTITUS DURING PENETRATION ...Laboratory Analysis, Mechanical Properties, Model Studies, Placer, Soil Loads, 8.0253

Stress Recorders
AN INVESTIGATION OF THE S/N FATIGUE LIFE GAGE ...Random, 8.0100

Temperature
OPERATIONAL EVALUATION OF NSRT SYSTEM ...Equipment, Special Mission Ships, Surface Environments, 8.0059

Requirement
OPTIMIZATION METHODS APPLIED TO THE PRELIMINARY DESIGN OF A NAVAL AUXILIARY ...Algorithms, Cost Analysis, Engineering Studies-other, Optimization Technique, Other-design-and-construction, 8.0297

Instrumentation-general
OCEANOGRAPHIC DATA SYSTEMS ...Acoustical, Data & Statistics Storage, Engineering Studies-other, Hydrodynamics, Pollution Sources-general, 4.0013
SATELLITE INTERROGATE ENVIRONMENTAL BUOY DEVELOPMENT ...Navigation Communication, Satellites, 8.0308
BIOLOGICAL INSTRUMENTATION ...Behavioral Ecology, Biological Sciences, Instrumental Services, Navigation Systems-other, 8.0064
DATA COLLECTION ...Charts, Data Acquisition, Data Analysis - General, Sampling, 4.0017
SUPPORT OF RESEARCH VESSEL VELERO 4 ...California, Equipment Purchase Operation, Facilities, Geology-general, Marine Biology, Training Grants, Fellowships, 4.0015
SYMPOSIUM ON RESEARCH NEEDS AND PRIORITIES FOR MARINE GEOLOGY OF THE GULF OF MEXICO ...Conventional Shelf, Gulf of Mexico, Mechanical Properties, Meetings, Sedimentation, Structural Studies, 11.0040
DETERMINATION OF EQUATION OF STATE, VISCOSITY AND COMPRESSIBILITY OF SEA WATER ...Acoustical, Currents-other, Density, Salinity, Temperature, Viscosity, 1.0145

SUBJECT INDEX

FOULING OF SENSORS ...Fouling, Inhibitors, Marine Biology, Organometallates, 8.0239
OCEANOGRAPHIC RESEARCH ...Acoustical, Hydrodynamics, Moorings, Naval Architecture-general, Water Motion Recorders, 3.0162
SHALLOW WATER OCEANOGRAPHY (SEALAB III) ...Diving and Scuba, Diving-system, Environmental Effects-geologic, Underwater-laboratory, 1.0146
BIOLOGICAL OCEANOGRAPHY & DETERIORATION - SHALLOW WATER MARINE SEDIMENTS & WATER COLUMN BACTERIA ...Biology, Continental Shelf, Marine Bacteria, Nephelometry, Vertical Distribution, 8.0073
ARCTIC UNDERSEAS RESEARCH, JOINT USA-CanADIAN HEAT BUDGET STUDY ...Arctic, Heat and Radiation Transfer, Physical Climatology, Sea Ice, 3.0071
SPACECRAFT OCEANOGRAPHY ...Instrumentation, Management, Photography, Satellites, Unmanned Satellite, 4.0157
SYSTEM OPERATIONS AND ACOUSTIC PHYSICS ...Acoustical, Ecological Theory, Liquids, Standards, Specifications, Systems Analysis, 12.0020
ACOUSTIC PROPAGATION STUDIES ...Acoustical, Technical Development, Transmission, 1.0044
GREAT LAKES RESEARCH - MONITORING OF WATER CHARACTERISTICS ...Data Acquisition, Forecasting-prediction, Geophysical Analysis, Great Lakes-general, Temperature, 3.0145
PHYSICAL OCEANOGRAPHY ...Buys, Model Studies, Pacific Ocean-north, 1.0160

Intertidal Areas
ESTUARINE SEDIMENTATION PROCESSES ...Eustatias, General Deposition, Morphology-general, New England Province, Tidal Streams, Tides, 7.0123
A STUDY OF THE ECOLOGY OF THE MICR-FAUNA LIVING BETWEEN INTERTIDAL MARINE SEDIMENTS ...Beach, Copepods, Crustacea - non-specific, New England Province, Salinity, 8.0073
QUATERNARY ENVIRONMENTS AND BIOTAS ...Biofacies, Palaeoecology, Temperature - Distribution, Quaternary Period, Western, 3.0157
STUDENT RESEARCH AT THE MARINE SCIENCE CENTER ...Facilities, Invertebrate Physiology, Invertebrates-non-specific, Oregon, Training Grants, Fellowships, 11.0039
THE SEDIMENTARY AND DIAGENETIC RECORD OF ENVIRONMENTAL PARAMETERS IN RECENT RAHMAN TIDAL FLATS ...British West Indies, Diagenesis, Environmental Effects-geologic, Local Stratigraphy, Paleoclimatology, 7.0143
MARINE ECOLOGICAL STUDIES ...Environmental Ecology, Habitat Studies, Invertebrates-non-specific, Stress, 5.0917
GULF OF CALIFORNIA BIOLOGY ...Arid and Desert, Bioluminescence, Gulf of California, Population Dynamics, Tropics, 5.0856
INTERAKTION OF INTERTIDAL POPULATIONS ...Competititve, Habitat Studies, Population Dynamics, Predation, 5.0864
TRANSVERSAL DRIFTS IN BOTTOM PROFILE ...Bathymetry, Benthonic-bottom, Ocean Waves - Currents, Waves, 3.0124
THE BIOLOGY OF THE INFANAA OF A TROPICAL SOFT BOTTOM AREA ...Aquatic Ecology, Benthic Fauna, Estuaries, Florida, Pollution - Effects of, 8.0079
PHYSIOLOGICAL VARIATION IN SURTIDAL AND INTERTIDAL MARINE INVERTEBRATES ...Habitat Studies, Invertebrates-non-specific, 5.0854
THE ORIGIN OF GRAVEL BARS IN THE INTERTIDAL ZONE, PARRSBOBO HARBOUR, NOVA SCOTIA, CANADA ...Canada, Location, Origin, Sand Bars, Size, 7.0177
GREAT LAKES RESEARCH - THE ORIGIN OF GRAVEL BARS IN THE INTERTIDAL ZONE, PARRSBOBO HARBOUR, NOVA SCOTIA, CANADA ...Canada, Location, Origin, Sand Bars, Size, 7.0177
MARINE RESEARCH - THE ORIGIN OF GRAVEL BARS IN THE INTERTIDAL ZONE, PARRSBOGO HARBOUR, NOVA SCOTIA, CANADA ...Canada, Location, Origin, Sand Bars, Size, 7.0177
STRATIGRAPHY OF RECENT INTERTIDAL SEDIMENTARY DEPOSITS OF THE SHEEPSHEAD MUDDYFLAT, NEW JERSEY ...New Jersey, Quaternary Period, Sedimentation, Stratigraphy-general, 8.0074
LITTORAL ENVIRONMENT OBSERVATION PROGRAM ...California, Development, Erosion, 7.0028
NATURE OF INTERTIDAL EROSION ON CORAL ATOLLS ...Atolls, Erosion, Fossil Limestone, Marine Biology (non-specific), 7.0028

Invertebrate Anatomy
PARASITIC COPEPODA ...CRUSTACEA ...Artemia, Copepods, Ectoparasites, Indian Ocean-general, 5.0431

ERIC
Invertebrate Physiology

SUBJECT INDEX

RESEARCH ON THE BIO-SYSTEMATICS OF THE CIRRIPEDIA ...Barnacles, Developmental Physiology, Visual Organs, ...5.0364

ECOLOGICAL, EXPERIMENTAL AND COMPUTER STUDIES OF ENDOGENOUS RHYTHMICITY ...Brain, Computer Methods -general, Crustacea -non-specific, Locomotion, ...5.0361

REPRODUCTION AND EMBRYONIC SURVIVAL IN ASCIDIANS ...Carassius, Reproductive System, Sea Squirts -Tunicates, Whole Body Culture & Rearing, ...5.0600

GROWTH LAYING IN BIVALVED MOLLUSKS -AN AID IN PALEOBIOGEOGRAPHIC INTERPRETATION ...Animal Taxonomy, Environmental Physiology, Freshwater Mussels, Scallops, Growth Rate, Invertebrate Physiology, ...5.0355

STUDIES ON MOLTING, GROWTH, AND DEVELOPMENT IN ACORN BARNACLES AND LARVAL DECAPods ...acarnaca, Developmental Physiology, Endocrine System, Feuling, ...5.0296

PURCHASE OF MATERIALS FOR & CONSTRUCTION OF, FLOATS, RACKS, BAGS, AND TRAYS FOR THE SUSPENSION OF VARIOUS TYPES OF CULTCH ...derivatives, Equipment Purchase Operation, Oysters, Spawning & Nesting Sites, Stocking of Fish & Shellfish, ...8.0008

SURVIVAL REQUIREMENTS OF JUVENILE AND ADULT BLUE CRABS ...Crabs, Environmental Physiology, Maturity & Growth Stages, Osmoregulation, Size, ...5.0473

ADULT SHRIMP STUDIES ...Alaska, Bays, Habitat Studies, Life History Studies, Shrimps - Common, ...5.0340

INITIATION OF METAMORPHOSIS IN AURELIA ...Growth Rate, Jelly Fish, Low Temp. but Above 32f, Metabolism, ...5.0599

PHYSIOLOGY OF THE LIMULUS HEART ...Cardiovascular Heart, Horseshoe Or King Crabs, Nervous System, ...5.0463

Bioluminescence

PHYSICAL AND BIOLOGICAL OCEANOGRAPHY OF A LIMNOUS BAY ...Bays, Circulation-general, Jamaica, Model Studies, Photoplankton, ...5.0976

MECHANISM STUDIES ON BIOLUMINESCENT REACTIONS WITH EMPHASIS ON ENERGY TRANSFER PROBLEMS ...Energy Conversion, Luciferase, Luciferin, ...1.0164

MID-DEPTH BIOLUMINESCENCE ...Crustacea -non-specific, Vertical Distribution, ...1.0162

BIOSYNTHESIS OF BROMOPHENOLS IN MARINE INVERTEBRATES ...Acorn Worms, Metabolism, Phenols, ...5.0961

GULF OF CALIFORNIA BIOLOGY ...Arid and Desert, Gulf of California, Intertidal Areas, Population Dynamics, Tropic, ...5.0856

PHYSIOLOGY OF LUMINESCENT SIGNAL SYSTEMS ...Photoception, Trace Elements, Visual Organs, ...5.0950

SEALAB III PARTICIPATION ...Behavioral Ecology, Divers, Diving and Scuba, Medical Studies, Submersibles, ...6.0091

Blood and Lymph

BIOCHEMICAL CHARACTERIZATION OF CHOLINESTERASES IN THE BLOOD AND CENTRAL NERVOUS SYSTEM OF LIMULUS POLYPHEMUS ...Cholineesterase, Enzyme-substrate, Horseshoe Or King Crabs, Nervous System, Reaction Rates, ...5.0468

Blood Typing Studies

THE COMPARATIVE IMMUNOLOGY OF LOWER ORGANISMS ...Comparative Physiology, Immunology, Serology and Immunology, ...5.0856

Calcification

HISTOCHEMICAL STUDIES OF MUCOSUBSTANCES IN THE MANTLE OF THE NORTHERN QUAHOG, MERCIENARIA MERCIENARIA ...Clams, Derivatives, Histochemistry -Cytochemistry, Mucopolysaccharides, Mucoproteins, ...5.0455

ULTRASTRUCTURAL AND AUTORADIOGRAPHIC INVESTIGATION OF CALCIFICATION IN FORAMINIFERS ...Calcium, Cell Wall, Cell organelles, Organoids, Organic molecules, Ossicles, Phytoplankton, Radiography, Submarine Animals, ...5.0788

CALCIFICATION MECHANISMS IN MARINE ORGANISMS ...Algaceae, General, Marine Plants, Mollusks -non-specific & Other, ...5.0160

DEMINERALIZATION-BORING MECHANISMS OF MOLLUSKS ...Gastropods -slugs,conch,nails, Invertebrate Anatomy, Invertebrate Physiology, Metabolism, ...5.0459

GASTROPOD ILYANASSA OBSOLETA ...Developmental Physiology, Gastropods -slugs,conch,nails, ...5.0417

FINE STRUCTURE OF JELLYFISH (CHYRTSARA QUINQUEARTA) MUSCLE ...Contraction and Relaxation, Jelly Fish, Microscopy -other, Muscleskeletal System, Skin Or Ectoderm, ...5.0659

THE BIOLOGY OF ROCK-BORING SIPUNCULIDS ...Caribbean Sea, Invertebrate Nutrition, Invertebrates -non-specific, Reefs, ...5.0577

DEMINERALIZATION-BORING MECHANISMS OF MOLLUSKS -Calcification, Gastropods -slugs,conch,nails, Invertebrate Anatomy, Metabolism, ...5.0459

THE PROCESS OF DEMINERALIZATION-BORING IN BIVALVES ...Calcification, Derivatives, Freshwater Mussels, Scallops, Invertebrate Anatomy, ...5.0366

MECHANISMS OF VENTILATORY CONTROL ...Crabs, Nervous System, Respiratory System, ...5.0471

Behavior

PHYSIOLOGICAL MECHANISMS UNDERLYING THE BEHAVIOR OF MARINE CRUSTACEANS ...Behavioral Ecology, Crabs, Shrimps - Common, ...5.0428

VISUAL AND ACOUSTICAL COMMUNICATION IN CERTAIN MARINE CRUSTACEANS -Atlantic Ocean-north, Auditory, Crabs, Visual Organs, ...5.0430

TEMPERATURE NEEDS FOR GONADAL DEVELOPMENT ...Caribbean Virginica, Biological Rhythms, Environmental Physiology, Oysters, Reproductive System, Water Temperature -non-specific, ...5.0465

PREY RELATIONSHIPS BETWEEN ECHINODERMS AND MOLLUSCS ...Behavioral Ecology, Gastropods -slugs,conch,nails, Predation, Starfishes, ...5.0351

LEARNING IN OCTOPUS ...Learning and Retention, Octopus, Squid, Cephalopods, Travel Grants, ...5.0491

CUES INVOLVED IN MOVEMENT AND STATIC ORIENTATION OF GASTROPODS ...Gastropods -slugs,conch,nails, Invertebrate Physiology, Light -other, Locomotion, ...5.0462

LIFE HISTORY AND DEVELOPMENT OF POLYCHAETOUS ANNELID LARVAE ...Developmental Physiology, Life History Studies, Lugworms, Marine Segmentedworm, Reproductive System, Whole Body Culture & Rearing, ...5.0604

BIOLGICAL SOUND ...Sound Production, ...5.0464

MORPHOLOGY, PHYSIOLOGY AND ECOLOGY OF MARINE LAMELLIBRANCHS ...Aquatic Ecology, Basic Embryology, Freshwater Mussels, Scallops, Invertebrate Anatomy, ...5.0479

TEMPERATURE TOLERANCE OF MARINE ANIMALS THROUGH BEHAVIORAL RESPONSES ...Environment Resistance, Mortality Rates, Thermal, Water Temperature -non-specific, ...5.0481

THERMAL PREFERENCES OF MARINE FISHES AND INVERTEBRATES ...Fish -non-specific, Invertebrates -non-specific, Thermal, Water Temperature -non-specific, ...5.0620

PHYSIOLOGY AND BEHAVIOR OF LARVAE (PHYSIOECOLOGY OF SHELLFISH PROGRAM) ...Basic Embryology, Clams, Maturity & Growth Stages, Oysters, Ph Acidity -other, ...5.0373

NEUROPHYSIOLOGICAL MEASUREMENTS IN BEHAVIOR ...Giant Water Bug, Water Strider, Horseshoe Or King Crabs, Locomotion, ...5.0499

CONDUCTION AND INTEGRATION ...Cellular Physiology, Hydra, Portuguese Man-of-war, Katydid, Muscleskeletal System, Nervous System, ...5.0488

NEURAL MECHANISMS OF LEARNING AND BEHAVIOR ...Brain, Gastropods -slugs,conch,nails, Learning and Retention, Mech of Transmission, ...5.0485

Biological Rhythms

TEMPERATURE NEEDS FOR GONADAL DEVELOPMENT AND SPawning OF DIFFERENT PHYSIOLOGICAL RACES OF THE AMERICAN OYSTER, CRASSOSTREA VIRGINICA ...Behavior, Environmental Physiology, Oysters, Reproductive System, Water Temperature -non-specific, ...5.0532

EXPERIMENTAL MANIPULATION OF MECHANICAL AND PHYSIOLOGICAL RHYTHMS - A DUAL APPROACH TO THE BIOLOGICAL CLOCK PROBLEM ...Acetabularia, Behavioral Ecology, Crabs, Perching Birds - Songbirds, ...5.0492

Bioluminescence

PHYSICAL AND BIOLOGICAL OCEANOGRAPHY OF A LIMNOUS BAY ...Bays, Circulation-general, Jamaica, Model Studies, Photoplankton, ...5.0976

MECHANISM STUDIES ON BIOLUMINESCENT REACTIONS WITH EMPHASIS ON ENERGY TRANSFER PROBLEMS ...Energy Conversion, Luciferase, Luciferin, ...1.0164

MID-DEPTH BIOLUMINESCENCE ...Crustacea -non-specific, Vertical Distribution, ...1.0162

BIOSYNTHESIS OF BROMOPHENOLS IN MARINE INVERTEBRATES ...Acorn Worms, Metabolism, Phenols, ...5.0961

GULF OF CALIFORNIA BIOLOGY ...Arid and Desert, Gulf of California, Intertidal Areas, Population Dynamics, Tropic, ...5.0856

PHYSIOLOGY OF LUMINESCENT SIGNAL SYSTEMS ...Photoception, Trace Elements, Visual Organs, ...5.0950

SEALAB III PARTICIPATION ...Behavioral Ecology, Divers, Diving and Scuba, Medical Studies, Submersibles, ...6.0091

Blood and Lymph

BIOCHEMICAL CHARACTERIZATION OF CHOLINESTERASES IN THE BLOOD AND CENTRAL NERVOUS SYSTEM OF LIMULUS POLYPHEMUS ...Cholineesterase, Enzyme-substrate, Horseshoe Or King Crabs, Nervous System, Reaction Rates, ...5.0468

Blood Typing Studies

THE COMPARATIVE IMMUNOLOGY OF LOWER ORGANISMS ...Comparative Physiology, Immunology, Serology and Immunology, ...5.0856

Calcification

HISTOCHEMICAL STUDIES OF MUCOSUBSTANCES IN THE MANTLE OF THE NORTHERN QUAHOG, MERCIENARIA MERCIENARIA ...Clams, Derivatives, Histochemistry -Cytochemistry, Mucopolysaccharides, Mucoproteins, ...5.0455

ULTRASTRUCTURAL AND AUTORADIOGRAPHIC INVESTIGATION OF CALCIFICATION IN FORAMINIFERS ...Calcium, Cell Wall, Cell organelles, Organoids, Organic molecules, Ossicles, Phytoplankton, Radiography, Submarine Animals, ...5.0788

CALCIFICATION MECHANISMS IN MARINE ORGANISMS ...Algaceae, General, Marine Plants, Mollusks -non-specific & Other, ...5.0160

DEMINERALIZATION-BORING MECHANISMS OF MOLLUSKS ...Gastropods -slugs,conch,nails, Invertebrate Anatomy, Invertebrate Physiology, Metabolism, ...5.0459
Environmental Physiology

AGING IN HYDROIDS ...Aging, Cell Injury and Autolysis, Developmental Physiology, Hydra, Portuguese Man-of-war, Senescence, ...5.0387

UTILIZATION OF ENVIRONMENTAL NUTRITIONAL RESOURCES BY STARFISH ...Digestive System, Invertebrate Nutrition, Maturity & Growth Stages, Metabolism, Starfishes, ...5.0591

MICROSTRAFICATION OF MARINE ZOOPLANKTON ...Growth Rate, Thermal, Vertical Distribution, Zooplankton, ...5.0753

TEMPERATURE NEEDS FOR GNADAL DEVELOPMENT AND SPAWNING OF DIFFERENT PHYSIOLOGICAL RACES OF THE AMERICAN OYSTER, CRASSOSTREA VIRGINICA ...Behavior, Biological Rhythms, Reproductive System, Water & Temperature-non-specific, ...5.0352

TEMPERATURE AND SALINITY TOLERANCE OF THE SAND SHRIMP, CRANGON SE? TEMSPINSOA ...Environment Resistance, Estuaries, Salinity, Shrimps - Common, Temperature, ...5.0437

LARVAL DEVELOPMENT OF SCYLLARIDEAN LOBSTERS ...Animal Taxonomy, Developmental Physiology, Invertebrate Nutrition, Laboratory, Lobsters, ...5.0409

EVOLUTIONARY DIVERGENCE OF DEEP WATER MARINE ANNELEDS ...Comparative Physiology, Digestive System, Lugworms, Marine Segmentedworm, Vertical Distribution, ...5.0662

EVOLUTIONARY DIVERGENCE ON ONUPHID POLYCHAETES ...Comparative Physiology, Environment Resistance, Invertebrate Nutrition, Lugworms, Marine Segmentedworm, Water Temperature-non-specific, ...5.0663

GROWTH LAYERING IN BIVALVED MOLLUSKS - AN APPROACH TO PALEOBIOGEOGRAPHIC INTERPRETATION ...Animal Physiology, Biological Rhythms, Freshwater Mussels, Scallops, Growth Rate, Invertebrate Physiology, ...5.0355

NEUROENDOCRINE PATHWAYS IN OSMOREGULATION IN CRUSTACEANS - Aquatic Ecology, Crabs, Endocrinology, Shrimps, ...5.0682

GROWTH, CONDITION, AND SURVIVAL OF SHELLFISH ...Adaptation, Maryland, Oysters, Water Quality-general, Water Salinity, ...5.0447

DEVELOPMENT OF CULTURE METHODS FOR ECOCLOGICALLY IMPORTANT MARINE ZOOPLANKTON SPECIES ...Aquatic Ecology, Copepods, Invertebrate Culture, Zooplankton, ...5.0834

GENETIC REGULATION OF HEMOGLOBIN SYNTHESIS IN ARTEMIA ...Hemoglobin, Marker Mutagens, Shrimps - Brine Or Fairy, ...5.0365

Immunology

THE DISEASES OF INVERTEBRATE ANIMALS ...Developmental Physiology, Invertebrate Pathology, Tumors, ...5.0545

THE COMPARATIVE IMMUNOLOGY OF LOWER ORGANISMS ...Blood Typing Studies, Comparative Physiology, Serology and Immunology, ...5.0656

Locomotion

ECOLOGICAL, EXPERIMENTAL, AND COMPUTER STUDIES OF ENDOSTEGIOUS RHYTHMICITY ...Biological Rhythms, Brain, Computer Methods -general, Crustacea -non-specific, ...5.0361

CUES INVOLVED IN VERTICAL MOVEMENT AND STATIC ORIENTATION OF GASTROPODS ...Behavior, Gastropods -slugs,conch,snails, Invertebrate Physiology, Light -other, ...5.0462

NEUROPHYSIOLOGICAL MECHANISMS IN BEHAVIOR ...Giants Water Bug, Water Strider, Horsehoe Or King Crabs, Proprioreceptors, ...5.0490

Metabolism

A NEW APPROACH TO NUTRITION, PHYSIOLOGY, AND MINERAL CYCLING OF FORAMINIFERANS ...Invertebrate Nutrition, Productivity - Food Chain, ...5.0809
Invertebrate Physiology

SUBJECT INDEX

UPTAKE AND ASSIMILATION OF ORGANIC COMPOUNDS IN MARINE ORGANISMS ...Active Transport, Invertebrates - non-specific, Nutrition, Organics, Productivity - Food Chain, ...5.0937

UTILIZATION OF ENVIRONMENTAL NUTRITIONAL RESOURCES BY STARFISH ...Digestive System, Environmental Physiology, Invertebrate Nutrition, Maturity & Growth Stages, Starfishes, ...5.0591

CAROTENOIDS, CAROTENOID CHROMOPROTEINS, AND ASSOCIATED LIPIDS IN ANIMALS ...Cartenoid Pigments, Catabolism and Degradation, Pigments - Animal-non-specific, ...5.0944

AMINO ACID & PROTEIN METABOLISM IN SCHISTOSOMES ...Amino Acids -non-specific, Flukes, Helminthes - Proteins -non-specific, ...5.0621

ECOLOGICAL AND EVOLUTIONARY IMPLICATIONS OF THE ECOTYPES OF ESTUARINE CRUSTACEAE ...Classical, Estuaries, Invertebrate Anatomy, Isopods, Productivity - Food Chain, ...5.0418

INTESTINAL ADSORPTION AND TRANSPORT OF NUTRIENTS IN ECHINODERMANS ...Active Trans., sport, Cellular Or Intracellular, Echinoderma other -other, Intestine, Sodium, ...5.0619

MORPHOLOGICAL REGULATORY MECHANISMS IN TERRESTRIAL AND MARINE ORGANISMS ...Amphibia -non-specific & Other, Collagen, Developmental Physiology, Fish - other, Porifera, ...5.0982

FERTILITY EFFECTS OF CHEMICAL AGENTS IN MARINE INVERTEBRATES ...Basic Embryology, Male Gametes, Reproductive System, Seaurchins Other & Other Echino- derms, ...5.0609

METABOLISM OF MARINE ECOSYSTEMS ...Energy Budgets, Food Webs, Other, Plankton -non-specific, Productivity - Food Chain, ...5.0966

BIOSYNTHESIS OF BROMOPHENOLS IN MARINE INVERTEBRATES ...Acorn Worms, Bioluminescence, Phenols, ...5.0961

METABOLISM OF COMPLETE WATER COLUMNS ...Antarctic Ocean, Autotrophic, Energy Budgets, Respiration, ...5.0967

BENTHIC COMMUNITIES ...Behavioral Ecology, Benthic Fauna, Bottom Sampling Device, Developmental Physiology, Fouling, Productivity - Food Chain, ...5.0561

CARBON DIOXIDE FIXATION IN HETEROTROPHIC ORGANISMS ...Alginates, Carbon Dioxide Fixation, Catabolism and Degradation, Glycogen, Oxygen, ...5.1033

PHYSIOLOGY AND ECOLOGY OF THE ADRIATIC BENTHOS ...Adriatic Sea, Benthic Organisms (non-specific), Marine Biology -non-specific, Microclimate-general, Productivity - Food Chain, ...5.0973

NITROGEN METABOLISM IN MOLLUSCS ...Biochemical, Evolutionary Studies-general, Gastropods -slugs,conch,anails, Metabolism (intracellular), Nitrogen, ...5.0806

SYMBIOSIS OF TROPICAL ZOANTHIDAE AND ZOAN-THELLAE ...Anthozoa, Messanger RNA, Symbiosis, Trop- ic, Zoanthella, ...5.0642

DEMINERALIZATION-BORING MECHANISMS OF MOL- LUSKS ...Calkification, Gastropods -slugs,conch,anails, Invertebrate Anatomy, Invertebrate Physiology, ...5.0859

PHYSIOLOGICAL VARIATION AND ECOLOGY OF MOL- LUSKS ...Energy Budgets, Gastropods -slugs,conch,anails, Population Dynamics, Reproductive System, Respiratory System, ...5.0472

UPTAKE OF ORGANIC COMPOUNDS BY MARINE INVERTEBRATES ...Amino Acids, Amino Acids -non-specific, Chemosensors, Invertebrate Nutrition, Invertebrates -non-specific, Marine Biology, Pulse,labelling, ...5.0938

MARINE ANIMAL USE IN THE STUDY OF HEALTH PROBLEMS ...Hormones, Hormones - Other, Life History Studies, ...5.0612

PROTEIN SYNTHESIS ACTIVATION IN SEA URCHIN EGGS ...Basic Embryology, Biogenesis, Proteins, Reproductive System, Sea Urchins & Other Echino-derms, ...5.0543

INITIATION OF METAMORPHOSIS IN AURELIA ...Biological Rhythms, Growth Rate, Jelly Fish, Low Temp. -but Above 32f, Water Light Quality & Quantity, ...5.0599

Musculoskeletal System

FINE STRUCTURE OF JELLYFISH (CHRYSAORA QUINQUICEREA) TENTACLE MUSCLE ...Contraction and Relaxation, Invertebrate Physiology, Jelly Fish, Microscopy - other, Skin Or Ectoderm, ...5.0659

COMPARATIVE MORPHOLOGY OF MARINE NEMATODES ...Comparative Physiology, Histology and Cytology, Invertebrate Anatomy, Nematoda -other, ...5.0567

REGULATION OF IONIC CONSTITUENTS OF PROTOPLASM ...Active Transport, Dermal, Ions (inorganic), Nervous System, Osmoregulation, ...5.0970

STUDIES IN MICRONEUROPHYSIOLOGY ...Barnacles, Brain, Contraction and Relaxation, Gastropods -slugs,conch,anails, ...5.0362

EXCITATION-CONTRACTION COUPLING IN MUSCLE ...Contraction and Relaxation, Crabs, Lobsters, Plasma Membrane, ...5.0438

Nervous System

NEUROPHYSIOLOGICAL INVESTIGATIONS OF LIMULUS CENTRAL NERVOUS SYSTEM ...Brain, Cardiovascular, Horse- shoe Or King Crabs, ...5.0469

GROWTH, DIFFERENTIATION AND NERVE TRANSMISSION IN THE HYDROID, CAMPANULARIA ...Basic Embryology, Developmental Physiology, Growth Rate, Hydro, Portuguese Man-of-war, ...5.0601

A HISTOCHEMICAL STUDY OF THE CENTRAL NERVOUS SYSTEM OF LIMULUS POLYPHEMUS ...Cholinesterase, Histochemistry - Cytochemistry, Horseshoe Or King Crabs, Organelle-enzyme Assn, ...5.1000

IONIC PERMEABILITIES OF THE SQUID GIANT AXON. ...Actions Potentials, Autonomic Nervous System, Calcium, Cricoid, Fish, Giant Axons, ...5.0970

PHYSIOLOGY OF THE LIMULUS HEART ...Biological Rhythms, Cardiovascular, Heart, Horseshoe Or King Crabs, ...5.0463

MECHANISMS OF VENTILATORY CONTROL ...Crabs, Invertebrate Physiology, Respiratory System, ...5.0471

STRUCTURE AND FUNCTION OF EYES ...Vertebrate Anatomy, Visual Organs, ...5.0379

CONDUCTION AND INTEGRATION ...Behavior, Cellular Physiology, Hydro, Portuguese Man-of-war, Kattydeis, Musculoskeletal System, ...5.1018

ION TRANSPORT MECHANISM IN GIANT AXON ...Active Transport, Atape, Cell Free Metabolism, Octopus, Squid, Cuttlefish, ...Plasma Membrane, ...5.0369

LABORATORY OF NEUROBIOLOGY ...Facilities, Puerto Rico, ...5.0364

BIOCHEMICAL CHARACTERIZATION OF CHOLINESTERASES IN THE BLOOD AND CENTRAL NERVOUS SYSTEM OF LIMULUS POLYPHEMUS ...Blood and lymph, Cholinesterase, Enzyme-substrate, Horseshoe Or King Crabs, Reaction Rates, ...5.0468

Brain

NEUROPHYSIOLOGICAL INVESTIGATIONS OF LIMULUS CENTRAL NERVOUS SYSTEM ...Cardiovascular, Horseshoe Or King Crabs, ...5.0469

THE EFFECT OF SOME NEUROTRANSMITTERS ON THE CENTRAL NERVOUS SYSTEM OF LIMULUS POLYPHEMUS ...Cardiovascular, Horseshoe Or King Crabs, Nervous System, Neurotransmitters, ...5.0470

ECOLOGICAL, EXPERIMENTAL, AND COMPUTER STUDIES OF ENDODGENOUS RHYTHMICITY ...Biological Rhythms, Computer Methods -general, Crustacea -non-specific, Locomotion, ...5.0361

NEUROENDOCRINE REGULATION ...Crustacea -non-specific, Endocrine System, Osmoregulation, Sodium, Water, ...5.0426

STUDIES IN MICRONEUROPHYSIOLOGY ...Barnacles, Contraction and Relaxation, Gastropods -slugs,conch,anails, Musculoskeletal System, ...5.0362

STUDIES ON INTEGRATIVE MECHANISMS OF NEURONS ...Central Nervous System, Mathematical Biology, Visual Org- ans, ...5.0635

NEURAL MECHANISMS OF LEARNING AND BEHAVIOR ...Behavior, Gastropods -slugs,conch,anails, Learning and Reten- tion, Mech of Transmission, ...5.0485

Osmoregulation

IONIC REGULATION IN THE QUEEN CONCH, STROMBUS GIGAS LINNAEUS ...Blood Plasma and Serum, Digestive System, Gastropods -slugs,conch,anails, ...5.0407

564
Invertebrate Physiology

Sensory Organs

Auditory

VISUAL AND ACOUSTICAL COMMUNICATION IN CERTAIN MARINE CRUSTACEANS ...Atlantic Ocean-north, Behavior, Crabs, Visual Organs, ...5.0430

Chemoreceptors

UPTAKE OF ORGANIC COMPOUNDS BY MARINE INVERTEBRATES ...Amino Acids, Amino Acids -non-specific, Invertebrate Nutrition, Invertebrates -non-specific, Marine Biology, Metabolism, Pulse-labeling, ...5.0938

Proprioceptors

STATOLOTH DIFFERENTIATION IN AURELIA (JELLYFISH) ...Calcium, Developmental Physiology, Differentiation Mechanism, Jelly Fish, ...5.0598

NEUROPHYSIOLOGICAL MECHANISMS IN BEHAVIOR ...Giant Water Bug, Water Strider, Horseshoe Or King Crabs, Locomotion, ...5.0490

Visual Organs

VISUAL AND ACOUSTICAL COMMUNICATION IN CERTAIN MARINE CRUSTACEANS ...Atlantic Ocean-north, Auditory, Behavior, Crabs, ...5.0436

RESEARCH ON THE BIO-SYSTEMATICS OF THE CIR- RIPEDIA ...Barnacles, Biological Rhythms, Developmental Physiology, ...5.0364

PHYSIOLOGY OF LUMINESCENT SIGNAL SYSTEMS ...Bioluminescence, Photoreception, Trace Elements, ...5.0950

CEPHALOPOD LENS DEVELOPMENT ...Basic Embryology, Differentiation Mechanism, Lens, Proteins, Microtubules, Octopus, Squid, Cuttlefish, ...5.0424

THE STRUCTURE AND FUNCTION OF CRUSTACEAN EYES ...Crustacea -non-specific, Invertebrate Anatomy, Light, other, Oceanic -pelagic, Vertical Distribution, ...5.0363

STRUCTURE AND FUNCTION OF EYES ...Vertebrate Anatomy, ...5.0379

Skin Or Ectoderm

FINE STRUCTURE OF JELLYFISH (CHRYSAORA QUINQUICERCA) TENTACLE MUSCLE ...Contraction and Relaxation, Invertebrate Physiology, Jelly Fish, Microscopy -other, Musculoskeletal System, ...5.0659

Cilia and Flagellae

A COMPARATIVE SYSTEMATIC INVESTIGATION OF MARINE CILIATES IN THE HOLOTRICHIOUS PROTOSTOMA ORDER HYMENOSTOMATIDA ...Animal Taxonomy, Ciliates, Comparative Physiology, Invertebrate Anatomy, ...5.0570

Derivatives

HISTOCHEMICAL STUDIES OF MUCOSUBSTANCES IN THE MANTLE OF THE NORTHERN QUAHOG, MERCENARIA MERCENARIA ...Calcification, Clams, Histochmistry -Cytosome, Major proteins, Mucopolysaccharides, Mucoproteins, ...5.0455

CONTINUED STUDIES OF THE SYSTEMATICS AND ZOOGEOGRAPHY OF WESTERN ATLANTIC CAECIDAE ...Animal Taxonomy, Atlantic Ocean-general, Gastropods -slugs,conch,snails, Invertebrate Anatomy, Publications-other, ...5.0696

CYTOTOXANOMY OF SPECIES RELATED PELECYPOD MOLLUSKS ...Animal Taxonomy, Clams, Invertebrate Anatomy, Oysters, Selection & Breeding, ...5.0413

ECOLOGY OF PLANKTONIC FORAMINIFERA AND RELATED STUDIES ...Flagellates, Foraminifera, Gastropods -slugs,conch,snails, Plankton Sampling, Vertical Distribution, ...5.0812

POPULATION GENETICS AND LARVAL ECOLOGY OF HAWAIIAN LITTORINA ...Gastropods -slugs,conch,snails, Hawaii, Maturity & Growth Stages, Polymorphism, ...5.0429

MECHANISMS OF CALCIUM CARBONATE DEPOSITION ...Barnacles, Biogeochemical Process, Calcium, Chemical Reactions, Fouling, ...5.0105

PURCHASE OF MATERIALS FOR & CONSTRUCTION OF FLOATS, RACKS, BAGS, AND TRAYS FOR THE SUSPENSION OF VARIOUS TYPES OF CULTCH ...Behavioral Physiology, Environment, Production Purchase Operation, Oysters, Spawning & Nesting Sites, Stocking of Fish & Shellfish, ...5.0008

THE PROCESS OF DEMINERALIZATION-BORING IN BIVALVES ...Calcification, Freshwater Mussels, Scallops, Invertebrate Anatomy, Invertebrate Physiology, ...5.0336

SUBJECT INDEX

Tissues

STUDIES IN OYSTER PATHOLOGY ...Invertebrate Pathology, Mortality Rates, Oysters, Pathology, ...5.0519

TISSUE CULTURE - VIROLOGY ...Animal Viruses (non-specific), Bacteria (non-specific), Cell Injury and Autolysis, Marine Biology, Monoslayer Culture, Oysters, ...5.0978

Venom

CHARACTERIZATION AND MODE OF ACTION OF PROTEIN VENOMS OF MARINE ANIMALS ...Leukin, Mechanism of Action, Sea Urchins & Other Echinoderms, Toxicology, Toxins, ...6.0102

ACTIONS OF BIO-TOXINS ON CELL MEMBRANES ...Muscle, Nervous System, Plasma Membrane, ...6.0128

Whole Body Culture & Rearing

EXPERIMENTAL STUDIES ON THE BIOLOGY AND FOOD CHAIN ECONOMICS OF THE CHAETOGNATHS ...Energy Budgets, Productivity - Food Chain, Reproductive System, Zooplankton, ...5.0777

REPRODUCTION AND EMBRYONIC SURVIVAL IN ASCIDIA NIGRA (SAVIGNY) ...Basic Embryology, Biological Rhythms, Laboratory, Reproductive System, Sea Squirt - Tunicates, ...5.0600

LIFE HISTORY AND DEVELOPMENT OF POLYCHAETOUS ANNELID LARVAE ...Behavior, Developmental Physiology, Life History Studies, Lugworms, Marine Segmentedworms, Reproductive System, ...5.0604

LIFE HISTORY OF THE SHARK COPEPOD, KRYERIA DISPAR ...Copepods, Developmental Physiology, Ectoparasites, Life History Studies, ...5.0933

BEARING AND SENSITIVITY STUDIES OF VARIOUS LIFE STAGES OF MARINE MACROINVERTEBRATES ...Blindwaterfowl, Crabs, Shrumps - Common, ...5.0490

Invertebrates -non-specific

STUDIES ON THE STRUCTURE OF HEMERYTHRIN ...Biochemical, Comparative Physiology, Configuration, Hemerythrin, ...5.0993

UPTAKE AND ASSIMILATION OF ORGANIC COMPOUNDS IN MARINE ORGANISMS ...Active Transport, Metabolism, Nutrition, Organics, Productivity - Food Chain, ...5.0937

SUPPORT OF TRAINING PROGRAMS IN INVERTEBRATE ZOOLOGY AND MARINE BOTANY ...Marine Biology, Marine Environments-general, Marine Plants, Meetings, Training Grants, Fellowships, ...11.0025

ORGANIZATION OF THE ACADEMY'S COLLECTION OF RECENT MARINE, TERRESTRIAL, AND FRESHWATER INVERTEBRATES ...Animal Taxonomy, Collections, ...5.0752

RESEARCH TRAINING IN MARINE BIOLOGY, PALEONTOLOGY AND SYSTEMATIC ZOOLOGY ...Animal Taxonomy, Oceanography-general, Paleontology, Training Grants, Fellowships, ...11.0035

STUDENT RESEARCH AT THE MARINE SCIENCE CENTER ...Facilities, Intertidal Areas, Invertebrate Physiology, Oregon, Training Grants, Fellowships, ...11.0039

COOPERATIVE SYSTEMATICS STUDIES IN ANTARCTIC BIOLOGY ...Animal Taxonomy, Antarctica, Cooperative-studies, Environment, Product Purchase Operation, ...5.0581

MARINE ECOLOGICAL STUDIES ...Environmental Ecology, Habitat Studies, Intertidal Areas, Stress, ...5.0917

REFERENCE COLLECTION OF GULF MARINE ANIMALS ...Animal Taxonomy, Collections, Gulf of Mexico, Vertebrates -non-specific, ...5.0657

PHYSIOLOGICAL VARIATION IN SUBTIDAL AND INTERTIDAL MARINE INVERTEBRATES ...Habitat Studies, Intertidal Areas, ...5.0548

ALGAE AS FOOD FOR MARINE INVERTEBRATE LARVAE HELD IN THE LABORATORY ...Algal Culture, Bulk Culture -other, Chesapeake Bay, Invertebrate Nutrition, ...5.0732

ECOLOGY OF PANAMANIAN REEF COMMUNITIES ...Behavioral Ecology, Panama, Productivity - Food Chain, Reef, Tropic, ...5.0866

THE BIOLOGY OF ROCK-BORING SIPUNCULIDS ...Caribbean Sea, Invertebrate Nutrition, Invertebrate Physiology, Reefs, ...5.0577

SYSTEMATICS OF ANTARCTIC SIPUNCULIDS AND ECHIU RIDS COLLECTED BY THE ELTANIN EXPEDITION ...Animal Taxonomy, Antarctica, Collections, Expeditions, ...5.0578

566
SUBJECT INDEX

Joining and Assembling

MEASUREMENT OF THE RATE OF CARBON DIOXIDE (C14) FIXATION INTO SUBCELLULAR FRACTIONS OF ALGAE ...Algae -General, Algal Culture, Bioindicators, Carbon Dioxide Fixation, Growth Rate, Intracellular Localization, ...5.0728

Mercury
RADIOCHEMICAL TECHNIQUES ...Food Spoilage Detection, Polonium, Radioactive Isotopes, Smoking, Wheat, ...6.0008

Polonium
RADIOCHEMICAL TECHNIQUES ...Food Spoilage Detection, Mercury, Radioactive Isotopes, Smoking, Wheat, ...6.0008

Radioisotopes -non-specific
STUDIES ON THE PHYSIOLOGY OF MARINE ORGANISMS USING RADIOISOTOPES ...Equipment Purchase Operation, Facilities, Marine Plants, ...12.0031

Italy
THE OSTRACODA OF THE BAY OF NAPLES ...Environmental Ecology, Invertebrate Anatomy, Life History Studies, Nomenclature, Classification, Shrimps -Seed Or Mussel, ...5.0415

AMERICAN TABLES COMMITTEE FOR THE NAPLES ZOOLOGICAL STATION ...Facilities, ...11.0008

Jamaica
PHYSICAL AND BIOLOGICAL OCEANOGRAPHY OF A LUMINOUS BAY ...Bays, Bioluminescence, Circulation-general, Model Studies, Phytoplankton, ...5.0976

BIOLUMINESCENCE ...Autotrophic, Bays, Bioluminescence, Phytoplankton, Responses to Growth, ...1.0165

SYSTEMATIC STUDIES OF SPONGES OF THE JAMAICAN FORE-REEF SLOPE ...Animal Taxonomy, Habitat Studies, Invertebrate Anatomy, Porifera, Reefs, ...5.0858

ISOTOPIC AND CHEMICAL COMPOSITION OF ORGANIC CARBONATES ...Biochemical, Chemical, Organic Limestone, Reefs, Sedimentary Petrogenesis, ...7.0084

Japan
GEOPHYSICAL INVESTIGATIONS OF THE SOUTHWEST MARGIN OF JAPAN ...Distribution, Ocean Basins, Regional Structure, Ships and Cruises, ...5.0012

INSPECTION OF OYSTER SEED - NEW ASIATIC SOURCES ...Captive Rearing, Commercial Fishing, Germ Free Animal, Oysters, ...5.0811

MARINE BIOLOGICAL INVESTIGATIONS - JAPANESE FISHERY OBSERVERS PROJECT ...Commercial Fishing, Gulf Of Alaska, Nets, Righteye Flounders, ...5.0012

ANALYSIS OF JAPANESE CATCH STATISTICS ...Commercial Fishing, Number Or Density, Pacific Ocean-north, Salmon -coho, Chinook, Sockeye, ...5.0166

Jelly Fish
PHYSALIA TOXIN AND THE ACTIVITY OF BIOLOGICAL MEMBRANES ...Animal Transport, Animal Toxins, Cellular Membranes (non-spec.), Toxicology, ...6.0107

ENHANCEMENT OF RECREATIONAL USES OF ESTUARINE WATERS THROUGH STUDY OF POTENTIAL CONTROL METHODS FOR STINGING SEA NETTLES ...Biological Control, Chesapeake Bay, Estuaries, Recreation Sites, Water Quality-general, ...5.0605

FINE STRUCTURE OF JELLYFISH (CHRYSAORA QUINQUICERIA) TENTACLE MUSCLE ...Contraction and Relaxation, Invertebrate Physiology, Microscopy -other, Musculotensile System, Skin or Cuticlederm, ...5.0659

STATOLITH DIFFERENTIATION IN AURELIA (JELLYFISH) ...Calcium, Developmental Physiology, Differentiation Mechanism, Propriocaptors, ...5.0598

INITIATION OF METAMORPHOSIS IN AURELIA ...Biological Rhythms, Growth Rate, Low Temp., but Above 32F, Metabolism, Water Light Quality & Quantity, ...5.0899

Joining and Assembling

Welding
Inert Gas
UNDERWATER WELDING ...Helium, Materials Used Undersea, Safety, Scientific-service-support, Subsurface Environments, ...8.0344

Ion Exchange
TRACE ELEMENT EQUILIBRIUM STUDIES ...Adsorption, Chelating Agents, Material Recovery, Trace Elements, Tracers, ...1.0088

Iron
NUCLEAR CHEMISTRY AND GEOCHEMISTRY RESEARCH ...Nucleus -General, ...7.0607

MICROBES AND CORROSION ...Cathodic Protection, Extracellular-enzymes, Fouling, Metals -non-specific, Microorganisms (non-specific), Respiration, ...8.0228

INTERACTIONS OF MARINE NUTRIENT COMPLEXES ...Marine Plants, Nutrients, Phosphorus, Phytoplankton, Tracers, ...5.0958

Isotope Tracer
Isotope Dilution
NUCLEAR OCEANOGRAPHIC TECHNIQUES ...Currents-ocean, Physical Properties, Radioactivity, Water Analysis, Water Motion Recorders, ...8.0087

MEASUREMENT OF COMMON LEAD IN THE EARTHS HYDROSHERE ...Atomic Absorption, Competition, Greenland, Lead, Other Sources, ...3.0069

Isotope Trace -other
TRACE ELEMENTS IN SEA WATER ...Activation Analysis, Long Island Sound, Radioactivity-general, Trace Element Analysis, ...1.0089

GEOCHEMICAL STUDIES OF CONTINENTAL WATERS ...Authigenesis, Element Ratios, Geochemical ...6.0167

Location, Pore Fluids, Radioisotopes, Water Analysis, ...12.0121

LIGHT ISOTOPE STUDIES ...Chemical Reactions, Circulation-general, Deuterium, Mixing, Oxygen, Particle-gas Transfer, ...1.0077

CIRCULATION OF ARTIFICIAL ...Arctic, Circulation-general, Oceanic Fronts, Tracers, Water Analysis-general, ...1.0072

UTILIZATION OF RADIOACTIVE TRACERS IN BEACH STUDIES ...Fluorometry, Tracers, ...7.0618

EFFECT OF NITRILOTRIACETIC ACID (NTA) UPON THE TOXICITY OF METALS TO SELECTED SPECIES OF ESTUARINE PHYTOPLANKTON ...Acids, Carbon, Chemicals (incl. algalicides), Estuaries, Phytoplankton, ...5.0829

Isotopes
Isotopes -non-specific
BIOLOGICAL INVESTIGATIONS WITH ISOTOPES ...Algae-General, Facilities, Marine Plants, Radiation Effects-non-specific, Radioecology, ...11.0025

Radioactive Isotopes
Carbon 
C-14 UPTAKE, LIMITING FACTORS AND EXCRETION PRODUCTS OF ANTARCTIC PHYTOPLANKTON ...Antarctic Ocean, Phytoplankton, Primary Productivity, Secretions and Products, ...5.0813
Joining and Assembling

SUBJECT INDEX
ZOOPLANKTON STUDIES IN BIG LAGOON, CALIFORNIA
...California, Plankton Sampling, Temporal Distribution, Vertical Distribution, Zooplankton, _5.0739

Process Control

STRUCTURAL DESIGN CRITERIA ...Flaw Detection Other,
Hull, Hydrodynamic Structures, Safety, Stress Concentrationtoughness, ...8.0283

Welting - Other
DEEP SUBMERGENCE SYSTEMS ...Buoyant,

Lakes
INSTRUEMTATION FOR LAKE CA YUGA HEAT RELEASE
STUDY ...Electric Power Plants, Heat Flow, New York, Temperature, Thermal Pollution, 8.0105
AIR -SEA INTERACTION PROCESS ...Boundary Layer Studies,
Buoys, Circulation-general, Profiles, Wind-water Interaction,
...3.0028
LOGISTIC SUPPORT AND MAINTENANCE OF FACILITIES
...Atlantic Ocean-north, Facilities, Maine, Marine Biology,
...12.0030
GEOLOGICAL STUDIES II, NORTHERN LAKE MICHIGAN
...Deposits-other, Lake Michigan, Rocks - Bedrock, Submergent, Water Level Fluctuation, 7.0164
TRAMMEL NET SAMPLING IN ESTUARINE AREAS ...Competition, Estuaries, Fish -non-specific, Nets, Population Dynamics, _5.0096
INVESTIGATION OF SPAWNING GROUND POTENTIALS
AND GROWTH AND SURVIVAL OF JUVENILE SOCKEYE
SALMON IN FRAZER LAKE SYSTEM ...Alaska, Censusing,
Nets, Salmon -coho,chinook,sockeye.., Spawning & Nesting
Sites, Tags, _5.0190

notational,

Propulsion, Navigation
Communication, Physical Properties, Submersibles, 8.0051
HY 130-150 STRUCTURAL STEELS ...High Yield, Low Alloy
Steels - Other, Materials Used Undersea, Stress Concentrationtoughness, Stress Corrosion, 8.0221
HY 80-110 STRUCTURAL STEELS ...High Yield, Materials
Used Undersea, Stress Concentration-toughness, 8.0222
HY 180/210 STRUCTURAL STEELS ...High Yield, Low Alloy
Steels - Other, ?garaging, Materials Used Undersea, Precipitation Hardening, Stress Concentration-toughness, ...8.0224
Geomorphology-topography, Marine

Korea
METABOLIC ADAPTATION TO COLD ...Cold, Female,
Hypothermia, Metabolism in Disease, Regulation, ...6.0092

Laboratory Analysis
RESEARCH ON TURBULENT CONVECTION ...Convection,
Forced Convection, Stratified, Turbulence, Turbulent, ...2.0058

DEVELOPMENT OF UNDER-ICE HORIZONTAL SONAR

SCANNING EQUIPMENT AND TECHNIQUES FOR LOCATING FISH SCHOOLS ...Behavioral Ecology, Commercial Fishing, Fish -non-specific, Nets, Sonar, ...8.0138
ATCHAFALAYA RIVER - GAILOU LAKE SYSTEM ...Benthic
Fauna, Louisiana, Number Or Density, Plankton Sampling, Vertical Distribution, ...5.0095

ELECTROKINETIC SOIL STUDY ...Buried Structures, Electroosmosis, Electroosrnosis, Electrophoresis, Marine Soils, Stabilization, ...8.0342
MARINE HYDRODYNAMICS ...Antarctic Ocean, Circulationgeneral, Model Studies, Waves, Waves-internal, 8.0196

ALPINE LIMNOLOGY PROJECT ...Core Analysis, Dust - Particulate Matter, Extrusives, Hawaii, Mountains-alpine, Vol-

DYNAMICS OF MOORED BUOY SYSTEMS USED IN

OCEANOGRAPHY R&D AND SURVEILLANCE ...Buoys,
Currents-ocean, Model Studies, Moorings, Waves, 8.0321
EXPERIMENTAL AND THEORETICAL RESEARCH ON TURBIDITY CURRENTS ...Currents- other, Hydraulic Structures,
Sedimentation, 7.0243
MARINE RADIOLOGICAL INSTRUMENTATION ...Acoustical,
Chemical Analysis (water), Circulation-general, Mixing,

canoes, 7.0236

STUDIES OF SOCKEYE SALMON, ONCORHYNCHUS NERKA, IN THE NUSHAGAK DISTRICT, ALASKA ...Alaska,
Commercial Fishing, Interbiotic Relat.(non-specif), Population
Dynamics, Salmon -coho,chinook,sockeye.., Spawning & Nesting Sites, ...5.0228
INVESTIGATION OF COMMERCIAL FISH POPULATIONS IN
WESTERN LAKE SUPERIOR ...Alewife,menhaden,shad,herring, Commercial Fishing, Lake Superior, Nets, Population

Radioactivity-general, Sampling, ...8.0062
OCEAN ENGINEERING STUDIES ...Applied Electronics, Data
Acquisition, Data Processing Services, Engineering Studiesgeneral, Instrumental Services, Sonar, 8.0052
MARINE LABORATORY ...Fishing Gear, Louisiana, Nets, Organism Sampling Devices, Technique Development, 11.0024

Dynamics, 5.0113
RELICT COPEPODS FROM LAKE TUBORG, ELLESMERE
ISLAND ...Brackish Water, Canada, Carbon-14, Copepods,
Plankton Sampling, ...5.0388
HYDROLOGY OF UPPER OLD TAMPA BAY, FLORIDA
FLUCTUATIONS IN SPECIES COMPOSITION AND YEARCLASS STRENGTH OF COMMERCIAL LANDINGS ...Commercial Fishing, Lake Erie, Scales, Size, Species, Comparison of

AN ENLARGED PROGRAM OF RESEARCH IN NEW

LABORATORIES OF MAINE SCIENCES ...Oceanographygeneral, ...11.0036

LABORATORY MODEL STUDIES ON PRESSURE DISTRIBUTION IN DETRITUS DURING PENETRATION ...Mechanical
Properties, Model Studies, Placer, Pressure, Soil Loads,
...8.0253

,

Labrador Sea
POLYCHAETES AND ECHINODERMS IN THE LABRADOR
SEA ...Animal Taxonomy, Brittle Stars, Lugworms, Marine Segmentedworm, Reproductive System, Starfishes, ..5.0603
AND
GRAND BANKS
OCEANOGRAPHY OF THE
LABRADOR SEA ...Buoys, Circulation-general, Icebergs,
Labrador Current, Meteorological Studies, 4.0124

Lagoons

5.0135

GREAT LAKES GEAR RESEARCH ...Commercial Fishing, Fish
-non-specific, Fishing Gear, Great Lakes-general, Population
Dynamics, ...8.0136
LIFE HISTORY OF THE BURBOT AND LONGNOSE SUCKER
...Codfishes, Hake, Lake Superior, Life History Studies,
Suckers, _5.0184

LABORATORY STUDIES TO CORRELATE ENGINEERING
PROPERTIES OF MARINE PLACER MATERIALS WITH
SAMPLING TOOL PERFORMANCE ...Coring and Dredging,
Gold, Mechanical Properties, Placer, Scientific-service-support,
_8.0244

Lakeshores-inlets
USE OF THE COASTAL ZONE FOR THE U. S. COASTLINE
OF LAKE ERIE AND LAKE SUPERIOR ...Lake Erie, Lake
Superior, Land Use, Social Aspects, Welfare Economics,
_9.0004

Land Use
USE OF THE COASTAL ZONE FOR THE U. S. COASTLINE
OF LAKE ERIE AND LAKE SUPERIOR ...Lake Erie, Lake

MANAGEMENT OF THE ENIWETOK MARINE BIOLOGICAL
LABORATORY ...Atolls, Facilities, Marine Biology (nonspecific), Reefs, _12.0028
SHRIMP PRODUCTION IN LOUISIANA SALT-MARSH IMPOUNDMENTS UNDER EXISTING AND MANAGED CONDITIONS ...Aquaculture & Fish-farming, Captive Rearing,

Superior,

Lakeshores-inlets,

Social

Aspects,

Welfare

Economics, -9.0004
MONITORING THE EFFECTS OF LAND USE ON SALMON
PRODUCTION ...Alaska, Environmental Ecology, Pulp, Paper ,
and Logging, Salmon & Trout - Non-specific, Streams, 5.0192

Louisiana, Shrimps - Common, Water Movement, Currents

EFFECTS OF MARSH MANAGEMENT STRUCTURES UPON
FISHES ...Alewife,menhaden,shad,herring, Crabs, Engineering
Structures-general, Shrimps - Common, Spawning & Nesting
Sites, Swamps-marshes, 5.0206

...5.0435

ECOLOGY OF MARSH FORAMINIFERA ...Foraminifera,
Productivity - Food Chain, Rate of Deposition, Swampsmarshes, 5.0747

568


SUBJECT INDEX

SOICO-ECONOMIC STUDY OF NARRAGANSETT BAY, RHODE ISLAND ...Bays, Benefity-cost Analysis, Estuaries, Rhode Island, Social Aspects, Water Quality Control-general, ...9.0019

Lanthanide Series
RADIODELEMENT STUDIES IN THE OCEANS - LANTHA-NIDES IN SEA WATER AND THEIR INTERACTIONS WITH MARINE SEDIMENTS AND SUSPENSION ...-Atlantic Ocean-general, Oceanic Fronts, Radiochemistry, Analysis, Trace Elements, Water Analysis, ...1.0104

Larvicides
LAKE SUPERIOR CHEMICAL CONTROL OF SEA LAMPREY ...Aquatic Ecology, Control of Nuisance Species, Lake Superior, Lampreys, Streams, ...5.0628
LAKE MICHIGAN CHEMICAL CONTROL OF SEA LAMPREY ...Animal Pollutant Sources, Control of Nuisance Species, Evaluation, Lake Michigan, Lampreys, ...6.0158
SEA LAMPREY AMMOCETE REESTABLISHMENT STUDIES ...Aquatic Ecology, Control of Nuisance Species, Great Lakes-general, Lampreys, Life History Studies, Population Dynamics, ...5.0629

Lasers and Masers
HOLOGRAPHIC INSTRUMENTATION FOR MARINE PLANKTON STUDIES ...Photography, Zooplankton, ...8.0066
RESEARCH IN AIR-ENERGY EXCHANGE ...Heat and Radiation Transfer, Optical, Thermal, Visible, ...3.0035

Launching Operations & Sites
Recovery Operations
WATER-TO-AIR RETRIEVAL ...Aircraft, Mathematical Models, Suspension-release, ...8.0276

Lead
SEA WATER CHEMISTRY ...Atmosphere Composition, Gases, Industrial-general, Technique Development, Trace Elements, ...1.0076
ISOTOPE AND TRACE ELEMENT STUDIES IN OCEANIC VOLCANIC ROCKS ...Lavas, Magma, Magmas, Petrology, Rare Earth Studies, Strontium, Trace Element Analysis, Volcanic, ...7.0075
HEMATOLOGICAL CHANGES IN F. HETEROCLITUS UPON EXPOSURE TO TOXIC METALS ...Blood Cells, Blood Plasma and Serum, Cadmium, Killifish - Cyprinodon, Toxins - other, ...5.0325
MEASUREMENT OF COMMON LEAD IN THE EARTHS HYDROSHERE ...Atomic Absorption, Composition, Greenland, Isotope Dilution, Other Sources, ...3.0069

Learning and Retention
LEARNING IN OCTOPUS ...Behavior, Octopus, Squid, Cuttlefish ... , Travel grants, ...5.0491
OPERANT OSMOTIC REGULATION IN A MARINE ANIMAL ...Environment Resistance, Octopus, Squid, Cuttlefish ... , Osmoregulation, Water Salinity, ...5.0664
NEURAL MECHANISMS OF LEARNING AND BEHAVIOR ...Behavior, Brain, Gastropods - slugs, conch, snails, Mech of Transmission, ...5.0485

Lecture Grants
SECOND AND FOURTH ANNUAL EDWIN A. LINK LEC-TURES ...Oceanography-general, Space, ...11.0019

Legal Aspects of Water
Legal Review
SURVEY OF MAINE LAW AFFECTING MARINE DEVELOP-MENT ...Legal Review, Maine, Marine Biology (non-specific), State Government, Survey Studies, Water Law-general, ...10.0002
PACIFIC SALMON FISHERIES - ECONOMICS OF MANAGEMENT ...Legal Review, Maine, Marine Biology, Economic Appraisals-general, Continental Shelf, International, Legal Review, Maine, Marine Biology (non-specific), State Government, Survey Studies, Water Law-general, ...10.0004
AN ANALYSIS OF THE LAW OF THE CONTINENTAL SHELF AND OF THE RESOURCES OF THE DEEP SEA FLOOR ...Continental Shelves, International, Legal Review, ...10.0005
PACIFIC SALMON FISHERIES - ECONOMICS OF MANAGEMENT ...Legal Review, Maine, Marine Biology (non-specific), State Government, Survey Studies, Water Law-general, ...10.0006

Line Islands
THE PORIFERA OF FANNING ISLAND, CENTRAL PACIFIC ...Animal Taxonomy, Dispersion - other, Environmental Effect-ecology, Polypora, ...5.0539
EVALUATION OF LOW LEVEL TEMPERATURE GRADIENTS OVER THE LINE ISLANDS NEAR THE EQUATOR ...Atmosphere Radiation, Radiation Balance, Temperature, ...1.0180
LINE ISLANDS EXPERIMENT ...Boundary Layer Studies, General Synoptic Observations, Physical Climatology, Satellites, Wind-water Interaction, ...3.0063
INTERACTIONS BETWEEN TURBULENCE, CLOUDS, SEA TEMPERATURE, ...Lutra Analysis - General, Indian Ocean-general, Patterns, Temperature, Turbulence, ...3.0025

Liquid
VISCOITY AND VISCOELASTICITY OF LIQUIDS AND GLASSES ...Glass, Instrumental Services, Morphology, State Variables - Ptv, Viscoelasticity, Viscosity, ...8.0260
MECHANICAL PROPERTIES ...Environmental General, Mechanical Properties, Special Mission Ships, Submersibles, Test Methods, ...8.0210
MOBILITY OF OIL-TYPE PRESERVATIVES IN IMMERSED WOOD ...Creosote, Evaluation, Forestry, Marine Biology (non-specific), Wood Preservatives-non-specific, ...8.0238

569
SUBJECT INDEX

Lithification

Authigenesis

SEDIMENTARY GEOCHEMISTRY -...Other, Precipitation, Removal-inorganics, Water Chemistry-other, 7.0.0190
GEOCHEMICAL STUDIES OF CONTINENTAL WATERS -...Element Ratios, Geochemical Analysis, Isotope, Isotope Tracer-other, Location, Pore Fluids, Radioisotopes, Water Analysis, 7.0.1021

Mineral Type

RECENTLY PRECIPITATED DOLOMITES AND ASSOCIATED MINERALS -...Clay Minerals-general, Crystal Growth, Dolomite, Phase Relationships, Precipitates, Silicate-general, 7.0.0096
KAOLINITE AS RELATED TO ENVIRONMENT OF DEPOSITION -...Diagenesis, Environment, Genetic Relationships, Kaolinite, 7.0.0239

Cementation

Cement Origin

ORGANIC INFLUENCES ON CALCIUM CARBONATE CEMENTATION -...Algae- General, Algal Culture, Biology, Marine Plants, Secretions and Products, 5.0.792
DIAGENESIS IN SEDIMENTS -...Cementing Material, Diagenesis, Model Studies, Pore Fluids, Textures-structures, 7.0.0192

Cementing Material

DIAGENESIS IN SEDIMENTS -...Cement Origin, Diagenesis, Model Studies, Pore Fluids, Textures-structures, 7.0.0192

Chemical Processes

Mineral Reactions

CLAY-INORGANIC AND ORGANIC-INORGANIC ASSOCIATIONS IN AQUATIC ENVIRONMENTS -...Clay, Deposits, Sedimentation, Suspension, Trace Elements, 7.0.0050

Intrastratal Solution

Mineral Concentration

NEARSHORE HEAVY METAL DEPOSITS OF THE GULF OF ALASKA -...Deposits, Distribution, Gulf of Alaska, Heavy Minerals, Sedimentation, 7.0.0019

Organic Digestion

FACTORS EFFECTING RATES OF ORGANIC DEPOSITION AND QUALITY OF WATER -...Clays, Lake Ontario, Organic Matter, Rate of Deposition, Swamps-marshes, 7.0.0261

Pore Fluids

GEOCHEMICAL STUDIES OF CONTINENTAL WATERS -...Authigenesis, Element Ratios, Geochemical Analysis, Isotope, Isotope Trace-other, Location, Radiocarbon, Water Analysis, 7.0.0121
DIAGENESIS OF CARBONATE SEDIMENTS -...Carbonates-general, Core Analysis, Diagenesis, Geochemistry-general, Trace Element Analysis, 7.0.0266
DIAGENESIS IN SEDIMENTS -...Cement Origin, Cementing Material, Diagenesis, Model Studies, Textures-structures, 7.0.0192

Lithification-general

SEA FLOOR STUDIES - DEPOSITIONAL AND EROSION PROCESSES -...Bearing Capacity, Distribution, Erosion, Sedimentation, Stability Analysis, 7.0.0200

Long Island Sound

TRACE ELEMENTS IN SEA WATER -...Activation Analysis, Isotope Trace-other, Radioactivity-general, Trace Element Analysis, 1.0.0085
LOCATION OF INSHORE SPawning AREAS -...Bluefish, Nets, Spawning & Nesting Sites, Water Temperature-non-specific, 5.0.0201
LARVAL STUDY OF THE LOBSTER -...Atlantic Ocean-north, Habitat Studies, Lobsters, Mark, Tag Or Capture-other, Maturity & Growth Stages, Plankton Sampling, 5.0.0371
POPULATION STRUCTURE OF THE LOBSTER -...Commercial Fishing, Diving and Scuba, Lobsters, Population Dynamics, Sinks, 5.0.0688
TAGGING PROGRAM -...Lobsters, Number Or Density, Population Dynamics, Tags, Temporal Distribution, 5.0.0372

Louisiana

SHRIMP PRODUCTION IN LOUISIANA SALT-MARSH MOUNDS UNDER EXISTING AND MANAGED CONDITIONS -...Aquaculture & Fish-farming, Captive Rearing, Lagoons, Shrimps - Common, Water Movement, Currents, 5.0.0435
OYSTER LEASE CONTROL MONUMENTS - BAY ADAM, BASTIAN BAY AND SANDY POINT BAY AREAS -...Commercial Fishing, Gulf of Mexico, Oysters, Plane, Tides, 5.0.0027
MARINE LABORATORY -...Marine Biology (non-specific), 5.0.0092
MARINE LABORATORY -...Fishing Gear, Laboratory Analysis, Nets, Organism Sampling Devices, Technique Development, 11.0.024
LAKE BOGNE-CHANDELEUR SOUND SYSTEM -...Benthic Fauna, Number Or Density, Plankton Sampling, River Delta, Vertical Distribution, 5.0.0191
TINMALLIER - TERREBONNE BAYS SYSTEM -...Benthic Fauna, Number Or Density, Plankton Sampling, River Deltas, Vertical Distribution, 5.0.0092
BRETON SOUND - MOUTH OF MISSISSIPPI RIVER SYSTEM -...Benthic Fauna, Number Or Density, Plankton Sampling, Salinity, Tides, Vertical Distribution, 5.0.0094
ATCHAFALAYA RIVER -...GAILOU LAKE SYSTEM -...Benthic Fauna, Lake, Number Or Density, Plankton Sampling, Vertical Distribution, 5.0.0095
EVALUATION OF PRESENT AND PROPOSED LAWS REQUIRING THE PROCESSING AND PACKAGING OF OYSTERS -...Food Processing -other, Legal Standards, Oysters, Packaging, 6.0.0277
CULTURE OF POMPANO IN BRACKISH WATER PONDS -...Aquaculture & Fish-farming, Brackish Water, Food Supply, Pompanso, Scads, Jacks, Stocking of Fish & Shellfish, 8.0.0004
CULTURE OF BLUE, CHANNEL, AND WHITE CATFISH IN BRACKISH WATER PONDS -...Aquaculture & Fish-farming, Blue Catfish, White Catfish, Brackish Water, Captive Rearing, Channel Catfish, 8.0.0006
ECOLOGICAL STUDIES OF THE BLUE CRAB, CALMENITES SAPIIDUS -...Aquatic Ecology, Crabs, Estuaries, Life History Studies, 5.0.0433
MOVEMENTS OF FRESHWATER CATFISH IN THE ESTUARIES OF SOUTHWEST LOUISIANA -...Blue Catfish, White Catfish, Environment Resistance, Estuaries, Migration, Water Salinity, 5.0.0090
BAYOU LAFOURCHE SEDIMENTATION STUDY, LOUISIANA -...Bayous, Channel, Morphology-general, Rate of Deposition, Sediment Yield, 9.0.0010

Luciferin

MECHANISM STUDIES ON BLOOMENESCENT REACTIONS WITH EMPHASIS ON ENERGY TRANSFER PROBLEMS -...Bioluminescence, Energy Conversion, Luciferase, 11.0.0164

Madagascar-malagasy Republic

A SYSTEMATIC STUDY OF ENTOCYTHERID OSTRACODS -...Animal Taxonomy, New Zealand, Publications -other, Shrimps - Seed Or Mussel, South America, 5.0.0492

Magnetic Phenomena

Superconducting Magnets

SUPERCONDUCTING MAGNETOMETER SYSTEMS EVALUATION -...Aircraft, Magnetometers, Technique Development, 8.0.0098

Magnetometers

DEEP-SEA CORE MAGNETOMETER AND A CORE ORIENTATION SYSTEM -...Coring and Dredging, Direction, Rock & Mineral Magnetics, 8.0.0140
Mammals

COMMUNICATIONS STUDIES ON TURSIOPS TRUNCATUS AND OTHER DELPHINIDS ...Cetaceans - Adapation, Cardiovascular System, Central Nervous System, Locomotion - animal, Mammals, Sound Production, Tape Recording, Audio, ...5.0624

ACOUSTIC RECORDING OF MARINE MAMMALS OF NOVA SCOTIA AND NEWFOUNDLAND ...Cetacea of Tierra Del Fuego ...Facilities, Survey Studies, Tierra Del Fuego, Travel Grants, ...5.0544

ACOUSTIC RECORDING OF MARINE MAMMALS OF NOVA SCOTIA AND NEWFOUNDLAND ...Mammals, Sound Production, Tape Recording, Audio, ...5.0579

BEHAVIORAL STUDIES OF CETACEANS ...Behavioral Ecology, Locomotion - animal, Sound Production, ...5.0592

DETERMINANTS AND CONTROL OF UNDERWATER VOCALIZATIONS IN THE CALIFORNIA SEA LION ...Acoustical, Seals, Sound Production, ...1.0003

WHISTLE CONTOURS IN ODONTOCETE CETACEANS ...Behavioral Ecology, Social Behavior, Sound Production, ...5.0536

BELUGA WHALES ...Acoustical, Behavioral Ecology, Life History Studies, Sound Production, Tape Recording, Audio, ...5.0527

ADMINISTRATION OF WHALING ACT, COMMERCIALLY UTILIZED WHALES ...Age, Food Supply, Growth Rate, Parasitology - other, Reproduction Studies (general), ...5.0648

ADMINISTRATION OF WHALING ACT, PROTECTED AND NON-COMMERCIAL WHALES ...Censusing, Migration, Reproduction Studies (general), Vertebrate Anatomy, ...5.0592

ADMINISTRATION OF WHALING ACT - DEVELOPMENT OF RESEARCH TOOLS ...Age, Management - other, Mark, Tag Or Capture - other, ...5.0670

CARDIOVASCULAR ADJUSTMENTS IN DIVING MAMMALS ...Adapation, Cardiovascular System, Effects on Cardiovascular system, Locomotion - animal, ...5.0567

COMPARATIVE PHYSIOLOGY OF RESPIRATORY MECHANICS IN MAMMALS ...Comparative Physiology, Sound Production, ...5.0645

STUDIES OF SOUND PRODUCTION ...Echolocation, Sound Production, ...5.0545

Mammals

THE CETACEAN BRAIN - A COMPARATIVE STUDY ...Central Nervous System, Comparative Physiology, Structure-cells, ...5.0641

Laboratory Rat

THE EVALUATION OF WHOLESOMENESS OF RADIATION SUB-Sterilized FOOD PRODUCTS USING RATS ...Animal Protein, Clams, Quantitative & Qualitative, Radiation, Thiaminase, ...5.0631

Sea Lions, Fur Seals

SEA OTTER ...Alaska, Metamorphosis, Population Dynamics, Range Or Territorial Distr., Stocking of Mammals, ...5.0528

UllTILIZATION OF FRESHWATER FISH FOR ANIMAL FOODS ...Fish & Shellfish, Fish Meals, Heating, Steaming, Thiaminase, ...5.0634

BOTTOM FISH, FISH WASTE, SCRAP FISH & OTHER SEA PRODUCTS FOR FUR ANIMAL DIETS ...Alewife, men-haden, haddock, bering, Antioxidants, Chubs, Notropis, Fish Meals, Management, ...5.0501

Seals

PERCEPTUAL, VOCAL, AND ECHO-RANGING BEHAVIOR OF SEALS AND SEA LIONS ...Auditory, Echolocation, Sound Production, Visual Organs, ...5.0547

PHYSIOLOGY OF MARINE MAMMALS ...Environmental Physiology, Mammals, ...5.0624

ANATOMICAL INVESTIGATIONS OF THE LOBODONTINAE ...Collections, Ross Sea, Vertebrate Anatomy, ...5.0568

THE EFFECTS OF SEAL AND FISH PREDATION ON CERTAIN ANTARCTIC BENTHIC COMMUNITIES ...Antarctica, Benthic Organisms (non-specific), Predation, Productivity - Food Chain, ...5.0592

CARDIOVASCULAR ADJUSTMENT TO DIVING ASPHYXIA ...Cardiovascular System, Locomotion - animal, Medical Studies, Regional Blood Flow & Volume, ...5.0552

POPULATION DYNAMICS OF ANTARCTIC SEALS ...Aerial Photography, Antarctica, Migration, Population Dynamics, ...5.0555

ACOUSTIC RECORDING OF MARINE MAMMALS OF NOVA SCOTIA AND NEWFOUNDLAND ...Atlantic Ocean-north, Canada, Mammals, Sound Production, Recording, Audio, ...5.0556

DEEP DIVING ANTARCTIC BIRDS AND MAMMALS ...Adaptation, Antarctica, Locomotion - animal, Penguins, Water Pressure, ...5.0565

DETERMINANTS AND CONTROL OF UNDERWATER VOCALIZATIONS IN THE CALIFORNIA SEA LION ...Acoustical, Mammals, Sound Production, ...1.0003

SEAL BIOLoGY AND HARVEST ...Alaska, Environmental Ecology, Interbiotic Relat.(non-specific), Life History Studies, Reproduction Studies (general), ...5.0525

WALRUS BIOLOGY AND POPULATION ...Behavioral Ecology, Censusing, Migration, Population Dynamics, Reproduction Studies (general), ...5.0525

BREEDING AND MATERNAL BEHAVIOR AMONG THE STELLER SEA LION ...Behavior, Developmental Physiology, Parturition, Spawning & Nesting Sites, ...5.0524

HAIR SEALS ...Age, Dispersion - other, Metamorphosis, Population Dynamics, Spawning & Nesting Sites, ...5.0525

FUR SEAL RESEARCH, PELAGIC INVESTIGATIONS ...Behavioral Ecology, Food Supply, Vertical Distribution, ...5.0567

FUR SEAL RESEARCH, POPULATION DYNAMICS ...Age, Growth Rate, Life History Studies, Mark, Tag Or Capture - other, Population Dynamics, ...5.0571

FUR SEAL RESEARCH, ANATOMY-BEHAVIOR-MORTALITY ...Behavior, Hair, Mortality Rates, Nutrition - other, Vertebrate Anatomy, ...5.0575

INTERNATIONAL WEDDELL SEA OCEANOGRAPHIC EX-PEDITION ...Organics, Population Dynamics, Primary Productivity, Productivity - Food Chain, Weddell Sea, ...5.0512

CARDIOVASCULAR STUDIES ON DIVING MAMMALS ...Adaptation, Basic Hemodynamics, Cardiovascular System, Control and Regulation, Heart, Locomotion - animal, ...5.0639
Mammals
ECHO RANGING SIGNALS ...Captive Rearing, Echolocation, Mark, Tag Or Capture -other, Sonar, Sound Production, ...5.0546

Vertebrates -non-specific
BIOCHEMISTRY OF FERTILIZATION AND EARLY DEVELOPMENT ...Basic Embryology, Fertilization, Reproductive System, Sea Urchins & Other Echinoderms, ...5.0330
REFERENCE COLLECTION OF GULF MARINE ANIMALS ...Animal Taxonomy, Collections, Gulf of Mexico, Invertebrates -non-specific, ...5.0657

Management
INSTITUTIONAL ARRANGEMENTS FOR THE MARINE SCIENCES ...International Affairs, Management and Administration, Oceanography-general, Savings and Investment, ...10.0005
AN ANALYSIS OF PHOSPHORUS AND NITROGEN COMPOUNDS IN TIDAL MARSHLAND DRAINAGE - LABORATORY PROCEDURES ...Colorimetry, Computer Applications, Conductometry, Nitrogen, Phosphate, Phosphite, Swamps-marshes, ...5.0761
AN ANALYSIS OF PHOSPHORUS AND NITROGEN COMPOUNDS IN TIDAL MARSHLAND DRAINAGE ...Nitrate, Nitrite, Phosphate, Phosphite, Swamps-marshes, Tidewater Arts, Water Properties-general, ...5.0953

UTILIZATION OF PHYSICAL AND MATHEMATICAL MODELS IN MARINE WATER RESOURCES RESEARCH AND MANAGEMENT ...Environmental Effects-geologic, Estuaries, Mathematical Analysis, Model Studies, Shoreline - Coastline, ...4.0084
TIDE MARSH ECOLOGY AND WILDLIFE ...Microorganisms (non-specific), Nitrogen Cycle, Nutrients, Phosphorus, Primary Productivity, Swamps-marshes, ...5.0870

CULTURE OF ATLANTIC CROAKER IN BRACKISH WATER PONDS ...Aquaculture & Fish-farming, Brackish Water, Captive Rearing, Drums, Ponds, Productivity (agricultural), ...8.0005

PROJECT AQUA-MAP - DEVELOPMENT OF AERIAL PHOTOGRAPHY AS AN AID TO WATER QUALITY MANAGEMENT ...Aerial Photography, Effluents-waste Water, Model Studies, New York, Pollutants-other, ...4.0167
THE EFFECT OF CONTROLLING SALT-MARSH MOSQUITOES ON BEEF CATTLE PRODUCTION, PLANT ECOLOGY, SOIL PRODUCTIVITY, AND ESTUARINE ANIMALS ...Cultural Control of Insects, Ectoparasitic Insects, Wetlands, ...5.0927

SPACECRAFT OCEANOGRAPHY ...Instrumentation, Instrumentation-general, Photography, Satellites, Unmanned Satellite, ...4.0157
FLOW AND SALINITY IN THE HUDSON ESTUARY, NEW YORK ...Estuaries, Fresh Water, Inflow, Salinity, Tides, ...2.0075

TECHNIQUES OF PLANNING ...Application, Control Systems, Mathematical Analysis, Operations Research, Planning, Southern, Systems Analysis, ...9.0017

Manganese
DEPOSITION RATES BY THE PROTACTINIUM METHOD ...Chemical, Distribution, Element Ratios, Sedimentary Petrogenesis, Thermal, Thorium, Uranium, ...7.0270

STRUCTURE, MINERALOGY, AND CHEMICAL COMPOSITION OF MARINE MANGANESE NODULES ...Chemistry, Mineralogy, Origin, Polished Sections, Precipitates, Textures-structures, ...7.0028

CATALYSIS AND KINETICS OF MANGANOUS ION OXIDATION IN AQUEOUS SOLUTION AND ADSORBED ON THE SURFACES OF SOLID OXIDES ...Adsorption, Heterogeneous Catalysis, Oxidation-other, Oxide, Precipitates, Solution, ...2.0063

Manometers
GROWTH AND CELLULAR MORPHOGENESIS IN NITELLA ...Elongation of Cell, Growth and Differentiation, Nitella, Plant Developmental Biology, Water Movement, ...5.0721

Mapping
FEASIBILITY STUDY FOR SYNTHETIC APERTURE ARRAY ACOUSTIC BOTTOM MAPPING SYSTEM ...Acoustic, Charts, Doppler, Geomorphology-topography, ...4.0061

VISIBLE REGION INSTRUMENTATION FOR OCEANOGRAPHIC SATELLITES ...Currents-ocean, Geomorphology-topography, Photography, Satellites, Shools, ...8.0058

MARINE GEOLOGY ...Acoustical, Bathymetry, Geomorphology-topography, Magnetic Studies, Sea Foe, Springing, ...7.0041
AIRBORNE SEA SURFACE MEASUREMENTS IN THE EUTHERAL PACIFIC ...Atolls, Humidity, Infrared Radiation, Oceanic Fronts, Radiation Detection, Temperature, ...1.0190

SYSTEM DESIGN STUDY FOR THE U.S. NAVAL OCEANOGRAPHIC OFFICE INTELLIGENCE DATA HANDLING SYSTEM ...Data Analysis - General, Data Reduction and Analysis, Geophysics-general, Optimization Technique, Systems Analysis, ...4.0016

BIO-AcouSTIC AND BIOLOGICAL SAMPLING GEAR STUDIES ...Acoustical, Indian Ocean-general, Organism Sampling Devices, Plankton (non-specific), ...8.0126

DEVELOPMENT OF A PHOTOGRAPHIC SUIT FOR STEREOSPHEROMETERS - ASTRONOMIC MAPPING BY SUMBERISIBLE ...Navigation, Photography, Sonar, Submersibles, Turkey, ...4.0060

CIRCULATION IN THE GULF OF MEXICO ...Circulation-general, Currents-ocean, Gulf of Mexico, Infrared Radiation, Oceanic Fronts, ...2.0022

SEA ICE MOVEMENT DYNAMICS ...Charts, Forecasting-prediction, Model Studies, Polar, Sea Ice, ...3.0097
LOCATING AND MAPPING THE EXISTING SEED OYSTER BEDS IN DELAWARE BAY ...Aquatic Ecology, Bays, Delaware Bay, Oysters, Spawning & Nesting Sites, ...5.0381

EVALUATION AND STATISTICAL ANALYSIS OF ALL DATA ...Data Analysis - General, Geomorphology-topography, Spawning & Nesting Sites, Statistics-general, ...4.0018

OCEANOGRAPHY ATLAS OF THE SOUTH CAROLINA CONTINENTAL MARGIN ...Atlases-maps, Continental Shelf, North Carolina, ...4.0059

GEO-HYDRAULIC SURVEYING AND CHARTING ...Airborne Gravimeters, Data Acquisition, Development of Models, Gravimetry Studies, Platforms, ...7.0106

DIVER-ASSISTED OCEANOGRAPHY ...Benthonic-bottom, Continental Shelf, Currents-bottom, Diving and Scuba, Geomorphology-topography, Waves-inner, ...4.0098

DEVELOPMENT OF OFFSHORE SOURCES OF SAND SUITABLE FOR BEACH RESTORATION AND NOURISHMENT ...Beach, Coring and Dredging, Ocean Mining, Shoreline Structures, Size, ...7.0012

TEKTITE I ...Diving and Scuba, Geologic Maps, Geology-general, Submersibles, ...4.0054

WESTERN PACIFIC ISLANDS ...Hawaii, Igneous Activity - Volcanism, Lava, Petrology, Sea Level Changes, ...7.0104

WORLD WIDE MARINE MINERAL RESOURCES ...Continental Shelf, Continental Slope, Economics, Potential of Deposit, Resources Inventories, ...4.0056

EASTERN TROPICAL PACIFIC COOPERATIVE SURVEY ...Bathythermographs, Pacific Ocean-cast, Ships and Cruises, ...4.0122

Maps
Charts
FEASIBILITY STUDY FOR SYNTHETIC APERTURE ARRAY ACOUSTIC BOTTOM MAPPING SYSTEM ...Acoustic, Charts, Doppler, Geomorphology-topography, ...4.0061

STRUCTURE OF OCEAN BASINS ...Basins, Bathymetry, Indian Ocean-general, Ridges, Structural Studies, ...7.0092

DATA COLLECTION ...Data Acquisition, Data Analysis - General, Instrumentation-general, Sampling, ...4.0017

SEA ICE MOVEMENT DYNAMICS ...Forecasting-prediction, Mapping, Model Studies, Polar, Sea Ice, ...3.0087

DISTRIBUTION MAPS OF ANTARCTIC HOLOTHURIANS AND ECHINOIDS ...Environmental Ecology, Sea Cucumber, Sea Urchins & Other Echinoderms, ...4.0157

ANALYSIS AND DISPLAY OF HYDROGRAPHIC DATA ...Compilation, Hydrographic, Reproduction, ...4.0022

572
### SUBJECT INDEX

#### Geologic Maps
- POTENTIALLY-ECONOMIC SAND AND SILT DEPOSITS IN LAKE ONTARIO, NEW YORK...Lake Ontario, New York, Potential of Deposit, Sands and Gravels, Submergent,...7.06534
- SEDIMENT DEPOSER-PATTERNS IN SUBMARINE CANYONS AND SUBSEA FANS...Distribution, Fann, North America, Submarine Canyons, Textures-structures,...7.0614
- TEKTITE I...Diving and Scuba, Geology-general, Mapping, Submergents,...4.06054
- CENTRAL CALIFORNIA CONTINENTAL MARGIN...California, Continental Shelf, Continental Slope, San Andreas Fault, Structural Studies,...7.0036

#### Gravity
- GRAVITY...Anomalies, Caribbean Sea, Geophysical Equipment, Navigation, Pacific Ocean-west,...7.0142

#### Maps-general
- ECLOGICAL STUDIES OF THE COPPER RIVER DELTA...Alaska, Cerastus, Spawning & Nesting Sites, Waterfowl -non-specific,...5.06885

#### Maps-other
- MONTVILLE STATION TEMPERATURE SURVEY (THAMES RIVER)...British Isles, Electric Power Plants, Estuaries, Temperature, Thermal Pollution,...1.0182
- A GLOBAL DIRECTORY OF TIDAL CONSTANTS...Arca, Tables, Compilations, Catalogs, Tides,...1.0079

#### Paleocurrents
- RELATION OF SEDIMENT STRUCTURES AND FLOW DIRECTIONS OF COASTAL CURRENTS...Coastlines-shorelines, Current Belling, Ocean Currents-other, Sedimentation, Textures-structures,...7.0276

#### Reconnaissance
- OREGON-NORTHERN CALIFORNIA PLACER DEPOSITS...California, Deposits-ores, Drilling and Coring, Oregon, Placer,...7.00699

#### Topographic
- EXPERIMENTAL VERIFICATION OF WIDE SWATH OCEAN BOTTOM CONTOURING WITH SPLIT BEAM RECEIVERS...Bathymetry, Caribbean Sea, Receivers, Sonar, Technique Development,...7.0302

#### Marinas
- CRITERIA FOR THE DESIGN OF SMALL CRAFT HARBO...Breakwaters, Coastal Engineering-other, Harbors, Seiches, Waves,...8.00036
- CRITERIA FOR EVALUATING THE QUALITY OF WATER BASED RECREATION FACILITIES...Boating, Fishing, Standards, Swimming, User Characteristics, Water Quality-general,...9.00085
- BACTERIOLOGICAL AND ESTHETIC OF PLEASURE BOAT WASTE DISCHARGE ON SMALL HARBO...Bacterial Pathogen Sources, Beautification, Harbors, Ship Wastes, Water Analysis,...6.0191

#### Marine Biology
- SEAWATER/SEDIMENT/BIOLOGY MONITORING PROGRAM...Data Acquisition, Sediments-other, Water Analysis-general,...1.0144
- ATLANTIC OCEANIC BIOLOGY...Atlantic Ocean-general, Ships and Cruises,...4.0126
- CONFERENCE REPORTS...Geophysics-general, Meetings, Tables, Compilations, Catalogs,...1.0034
- BIOLOGY CONFERENCE SERIES...Ecology (animal), Meetings, Plant Ecology (non-specific),...1.0035
- ARCTIC FIELD RESEARCH...Arctic, Geology-general, Glaciology-general, Micrometeorology,...11.0010
- MARINE BIOLOGY RESEARCH AT THE BERMUDA BIOLOGICAL STATION...Bermuda, Ecology (animal), Marine Biology (non-specific), Plant Ecology (non-specific),...12.0006
- SEYCHELLES...Ships and Cruises, Teaching and Research,...12.0040

#### Marine Biology
- SUPPORT OF TRAINING PROGRAMS IN INVERTEBRATE ZOOLOGY AND MARINE BOTANY...Marine Environments-general, Marine Plants, Meetings, Training Grants, Fellowships,...11.0028
- A TRAINING PROGRAM FOR GRADUATE STUDENTS IN MARINE SCIENCES AT THE FRIDAY HARBOR LABORATORIES...Marine Biology (non-specific), Training Grants, Fellowships, Washington,...11.0008
- LOGISTIC SUPPORT, MAINTENANCE AND RENOVATION OF FACILITIES...Facilities, Maine, Marine Plants,...12.0029
- INVESTIGATIONS IN MARINE BIOLOGY...Massachusetts, Teaching and Research,...11.0027
- SUPPORT OF RESEARCH VESSEL VELERO IV...California, Equipment Purchase Operation, Facilities, Geology-general, Instrumentation-general, Training Grants, Fellowships,...8.00115
- SUPPORT OF UNIVERSITY OF GEORGIA MARINE INSTITU...RESEARCH VESSEL OPERATION...Continental Shelf, Continental Slope, Distribution, Environmental Ecology, Estuaries, Geomorphology-topography, Pollution Sources-general, Harbors, Crustaceans, Textures-structures,...12.0026
- STANFORD BIOLOGICAL OCEANOGRAPHY...Phytoplankton, Primary Productivity, Productivity - Food Chain, Ships and Cruises, Training Grants, Fellowships, Zooplankton,...11.0005
- SUPPORT OF THE RESEARCH VESSEL AHOYAH III...California, Diving and Scuba, Equipment Purchase Operation, Geology-general, Harbors, Water, Cruses,...12.0008
- RESEARCH TRAINING LABORATORY...Facilities, Massachusetts,...12.0032
- LOGISTIC SUPPORT AND MAINTENANCE OF FACILITIES...Atlantic Ocean-north, Facilities, Lakes, Maine,...12.0030
- APPLIED MARINE ENGINEERING PROGRAM...MAINTENANCE...California, Engineering Studies-general, Harbors, Marine Biology (non-specific), Other-design-and-construction, Scientific-service-support, Teaching and Research, Training Grants, Fellowships,...11.0006
- THE POSTPLEISTOCENE OCEANOGRAPHY AND BIOLOGY OF THE EASTERN NORTH PACIFIC...Climatography, Ocean History, Pacific Ocean-east, Pacific Ocean-north,...7.0159
- SUPPORT FOR THE OPERATION OF OCEANOGRAPHIC RESEARCH VESSELS...Black Sea, Mediterranean Sea-general, Sedimentation, Harbors, Cruses, Water Analysis-general,...11.0030
- SUPPORT OF RESEARCH VESSEL AT LAMONT GEOLOGICAL OBSERVATORY...Distribution, Patterns, Ridges, Seismic Studies, Harbors, Cruises,...12.0037
- SUPPORT OF TWO RESEARCH VESSELS...Air-sea Boundary-general, General Sea Water Chemistry, Great Lakes-general, Harbors, Ships and Cruises, Water Properties-general,...12.0034
- PARTICIPATION IN U.S.A.P. EXPEDITIONS...Antarctica, Data Acquisition, Data Analysis - General, Harbors, Cruses, Teaching and Research,...12.0012
- FACTORS INFLUENCING THE INTENSITY OF BIOLUMINESCENCE...Bioluminescence, Cell. env.(non-specific & &), Kinetics, Optical, Trace Elements,...1.0169
- THE OCCURRENCE AND EFFECTS OF PLANKTON IN THE SEA...Air-sea Boundary-general, Plankton (non-specific),...5.0781
- ACOUSTIC-VIDEO SYSTEM FOR AQUATIC BIOACOUSTICAL AND ETHEROLOGICAL RESEARCH...Acoustical, Behavioral Ecology, British West Indies, Marine Environments-general,...1.0049
- RESEARCH IN OCEAN PROPERTIES...Acoustical, Geomorphology-topography, Geophysical Equipment, Model Studies, Seismic Studies, Suspensions,...1.0036
- ARCTIC SUB-ICE STUDY...Acoustical, Arctic Ocean, Sea Ice, Submersibles,...3.0074
- CHEMICAL STUDIES OF THE OCEANIC ENVIRONMENT...Chemical Reactants, Mixing Oceanic Fronts, Pacific Ocean-east, Trace Elements, Water Analysis-general,...1.0136
- ARCTIC SUB-ICE STUDY...Acoustical, Arctic Ocean, Sea Ice, Submersibles,...3.0074
- RESEARCH IN OCEAN PROPERTIES...Acoustical, Geomorphology-topography, Geophysical Equipment, Model Studies, Seismic Studies, Suspensions,...1.0036
- BIOACOUSTIC...Instrumental Services, Marine Biology (non-specific), Telemetry,...8.0070
- FOULING OF SENSORS...Fouling, Inhibitors, Instrumentation-general, Organometallics,...8.0239
- HANDBOOK OF MARINE TECHNOLOGY...Engineering Studies-general, General Sea Water Chemistry, Geology-general, Handbooks, Meteorological Studies, Submersibles,...11.0014
Marine Biology

DEEP OCEAN RESEARCH AND DEEP OCEAN ENGINEERING ...Abyssal, Engineering Studies-general, Geophysics-general, Structural Studies, Submersibles, Textures-structures ...4.0131

MARINE BIOLOGY STUDIES ON FAIRFAX ISLAND ...Aus...Collections, Data Acquisition, Islands, Reefs, ...5.0874

SUPPORT OF THE MARINE BIOLOGY PROGRAM AT THE LAMONT, GEOLOGICAL OBSERVATORY ...Equipment Purchase Operation, New York, ...11.0133

A PROGRAM FOR THE TRAINING OF STAFF MEMBERS FROM THE SCHOOL OF FISHERIES OF THE CATHOLIC UNIVERSITY OF VALPARAISO CHILE ...Chile, Fish (non-specific, Food Processing Industry, Teaching and Research, ...5.0181

THE ECOLOGICAL ARCHITECTURES OF THE MARINE BIOSPHERE ...Marine Biology (non-specific), ...5.0859

OCEANOGRAPHIC SURVEY OF CONTINENTAL SHELF WATERS OFF CHESAPEAKE BAY ...Chesapeake Bay, Continental Shelf, Salinity, Temperature, ...4.0135

SEA USE ...General Synoptic Observations, Oceanography-general, Pacific Ocean-east, Platforms, Seamounds-guyots, ...7.0386

OCEANOGRAPHIC RESEARCH ...Acoustical, Density, Gas-es, Thermal, Water Motion, ...1.0142

MARINE POLYCHAETA WORMS OFF THE COLUMBIA RIVER, OR, OREGON ...Animal Taxonomy, Collections, Lugworms, Marine Segmentedworm, ...5.0755

BIOLOGICAL OCEANOGRAPHY ...Acoustical, Atlantic Ocean-north, Food Production, S-meridies, ...1.0022

BIOLOGICAL OCEANOGRAPHIC AND DETERIORATION, POLYMER STUDIES ...Corrosion General, Lubricants and Fluids, Marine Bio Big (non-specific, Plant), plankton (non-specific), Wear, Friction, ...8.0235

TISSUE CULTURE - VIROLOGY ...Animal Viruses (non-specific), Bacteria (non-specific), Cell Injury and Autolysis, Monolayer Culture, Oysters, Tissues, ...5.0978

COASTAL AND INSHORE OCEANOGRAPHY ...Alaska, Estuaries, Shoreside - coastline, Water Analysis-general, Water Properties-general, ...5.0851

POPULATION DYNAMICS (BIOMETRICS) OF EXPLOITED FISH GROUPS OF THE NORTH PACIFIC OCEAN AND PACIFIC COAST ...Meteorological Studies, Model Studies, Number Or Density, Pacific Ocean-north, Population Dynamics, ...5.0875

146 D EASTROPAC ...Meteorological Studies, Pacific Ocean-east, Tropic, Tuna, Mackerel, Albacore..., ...7.0213

SURVEY, EVALUATION & SUMMARIZATION OF LITERATURE ON ENVIRONMENTAL REQUIREMENTS OF MARINE ORGANISMS LEVELS OF POTENTIAL TOXICANTS (ABBREV ...Biological, Chemical, Environmental Effects-geologic, Geosciences, Library, Marine Environments-general, Survey Studies, ...4.0037

DETERMINATION OF SELECTED ENVIRONMENTAL REQUIREMENTS OF IMPORTANT MARINE PHYTOPLANKTON SPECIES ...Atlantic Ocean-general, ...4.0125

ARCITIC EAST OCEANOGRAPHIC PROJECT (OCEANOGRAPHY OF THE BAFFIN BAY REGION) ...Baffin Bay, Circulation-general, Polar, Sea Water Chemistry-other, Water Properties-general, ...4.0125

STANDING STOCK AND GROWTH OF BACTERIA IN THE SEA ...Atp X Adenosine Triphosphate, Carbohydrates, Growth (non-specific & Ot.), Photoplankton, Standing Crops, ...5.0749

UPTAKE OF ORGANIC COMPOUNDS BY MARINE INVERTEBRATES ...Amino Acids, Amino Acids -non-specific, Chromatographs, Invertebrate Nutrition, Invertebrates-non-specific, Metabolism, Pulse-labeling, ...5.0938

PROVIDE RESEARCH FACILITIES AND SERVICES ...Facilities, ...12.0031

RADIOECOLOGICAL RESEARCH ON MARINE ORGANISMS ...Facilities, Marine Biology (non-specific), ...11.0029

Marine Animals

POPULATION STUDIES OF HAUSTORIDAE AND GAMMARIDEA FROM NEW ENGLAND AND ON INFANAL AND EPIFAUNAL MARINE AMPHIPODS AT ENIWETOK ...Aotlia, Habitat Studies, Micronesia, Population Dynamics, Shrimp - Amphipods, ...5.0866

...Abyssal, Engineering Studies-general, Geophysics-

SUBJECT INDEX

CELL DIVISION, BIOENERGETICS, CHEMISTRY OF MUSCLE ...Bioenergetics, Cell Cycle, Configuration, Oxytocin, Organic, ...5.0987

FILAMENTOS, MORPHOGENESIS AND CONTRACTION OF MUSCLE ...Contraction and Relaxation, Fibers and Filaments, Subunits, ...5.0966

FISHERIES OCEANOGRAPHY AND ENVIRONMENTAL ASSESSMENT AND PREDICTION ...Commercial Fishing, Connection, Oceanography-general, Spacecraft Sensory Devices, Thermal, ...4.0150

SPECTRAL SIGNATURES OF FISH SCHOOL IDENTIFICATION ...Atomic Absorption, Fish (non-specific, Oil, Oils-fat, Spectral Reflectance, ...4.0151

DETECTION AND CLASSIFICATION OF FISH AND MINERAL OIL SLEDS FROM THE SENSING OF ORBITAL ALTITUDE ...Fish (non-specific, Oil, Oils-fat, Spectral Reflectance, Ultra - Violet Radiation, ...4.0140

NEUROPHYSIOLOGICAL INVESTIGATIONS OF LIMULUS CENTRAL NERVOUS SYSTEM ...Brain, Cardiovascular, Horseradish Or King Crabs, Nervous System, ...5.0469

THE ACCUMULATION OF FISSION PRODUCTS BY MARINE FISH AND SHELLFISH ...Chloride (non-specific & Ot.), Contamination - Water, Estuaries, Food Chains, Radioactivity-general, ...5.0167

STUDIES ON THE PHYSIOLOGY OF MARINE ORGANISMS USING RADIOTRACERS ...Equipment Purchase Operation, Facilities, Marine Plants, Radiotracers -non-specific, ...12.0031

A NEW APPROACH TO NUTRITION, PHYSIOLOGY, AND MINERAL CYCLING OF FORAMINIFERA ...Foraminifera, Invertebrate Nutrition, Metabolism, Productivity - Food Chain, ...5.0899

A STUDY OF THE DEEP CIRCULATION AND DEEP FISH POPULATIONS IN THE PACIFIC OCEAN ...Currents-ocean, Fish (non-specific, Pacific Ocean-general, Tides, Vertical Distribution, ...2.0065

BIOLOGICAL PRODUCTIVITY IN THE SARGASSO SEA, THE GULF STREAM AND IN THE ATLANTIC COASTAL WATERS OFF CAPE HATTERAS ...Continental Shelf, Phytoplankton, Primary Productivity, Productivity - Food Chain, Proteins, ...5.1005

INOCULATED PACK STUDIES ON LOW-DOSE IRRADIATED MARINE PRODUCTS - SHRIMP ...Clostridium Botulinum, Microbiology...general, ...6.0017

RADIOELEMENT STUDIES IN THE OCEANS-PLANKTON DISTRIBUTION STUDIES ...Chemical Reactions, Foraminifera, Number Or Density, Proteozoa-other, Vertical Distribution, ...5.0795

SEASONAL DISTRIBUTION AND ABUNDANCE OF DERMAL FISH AND INVERTEBRATES IN THE MARINE WATERS ADJACENT TO THE MOUTH OF THE COLUMBIA RIVER ...Benthic Fauna, Number Or Density, Productivity (non-specific), Radioactivity-general, Vertical Distribution, ...5.0930

MECHANISM STUDIES ON BIOLUMINESCENT REACTIONS WITH EMPHASIS ON ENERGY TRANSFER PROBLEMS ...Bioluminescence, Energy Conversion, Luciferase, Luciferin, ...1.0164

COMMUNICATIONS STUDIES ON TURSIOPS TRUNCATUS AND OTHER DELPHINIDS ...Central Nervous System, Linguistics, Mammals, Neuristors Neurol Nets, Sound Production, ...5.0854

ATLANTIC OCEANIC BIOLOGY ...Atlantic Ocean-general, Marine Biology, Ships and Cruises, ...4.0126

INFECTIONS IN MARINE MAMMALS USED AS LABORATORY ANIMALS ...Aging, Cell Injury and Autolysis, Developmental Physiology, Environmental Physiology, Hydra, Portuguese Man-of-war, ...5.0597

SHARK RESEARCH ...Control of Nuisance Species, Fish Repellents, ...5.0647

574
CONTROLLED ENVIRONMENTAL FACTORS ON THE UPTAKE AND ASSIMILATION OF ORGANIC COMPOUNDS CAROTENOIDS, CAROTENOID CHROMOPROTEINS, AND EVOLUTION OF ALL-FEMALE FISHES ...Female, Gambusia, THE PORIFERA OF FANNING ISLAND, CENTRAL PACIFIC RESEARCH ON INDO-WEST PACIFIC MARINE MOLLUSKS PARASITIC THE ALPHEID SHRIMP OF AUSTRALIA ...Animal Taxonomy, DYNAMICS OF OCEANIC PLANKTON PORCELLANID CRABS OF AUSTRALIA ...Australia, Collections, Pubilications -other, Shrimps - Common, -slugs,conch,snails, Indian Ocean-general, Invertebrate Anatomy, -slugs,conch,snails, ...5.0944 RESEARCH ON INDO-WEST PACIFIC MARINE MOLLUSKS OF THE FAMILY CONIDAE ...Animal Taxonomy, Gastropods -slugs,conch,snails, Indian Ocean-general, Invertebrate Anatomy, ...5.0517 THE PORIFERA OF FANNING ISLAND, CENTRAL PACIFIC ...Animal Taxonomy, Dispersion -other, Environmental Effects-geologic, Line Islands, Porifera, ...5.0539 PORELLANID CRABS OF AUSTRALIA ...Australia, Collections, Crabs, Museum, Nomenclature, Classification, ...5.0534 SUPPORT OF TRAINING PROGRAMS IN INVERTEBRATE ZOOLOGY AND MARINE BOTANY ...-non-specific, Marine Biology, Marine Environments-general, Marine Plants, Molluscs, Training Grants, Fellowships, ...11.0028 DYNAMICS OF OCEANIC PLANKTON ...Growth Rate, Number Or Density, Productivity (agricultural), RNA , Zooplankton, ...5.0525 THE PHYSHISHIP OF AUSTRALIA ...Animal Taxonomy, Australia, Collections, Publications -other, Shrimps - Common, ...5.0425 THE ECOLOGY, MIGRATIONS AND BEHAVIOR OF MARINE TURTLES ...Behavioral Ecology, Migration, Reptile Studies -other, Spawning & Nesting Sites, Turtles, Terrapins, Turtles, ...5.0066 STRUCTURE OF THE FISH FAUNA OF A FLORIDA CORAL REEF ...Ecological, Fish -non-specific, Reefs, Vertical Distribu- tion, ...5.0273 STUDIES IN THE PHYSIOLOGY AND BIOCHEMISTRY OF DEEP-SEA FISHES ...Environmental Physiology, Fish -non-specific, Metabolism, Vertical Distribution, Water Pressure, ...5.0237 ECOLOGY OF THE PORITIES FUCATA REFLL.FLAT COM. ...Australia, Panama, Productivity -Food Chain, Puerto Rico, Africa, ...5.0667 VISUAL AND ACOUSTICAL COMMUNICATION IN CERT. MARINE CRUSTACEANS ...Animal Ocean-north, Authority, Behavior, Crabs, Visual Organs, ...5.0430 TREMATODES OF FISHES OCCURRING ON THE WEST COAST OF NORTH AMERICA ...-Collections, Comparative Physiology, Nearctic, Pacific Ocean-general, Trematoda -other, ...5.0636 MONOGRAPH OF THE CEPHALOPODS OF THE NORTH ATLANTIC ...-Animal Taxonomy, Atlantic Ocean-north, Depth, Nomenclature, Classification, Optical, Publications -other, Salinity, Temperature, ...5.0411 ECOLOGY AND SEQUIMENTARY PATTERNS OF FORAMINIFERA ...Chemistry, Environmental Ecology, Environmental-Effects-geologic, Foraminifera, Vertical Distribution, ...5.0746 DEVELOPMENT IN ILYANASSA ...Basic Embryology, Gastropods -slugs,conch,snails, Metabolic Inhibitors, Other, ...5.0924 CYTOTOLOGICAL CHARACTERISTIC ...Animal Taxonomy, Basid. Embryology, Forifera, Speciation, Structural Functions, ...5.0527 TAXONOMY AND CYTOLOGY OF NEARSHORE MARINE OS- TRACODA ...Animal Taxonomy, Bivalves, Class Ostracoda, Ecological Analysis/Ecosystem, Plankton, Elevonshores, Shrimps - Seed Or Mussel, ...5.0707 IONIC REGULATION IN THE QUEEN CONCH, STROMBUS GIGAS LINNAEUS ...Blood Plasma and Serum, Digestive System, Gastropods -slugs,conch,snails, Osmoregulation, ...5.0407 SYSTEMATIC STUDIES ON HERMIT CRABS AND OTHER DECAPOD CRUSTACEANS ...Animal Taxonomy, Atlantic Ocean-south, Crabs, Developmental Physiology, Life History Studies, ...5.0408 A COMPARATIVE SYSTEMATIC INVESTIGATION OF MARINE CILIATES IN THE HOTLICHROUS PROTOZOOAN ORDER HYMENOSTOMATIDA ...Animal Taxonomy, Cilia and Flagellae, Ciliates, Comparative Physiology, Invertebrate Anatomy, ...5.0640 PERCEPTUAL, VOCAL, AND ECHO-RANGING BEHAVIOR OF SEALS AND SEA LIONS ...Auditory, Echolocation, Seals, Sound Production, Visual Organs, ...5.0647 WATER AND SALT REGULATION IN NERED POLYCHAETES ...-live, Transport, Comparative Physiology, Locomotion, Marine Segmentedworm, Osmoregulation, Salt, ...5.0648 CYTOTAXONOMIC STUDIES OF TELEOST FISHES ...-Behavioral Ecology, Fish -non-specific, Reefs, Marine Environment, Taxonomy, ...5.0642 MARINE ZOOGEOGRAPHY ...Fish -non-specific, Tables, Compositions, Catalogs, ...5.0859 ICTHYOFUANA OF THE FLORIDA CURRENT ...Fish -non-specific, Florida, Number Or Density, Temporal Distribution, Vertical Distribution, ...5.0666 ECOLOGY OF SKELETAL PLANKTON ...Animal Taxonomy, Collections, Flagellates, Gastropods -slugs,conch,snails, Paleoenvironments, Temporal Distribution, Vertical Distribution, ...5.0997 RESEARCH IN MARINE BENTHIC ECOLOGY OFF OREGON ...Benthic Fauna, Environmental Ecology, Number Or Density, Oregon, Vertical Distribution, ...5.0996 MARINE VERTEBRATES OF THE CALIFORNIA PENINSULA ...Animal Taxonomy, California, Environmental Ecology, Range Or Territorial Dist. , Temperature, ...5.0554 RELATIONSHIPS AMONG POPULATIONS OF LIMNORIA TRIPUNCTATA ...Animal Taxonomy, Iisopods, Population Dynamics, Reproductive System, ...5.0477 ENERGY REQUIREMENTS OF MARINE ORGANISMS ...Energy, Sharks, Thermoregulation, Tuna, Mackeral, Albacore, ...Water Pressure, ...5.0273 MICROSTRATIFICATION OF MARINE ZOOLANKLON ...Environment, Environmental Physiology, Growth Rate, Thermal, Vertical Distribu- tion, Zooplankton, ...5.0753 CHARACTERIZATION AND MODE OF ACTION OF PROTEIN VENOMS OF MARINE ANIMALS ...Leechin, Mechanism of Action, Sea Urchins & Other Echinoidea, Toxins, Venom, ...5.1002 RESEARCH V. A.AINING IN MARINE BIOLOGY, PALEON- TOLOGY AND SYSTEMATIC ZOOLOGY ...Animal Taxonomy, Invertebrates -non-specific, Oceanography-general, Paleontology, Training Grants, Fellowships, ...11.0063 LOGISTIC SUPPORT, MAINTENANCE AND RENOVATION OF FACILITIES ...-Colonies, Maine, Marine Biology, Marine Plants, ...12.0028 SYSTEMATICS OF DEEP SEA TREMATODES ...Animal Taxonomy, Helminths, Organic Evolution, Trematoda -other, Vertical Distribution, ...5.0646 PREDATOR PREY RELATIONSHIPS BETWEEN ECHIN- ODERMS AND MOLLUSCE ...-Behavior, Behavioral Ecology, Gastropods -slugs,conch,snails, Predation, Starfishes, ...5.0351 NUTRITIONAL STUDIES ON MARINE ORGANISMS ...Crustacea -non-specific, Invertebrate Nutrition, Nutrition Stud- ies, Organics, Phytoplankton, ...5.1001 RESEARCH ON THE BIO-SYSTEMATICS OF THE CIR- RIFEDEA ...-Echinoderm, Biological Rhythms, Developmental Physiology, Visual Organs, ...5.0364 PRODUCIVITY OF OCEANIC POPULATIONS OF VERTI- CAIY MIGRATING ANIMALS ...Migration, Plankton (non- specific), Population Dynamics, Productivity (agricultural), Vertical Distribution, ...5.1019 ECOLOGICAL, EXPERIMENTAL AND COMPUTER STUDIES OF ENDOGENOUS RHYTHMICITY ...-Behavioral Rhythms, Brain, Computer Methods -general, Crustacea -non-specific, Locomotion, ...5.0361 PHYSIOLOGY OF MARINE MAMMALS ...Environmental Physiology, Mammals, Seals, ...5.0624
COASTAL LOBSTER FISHERY ...Censusing, Commercial Fishing, Legislation, Lobsters, Massachusetts, ...5.0452

FOOD HABITS STUDY OF ORGANISMS OF THE CALIFORNIA CURRENT SYSTEM ...Behavioral Ecology, California, California Current, Food Supply, Pacific Ocean-general, ...5.0444

BRISTOL BAY INTERMEDIATE HIGH SEAS-INSHORE TESTING ...Age, Alaska, Bays, Commercial Fishing, Salmon - coho,chinook,sockeye, ...5.0022

OFFSHORE SALMON ABUNDANCE INDEX ...Alaska, Commercial Fishing, Number Or Density, Salmon -coho,chinook,sockeye, Streams, ...5.0021

OPERATIONAL TESTING OF THE PELAGIC TRAWLS ON SMALL DRAGGERS ...Fishing Gear, Nets, ...5.0444

KODIAK KING CRAB ENVIRONMENTAL ZONE SURVEY ...Alaska, Continental Shelf, Environmental Ecology, Horseshoe Or King Crabs, Reproductive System, ...5.0348

COLLECTION OF MATERIALS AND DATA FOR AGE-GROWTH ANALYSIS ...Age, Commercial Fishing, Fish -other, Growth Rate, ...5.0330

DEMONSTRATION OF THE LIMITATIONS AND EFFECTS OF WASTE DISPOSAL ON VARIOUS MARINE PLANTS, Ocean, Outlet, Pollution - Effects Of, Pollution Effects, Sewers, ...6.0146

DISTRIBUTION OF LIFE WITH DEPTH ...Continental Shelf, Motion Pictures -non-specific, North Carolina, Photography, Vertical Distribution, ...5.0885

BIONOMICS OF FISHES AND SHELLFISHES ...Aquaculture & Fish Farming, Bays, Economics-general, Environmental Ecology, Oregon, Productivity - Food Chain, ...5.0920

MORPHOLOGY, PHYSIOLOGY AND ECOLOGY OF MARINE AMARILLIBRANCHS ...Aquatec Ecology, Basic Embryology, Behavior, Freshwater Mussels, Scallops, Invertebrate Anatomy, ...5.0479

THE INFLUENCE OF ENVIRONMENTAL FACTORS UPON DEVELOPING MERISTIC STRUCTURES IN THE MARINE FISH, FUNDULUS MAJALIS (WALBAUM) ...Basic Embryology, Developmental Physiology, Environmental Physiology, Killifishes - Cyprinod, Water Temperature-non-specific, ...5.0298

COLLECTION AND SURVEY OF NORTH CAROLINA MARINE AND ESTUARINE MOLLUSCA ...Collections, Estuaries, Mollusks -non-specific & Other, North Carolina, Survey Studies, ...5.0480

CRUSTACEAN COLLECTION OF EAST COAST OF UNITED STATES ...Atlantic Ocean-north, Collections, Crustacea -non-specific, Estuaries, North Carolina, ...5.0281

SYSTEMATICS, ZOOGEOGRAPHY, AND ECOLOGY OF ELASMOMBRANCHS OF THE WESTERN ATLANTIC OCEAN ...Animal Taxonomy, Aquatic Ecology, Atlantic Ocean-general, Chondrichthyes -non-specific, ...5.0312

FISH COLLECTION OF NORTH CAROLINA AND WESTERN ATLANTIC FISHES ...Atlantic Ocean-north, Collections, Fish -non-specific, Fresh Water, North Carolina, ...5.0133

A HISTOCHEMICAL STUDY OF THE CENTRAL NERVOUS SYSTEM OF LIMULUS POLYPHEMUS ...Cholinesterase, Histochimistry - Cytochem, Horseshoe Or King Crabs, Nervous System, Orpanelle-enzyme Assm, ...5.1000

REFERENCE COLLECTION OF GULF MARINE ANIMALS ...Animal Taxonomy, Collections, Gulf of Mexico, Invertebrates -non-specific, Vertebrates -non-specific, ...5.0657

STUDY OF LIFE HISTORY AND ECOLOGY OF SERPULIDAE IN TEXAS COASTAL WATERS ...Gulf of Mexico, Life History Studies, Lugworms, Marine Segmentedworm, Texas, ...5.0656

ECOLOGY OF MARSH FORAMINIFERA ...Foraminifera, Lugworms, Production - Food Chain, Rate of Deposition, Swamps-marshes, ...5.0747

CILI A DIFFERENTIATION IN MARINE EMBRYOS ...Basic Embryology, Cilia and Flagella, Lugworms, Marine Segmentedworm, Sea Urchins & Other Echinoderms, ...5.0617

SYSTEMATIC MORPHOLOGY AND ECOLOGY OF THE GENUS ERVILIA (MOLLUSCA: PELECYPODA) IN THE WESTERN ATLANTIC ...Animal Taxonomy, Atlantic Ocean-general, Ecology (animal), Freshwater Mussels, Scallops, Invertebrate Anatomy, ...5.0458
SUBJECT INDEX

PHYSIOLOGICAL VARIATION IN SUBT.DAL AND INTER-TIDAL MALE INVERTEBRATES (Subtidal Studies, Inter-tidal Area, Invertebrates -non-specific, 5.0548)

THE MORPHOLOGY, HISTOCHEMISTRY, AND MODE OF SECRETION IN THE VENOM GLAND OF SEA EEL (Chironomidae - Euchromy, Venom, Vertebrate Anatomy, 5.0529)

INVESTIGATIONS OF THE INDUCING CAPACITY OF THE POLAR LODGE IN THE DEVELOPMENT OF THE MARINE GASTROPOD ILYANASSA OBSOLETA (Developmental Physiology, Gastropods - slug, conch, snails, Invertebrate Physiology, 5.0417)

THE EPICARIDEA OF THE EASTERN PACIFIC (Animal Taxonomy, Isopods, Pacific Ocean-east, 5.0559)

SHALLOW WATER MEGABENTHOS OF THE BERMUDA PLATFORM (Benthic Fauna, Benthonic-bottom, Bermuda, Continental Shelf, 5.0648)


ENERGY AND ELEMENT TRANSFER IN LOWER MARINE TROPHIC LEVELS (Copepods, Energy Budgets, Oregon, Phytoplankton, Marine Ecosystems, 5.0583)

THE ROLE OF FECAL PELLETS IN MARINE FOOD CHAINS (Copepods, Energy Budgets, Oregon, Phytoplankton, 5.0583)

OREGON FISHES - THEIR CLASSIFICATIONS, DISTRIBUTIONS AND LIFE HISTORIES (Animal Taxonomy, Fresh Water, Life History Studies, Oregon, Vertical Distribution, 5.0574)

OREGON FISHES - THEIR CLASSIFICATION, DISTRIBUTION AND BIOLOGY (Animal Taxonomy, Fish -non-specific, Fresh Water, Oregon, Vertical Distribution, 5.0574)

EARLY LIFE HISTORY OF BOREAL FISH (Clupea, Fish -non-specific, Life History Studies, 5.0137)

ALBACORE TUNA - THEIR CLASSIFICATION, ECOLOGY, ENVIRONMENTAL ECOLOGY, LIFE HISTORY STUDIES, TAGS, TUNA, Mackerel, Albacore, 5.0143

FISH GENETICS AND ECOLOGY (DNA Other, Estuaries, Fish -non-specific, Life History Studies, 5.0539)

FINANCING OF FISHING VESSELS (Commercial Fishing, Economics, Fish & Shellfish, Rhode Island, Savings and Investment, 4.0185)

REAR AND DESCRIBE LARVAE OF BIVALVES (Captive Rearing, Clams, Developmental Physiology, Freshwater Muscles, Scallops, Invertebrate Culture, 5.0659)

ALGAE AS FOOD FOR MARINE INVERTEBRATE LARVAE HELD IN THE LABORATORY (Algal Culture, Bacterial Culture -other, Cheopse B, Invertebrate Nutrition, Invertebrates -non-specific, 5.0712)

ULTRASTRUCTURAL STUDIES OF PARASITIC AND SAPROPHYTE PLANTS AND PROTOZoa ASSOCIATED WITH MARINE INVERTEBRATES (Cell Cycle, Electron Microscopy, Host-parasite Interactions, Myxomycetes, Protozoa, 5.0559)

BENTHIC MARINE FAUNA OF THE UPPER SHELF OFF VIRGINIA (Animal Taxonomy, Benthic Fauna, Benthonic-bottom, Continental Shelf, Organism Sampling Devices, Virginia, 5.0560)

BIOCHEMICAL AND BIOPHYSICAL STUDIES OF THE MARINE ENVIRONMENT (Copepods, Energy, Energy Budgets, Organisms, Productivity - Food Chain, 5.0767)

SYSTEMATICS AND ZOOGEOGRAPHY OF THE BLENNOID FISHES (Animal Taxonomy, Bone, Fish -other, Nomenclature, Classification, World Wide, 5.0501)


SYSTEMATIC REVISION OF THE FAMILY PERIPLOMETRIDAe (Animal Taxonomy, Freshwater Muscles, Scallops, Nomenclature, Classification, 5.0561)

STUDY OF NORTH AND EQUATORIAL ATLANTIC PLANK-TONIC FORAMINIFERA (Foraminifera, Number Or Density, Oceanic, Oceanography, Organism Sampling Devices, Vertical Distribution, 5.0764)


DISTRIBUTION MAPS OF ANTARCTIC HOLOTHURIANS AND ECHINOIDS - ECHINODERMAT (Charts, Environment, Ecology, Sea Cucumber, Sea Urchins & Other Echinoderms, Vertical Distribution, 5.0573)

MARINE POLychaetes OF THE NEW ENGLAND RIVER (Gulf of ST. LAWRENCE TO CHEAPEAKKE BAY) (Animal Taxonomy, Lugworms, Marine Segmentedworm, Nomenclature, Classification, Northeast, Vertical Distribution, 5.0574)

MARINE POLychaetes OF THE COLUMBIA RIVER, OREGON (Animal Taxonomy, Collections, Lugworms, Marine Segmentedworm, Marine Biology, 5.0575)

SYSTEMATICS AND BIOLOGY OF EPPLELAGIC AND BATHYPELAGIC FISHES (Animal Taxonomy, Atlantic Ocean-north, Fish -other, Indian Ocean-general, Vertebrate Anatomy, Vertical Distribution, 5.0549)

MARINE NEMATODES OF THE CAPE COD AREA (Animal Taxonomy, Taxonomy, Collections, Habitat Studies, Nematoda -other, Northeast, 5.0566)

COMPARATIVE MORPHOLOGY OF MARINE NEMATODES (Comparative Physiology, Histology and Cytology, Invertebrate Anatomy, Mebaskeletal System, Nematomorpha, 5.0567)

A BIBLIOGRAPHY OF THE MARINE MOLLUSKS OF THE INDO-PACIFIC REGION (Animal Taxonomy, Asia, Bibliography, Computer Methods -general, Mollusks -non-specific & Other, 5.0598)

HYPERIID AMPHIDIPS FROM THE GULF OF GUINEA (Animal Taxonomy, Collections, Guinea, Oceanography -general, Shrimp -Amphipods, Vertical Distribution, 5.0588)

SYSTEMATICS AND ECOLOGY OF MARINE BIRDS (Animal Taxonomy, Handbooks, Range Or Territorial Dist., Shorebirds, Guineafowl, terns, skimmer, World Wide, 5.0582)

MOVEMENTS OF SEABIRDS IN THE HUMBOLDT CURRENT (Aves -other, Biological Rhythms, Humboldt Or Peru Current, Population Dynamics, Temporal Distribution, 5.0583)

BIOLOGY, MORPHOLOGY, AND EVOLUTION OF THE DISK-FISH OR SHARKSUCKERS (Animal Taxonomy, Ethological, Fish -other, Host Specificity, Vertebrate Anatomy, 5.0598)

PACIFIC OCEAN BIOLOGICAL SURVEY PROGRAM (Birds -non-specific, Islands, Meteorological Studies, Pacific Ocean-general, Vertical Distribution, 5.0598)

AUTOMATIC DATA PROCESSING - SEABIRD DISTRIBUTION (Birds -non-specific, Computer Methods -general, Nomenclature, Classification, Range Or Territorial Dist., World Wide, 4.0020)

COPEPODS PARASITIC ON SHARKS OF THE WEST COAST OF FLORIDA (Animal Taxonomy, Copepods, Ectoparasites, Florida, Sharks, 5.0391)

OSTRACODA OF THE INDIAN OCEAN (Animal Taxonomy, Bivalvean, Indian Ocean-general, Quaternary Period, Shrimps -Seed Or Mussel, 5.0385)

ABYSSAL OSTRACODAES OF THE WORLD (Abyssal, Core Collections, Abyssal Ostracoda, World Wide, 5.0386)

REPRODUCTIVE ISOLATING MECHANISMS IN PARASEIS A INSHORE MARINE FISHES (Animal Taxonomy, Copepods, Energy, Energy Budgets, Organisms, Productivity - Food Chain, 5.0767)

THE BIOLOGY OF ROCK-BORING SIPUNCULIDS (Caribbean Sea, Invertebrate Nutrition, Invertebrate Physiology, Invertebrates -non-specific, Rocke, 5.0577)

SYSTEMATICS OF ANTARCTIC SIPUNCULIDS AND ECHIU-RIDS COLLECTED BY THE ELTANIN EXPEDITION (Animal Taxonomy, Antarcita, Collections, Expeditions, Invertebrates -non-specific, 5.0578)


THE CEPHALOPODS OF THE CENTRAL PACIFIC (Number Or Density, Octopus, Squid, Cuttlefish, Vertical Distribution, 5.0598)

SYSTEMATIC STUdIES ON MOLLUSKS FROM WALTERS SHOALS, INDIAN OCEAN (Animal Taxonomy, Collections, Ethiopian, Indian Ocean-general, Mollusks -non-specific & Other, 5.0402)

Marine Biology

STOMATOPOD CRUSTACEA FROM THE WESTERN ATLANTIC ...Animal Taxonomy, Atlantic Ocean-general ...Shrimps - Mantis ...5.0395

THE SYSTEMATICS AND DISTRIBUTION OF THE WORLD-WIDE wake FAMILY BATHYPLECTODAE ...Animal Taxonomy, Life History Studies, Number Or Density ...Octopus, Squid, Cetacea ...5.0400

LIFE HISTORY OF THE SHARK COPEPOD, KROYERIA DISPAR ...Copepods, Developmental Physiology, Ectoparasites, Life History Studies, Whole Body Culture & Rearing ...5.0393

ABYSSAL AND BATHyal SYNONIDAE OF WORLD ...Abys- sal, Animal Taxonomy, Bathyal, Crustacea -non-specific, Vertical Distribution, World Wide ...5.0384

SYSTEMATIC STUDY OF MYODOCOPID OSTRACODS OF THE INDIAN OCEAN ...Animal Taxonomy, Collections, Expeditions, Indian Ocean-general, Shrimps - Seed Or Mussel ...5.0394

NEPHELOPIST LOBSTERS OF THE WESTERN ATLANTIC ...Animal Taxonomy, Atlantic Ocean-north, Collections, Lobsters ...5.0396

STOMATOPOD CRUSTACEA OF THE EASTERN PACIFIC REGION ...Animal Taxonomy, Atlantic Ocean-general, Pacific Ocean-east, Shrimps - Mantis ...5.0397

SYSTEMATIC REVISION PLATYCEPHALIDAE (PISES) ...Classical, Fish -other, Indian Ocean-general, Museum Nomenclature, Classification ...5.0050

STUDIES OF FISH FAMILIES ARIDAE AND ASPREDINIDAE ...Animal Taxonomy, Fish -other, Interbiotic Relat.(non-specific), Neotropical, Tropical ...5.0045

RESEARCH ON MINERAL STRUCTURE REVEALED BY AN ELECTRON MICROSCOPE ...Comparative Anatomy, Electron Microscopy, Geology, Mineralogy, Paleontology ...5.0053

ELASMOBRANCH PHARMACOLOGY ...Drug Evaluation, Mechanism of Action, Neoreffective, Sharks ...5.0118

STUDIES OF SHARK REPELLENTS AND OTHER ANTI- SHARK MEASURES ...Fish Repellents, Shark Repellents, Sharks ...5.0132

ACTIVE CHEMICAL PRINCIPLES DERIVED FROM ECHINODERMS ...Chemoreceptors, Holothurian, Marine Plants, Toxicology ...5.0017

BIOLOGICAL OCEANOGRAPHY ...Acoustical, Atlantic Ocean-north, Marine Biology, Sound Production, Submersibles ...5.0102

MARINE ANIMAL TOXINS ...Fish Repellents, Mechanism of Action, Sharks, Toxins ...5.0116

STUDY OF FISH MUCUS BIOCHEMISTRY ...Fish -non-specific, Locomotion- animal, Mucus ...8.0172

GLOBAL VOLUME REVERBERATION LIMITATION STUDIES ...Acoustical, Atlantic Ocean-north, Reverberation, Scattering, Sound Production ...5.0037

BIOLOGICAL FALSE TARGETS AND RELATED ACOUSTIC CHARACTERISTICS ...Animal Taxonomy, Behavioral Ecology, Fish -non-specific, Sound Production ...5.0041

OCEAN WATER INTRUSION INTO BACK BAY, VIRGINIA, & CURRITUCK SOUND, NORTH CAROLINA, ON THE CHARACTERISTICS OF SEA MILFOIL, PULMONARIACEAE ...4.0057

MIGRATORY HABITS OF LARGE SHARKS ...Atlantic Ocean-north, Fishing, Migration, Sharks, Tags ...5.0147

 EFFECT OF EURASIAN WATERMILFOIL CONTROL PROCEDURES ON WILDLIFE AND OTHER ORGANISMS IN AQUATIC ENVIRONMENTS ...Contamination - Water, Disrupt, Evaluation, Water Milfoil, Waterweed ...5.0070

AGE DETERMINATION OF LARGE ATLANTIC SHARKS ...Age, Atlantic Ocean-north, Growth Rate ...5.1028

DISTRIBUTION OF YOUNG STAGES OF COASTAL FISHES ...Continental Shelf, Estuaries, Fish -non-specific, Maturity & Growth Stages, Number Or Density, Ships and Cruises ...5.0116

INFLUENCE OF THE PHYSICAL ENVIRONMENT ON DISTRIBUTION OF YOUNG STAGES OF COASTAL GAME FISH ...Continental Shelf, Environmental Ecology, Fish -non-specific, Maturity & Growth Stages, Physical-general, Range Or Territorial Distr ...5.0111

INVENTORY AND ATLAS OF GULF COAST SPORT FISHING FACILITIES ...Inland Sea Charts, Maps, Fishing, Gulf of Mexico, Handbooks, Management -other ...5.0006

EXPLORATORY COLLECTION AND CARE OF AQUATIC INVERTEBRATES FOR TESTING AT 7BURON ...Bioassay, Brackish Water, Captive Rearing, Invertebrates -non-specific, Pesticides -non-specific ...5.0055

INVENTORY AND ATLAS OF MARINE SPORT-FISHING FACILITIES ...Atlantic Ocean-north, Eastern, Fishing, Handbooks, Recreation Sites ...5.0102

LIFE HISTORY OF BILLFISHES ...California, Censusing, Life History Studies, Marlin, Billfishes, Sillfish ...5.0195

TEMPERATURE TOLERANCE OF MARINE ANIMALS THROUGH BEHAVIORAL RESPONSES ...Behavior, Environment, Mortality Rates, Thermal, Water Temperature -non-specific ...5.0018

THERMAL PREFERENCES OF MARINE FISHES AND INVERTEBRATES ...Behavior, Fish -non-specific, Invertebrates -non-specific, Thermal, Water Temperature-non-specific ...5.0209

EFFECTS OF HOT WATER MASSES ON MARINE FISHES ...Atlantic Ocean-north, Behavior, Fish -non-specific, High Temp ...4.0105

ENVIRONMENTAL EFFECTS ON ISTIOPHORID FISH DISTRIBUTION ...Environmental Ecology, Gulf of Mexico, Marlin, Billfishes, Sillfish, Ships and Cruises, Temporal Distribution ...5.0070

SAN PABLO BAY STUDY ...Bays, Benthic Fauna, Bottom Sampling Device, Excavation, Pollution - Effects of, Spill Boats, ...5.0136

LIFE HISTORY AND BEHAVIOR OF FISHES ON ARTIFICIAL REEFS ...Behavioral Ecology, Fish -non-specific, Habitat Studies, Life History Studies, Population Dynamics ...5.0121

HYDROGRAPHY, SEDIMENTATION AND CHEMICAL ASPECTS OF THE REEF ENVIRONMENT ...Aquatice Ecosystems, Currents-ocean, Environmental Ecology, Fish -non-specific, Reefs ...5.0212

DESIGN, CONSTRUCTION AND LONGEVITY OF ARTIFICIAL FISHING REEFS ...Atlantic Ocean-north, Currents-ocean, Reefs, Tides ...5.0013

1965 SALT-WATER ANGLING SURVEY ...Animal Taxonomy, Censusing, Fish -non-specific, Fishing ...5.0011

TRACKING MIGRATIONS OF BLUEFISH POPULATIONS ALONG ATLANTIC COAST TO LEARN BIOLOGY OF THE SPECIES (MIGRATORY HABITS OF BLUEFISH) ...Atlantic Ocean-north, Bluefish, Migration, Population Dynamics, Tags ...5.0120

EFFECT OF TEMPERATURES AND CIRCULATION OF CONTINENTAL SHELTER WATER ON THE DISTRIBUTION OF FISHES ...Continental Shelf, Fish -non-specific, Surface Environments, Temperature, Water Movement, Currents, Water Temperature-non-specific ...5.0102

PACIFIC COASTAL ENVIRONMENT AS RELATED TO DISTRIBUTION AND ABUNDANCE OF GAME SPECIES - SEA SURFACE TEMPERATURE MEASUREMENTS ...Aquatic Ecology, California, Spectral Reflectance, Temperature ...5.0175

TAGGING PROGRAM WITH WOODS HOLE AND INTERNA- TIONAL GAME FISH ASSOCIATION FOR MARLIN, SAILFISH AND OTHER GAME SPECIES MIGRATION STUDIES ...Marlin, Billfishes, Sillfish, Ecogenea, Atlantic Ocean-general, Population Dynamics, Tags ...5.0036

HYPOTHETICAL DISTRIBUTION OF 14 SPECIES OF AT- LANTIC COASTAL GAME FISHES ...Aquatic Ecology, Atlantic Ocean-general, Environmental Ecology, Fish -other, Water Temperature-non-specific ...5.0123

AGE AND GROWTH OF BLUEFISH ...Age, Atlantic Ocean-north, Bluefish, Growth Rate, Population Dynamics, Scales ...5.0127

UPGRADING CONVENTIONAL FISHING TECHNIQUES ...Commercial Fishing, Fishing Gear, Netu, Pacific Ocean-north, Sonar, Telemetry ...5.0150

ATLAS OF MARINE FAUNA ...Atlantic Ocean-north, Crustacea -non-specific, Fish -non-specific, Handbooks, Mollusks -non-specific & Other ...5.0101
SUBJECT INDEX

PELAGIC FISH EXPLORATIONS ...Codfishes, Hake, Commercial Fishing, Fish -other, Nets, Pacific Ocean-east, Vertical Distribution, ...5.0172

BOTTOMFISH EXPLORATIONS ...Commercial Fishing, Fish -other, North Pacific Ocean, East, Vertical Distribution, ...5.0168

IMMUNOLOGY AND SEROLOGY OF MARINE ANIMALS ...Agglutination Tests, Biochemical Analysis, Blood Plasma and Serum, Immunology, Pathology, ...5.0037

ZOOPLANKTON OF THE GULF OF MAINE ...Atlantic Ocean-north, Plankton Sampling, Population Dynamics, Vertical Distribution, Zooplankton, ...5.0789

ABUNDANCE AND AVAILABILITY OF PRE-RECRUIT HERRING ...Alewife, menhaden, shad, Herring, Aquatic Ecology, Environmental Ecology, Life History Studies, Number Or Density, Vertical Distribution, ...5.0280

SAMPLING OF THE ATLANTIC COMMERCIAL CATCH ...Alewife, menhaden, shad, Herring, Atlantic Ocean-general, Commercial Fishing, Nets, Number Or Density, ...5.0129

POPULATION STUDIES ...Alewife, menhaden, shad, Herring, Animal Distr. (non-specific), Animal Taxonomy, Environmental Ecology, Population Dynamics, ...5.0130

ACCUMULATION OF RADIOACTIVITY BY INVERTEBRATES (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION) ...Contamination - Water, Cooperative-studies, Diagnostic Procedures, Radioactivity-general, Reactor Sites & Rad Waste, ...5.0474

ACCUMULATION OF RADIONUCLIDES BY VERTEBRATES (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION) ...Biological, Contamination - Water, Estuaries, Radioactivity-general, ...5.0293

ACCUMULATIVE EFFECT OF RADIOACTIVITY ON ORGANISMS IN EXPERIMENTAL MARINE ENVIRONMENTS ...Contamination - Water, Cooperative-studies, Estuaries, Laboratory, Radioactivity, ...5.0631

THE EFFECTS OF RADIATION ON THE PHYSIOLOGY OF MARINE ORGANISMS (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION) ...Cooperative-studies, Fish -other, Radiation Sensitivity, Vertebrate Anatomy, Vertebrates Excl. man, ...5.0295

GULF-PENINSULA KING CRAB STUDIES ...Commercial Fishing, Crabs, Gulf of Alaska, Habitat Studies, Population Dynamics, ...5.0342

MARINE BIOLOGICAL INVESTIGATIONS - TAXONOMIC COLLECTION OF THE FRESH AND SALTWATER FISHES OF ALASKA ...Alaska, Animal Taxonomy, Collections, Fish -non-specific, Fresh Water, ...5.0008

GULF OF ALASKA DEMERSAL FISH INVESTIGATIONS ...Fish -non-specific, Gulf of Alaska, Population Dynamics, Productivity (agricultural), Vertical Distribution, ...5.0109

MARINE BIOLOGICAL INVESTIGATIONS - NEKTON OF INSIDE WATERS OF SOUTHERN ALASKA ...Alaska, Plankton Sampling, Population Dynamics, Temporal Distribution, Zooplankton, ...5.0521

MARINE BIOLOGICAL INVESTIGATIONS - ANALYSIS OF HERRING FISHERY DATA ...Age, Alaska, Alewife, menhaden, shad, Herring, Data Analysis - General, Dispersion -other, ...5.0010

FUR SEAL RESEARCH, PELAGIC INVESTIGATIONS ...Behavioral Ecology, Food Supply, Seals, Vertical Distribution, ...5.0667

EFFECTS OF CHEMICALS ON THE PHYSIOLOGY OF SEA LAMPREY AMMOCETES (PETROMYZON MARINUS) ...Contamination, Control of Nuisance Species, Environmental Physiology, Lampreys, Maturity & Growth Stages, ...5.0631

TAXONOMIC REVISION OF BATHYLAGIDAE ...Animal Taxonomy, Deepsea Smelts, Tables, Compilations, Catalogs, Temperature, Tropics, ...5.0655

STUDIES ON ANACANTHINE FISHES ...Animal Taxonomy, Atlantic Ocean-north, Continental Shelf, Fish -other, Publications -other, ...5.0048

SYSTEMATIC STUDIES ON THE FAMILIES SCOMBRIDAE ...Animal Taxonomy, Indian Ocean-general, Nomenclature, Classification, Tuna, Mackerel, Albacore ...Vertebrate Anatomy, ...5.0056

POPULATION DYNAMICS OF NEW ENGLAND GROUNDFISH ...Atlantic Ocean-north, Codfishes, Hake, Lefteye Flounders, Population Dynamics, Rockfish, Scorpionfish, ...5.0103

INVESTIGATE SYSTEMATICS AND ECOLOGY OF TUNA LARVAE AND JUVENILES ...Animal Taxonomy, Artificial Incubation, Maturity & Growth Stages, Spawning & Nesting Sites, Tuna, Mackerel, Albacore, ...5.0079

INVESTIGATE SEASONAL VARIATIONS, SURFACE WATER TYPES, HAWAIIAN AREA (Ko-O HEAD) ...Commercial Fishing, Hawaii, Heat and Radiation Transfer, Oceanic Fronts, Salinity, Temperature, Tuna, Mackerel, Albacore, ...Water Salinity, Water Temperature-non-specific, ...5.0148

FISHES TAKEN INCIDENTAL TO SHRIMP TRAWLING ...Atlantic Ocean-south, Fish -non-specific, Nets, Number Or Density, Shrimps - Common, ...5.0072

SYSTEMATIC STUDIES OF FISHES ...Animal Taxonomy, Developmental Physiology, Fish -non-specific, Life History Studies, Vertebrate Anatomy, ...5.0059

IDENTIFICATION AND DESCRIPTION OF FISH LARVAE ...Animal Taxonomy, Atlantic Ocean-north, Fish -non-specific, Life History Studies, Southern, ...5.0074

REPRODUCTION AND FECUNDITY OF TUNAS ...Behavioral Rhythms, Female Gametes, Fertility, Tuna, Mackerel, Albacore, ...5.0159

DISTRIBUTION AND ECOLOGY OF ATLANTIC TUNAS ...Atlantic Ocean-north, Fish -non-specific, Range Or Territory, ...5.0063

MIGRATION OF ATLANTIC TUNAS ...Africa, Atlantic Ocean-general, Migration, Tags, Tuna, Mackerel, Albacore, ...5.0064

FEEDING HABITS OF ATLANTIC TUNAS AND NEKTON ECOLOGY ...Atlantic Ocean-general, Food Supply, Plankton (non-specific), Productivity - Food Chain, Tuna, Mackerel, Albacore, ...5.0024

POPULATION DYNAMICS OF ATLANTIC TUNAS ...Atlantic Ocean-general, Censusing, Commercial Fishing, Population Dynamics, Tuna, Mackerel, Albacore, ...5.0065

INTERRELATIONS WITHIN THE PHYSICAL ENVIRONMENT ...Commercial Fishing, Density, Environmental Ecology, Sea Level Variations, Temporal Distribution, ...5.0978

MONITORING SURVEY AND TIME-SERIES ANALYSIS OF SUBSURFACE TEMPERATURE IN THE NORTH PACIFIC OCEAN ...Pacific Ocean-north, Subsurface Environments, Temperature, Thermocline, Water Temperature-non-specific, ...5.0176

MECHANISMS AFFECTING THE VERTICAL AND HORIZONTAL DISTRIBUTION OF TUNAS AND RELATED SPECIES ...Behavioral Ecology, Environmental Ecology, Mark, Tag Or Capture -other, Tuna, Mackerel, Albacore, ...Vertical Distribution, ...5.0087

OCEAN ENGINEERING ...Bathymetry, Commercial Fishing, Fishing Gear, Instrumental Services, Telemetry-other, ...5.0152

FISHING GEAR RESEARCH AND DEVELOPMENT ...Commercial Fishing, Fishing Gear, Meetings, Nets, ...5.0153

SHELLFISH EXPLORATIONS ...Benthic Fauna, Clams, Commercial Fishing, Mark, Tag Or Capture -other, Population Dynamics, ...5.0014

MARINE FISH BEHAVIOR ...Behavioral Ecology, Commercial Fishing, Fish -non-specific, Fishing Gear, ...5.0176

BIOLOGICAL STUDIES OF NORTHWEST ATLANTIC GROUNDFISH ...Atlantic Ocean-north, Codfishes, Hake, Freshwater Mussels, Scallops, Righteye Flounders, Rockfish, Scorpionfish, ...5.0104

EXPLORATION OF LATENT RESOURCES ON THE CONTINENTAL SHELF/SLOPE ...Atlantic Ocean-north, Commercial Fishing, Continental Shelf, Nets, Survey Studies, ...5.0102

STUDIES OF THE BENTHIC INVERTEBRATES OF THE ATLANTIC CONTINENTAL SHELF ...Atlantic Ocean-north, Benthic Fauna, Continental Shelf, Population Dynamics, Productivity - Food Chain, ...5.0023

LOBSTER RESEARCH ...Commercial Fishing, Environmental Ecology, Habitat Studies, Lobsters, Population Dynamics, ...5.0436

MARINE BIOLOGICAL INVESTIGATIONS STUDIES PROJECT (FISHES) ...Alaska, Aquatic Ecology, Bays, Fish -non-specific, Population Dynamics, ...5.0011

MARINE BIOLOGICAL INVESTIGATIONS - SURFACE ZOOPLANKTON PROJECT ...Alaska, Number Or Density, Plankton Sampling, Vertical Distribution, Zooplankton, ...5.0073

MARINE BIOLOGICAL INVESTIGATIONS - JAPANESE FISHERY OBSERVERS PROJECT ...Commercial Fishing, Gulf of Alaska, Japan, Nets, Righteye Flounders, ...5.0012

581

Marine Biology
Marine Biology

SUBJECT INDEX

BOTTOMFISH EXPLORATIONS ...Bering Sea, Fish -other, Gulf of Alaska, Nets, Vertical Distribution, ...5.0030

BERING SEA BAKANUR STUDIES ...Bering Sea, Commercial Fishing, Crabs, Environmental Ecology, Migration, ...5.0031

PINK SALMON INVESTIGATIONS - EARLY SEA LIFE OF SALMON ...Alaska, Environmental Physiology, Life History Studies, Parasitology -other, Water Temperature-non-specific, ...5.0034

COMPOSITION STUDIES OF FISH AND SHELLFISH AS RELATED TO STORAGE AND PROCESSING PROBLEMS ...Crabs, Fish -other, Freezing, Mackerel, Packaging, Rancidity, ...6.0046

CONTRIBUTIONS TO THE BIOLOGY OF THE ROYAL RED SHRIMP, HYMENOPENAEUS ROBUSTUS ...Atlantic Ocean-south, Maturity & Growth Stages, Number Or Density, Shrimps - Common, Vertical Distribution, ...5.0041

GROUNDFISH INVESTIGATIONS (POTENTIAL YIELD OF UNDERUTILIZED GROUNDFISH STOCKS) ...Codfishes, Hake, Commercial Fishing, Legislation, Number Or Density, Rockfish, Sciaenids, ...5.0071

OCEAN GROWTH AND MORTALITY OF SALMON ...Growth Rate, Mortality Rates, Salmon -coho, chinook, sockeye, Scales, Tagging, ...5.0072

PACIFIC FISH PHYSIOLOGY AND BIOCHEMISTRY (SALMON IMMUNOCHEMISTRY) ...Immunochemistry, Maturity & Growth Stages, Salmon -coho, chinook, sockeye, Stress, ...5.0032

ANALYSIS OF JAPANESE CATCH STATISTICS ...Commercial Fishing, Japan, Number Or Density, Pacific Ocean-north, Salmon -coho, chinook, sockeye, ...5.0016

POPULATION DYNAMICS (BIOMETRICS) OF EXPLOITED FISH SPECIES ...Fishery Biology, Meteorological Studies, Model Studies, Number Or Density, Pacific Ocean-north, Population Dynamics, ...5.0017

IDENTIFICATION OF SOCKEYE SALMON STOCKS BY BONE MINERALS ...Animal Taxonomy, Bone, Chemical Analysis, Pacific Ocean-general, Salmon -coho, chinook, sockeye, ...5.0023

GULF OF ALASKA SOCKEYE SALMON SCALES, PROTOCOL AREA SOCKEYE SALMON SCALES, AND GULF OF ALASKA PINK SALMON SCALES ...Animal Taxonomy, Gulf of Alaska, Life History Studies, Salmon -coho, chinook, sockeye, Scales, ...5.0034

ADMINISTRATION OF WASHING ACT ...DEVELOPMENT OF RESEARCH TOOLS ...Age, Management -other, Mark, Tag Or Capture -other, ...5.0070

DESCRIPTIONS OF NEW SHARKS ...Animal Taxonomy, Collections, Nomenclature, Classification, Publications -other, Sharks, ...5.0057

A REVISION OF THE CAT SHARKS, SCYLIORHINIDAE ...Animal Taxonomy, Collections, Nomenclature, Classification, Sharks, Vertebrate Anatomy, ...5.0058

DIAGNOSTIC CHARACTERS & DEVELOPMENT OF EXTERNAL SCALE GROOVED SHRIMPS OF GENUS PLEUROPEUS FROM WESTERN ATLANTIC ...Atlantic Ocean-general, Developmental Physiology, Invertebrate Anatomy, Reproductive System, Shrimps - Common, ...5.0085

CIRCULATION DYNAMICS (GULF OCEANOGRAPHY PROGRAM) ...Circulation-general, Environmental Changes, Gulf of Mexico, Shrimps - Common, Thermodynamics, ...5.0045

SPACE APPLICATIONS TO FISHERIES OCEANOGRAPHY (GULF OCEANOGRAPHY PROGRAM) ...Commercial Fishing, Computer Applications, Forecasting-prediction, Satellites, Water Environment-other, ...5.0017

PREDICTING COMMERCIAL SHRIMP ABUNDANCE (SHRIMP DYNAMICS PROGRAM) ...Bays, Behavioral Ecology, Commercial Fishing, Environmental Ecology, Population Dynamics, Shrimps - Common, ...5.0049

BIOLOGICAL OCEANOGRAPHY (GULF OCEANOGRAPHY PROGRAM) ...Environmental Ecology, Food Supply, Gulf of Mexico, Productivity - Food Chain, Shrimps - Common, ...5.0038

TAXONOMY AND BIOLOGY OF CLUPEID FISHES ...Alewife, menhaden, shad, herring, Anchovies, Animal Taxonomy, Atlantic Ocean-general, Handbooks, ...5.0060

STOCK IDENTIFICATION OF ATLANTIC TUNAS ...Atlantic Ocean-general, Caribbean Sea, Electrophoresis -non-specific, Tuna, Mackerel, Albacore, ...5.0022

INVESTIGATE TUNA SUBPOPULATIONS THROUGH THE USE OF BLOOD GROUPS AND INHERITED PROTEINS ...Blood Proteins -non-specific, Blood Typing Studies, Pacific Ocean-general, Population Dynamics, Tuna, Mackerel, Albacore, ...5.0077

INCREASE EFFICIENCY OF HAWAIIAN SKIPJACK FISHERY ...Captive Rearing, Commercial Fishing, Food Supply, Hawaii, Tuna, Mackerel, Albacore, ...5.0077

DEVELOP TECHNIQUES FOR CAPTURING JUVENILE TUNA ...Blood Typing Studies, Nets, Population Dynamics, Tuna, Mackerel, Albacore, Vertical Distribution, ...5.0078

DESCRIPTIVE PHYSICAL OCEANOGRAPHY OF THE EASTERN TROPICAL ATLANTIC ...Atlantic Ocean-general, Environmental Ecology, Fish -non-specific, Productivity - Food Chain, Tropic, ...4.0127

INVESTIGATE POPULATION DYNAMICS OF ALBACORE ...American Samoa, Commercial Fishing, Population Dynamics, Tuna, Mackerel, Albacore, Water Environment -other, ...5.0081

ASSESSMENT OF CENTRAL PACIFIC TUNA RESOURCES ...Commercial Fishing, Pacific Ocean-general, Population Dynamics, Size, Tuna, Mackerel, Albacore, ...5.0082

DEVELOP HIGH-SEAS TUNA FISHERY ...Commercial Fishing, Fishing Gear, Pacific Ocean-general, Tropic, Tuna, Mackerel, Albacore, ...5.0084

DEVELOP FISHERIES FOR NON-TUNA RESOURCES ...Commercial Fishing, Fishing Gear, Hawaii, Pacific Ocean-general, Snuppers, ...5.0084

FISHERY FORECASTING - TEMPERATE FISHERIES ...Circulation-general, General Synoptic Observations, Low Temp -but Above 32f, Pacific Ocean-other, ...6.0000

LOCAL FISHERY SYSTEMS DEVELOPMENT ...California, Commercial Fishing, Sharks, Shrimps - Common, Swordfish, ...5.0047

SCHOOLING BEHAVIOR ...Alewife, menhaden, shad, herring, Anchovies, Behavioral Ecology, Environmental Ecology, Tuna, Mackerel, Albacore, ...5.0038

146 D EASTROPAC ...Marine Biology, Meteorological Studies, Pacific Ocean-east, Tropic, Tuna, Mackerel, Albacore, Vertical Distribution, ...4.0113

INVESTIGATE POPULATION DYNAMICS OF SKIPJACK TUNA IN HAWAIIAN WATERS ...Commercial Fishing, Economics, Environmental Ecology, Hawaii, Population Dynamics, Tuna, Mackerel, Albacore, ...5.0087

NORTHERN SHRIMP EXPLORATIONS ...Atlantic Ocean-north, Censusing, Commercial Fishing, Fishing Gear, Shrimps - Common, ...5.0047

THE OCEANOGRAPHY OF NEW ENGLAND FISHING BANKS ...Continental Shelf, Fish -other, Number Or Density, Vertical Distribution, Water Environment-other, ...5.0091

MICROBIOLOGY OF MARINE AND ESTUARINE INVERTEBRATES ...Estuaries, Marine Bacteria, Microbiological Analysis, Oysters, ...5.0079

PACIFIC OYSTER MORTALITY STUDIES ...Invertebrate Pathology, Mortality Rates, Oysters, Pacific Ocean-general, Pathology, ...5.0042

TUNA PURSE SEINE NET ...Commercial Fishing, Fishing Gear, Nets, Tuna, Mackerel, Albacore, ...5.0016

PHYSIOLOGY OF MARINE ORGANISMS ...Energy, Environmental Physiology, Fish -non-specific, Food Supply, ...5.0039

FISH POPULATION PARAMETERS ...Age, Biological Rhythms, Life History Studies, Population Dynamics, Size, ...5.0015

REARING MARINE FISH ...Alewife, menhaden, shad, herring, Anchovies, Captive Rearing, Environmental Physiology, Tuna, Mackerel, Albacore, ...5.0016

PRODUCTIVITY MEASURES ...Number Or Density, Ocean Currents-other, Organism Sampling Devices, Pacific Ocean-east, Primary Productivity, Productivity - Food Chain, Zooplankton, ...5.0040

CALIFORNIA CURRENT SURVEYS ...California Current, Environmental Ecology, Fish -non-specific, Pacific Ocean-east, Plankton (non-specific), ...5.0014

SUBPOPULATIONS ...Anchovies, Commercial Fishing, Pacific Ocean-general, Population Dynamics, ...5.0042

DEVELOPMENT OF FISHNET BATHYKMORPHOGRAPH ...Commercial Fishing, Fishing Gear, Instrumental Services, Nets, Readout Systems, ...8.0102

FIELD STUDY - CAPE COD, MASS. ...Animal Distribution, Environmental Ecology, Mammals -non-specific, Benthonic-bottom, Buoyes, Environmental Ecology, Sediments-other, Temperature, ...5.0084

HISTOPATHOLOGIC EFFECTS OF POLLUTANTS ON CELLS AND TISSUES OF MARINE FISHES ...Contamination, ...5.0085

582
DETERMINATION OF CHLOROPHYLL DERIVATIVES ...Catabolism and Degradation, Collar Injury and Autolysis ...Fluorometry, Phytoplankton ...5.0770

RELATIONSHIP OF PHOTOSYNTHESIS TO RESPIRATION OF OCEANIC MICROALGAE ...Light, Mass Spectroscopy, Oxygen, Photosynthesis, Respiration ...5.0774

ENVIRONMENTAL EFFECTS ON THE METABOLISM OF MARINE ALGAE ...Enzymes, Glycolic Acid, Laminaran ...non-specific & Ot), Light, Phytoplankton, Responses to Growth, 5.0702

LOGISTIC SUPPORT, MAINTENANCE AND RENOVATION OF FACILITIES ...Facilities, Maine, Marine Biology, ...12.0029

MOLECULAR MECHANISMS IN BIOLOGICAL CLOCKS ...Control and Regulation, Gonyaulax, ...5.0983

SYSTEMATICS AND ECOLOGY OF SUBTIDAL BENTHIC MARINE ALGAE ...Algae- General, Benthic Flora, Benthic- bottom, Habitat Studies, Plant Taxonomy, Range Or Territorial Dist ...5.0701

PHYSIOLOGY AND ECOLOGY OF MARINE DIATOMS ...Algae- Diatoms, Algal Culture, Habitat Studies, Nutrition Studies, Physiological Ecology, Plant Taxonomy, ...5.0735

NUTRIENT LIMITATION AND SOURCES OF NITROGEN FOR MARINE PRIMARY PRODUCTIO ...Mathematical Biophysical, Nitrogen Fixation, Other Models, Phytoplankton, Primary Productivity, ...5.0845

ALGAL SUBSTANCES IN THE MARINE FOOD WEB ...Food Chain, Food Webs, Humic Acid, Phaeophyta (non-specific & Ot), Phenol, Secretions and Products, ...5.0728

RESTORATION, PHAGOCYTA KLORATION OF MARINE ALGAE ...Applied Ecology, Growth and Differentiation, Habitat Studies, Laminaran ...non-specific & Ot), Pacific Ocean-west, ...5.0690

ORGANIC INFLUENCES ON CARBONIC CARBONATE CE- MENTATION ...Algae- General, Algal Culture, Biology, Cem- ment Genesis, Secretions and Products, ...5.0729

LIGHT REQUIREMENTS FOR MARINE ALGAE ...Algae- General, Algal Culture, Autothetic, Light, Pigments, ...5.0703

ECOLOGICAL STUDIES OF ROCKY SUBTIDAL AREAS ...Animal Taxonomy, Habitat Studies, Plant Taxonomy, ...5.0865

ULTRAVIOLET ABSORPTION IN COASTAL WATERS ...Biological, Physical Parameters, Plant Prod. (non-specific), Sewage, Total Organic Carbon, Ultra - Violet Radiation, ...6.0138

DEMONSTRATION OF THE LIMITATIONS AND EFFECTS OF WASTE DISPOSAL ON AN OCEAN SHELF ...Ocean, Outlet, Pollution - Effects of, Pollution Effects, Sewers, ...6.0146

CONTROL OF PLANT PATHOGENS USING ACTIVE AN- TIMICROBIAL SUBSTANCES ISOLATED FROM MARINE ALGAE ...Endogenous Biological Extracts, Fungi - non-specific, Growth Substances, Nutrition in Disease, ...6.0127

INVESTIGATIONS ON THE CRUSTOSE CORALLINES OF THE NORTH ATLANTIC ...Atlantic Ocean-north, Diving and Scuba, ?enant Taxonomy, Rhodophyta (non-specific & Ot), Sedimentary general, ...7.0172

ACTIVE CHEMICAL PRINCIPLES DERIVED FROM ECHIN- ODERSMS ...Chemoreceptors, Holoehin, Toxicology, ...6.0117

PHYSIOLOGICAL AND BIOCHEMICAL REQUIREMENTS OF PHYTOPLANKTON SPECIES ...Algal Culture, Media, Nutrition Studies, Phytoplankton, Planktonic - Floating, ...5.0995

PRODUCTIVITY OF ESTUARINE AND MARINE ECOSYSTEMS (A COOPERATIVE AGREEMENT WITH THE DIATOM GROUP, CONSTRUCTION ...Algae- General, Estuaries, Phytoplankton, Primary Productivity, Standing Crops, ...5.1010

PRIMAR PRODUCITIVITY ...Primary Productivity, Productivity - Food Chain, Sta i Jing Crops, ...5.0955

INTERACTIONS OF MARINE NUTRIENT COMPLEXES ... Nutrients, Phosphorus, Phytoplankton, Tracers, ...5.0956

DETERMINATION OF SELECTED ENVIRONMENTAL REQUIREMENTS OF IMPORTANT MARINE PHYTOPLANKTON SPECIES ...Axenic Culture, Growth and Differentiation, Marine Biology, Phytoplankton, Responses to ...5.0999

DEVELOPMENT OF A METHOD FOR CHRONIC TOXICITY BIOASSAY USING MARINE PLANKTONIC ALGAE ...Algal Culture, Bioassays, Microbiological Analysis, Monitoring (long

SUBJECT INDEX

Marine Environments-general

TERM STUDIES), Phytoplankton, Technique Development, Toxicology, ...5.0726

STUDY OF NITROGEN METABOLISM IN MARINE ALGAE ...Biodi.vators, Enzymes, Microbiological Analysis, Pollution - Effects of, Quantitative & Qualitative ...5.0727

COLLECTION AND EXTRACTION OF MARINE INVERTEBRATES AND PLANTS ...Collections, Extracts, Lyophiliza- tion, ...5.0697

CALCIFICATION MECHANISMS IN MARINE ORGANISMS ...Algae- General, Calcification, Mollusks -non-specific & Other, ...5.1016

BIOLICAL INVESTIGATIONS WITH ISOPTES ...Algae- General, Facilities, Isotopes -non-specific, Radiation Effects -non-specific, Radiocarbon, ...11.0016

STRUCTURAL AND FUNCTIONAL ORGANELLE INTERAC- TIONS ...Differentiation Mechanism, Organelle & Membrane Formation, Plant Developmental Biology, Structural Functions, Tissue Techniques, ...5.0689

NEW DRUGS FROM THE SEA, ESPECIALLY ANTIBIOTICS ...Antibiotics, Caribbean Sea, Pacific Ocean-general, ...6.0123

Biosynthesis of 3-HYDROXYTRYRAMINE in MONOS- TROMA FUSCUM ...Biosynthesis, Chlorophyll (non- specific & Ot), Dopa Decarboxylase, Tyramine, Tyrosinase, ...5.0720

Marine Environments-general

EFFECTS OF HEATED WATER DISCHARGE ON THE MARINE ENVIRONMENT ...Pollution - Effects of, Pollution Sources-other, Thermal Pollution, ...6.0142

COMMITTEE ON OCEANOGRAPHY ...Air-sea Boundary- general, Committee-support, Oceanocephraphy-general, Radioac- tivity-general, ...11.0016

SUPPORT OF TRAINING PROGRAMS IN INVERTEBRATE ZOOLOGY AND MARINE BOTANY ...Invertebrates -non- specific, Marine Biology, Marine Plants, Meetings, Training Grants, Fellowships, ...11.0028

ACOUSTIC-VISSUAL SYSTEM FOR AQUATIC BIOACOUSTI- CAl AND ETHOLOGICAL RESEARCH ...Acoustical, Behavioural Ecology, British West Indies, Marine Biology, ...5.0849

PREDICTION OF BIOLOGICAL POPULATIONS FROM THE PHYSICAL OCEANIC ENVIRONMENT ...Phytoplankton, Range Or Territorial Dist, ...5.0927

DIVERSITY COMMUNICATION TESTS ...Buys, Forecasting- prediction, Satellites, Telemetry-ether, Very High Frequency, ...4.0061

SATURATED DIVING FACILITIES FOR DIVER-SCIENTIST AND RELATED RESEARCH ...Controls, Data Acquisition, Model Studies, Submersibles, Underwater-construction, Underwater-laboratory, ...8.0313

MEASUREMENT AND INTERPRETATION OF MO- TIONALLY-INDUCED ELECTRIC FIELDS IN THE SEA ...Currents-ocean, Electrical, Forecasting-prediction, Model Studies, Moorings, Water Motion Recorders, ...1.0139

NUMERICAL OCEANOGRAPHIC MODEL DEVELOPMENT FOR ENVIRONMENTAL PREDICTION ...Forecasting-predic- tion, Meteorological Studies, Model Studies, Oceanic Fronts, Weather Forecasting, ...4.0077

INVESTIGATION OF NUCLEAR THERMIONIC POWER FOR MARINE APPLICATIONS ...Electron Emission, Nuclear Power, Power Conversion Systems, Thermoelectric, ...5.0155

A SURVEY OF THE MARINE ENVIRONMENT FROM FORT ROSS, SONOMA COUNTY, TO POINT LOBOS, MON- TEREY COUNTY ...California, Effluents-waste Water, Pollu- tion - Effects of, Pollution Effects, ...9.0603

LABORATORY STUDIES TO DETERMINE ROCK PROPER- TIES UNDER HYDROSTATIC (SEA WATER) PRESSURE Environmental Effects-geologic, Physical Properties, Rock Mechanics, Survey Studies, ...5.0830

HISTORICAL STUDY ON EFFECT OF HARBOR DREDGING ON THE ENVIRONMENT (ENVIRONMENTAL F/C/TORS PERTINENT TO EFFECTS ON MARINE ENVIRONMENTS) ...Dredging, Environmental Effects-geologic, Excavation, Har- bors, Ocean Mining, ...6.0135

MEASUREMENT OF IONIC CONCENTRATIONS IN ESTUARINE AND MARINE ENVIRONMENTS (A COOPERATIVE AGRE- EMENT WITH THE ATOMIC ENERGY COMMISSION) ...Estuaries, Pollution - Effects of, Pollution Effects, Radioac- tivity-general, Reuctor Sites & Rad Waste, ...6.0912

585
Marine Environments-general

SURVEY, EVALUATION & SUMMARIZATION OF LITERATURE ON ENVIRONMENTAL REQUIREMENTS OF MARINE ORGANISMS LEVELS OF POTENTIAL TOXICANTS (ABBREV ...Biology, Chemical, Environmental Effects-geologic, Geosciences, Library, Marine Biology, Survey Studies, ...4.0427

Maryland

ECONOMIC ANALYSIS OF THE MARKET STRUCTURE OF THE COMMERCIAL FISHING INDUSTRY IN THE NORTHEAST ...Commercial Fishing, Fish & Shellfish, Market Structure, Northeast, Processing, ...4.0182

ANALYSIS OF AN ATTEMPT TO CONTROL BEACH EROSION AT SCIENTISTS CLIFFS, MARYLAND ...Beaches, Chesapeake bay, Engineering Studies-other, Erosion, Groin, ...8.0028

GROWTH, CONDITION, AND SURVIVAL OF SHELLFISH ...Adaptation, Environmental Physiology, Oysters, Water Quality-general, Water Salinity, ...5.0447

Mass Wasting

SEDIMENTATION ...Acoustical, Gravity Tectonics, Gulf of Mexico, Mechanical Properties, Sedimentation, ...7.0201

Massachusetts

ECOLOGICAL STUDY OF DUXBURY BAY ...Aquatic Ecology, Bays, Habitat Studies, Survey Studies, Tides, ...5.0898

PILING PRESERVATIVES THRESHOLD STUDIES ...Biological, Fouling, North Carolina, Preservatives, Wood, ...8.0232

INVESTIGATIONS IN MARINE BIOLOGY ...Marine Biology, Teaching and Research, ...11.0027

THE INFLUENCE OF DEPOSIT FEEDING BENTHOS ON THE STABILITY OF BOTTOM SEDIMENTS AND COMMUNITY TROPHIC STRUCTURE ...Benthic Fauna, Benthonic-bottom, Productivity - Food Chain, Suspension, ...5.0559

RESEARCH TRAINING LABORATORY ...Facilities, Marine Biology, ...12.0032

AIR-SEA EXCHANGE ...Albedo, Heat and Radiation Transfer, Infrared Radiation, Temperature, Towers, ...3.0026

COASTAL LOBSTER FISHERY ...Censusing, Commercial Fishing, Legislation, Lobsters, ...5.0453

OFFSHORE LOBSTER FISHERY ...Censusing, Commercial Fishing, Lobsters, Nets, ...5.0453

WEIR, TRAP AND SEINE FISHERY ...Censusing, Commercial Fishing, Fishing Gear, Nets, ...4.0010

ANADROMOUS FISHERY ...Alewife, menhaden, shad, herring, Censusing, Commercial Fishing, ...4.0011

DISSEMINATION OF COMMERCIAL FISHERIES STATISTICS ...Commercial Fishing, Periodicals, ...4.0029

IMPACT AND FATE OF POLLUTION IN ESTUARIAL WATERS ...Degradation, Estuaries, Pollutants - Path of Pollution Effects, ...6.0153

THE POPULATION ECOLOGY OF GEMMA GEMMA (PELECYPODA, VENERIDAE), A DOMINANT SPECIES IN BARNSTABLE HARBOR, MASS ...Clams, Habitats, Population Dynamics, ...5.0460

FORAMINIFERA FROM HEDLEY HARBOR, MASSACHUSETTS ...Environmental Ecology, Foraminifers, Habitats, Number Or Density, Vertical Distribution, ...5.0863

INTERPRETING THE ORIGIN AND DISTRIBUTION OF COASTAL SEDIMENTS Canada, Distribution, Origin, Shoreline - Coastaline, Size, ...7.0213

Material Parameters

Environment General

MECHANICAL PROPERTIES ...Liquid, Mechanical Properties, Special Mission Ships, Submersibles, Test Methods, ...8.0210

Orientation

PRODUCTION OF PLATES OF FIBER COMPOSITES BY SOLIDIFICATION, FORMING AND A COMBINATION OF BOTH ...Aluminum, Fiber, Filament, Intermetallic Compound, Metal Matrix, Nickel, ...8.0230

Stability

HUMIDITY SENSORS ...Strain, Fluoride, Humidity Instruments, Transducers, ...8.0083

Viscosity

VISCOSITY AND VISCOSITETICITY OF LIQUIDS AND GLASSES ...Glass, Instrumental Services, Liquid, Morphology, State Variables - P, Viscosityunits, ...8.0260

Material Prameters

Thermal

ADVANCES HEAT SOURCES AND THERMAL INSULATION MATERIALS FOR SWIMMER HEATING ...Diving and Scuba, Diving-system, Heat Transfer, Heating, Thermal Insulators, ...8.0021

Materials Used Undersea

ANTI-FOULING MEANS FOR MARINE PROPPELLERS ...Corrosion Prevention-other, Fouling, Marine Propulsion, ...8.0240

ANTIFOULING RESEARCH ...Corrosion Prevention-other, Fouling, Water, ...8.0200

PASSIVE BUOYANCY SYSTEMS ...Buoyant, Flotation, Engineering Studies-general, Foum, Porous, Other-design-and-construction, Submersibles, ...8.0253

UNDERWATER WELDING ...Helium, Inert Gas, Safety, Scientific-service-support, Subsurface Environments, ...8.0344

FRICITIONAL RESISTANCE HULL SCALE AND COATINGS CORROSION General, Maintenance-system, Paint - General, Wear, Friction, ...8.0227

MICROBIAL CORROSION AND DETERIORATION OF NAVAL MATERIALS ...Biological, Classification Or Taxonomy, Fouling, Ionic Effect, Marine Bacteria, ...8.0203

THE ROLE OF MARINE ORGANISMS IN THE DEGRADATION OF NAVAL MATERIALS ...Biological, Marine Bacteria, Model Studies, Reaction Rates, ...8.0241

OCEAN ENGINEERING RESEARCH ...Alloys, Engineering Studies-general, Mooringo, Water, Water Properties-general, ...8.0560

EFFECTS OF MATERIAL VARIATIONS IN THE COMPUTERIZED DESIGN OF PRIMARY HULL STRUCTURE ...Bulkheads, Computer Applications, Engineering Studies-other, Low Alloy Steels, Strength, Cohesion, ...8.0298

PRESEVATION OF WOODS IN THE MARINE ENVIRONMENT ...Biological, Fouling, Habitat Studies, Marine Fungi (non-specific), Preservatives, Wood, ...8.0216

METAL ANALYSIS/TEST INSPECTION ...Flaw Detection ...Other, Hull, Penetrating Ray, Standards, Specifications, Ultrasonic and Sonic, ...8.0218

STRUCTURAL TITANIUM ALLOYS -100 KSI YIELD STRENGTH ...Strength - Weight Ratio, Stress Concentration-toughness, Titanium, ...8.0219

STRUCTURAL TITANIUM ALLOYS -120/150 KSI YIELD STRENGTH ...Fatigue, Strength - Weight Ratio, Stress Concentration-toughness, Submersibles, Titanium, ...8.0219

REINFORCED PLASTIC STRUCTURES ...Buoyant, Flotation, Laminates, Plastic Matrix, Strength - Weight, ...8.0212

STRUCTURAL PLASTICS-DEEP SUBMERGENCE ...Design Data, Epoxy, Fiber, Flament, Glass, Plastic Matrix, ...8.0213

BUOYANCY MATERIALS ...Buoyant, Flotation, Microsphere, Microballoon, Plastic Matrix, Submerged Ships, ...8.0214

HY 130-150 STRUCTURAL STEELS ...High Yield, Low Alloy Steels - Other, Stress Concentration-toughness, Welding - Other, ...8.0220

HY 180/210 STRUCTURAL STEELS ...High Yield, Low Alloy Steels - Other, Machining, Precipitation Hardening, Stress Concentration-toughness, Welding - Other, ...8.0224

Materials-composites

Laminates

REINFORCED PLASTIC STRUCTURES ...Buoyant, Flotation, Materials Used Undersea, Plastic Matrix, Strength - Weight Ratio, ...8.0212

586
<table>
<thead>
<tr>
<th>Mediterranean Sea</th>
<th>SUBJECT INDEX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aegean Sea</td>
<td>Metabolic Inhibitors</td>
</tr>
<tr>
<td>AELEAN SEA BIOLOGY ...Benthic Organisms (non-specif), Currents-longshore, Plankton (non-specif), Range Or Territorial Dist., Temporal Distribution, ...</td>
<td>DEVELOPMENT IN ILYANASSA ...Basic Embryology, Gastropods-slugs,conch,snails, Other, ...</td>
</tr>
<tr>
<td>Mediterranean Sea-general</td>
<td>Metabolism &amp; Metab. diseases</td>
</tr>
<tr>
<td>SUPPORT FOR THE OPERATION OF OCEANOGRAPHIC RESEARCHVESSELS ...Black Sea, Marine Biology, Sedimentation, Ships and Cruises, Water Analysis-general, ...</td>
<td>METABOLISM OF NEUROHUMORAL TRANSMITTER SUBSTANCES IN MARINE ANIMALS ...Animal Toxins, Basic Studies, Mech of Transmission, Structural Functions, ...</td>
</tr>
<tr>
<td>MEDITERRANEAN OCEANOGRAPHY</td>
<td></td>
</tr>
<tr>
<td>Conversion, Data Analysis - General, Heat and Radiation Transfer, Ships and Cruises, Surface Environments, ...</td>
<td></td>
</tr>
<tr>
<td>EASTERN ATLANTIC AND MEDITERRANEAN OCEANOGRAPHY ...Acoustical, Atlantic Ocean, Bathymetry, Data Analysis - General, Oceanography-general, ...</td>
<td></td>
</tr>
<tr>
<td>ECOCLOGICAL INVESTIGATIONS OF SOME COMMON MARINE FISHES OFF THE MEDITERRANEAN COAST OF ISRAEL. ...Fish -non-specific, Population Dynamics, Productivity - Food Chain, Range Or Territorial Dist., ...</td>
<td></td>
</tr>
<tr>
<td>OCEAN DYNAMICS SEA AIR INTERACTION MODELS - MEDITERRANEAN ...Acoustical, Hydrodynamics, Model Studies, Surface Environments, Wind-water Interaction, ...</td>
<td></td>
</tr>
<tr>
<td>Mediterranean Sea-other</td>
<td></td>
</tr>
<tr>
<td>THEORETICAL STUDY OF OCEAN TIDES FOR PURPOSES OF WORLDWIDE PREDICTION ...Earth Tides, Forecasting-prediction, Tides, Waves, ...</td>
<td></td>
</tr>
<tr>
<td>Meetings</td>
<td></td>
</tr>
<tr>
<td>WORKSHOP ON EFFECTS OF ATOMIC RADIATION ON OCEANOGRAPHY ...Atomic Bomb, Commercial Radiation, Radiation Effects-non-specific, Radioactivity, ...</td>
<td></td>
</tr>
<tr>
<td>CONFERENCE REPORTS ...Geophysics-general, Marine Biology, Tables, Compilations, Catalogs, ...</td>
<td></td>
</tr>
<tr>
<td>BIOLOGY CONFERENCE SERIES ...Ecology (anim.&quot;) ...Marine Biology, Plant Ecology (non-specific), ...</td>
<td></td>
</tr>
<tr>
<td>SUPPORT OF TRAINING PROGRAMS IN INVERTEBRATE ZOOLOGY AND MARINE BOTANY ...Invertebrates -non-specific, Marine Biology, Marine Environments-general, Marine Plants, Tropical Communities, Fellowships, ...</td>
<td></td>
</tr>
<tr>
<td>A SYMPOSIUM ENTITLED ORGANIC CHEMISTRY OF NATURAL WATERS ...Alaska, Chemical-general, Organic, Organic Matter, Organic-general, Organic-polymer, Organic-polymer-general, Organic-water, Polar Sediments, Water Analysis, Water Chemistry, ...</td>
<td></td>
</tr>
<tr>
<td>COOPERATIVE RESEARCH AND TRAINING PROGRAM IN BIOLOGICAL OCEANOGRAPHY ...Caribbean Sea, Facilities, Marine Biology (non-specific), Ships and Cruises, Training Grants, Fellowships, ...</td>
<td></td>
</tr>
<tr>
<td>SYMPOSIUM ON RESEARCH NEEDS AND PRIORITIES FOR MARINE GEOLOGY OF THE GULF OF MEXICO ...Continental Shelf, Gulf of Mexico, Instrumentation-general, Mechanical Properties, Sedimentation, Structural Studies, ...</td>
<td></td>
</tr>
<tr>
<td>CONFERENCE ON THE FUTURE OF THE U.S. FISHING INDUSTRY ...Commercial Fishing, Fish -non-specific, ...</td>
<td></td>
</tr>
<tr>
<td>SYMPOSIUM ON THE MINERAL RESOURCES OF THE WORLD OCEAN ...Engineering Studies-general, Ocean Mining, Policy Making, Rhode Island, ...</td>
<td></td>
</tr>
<tr>
<td>MARINE SCIENCE STUDIES ...Oceanography-general, ...</td>
<td></td>
</tr>
<tr>
<td>EVALUATION, COORDINATION, AND PLANNING OF PACIFIC SALMON AND STEELHEAD RESEARCH AND MANAGEMENT ACTIVITIES ...Commercial Fishing, Fishery Development - other, Management - other, Rainbow Trout, Steelhead Trout, Salmon -coho, chinook,sockeye, ...</td>
<td></td>
</tr>
<tr>
<td>FISHING GEAR RESEARCH AND DEVELOPMENT ...Commercial Fishing, Fishing Gear, Nets, ...</td>
<td></td>
</tr>
<tr>
<td>Melaniesia</td>
<td></td>
</tr>
<tr>
<td>HEAT FLOW MEASUREMENTS ...Basins, Heat Flow Measurements, Philippines, Ridges, Temperature, ...</td>
<td></td>
</tr>
<tr>
<td>Melanin</td>
<td></td>
</tr>
<tr>
<td>POLYPEPTIDE INTERACTIONS ON A STEL BLE SEASHORE ...Biochemical, Light-catalyzed, Origin of Life, Polypeptides, ...</td>
<td></td>
</tr>
</tbody>
</table>

590
SUBJECT INDEX

Microsphere, Microballoon
BUOYANCY MATERIALS ...Buoyant, Flotational, Materials Used Undersea, Plastic Matrix, Submerged Ships, ...8.0014

Microtechnique
Other
DEVELOPMENT IN ILYANASSA ...Basic Embryology, Gastropods - slugs,conch,snails, Metabolic Inhibitors, ...5.0594

Middle-east-general
BIOLOGY-MIDDLE EAST WATERS ...Cell Cycle, Marine Biology (non-specific), Phenology, Red Sea, Reproductive System, Synchronization, ...6.0029

Military Aspects
AN EXPERIMENTAL AND THEORETICAL STUDY OF THE MARINE AND CONTINENTAL CLIMATES OF POINT CONCEPTION TO THE MORRO BAY REGION OF CALIFORNIA ...California, General Synoptic Observations, Micrometeorology, Shoreline - coastline, ...3.0055
OCEANIC INTERNAL MOTIONS AFFECTING OPERATIONS ...Bermuda, Buoys, Thermal, Water Motion Recorders, Waves-internal, ...2.0115
INVESTIGATION OF NAVAL SHIP FORMS ...Bulkheads, Engineering Studies-other, ...8.0030
OCEAN PRESSURE RESEARCH ...Ordinance, Pressure, Underwater Warfare, ...1.0173
-CEANOGRAPHIC RESEARCH ...Acoustical, Anti-submarine-warfare, California, Temperature, Transmission, ...1.0005

Military Tactics
Anti-submarine-warfare
(U) OCEANIC CRUSTAL AND MANTLE STRUCTURE - ITS ORIGIN AND EFFECT ON EXTERNAL FILES ...Crust, Earth Interior, Earth Magnetism, Ocean Basins, Origin, ...7.0145
OCEAN DYNAMICS IN THE STRAITS OF GIBRALTAR AND ADJACENT AREAS ...Acoustical, Computer Applications, Hydrodynamics, Model Studies, Strait of Gibraltar, Submerged ships, ...1.0141
OCEANOGRAPHIC RESEARCH ...Acoustical, California, Military Aspects, Temperature, Transmission, ...1.0005
PRECISE RADIO NAVIGATION FOR SHIPS ...Moorings, Navigation, Navigation Communication, Technique Development, ...4.0099

Mineral Analysis
USES OF STATISTICAL INFERENCE AND EXPERIMENTAL DESIGN FOR EFFICIENT COLLECTION OF OCEAN DATA ...Data & Statistics Storage, Information Retrieval Methods, Sampling, ...4.0015

Mineral Appraisals
Appraisals-general
PACIFIC SALMON FISHERIES - ECONOMICS OF MANAGEMENT ...Continental Shelf, International, Legal Review, Legal Studies-general, Ocean Mining, Science & Technology, ...10.0006
MARINE HEAVY-EYETALS PRODUCTION INFORMATION, ON WORLDWIDE BASIS ...Beneficiation, Deposits-ore, Documents & Literature, Heavy Elements, Ocean Mining, ...7.0006

Dimensions-distribution
DISTRIBUTION OF HEAVY METALS, WESTERN GULF OF MEXICO ...Apatite, Carbonation, Chemical Reactions, Equilibrium - Chemical, High Pressure Reactor, Reaction-general, Solubility, Sulphate, Sulfite, ...1.0127
MARINE GEOLOGY STUDIES, GULF OF MEXICO-CARIBBEAN REGION ...Distribution, Geology-general, Gulf of Mexico, Ocean Mining, Tectonics-general, ...7.0013
RESOURCES OF THE BERING CONTINENTAL MARGIN ...Bering Sea, Continental Shelf, Geology-general, Ocean History, Ocean Mining, ...7.0016

Minerals
FEASIBILITY STUDY OF THE USE OF ELECTRICAL METHODS FOR DETERMINING SIZE AND SHAPE OF DEPOSITS ...Electric Logging, Instrumental Services, Methodology, Ocean Mining, Technique Development, ...7.0006

Estimates of Reserves
THE ECONOMIC POTENTIAL OF THE MINERAL AND BOTANICAL RESOURCES OF THE U.S. CONTINENTAL SHELF AND SLOPE ...Ag Uses of Nat, resource-other, Continental Shelf, Continental Slope, Ocean Mining, Potential of Deposit, ...7.0011

Potential of Deposit
PETITIONALLY-ECONOMIC SAND AND SILT DEPOSITS IN LAKE ONTARIO, NEW YORK ...Geologic Maps, Lake Ontario, New York, Sands and Gravel, Submerged, ...7.0024
THE ECONOMIC POTENTIAL OF THE MINERAL AND BOTANICAL RESOURCES OF THE U.S. CONTINENTAL SHELF AND SLOPE ...Ag Uses of Nat, resource-other, Continental Shelf, Continental Slope, Estimates of Reserves, Ocean Mining, ...7.0011
JOINT STUDY OF THE CONTINENTAL MARGIN OFF OREGON BY OREGON STATE UNIVERSITY AND THE UNITED STATES GEOLOGICAL SURVEY ...Continental Shelf, Geophysics-general, Mineralogy, Ocean Basins, Oregon, ...7.0046
PUERTO RICO COOP - MONA PASSAGE ...Continental Shelves, Land Economics, Mine Waste, Oil - Petroleum, Puerto Rico, Sands and Gravel, ...7.0034
MISSISSIPPI DELTA ...Deltas, Distribution, Heavy Minerals, Mississippi, Ocean Mining, Sedimentary History, ...7.0014
OREGON-CALIFORNIA BLACK SANDS ...Beaches, California, Heavy Mineral Analysis, Heavy Minerals, Mineralogy, Ocean Mining, ...7.0015
REWARD PENINSULA NEARSHORE ...Bering Sea, Heavy Minerals, Sea Level Changes, Submerged, Tectonics-general, ...7.0017
WORLD WIDE MARINE MINERAL RESOURCES ...Continental Shelf, Continental Slope, Economics, Mapping, Resource Inventories, ...4.0056
ANALYSIS AND INTERPRETATION OF DATA FROM GEOPHYSICAL AND PHOTOGRAM SURVEY OF CORONADO BANK, OFF SOUTHERN CALIFORNIA ...California, Ocean Mining, Phosphate, Photography, ...7.0004
GEODETICAL, GEOPHYSICAL, OCEANOGRAPHIC, AND EOCOLOGICAL DATA ON WORLDWIDE BASIS, ON AREAS OF HEAVY METALS POTENTIAL ...California, Continental Shelf, Drilling and Coring, Oregon, Placer, ...7.0005

Resource Inventories
MARINE MINERAL RESOURCES OF THE NORTH CAROLINA CONTINENTAL MARGIN ...Continental Shelf, North Carolina, ...7.0026
WORLD WIDE MARINE MINERAL RESOURCES ...Continental Shelf, Continental Slope, Economics, Mapping, Potential of Deposit, ...4.0056

Mineralogy
MINERALOGICAL CONTROLS ON THE CHEMICAL COMPOSITION OF OCEAN WATER ...Chemical Reactions, Clay Minerals-general, Discriptions of Minerals, Mexico, Silicate-general, ...1.0118

Minerals
Apatite Series
Apatite-general
RESEARCH ON THE PHYSICAL CHEMISTRY OF CHEMICAL REACTIONS IN SEA WATER ...Acids, Carbonate, Bicarbonate, Chemical Reactions, Equilibrium - Chemical, High Pressure Reactor, Reaction-general, Solubility, Sulphate, Sulfite, ...1.0127

Carbonates
Aragonite
ALTERATION OF MINERALS ...Chemistry, Mineralogy, Saline Water Systems, Silicates, Solution Chemistry, ...7.0056

593
Minerals

Calcite

Stable Isotope Fractionation in Echinoderm Calcite ...Animal Taxonomy, Biogeochemical Process, Carbon, Living Organisms, Marine Organisms, Oxygen, Sea Feathers, sea Lily, Sea Urchins & Other Echinoderms, ...7.0085

Clay Minerals

Clay Minerals-General

Mineralogical Controls on the Chemical Composition of Ocean Water ...Chemical Reactions, Clay Minerals, Dissolutions of Minerals, Mexico, Mineralogy, Silicate-Gereral, ...1.0118

Marine Geology of the California Continen Tal Borderland with Emphasis on Future Economic Development and General Resource Value ...California, Continental Shelf, Heavy Elements, Mineralogy, Ocean Mining, ...7.0010

The Extraction of Potassium from Fresh and Saline Waters by Clay Minerals ...Adsorption Capacity, Extraction, Potassium, Water Analysis, ...1.0096

Recently Precipitated Dolomites and Associated Minerals ...Crystal Growth, Dolomite, Mineral Type, Phase Relationships, Precipitates, Silicate-General, ...7.0096

Illite

Paleosalinity Determination by the Boron in I l lite Method ...Boron, Illinois, Intertidal - Ctonate Water, Salinity, Swamps-marshes, ...7.0238

Kaolinite

Kaolinite As Related to Environment of Deposition ...Diagenesis, Environment, Genetic Relationships, Mineral Type, ...7.0239

Silicate-General

Mineralogical Controls on the Chemical Composition of Ocean Water ...Chemical Reactions, Clay Minerals-General, Dissolutions of Minerals, Mexico, Mineralogy, ...1.0118

Solution-Silicate Reactions and Equilibria ...Chemical Reactions, Chemistry, Equilibrium - Chemical, Groundwater, Reaction-general, Solution, Solution Chemistry, ...1.0097

Recently Precipitated Dolomites and Associated Minerals ...Clay Minerals-General, Crystal Growth, Dolomite, Mineral Type, Phase Relationships, Precipitates, ...7.0096

Silicates

Alteration of Minerals ...Aragonite, Chemistry, Mineralogy, Saline Water Systems, Solution Chemistry, ...7.0056

Quartz

Precision Quartz Capacitance Pressure Transducers ...Capacitance, Pressure, Technique Development, Transducers, ...8.0121

Mississippi

Mississippi Delta ...Deltas, Distribution, Heavy Minerals, Ocean Mining, Potential of Deposit, Sedimentary History, ...7.0014

Mississippi River

A Study of Colinform Bacteria and Escherichia Coli on Polluted and Unpolluted Oyster Bottoms of Mississippi ...Coliforms (non-specific), Identification, Sampling, Sewage, Vertical Distribution, ...5.0465

Environmental of Deposition of Argillaceous Sediments ...Adsorption Capacity, Boron, Chemistry, Clays, Deltas, ...7.0240

Mixing


Columbia River Effects in the Northeast Pacific ...Red Load, Benthonic-bottom, Columbia River, Ocean Waves - Currents, Ocean Fronts, ...2.0065

Air/Sea Interaction Study ...Convection, Profiles, Thermal, Thermocline, Waves, ...2.0114

Circulation Studies ...Circulation-general, Currents-ocean, Gulf of Mexico, Hydrodynamics, Pacific Ocean-east, ...2.0042

Physical Oceanography ...Convection, Hawaii, Heat and Radiation Transfer, Thermal, Wind-water Interaction, ...3.0034

Light Isotope Studies ...Chemical Reactions, Circulation-general, Deuterium, Isotope Tracer-other, Oxygen, Particle-gas Transfer, ...1.0077

The Contribution of Advection and Local Heating to the Maintenance of the Thermal Structure in the North Pacific Ocean ...Circulation-general, Convection, Heat and Radiation Transfer, Pacific Ocean-north, Thermal, ...1.0183

Ocean-Atmosphere Studies with Stable Isotopes and Dissolved Gases ...Air-sea Boundary-general, Equilibrium - Chemical, Gases, Ocean Fronts, Particle-gas Transfer, Tracers, ...3.0005

Tritium as a Tracer for Mixing Processes ...Currents-ocean, Radioactivity-general, Salinity, Tracers, Tritium, ...2.0053

Study of Oceanic Turbulence ...Energy, Hydrodynamics, Subsurface Environments, Turbulence - Sea Water, Water Motion, ...3.0055

Circulation Around Oceanic Islands ...Circulation-General, Density, Islands, Thermodynamics, Waves-internal, Wind-water Interaction, ...2.0010

Exchange Meteorologist with Japanese Antarctic Research Expedition ...Air-sea Boundary-general, Antarctic Ocean, General Synoptic Observations, Radiosonde, Sea Ice, ...3.0013

Chemical Features of the Subarctic Boundary in the Northern Pacific Ocean ...Carbon Dioxide, Circulation-general, Gases, Ocean Fronts, Pacific Ocean-north, Sub-polar, ...1.0125

Optical Oceanography in Florida Bay, Florida Straits and Bahama Bank ...Distribution, Optical, Optical Devices, Sedimentation, Wind-water Interaction, ...1.0163

Experimental Study of the Interrelations Between Wind-Wave Properties ...Hydrodynamics, Pressure, Turbulence - Sea Water, Waves, Wind-water Interaction, ...2.0123

Research in Oceanic Physics ...Atlantic Ocean-south, Convection, Oceanic Fronts, Thermodynamics, Wind-water Interaction, ...2.0059

Study of Stability and Shear in the Top 500 Meters of the Ocean ...California Current, Density, Water Motion, Water Motion Recorders, ...1.0126

Systematic Studies of Antarctic Copepods ...Animal Taxonomy, Antarctic Ocean, Copepods, ...5.0461

Physical Oceanography in Oregon Shelf and Slope Waters ...Continental Shelf, Continental Slope, Hydrodynamics, Oregon, Thermodynamics, ...2.0074

The Institute for the Development of Riverine and Estuarine Systems (IDRES) ...Delaware River, Estuaries, Waste Disposal-General, ...12.0043

Natural Radiocarbon Measurements ...Carbon-14, Facilities, Oceanic Fronts, Pacific Ocean-general, Radioactivity, ...1.0084

Chemical Properties of Sea Water and Their Use in Studies of Water Masses and Mixing ...Chemical Reactions, Gases, Oceanic Fronts, Pacific Ocean-east, Water Analysis, ...1.0126

Characteristics, Causes, and Prediction of Upwelling Water Masses off Oregon ...Forecasting-prediction, Oceanic Fronts, Oregon, Pacific Ocean-east, Water Motion Recorders, ...2.0062

Organic Matter ...Atlantic Ocean-general, Oceanic Fronts, Organics, Oxygen, Temperature, Ships and Cruises, ...1.0111

Mixing Processes Influencing the Oceanic Environment ...Currents-ocean, Density, Model Studies, Moorings, Underwater-construction, ...2.0085

Chemical Studies of the Oceanic Environment ...Chemical Reactions, Marine Biology, Oceanic Fronts, Pacific Ocean-east, Trace Elements, Water Analysis-General, ...1.0136

Fine Structure Feature of the Temperature and Salinity at Water Mass Boundaries in Pacific
### Model Studies

- **BOTTOM CURRENTS AND DEEP SEA TIDES**...Abyssal, Acoustical, Benthonic-bottom, Currents-other, Finite Differences, Tides...6.0014

- **CIRCULATION STUDIES**...Circulation-general, Currents-ocean, Gulf of Mexico, Thermal, Tropical Cyclones...2.0044

- **OCEAN CIRCULATION**...California Current, Circulation-general, Forecasting-prediction, Hydrodynamics, Submarine Canyons...2.0002

- **ACOUSTIC SCATTERING**...Acoustical, Interfaces, Reflection, Scattering, Surface Environments...7.0034

- **HYDRODYNAMIC EFFECTS OF SUBMERGED BODY**...Air-sea Boundary-general, Fluid Dynamics, Theoretical Analysis, Water Tunnels Tables...8.0017

- **LOCALIZED SCOUR AROUND PLING SUBJECTED TO FIRST-ORDER STOKIAN WAVES**...Erosion Control, Scouring, Water Tunnels Tables, Wave Action, Waves in Liquids...7.0043

- **AN ANALYTICAL AND EXPERIMENTAL STUDY OF BED FORMS UNDER WATER WAVES**...Channel Roughness, Friction, Geomorphology-topography, Water Tunnels Tables, Wave Action, Waves...6.0110

- **BARRERS POINT HARBOR MODEL STUDY**...Harbors, Inflow, Stresses...7.0001

- **PROJECT EVAPORATION**...Data Analysis - General, Evaporation, Oklahoma, Waves...5.0031

- **INVESTIGATION OF THE CIRCULATION OF LAKE SUPERIOR OR LAKE SUPERIOR, LAKE Superior, Stratified Flow, Temperature, Thermodynamics, Water Motion...2.0064

- **UTILIZATION OF PHYSICAL AND MATHEMATICAL MODELING IN OCEAN CURRENT STUDIES RESEARCH AND MANAGEMENT**...Environmental Effects-geologic, Estuaries, Management, Mathematical Analysis, Shoreline - Coastline...4.0084

- **HORIZONTAL DISPERSION IN SHALLOW ESTUARIES OF IRREGULAR SHAPE**...Circulation - water, Dispersion - water, Estuaries, Lake Michigan, Water Quality-general...2.0044

- **EXPERIMENTAL AND THEORETICAL STUDY OF THE HYDRODYNAMICS OF DISPERSION IN RIVERS AND ESTUARIES**...Dispersion - water, Estuaries, Flow Characteristics - water, Streams, Water Motion...2.0067

- **DYNAMIC MODEL STUDY OF LAKE ERIE**...Hydraulics-general, Inflow, Lake Erie, Synthetic Hydrology...4.0075

- **EUTROPHICATION OF TIDAL WATER**...Environmental Effects-ecologic, Estuaries, Great Lakes-general, Water Quality Control-general...1.0009

- **GREAT LAKES RESEARCH - HARBOR CURRENTS IN LAKE ERIE**...Beach, Development, Energy, General Transport Effects, Lakes-general, Sedimentation...7.0124

- **GREAT LAKES RESEARCH - HARBOR CURRENTS**...Great Lakes-general, Harbors, Ocean Currents-other, Pressure-density, Water Level Fluctuation, Wind-water Interaction...2.0074

- **MACHINES AND MATERIALS**...Computer Applications, Engineering Studies-other, Fountains-general, Soil Dynamics, Waves...6.0044

- **SECOND HAND PRICES FOR TANKERS**...Economics, Price & Value, Tankers, Trends-projections...4.0014

- **AN OPTIMUM LOADING SEQUENCE FOR CONTAINERitates**...Computer Applications, Engineering Studies-other, Freight, Loading/unloading, Packing...8.0033

- **CONTROL OF SUPERCONDUCTING MACHINES FOR SHIP PROPULSION**...Engineering Studies-general, Marine Propulsion, Mathematical Analysis, Operational Aspect...8.0030

- **DIAGENESIS IN SEDIMENTS**...Cement Origin, Cementing Material, Diagenesis, Por Fluids, Textures-structures...7.0192

- **THE APPLICATION OF MATHEMATICAL METHODS IN CERTAIN GEODRAPHIC OCEANOGRAPHS**...Mathematical Analysis, Oceanography-general...4.0075

### SUBJECT INDEX

- **POLLUTION STUDY OF THE VENICE DISTRICT CANAL**...California, Canals, Synthetic Hydrology, Water Quality-general...6.0141

- **PROJECT AQUA-MAP**...Development of AERIAL PHOTOGRAPHY AS AN AID TO WATER QUALITY MANAGEMENT...Aerial Photography, Effluents-waste Water, Management, New York, Pollution-other...4.0107

- **AN ECONOMIC EVALUATION OF WATER POLLUTION CONTROL, YAGUINA BAY, ORE**...Alternative Planning, Bays, Benefits-cost Analysis, Oregon, Systems Analysis, Water Quality Control-general...6.0173

- **OCEAN DYNAMICS SEA AIR INTERACTION MODELS - MEDITERRANEAN**...Acoustical, Hydrodynamics, Mediterranean Sea-general, Surface Environments, Wind-water Interaction...3.0002

- **OCEAN CURRENTS IN THE STRAITS OF GIBRALTAR AND ADJACENT AREAS**...Acoustical, Anti-submarine-warfare, Computer Applications, Hydrodynamics, Strait of Gibraltar, Submerged Ships...1.0014

- **OCEAN DYNAMICS - OCEANOGRAPHIC ANALYSES AND FORECASTING MODELS**...Acoustical, Air-sea Boundary-general, Hydrodynamics, Surface Environments, Temperature...1.0044

- **OCEANOGRAPHIC RESEARCH-INVESTIGATIONS IN SHALLOW WATER**...Acoustical, Environmental Effects-geologic, Salinity, Thermal, Water Motion...1.0009

- **INTERNAL WAVE STUDIES**...Acoustical, Refraction, Scattering, Surface Environments, Waves-interaction...1.0021

- **ARCTIC UNDERSEA RESEARCH, PHYSICAL AND CHEMICAL PROPERTIES OF SEA ICE**...Arctic Ocean, Environmental Effects-geologic, Ice Properties-general, Sea Ice...3.0076

- **NUMERICAL WAVE PREDICTION**...Development of Models, Forecasting-prediction, Numerical Analysis-other, Waves...2.0104

- **ADVANCED TECHNOLOGY AND BOTTOM PREDICTIONS**...Acoustical, Benthonic-bottom, Data Acquisition, Data Analysis - General, Forecasting-prediction, Seismic Studies...1.0045

- **OCEAN CURRENTS AND CIRCULATION**...Circulation-general, Currents-ocean, Data Acquisition, Energy, Temperature...3.0015

- **SHALLOW WATER ACOUSTIC STUDIES**...Acoustical...1.0042

- **AMBIENT NOISE RESEARCH STUDIES**...Acoustical, Depth, Noise, Spectra...1.0023

- **ENVIRONMENTAL SUPPORT OF SONAR DESIGN**...Acoustical, Liquids, Ships and Cruises, Transmission, Water Properties-general...1.0015

- **GENERAL COASTAL INLET STUDIES**...Coastal Engineering-other, Coastlines-shorelines, Discharge, Synthetic Hydrology...7.0125

- **GREAT LAKES RESEARCH - COASTAL AREA SEDIMENTATION**...Beach, Development, Energy, General Transport Effects, Great Lakes-general, Sedimentation...7.0124

- **GREAT LAKES RESEARCH - WATER-LEVEL DISTURBANCES**...Lake Erie, Lake Michigan, Sea Level Variations, Shores, Water Level Fluctuation...2.0086

- **GREAT LAKES RESEARCH - HARBOUR CURRENTS**...Great Lakes-general, Harbors, Ocean Currents-other, Pressure-density, Water Level Fluctuation, Wind-water Interaction...2.0074

- **MECHANICS OF SAND MOVEMENT BY WAVES**...Ocean Waves - Currents, Shoreline Structures, Size, Wave Motion in Fluids-other, Waves...7.0021

- **UNSTEADY FLOW AND SALINE INTRUSION IN ESTUARIES**...Channels, Computer Applications, Morphology-general, Saline Water Intrusion, Unsteady Flow...2.0066

- **NUMERICAL SIMULATION OF HYDRODYNAMIC PHENOMENA BY DIGITAL COMPUTER**...Groundwater, Open Channel Flow, Porous Media - Flow Through, Subsurface Flow, Waves...4.0083

- **LABORATORY MODEL STUDIES OF PENETRATION INTO A SIMULATED COHESIONLESS DETRITUS**...Coring and Dredging, Gravel, Mechanical Properties, Soil Sampling, Technique Development...8.0025

- **FEASIBILITY STUDY ON HORIZONTAL TEST TANK FOR PREREQUISITE STUDIES**...Oceangoing, Porous Media - Flow Through, Subsurface Flow, Waves...4.0083

- **LABORATORY MODEL STUDIES ON DISTURBANCE OF CERTAIN DETRITUS BY PENETRATION**...Disturbed/undisturbed...8.0025

- **LABORATORY MODEL STUDIES ON DISTURBANCE OF CERTAIN DETRITUS BY PENETRATION**...Disturbed/undisturbed...8.0025
LABORATORY MODEL STUDIES ON PRESSURE DISTRIBUTION IN DETRITS DURING PENETRATION ...Laboratory Analysis, Mechanical Properties, Placer, Pressure, Soil Loads, ...5.0253

FINITE ELEMENT TECHNIQUES ...Distribution, Finite Differences, Mathematical Analysis, Mechanical Properties, Rock Mechanics, ...5.0254

INVESTIGATE FACTORS DETERMINING DISTRIBUTION OF PHYSICAL AND CHEMICAL PROPERTIES OF THE PACIFIC OCEAN ...Currents-ocean, Hawaii, Mathematical Analysis, Oceanic Fronts, Pacific Ocean-general, ...5.0488

PHYSICAL OCEANOGRAPHY ...Buoy, Instrumentation-general, Pacific Ocean-north, ...1.0166

POPULATION DYNAMICS (BIOMETRIC) OF EXPLOITED FISH GROUPS OF THE NORTH PACIFIC OCEAN AND PACIFIC COAST ...Marine Biology, Meteorological Studies, Number Or Density, Pacific Ocean-north, Population Dynamics, ...5.0417

MULTISPECIES FISHERIES MODELS ...California, Commercial Fishing, Economics, Oceanic, Pelagic, Pacific Ocean-east, Production & Processing, ...1.0065

DISPOSAL TO MARINE WATERS ...Circulation-general, Monitoring (long Term Studies), Pollution - Effects of, Pollution Sources-general, Shoreline - Coastline, ...5.0377

COASTAL DIFFUSION OF POLLUTANTS ...Currents-other, Ocean, Oregon, Outlet, Pulp and Paper Wastes, ...5.0174

ICERBERG DRIFT AND DETERIORATION ...Circulation-general, Icebergs, Ocean Currents-other, ...3.0076

EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS ...Diet, Estuaries, Mode of Action -animal, Pollution - Effects of, Sevin, ...5.0919

Models

Math Models

ECONOMIC ANALYSIS OF THE MARKET STRUCTURE OF THE COMMERCIAL FISHING INDUSTRY IN THE NORTHEAST ...Commercial Fishing, Fish & Shellfish, Market Structure, Marketing, Northeast, Productivity (agricultural), ...5.0151

Mollusks

Chitons

PRIMARY STRUCTURE OF INVERTEBRATE HEMOGLOBINS ...Biological, Chemical, Configuration, Gastropods - slugs,conch,snails, Globin - incl. myoglobin, ...5.0610

Clams

HISTOCHEMICAL STUDIES OF MUCOSUBSTANCES IN THE MANTLE OF THE NORTHERN QUAHOG, MERCIERIANA MERCERIANA ...Calcification, Derivatives, Histochemistry - Cytochem, Mucopolysaccharides, Mucoproteins, ...5.0455

CYTOTOXICITY OF SPECIES OF RELATED PELECYPOD MOLLUSKS ...Animal Taxonomy, Derivatives, Invertebrate Anatomy, Oysters, Selection & Breeding, ...5.0413

ECOLOGY OF MARINE BIVALVE MOLLUSCAN LARVAE ...Behavioral Ecology, Fouling, Population Dynamics, Productivity - Food Chain, Vertical Distribution, ...5.0370

DESIGN AND CONSTRUCTION OF BARGE AND CLAM DREDGE FOR SURVEY OF FLORIDA'S COMMERCIAL CLAMS ...Commercial Fishing, Flurida, Habitat Studies, Other-design-and-construction, ...5.0259

PRELIMINARY MODIFICATIONS AND CONTROL OF NATURAL GROWING AREA ENVIRONMENTS ...Captivity, Rearing, Growth Rate, Mineral Content -water, Oysters, Predation, ...5.0495

SURVEY OF A POTENTIAL HARD CLAM FISHERY ...Commercial Fishing, Corting and Dredging, Estuaries, Georgia, Spawning & Settling Sites, ...5.0420

ENTEROVIRUSES IN DEPURATED HARD CLAMS, MERCIERIA MERCERIANA ...Detection, Enteroviruses of Humans, Microbiological Analysis, Sanitation, ...5.0057

EVALUATION OF PARAMETERS OF OPERATION ...Sanitation, ...5.0058

THE POPULATION ECOLOGY OF GEMMA GEMMA (PELECYPODA, VENERIDAE), A DOMINANT SPECIES IN BARNSTABLE HARBOR, MASS ...Habitats, Mass, Population Dynamics, ...5.0460

SHELLFISHERIES RESEARCH ...Commercial Fishing, Crabs, Life History Studies, Number Or Density, Oysters, ...5.0383

THE DEVELOPMENT OF HATCHERY TECHNIQUES TO AID IN THE PRODUCTION OF ECONOMIC MOLLUSKS ...Aquaculture & Fish-farming, Captive Rearing, Fish Supply, Oysters, Spawning & Netting Sites, ...5.0483

REAR AND DESCRIBE LARVAE OF BIVALVES ...Captive Rearing, Developmental Physiology, Freshwater, Mollusks, Scallop, Invertebrate Culture, ...5.0507

PHYSIOLOGY AND BEHAVIOR OF LARVAE (PHYOECOLOGY OF SHELLFISH PROGRAM) ...Basic Embryology, Behavior, Maturity & Growth Stages, Oysters, Ph, Acidity -water, ...5.0373

ECOLOGY AND DISTRIBUTION OF OYSTERS AND CLAMS ...Animal Dist. (non-specific), Oysters, Ponds, Productivity - Food Chain, ...5.0444

SHELLFISH EXPLORATIONS ...Benthic Fauna, Commercial Fishing, Mark, Tag Or Capture -other, Population Dynamics, ...5.0514

SEA CLAM EXPLORATIONS ...Animal Dist. (non-specific), Atlantic Ocean-north, Commercial Fishing, Population Dynamics, ...5.0456

SURF CLAM BIOLOGY ...Age, Growth Rate, Life History Studies, Reproductive System, Tag, ...5.0449

HISTOPATHOLOGIC EFFECTS OF POLLUTANTS ON CELLS AND TISSUES OF MARINE INVERTEBRATES ...Contamination - Water, Invertebrate Pathology, Pathology, Pollution - Effects of, Pollution Sources-other, ...5.0497

PURIFICATION OF HARD CLAMS FROM POLLUTED WATERS ...Animal Viruses (non-specific), Contamination - Water, Estuaries, Intestinal Bacteria, New Jersey, ...5.0647

ORGANISMS RESPONSIBLE FOR TOXICITY OF ALASKAN CLAMS ...Alaska, Biological Pollutants -general, Food Spoilage Detection, Microbiological, Pollutants-general, ...5.0344

MICROBIOLOGY OF ESTUARINE AND SHELLFISH POLLUTION ...Biotic Indicators, Estuaries, Oysters, Pollution Effects, Sanitation, Waste Water Treatment-general, ...5.0162

Freshwater Mussels, Scallops

MICROBIOLOGICAL INVESTIGATIONS OF THRESHOLD PANELS ...Catabolism and Degradation, Degradation, Marine Bacteria, Marine Fungi (non-specific), Wood, Wood Preservatives-non-specific, ...5.0243

GROWTH LAYERING IN BIVALVED MOLLUSKS - AN AID IN PALEOBIOGEOGRAPHIC INTERPRETATION ...Animal Taxonomy, Biological Rhythms, Environmental Physiology, Growth Rate, Invertebrate Physiology, ...5.0355

MORPHOLOGY, PHYSIOLOGY AND ECOLOGY OF MARINE LAMELLIBRANCHS ...Animal Taxonomy, Basic Embryology, Behavior, Invertebrate Anatomy, ...5.0479

SYSTEMATICS MORPHOLOGY AND ECOLOGY OF THE GENUS ERVILIA (MOLLUSCA: PELECYPODA) IN THE WESTERN ATLANTIC ...Animal Taxonomy, Atlantic Ocean, General Ecology, Invertebrate Anatomy, ...5.0458

REAR AND DESCRIBE LARVAE OF BIVALVES ...Captive Rearing, Clams, Developmental Physiology, Invertebrate Culture, ...5.0507

SYSTEMATIC REVISION OF THE FAMILY PERIPLOMATIDAE ...Animal Taxonomy, Nomenclature, Classification, ...5.0401

MARINE INVERTEBRATE EXPLORATIONS ...Commercial Fishing, Pacific Ocean-general, Shrimp - Common, Temporal Distribution, Vertical Distribution, ...5.0723

BIOLICAL STUDIES OF NORTHWEST ATLANTIC GROUNDFISH ...Atlantic Ocean-north, Codfishes, Hake, Righteye Flounders, Rockfish, Scorpaenfish, ...5.0104

THE PROCES OF DEMINERALIZATION-BORING IN BIVALVES - Calcification, Derivatives, Invertebrate Anatomy, Invertebrate Physiology, ...5.0366

EPIZOOTICS IN EXPERIMENTAL MARINE SHELLFISH POPULATIONS ...Epizootic, Mortality Rates, Oysters, Pathology, ...5.0520

Gastropods - slugs,conch,snails

RESEARCH ON INDO-WEST PACIFIC MARINE MOLLUSKS OF THE FAMILY CONIDAE ...Animal Taxonomy, Indian Ocean, General, Invertebrate Anatomy, Number Or Density, ...5.0517

597
**Mollusks**

**SUBJECT INDEX**

**CONTINUED STUDIES OF THE SYSTEMATICS AND ZOOGEOGRAPHY OF WESTERN ATLANTIC CAECIDAE** ...Animal Taxonomy, Alliances, Oceanic, Derivatives, Invertebrate Anatomy, Publications -other, ...5.0596

**DEVELOPMENT IN ILYANASSA** ...Basic Embryology, Metabolism, Invertebrates, Other, ...5.0594

**IONIC REGULATION IN THE QUEEN CONCH, STROMBUS GIGAS LINNAEUS** ...Blood Plasma and Serum, Digestive System, Osmoregulation, ...5.0407

**ECOLOGY OF SKELETAL PLANKTON** ...Animal Taxonomy, Collections, Flagellates, Paleoenvironments, Temporal Distribution, Vertical Distribution, ...5.0597

**POPULATION STUDIES ON INTERTIDAL INVERTEBRATES** ...Australia, Growth Rate, Longevity, Oregon, Starfishes, ...5.1021

**PREDATOR-FREY RELATIONSHIPS BETWEEN ECHINODERMS AND MOLLUSCS** ...Behavior, Behavioral Ecology, Predation, Starfishes, ...5.0531

**ECOLOGY OF PLANKTONIC FORAMINIFERA AND RELATED STUDIES.** Derivatives, Flagellates, Foraminifera, Planktonic Sampling, Vertical Distribution, ...5.0812

**NUCLEAR ACID AND PROTEIN SYNTHESIS DURING OOGENESIS** ...Autoradiography, Basic Embryology, Gene Action, Lactogens, Marine Segmentedworm, Reproductive System, ...5.1024

**POPULATION GENETICS AND LARVAL ECOLOGY OF HAWAIIAN LITTORINA** ...Derivatives, Hawaii, Maturity & Growth Stages, Polymorphism, ...5.0429

**CUES INVOLVED IN VERTICAL MOVEMENT AND STATIC ORIENTATION OF GASTROPODS** ...Behavior, Invertebrate Physiology, Light, -other, Locomotion, ...5.0462

**CONTINUED STUDIES ON THE INFLUENCE OF THE EGG CORTEX ON THE DEVELOPMENT OF THE MOLLUSCAN EMBRYO** ...Basic Embryology, Differentiation Mechanism, Octopus, Squid, Cuttlefish, ...Plasma Membrane, Surface Properties, -other, ...5.0423

**SYMBIOSIS BETWEEN MARINE ALGAE AND INVERTEBRATES** ...Photosynthetically Active, Symbiosis, Zoanthella, ...5.0730

**INVESTIGATIONS OF THE INDUCING CAPACITY OF THE POLAR LOBE IN THE DEVELOPMENT OF THE MARINE Gastropod, ILYANASSA OBSOLETA** ...Developmental Physiology, Invertebrate Physiology, ...5.0417

**DISTRIBUTION AND ABUNDANCE OF OYSTER DRILLS (ULRASPINX CINEREA) IN THE JAMES RIVER, VIRGINIA** ...Aquatecology, Number Or Density, streams, Vertical Distribution, Virginia, ...5.0508

**ULTRASTRUCTURE OF EARLY CLEAVAGE STAGES IN THE EGG OF LYMNAEA SP** ...Basic Embryology, Cell Cycle, Electron Microscopy, Invertebrate Anatomy, Microtubules, ...5.0590

**METHODS OF CONTROL OF PREDATORS AND COMPETITORS (PREDATOR CONTROL PROGRAM)** ...Competition, Control of Nuisance Species, Oysters, Predation, ...5.0378

**PLANKTON AND BENTHIC COMMUNITIES OF THE GREAT LAKES** ...Aquatecology, Benthic Organisms, non-specif, Lake Erie, Lactogens, Marine Segmentedworm, Plankton (non-specific), ...5.0801

**NITROGEN METABOLISM IN MOLLUSCS** ...Biochemical, Evolutionary Studies-general, Metabolism, Metabolism (intracellular), Nitrogen, ...5.0506

**DEMINALIZATION-BORING MECHANISMS OF MOLLUSCS** ...Calcification, Invertebrate Anatomy, Invertebrate Physiology, Metabolism, ...5.0459

**PHYSIOLOGICAL VARIATION AND ECOLOGY OF MOLLUSCS** ...Energy Budgets, -stabilome, Population Dynamics, Reproductive System, Respiratory System, ...5.0472

**PRIMARY STRUCTURE OF INVERTEBRATE HEMOCYTOGLOBINS** ...Biochemical, Chitons, Configuration, Globin-incl. myoglobin, ...5.0610

**STUDIES IN MICRONEUROPHYSIOLOGY** ...Barnacles, Brain, Contraction and Relaxation, Musculoseletal System, ...5.0362

**NEURAL MECHANISMS OF LEARNING AND BEHAVIOR** ...Behavior, Brain, Learning and Retention, Mech of Transmis., ...5.0485

**Mollusks -non-specific & Other**

**FREEZING AND DRYING OF LIVING CELLS** ...Animal Nematodes, non-specific, Cell Injury and Autolysis, Cell. env. (non-specific & Ot.), Freeze-dry Techniques, Tissue Techniques, ...5.0540

**SHELLFISH EMBRYOLOGY AND LARVAE DEVELOPMENT STUDY** ...Basic Embryology, Captive Rearing, Crustacea -non-specific, Training Grants, Followships, ...5.0548

**SHELLFISHERIES** ...Censusing, Commercial Fishing, Crustacea -non-specific, Legislation, ...5.0402

**COLLECTION AND SURVEY OF NORTH CAROLINA MARINE AND ESTUARINE MOLLUSCA** ...Collections, Estuaries, North Carolina, Survey Studies, ...5.0400

**A NON-DESTRUCTIVE METHOD FOR ESTIMATING POPULATION DENSITY AND DISTANCE TO NEAREST NEIGHBOR FOR ESTUARINE MOLLUSCS** ...Aquatic Ecology, Estuaries, Number Or Density, Population Dynamics, Range Or Territorial Dist., ...5.0439

**EARLY LIFE OF BOREAL FOOD FISH AND SHELLFISH** ...Animal Taxonomy, Fish -non-specific, Life History Studies, Mortality Rates, ...5.0139

**A BIBLIOGRAPHY OF THE MARINE MOLLUSKS OF THE INDO-PACIFIC REGION** ...Animal Taxonomy, Asia, Bibliography, Computer Methods -general, ...5.0398

**SYSTEMATIC STUDIES ON MOLLUSKS FROM WALTERS SHOALS, INDIAN OCEAN** ...Animal Taxonomy, Collections, Ethnobotany, Indian Ocean, ...5.0402

**ATLAS OF MARINE FAUNA** ...Atlantic Ocean-north, Crustacea -non-specific, Fish -non-specific, Handbooks, ...5.0101

**PHYSICAL AND CHEMICAL CHARACTERISTICS OF THE UPPER CHESAPEAKE BAY** ...Chenagial, Chesapeake Bay, Crustacea -non-specific, Environmental Ecology, Physical-general, ...5.0159

**CALCIFICATION MECHANISMS IN MARINE ORGANISMS** ...Algae -General,Calcification, Marine Plants, ...5.1016

**Octopus, Squid, Cuttlefish**

**LEARNING IN OCTOPUS** ...Behavior, Learning and Retention, Travel Grants, ...5.0491

**CONTINUED STUDIES ON THE INFLUENCE OF THE EGG CORTEX ON THE DEVELOPMENT OF THE MOLLUSCAN EMBRYO** ...Basic Embryology, Differentiation Mechanism, Octopus, Squid, Cuttlefish, ...Plasma Membrane, Surface Properties, -other, ...5.0423

**SYSTEMATICS AND ZOOGEOGRAPHY OF ANTARCTIC CEPHALOPODS** ...Animal Taxonomy, Antarctic Ocean, Australian, Publications -other, ...5.0412

**PHYSICAL AND RADIOCHEMICAL CHEMISTRY OF OCEAN SOLUTIONS** ...Chemical Reactions, Pacific Ocean-north, Radioactive Fallout, Radioactivity-general, Tracers, ...5.0433

**THE CEPHALOPODS OF THE CENTRAL PACIFIC** ...Number Or Density, ...5.0399

**THE SYSTEMATICS AND DISTRIBUTION OF THE WORLD-WIDE SQUID FAMILY BATHYTEUTHIDAE** ...Animal Taxonomy, Life History Studies, Number Or Density, World Wide, ...5.0400

**IONIC PERMEABILITIES OF THE SQUID GIANT AXON** ...Behavior, Basic Physiology, Cellular Physiology, Microelectrodes, Nervous System, Per seability, ...5.0579

**CEPHALOPOD LENS DEVELOPMENT** ...Basic Embryology, Differentiation Mechanism, Lens Proteins, Microtubules, Visual Organs, ...5.0424

**OPERANT OSMOTIC REGULATION IN A MARINE ANIMAL** ...Environmental Resistance, Learning and Retention, Osmoregulation, Water Salinity, ...5.0664

**ION TRANSPORT MECHANISM IN GIANT AXON** ...Active Transport, Atpeae, Cell Free Metabolism, Nervous System, Plasma Membranes, ...5.0309

**Oysters**

**COLUMBIA RIVER STUDIES** ...Columbia River, Contamination ...Water, Invertebrates, Pollution Effects, Radioactivity-general, Reproductive System, ...5.0518

**TEMPERATURE NEEDS FOR GONADAL DEVELOPMENT AND SPAWNING OF DIFFERENT PHYSIOLOGICAL RACES OF THE AMERICAN OYSTER, CRASSOSTREA VIRGINICA** ...Behavior, Biological Rhythms, Environmental Physiology, Reproductive System, Water Temperature-non-specific, ...5.0432

**CYTOXAN FORMATION OF SPECIES OF RELATED PELECYPOD MOLLUSKS** ...Animal Taxonomy, Clams, Derivatives, Invertebrate Anatomy, Selection & Breeding, ...5.0413

**SYSTEMS ENGINEERING AND DEVELOPMENT OF COMMERCIALLY VALUABLE MARINE AND ESTUARINE RESOURCES IN THE DELAWARE AREA** ...Aquaculture & Fish-farming, Commercial Fishing, Delaware, Fish & Shellfish, Quality -non-specific, ...5.0002
<table>
<thead>
<tr>
<th>Subject</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monocots</td>
<td></td>
</tr>
<tr>
<td>Elodea, Waterweed, Thalassia</td>
<td></td>
</tr>
<tr>
<td>ECOLOGICAL STUDIES OF THE SOUTHEASTERN FLORIDA SEA GRASS COMMUNITY - PRIMARY PRODUCTION BY THALASSIA TESTUDINUM KONG - Florida, Primary Productivity, Submerged Plants, Translocation, Tropics...</td>
<td>5.0695</td>
</tr>
<tr>
<td>WATER QUALITY AND FUNGI-NEMATODE-SEA GRASS RELATIONSHIPS - Florida, Habitat Studies, Marine Fungi (non-specific), Nematoda -other, ...</td>
<td>5.0878</td>
</tr>
<tr>
<td>Grasses</td>
<td></td>
</tr>
<tr>
<td>Chlorideae (non-specific &amp; Ot)</td>
<td></td>
</tr>
<tr>
<td>THE ACCUMULATION OF FISSION PRODUCTS BY MARINE FISH AND SHELLFISH - Contamination - Water, Estuaries, Food Chains, Radioactivity-general, Radioecology, ...</td>
<td>6.0167</td>
</tr>
<tr>
<td>FIELD EXPERIMENTS ON THE FLUX OF RADIONUCLIDES THROUGH A SALT MARSH ECO SYSTEM - Georgia, Model Studies, Productivity - Food Chain, Swamps-marshes, Water Cycle, ...</td>
<td>5.0965</td>
</tr>
<tr>
<td>CALORIC STUDIES OF SPARTINA AND THE MARSH CRAB SEASAC RETICULATUM - ...Calorimetry, Crabs, Energy Budgets, Swamps-marshes, ...</td>
<td>5.0380</td>
</tr>
<tr>
<td>Potamogeton, Ruppia, Zoestera</td>
<td></td>
</tr>
<tr>
<td>ARCTIC BIOLOGICAL OCEANOGRAPHY - ...Adaptation, Artic Ocean, Growth and Differentiation, Phytoplankton, Water - Light Qual. &amp; Quant., Water Temperature -other, ...</td>
<td>5.0853</td>
</tr>
<tr>
<td>ECOLOGY AND NITROGEN CYCLE IN A MARINE PLANT COMMUNITY - Bering Sea, Nitrogen, Physiological Ecology, Primary Productivity, Sewage, ...</td>
<td>5.0676</td>
</tr>
<tr>
<td>ECOLOGY OF EELGRASS - Alaska, Bering Sea, Food Webs, Phytoplankton, Primary Productivity, ...</td>
<td>5.0677</td>
</tr>
<tr>
<td>Montana</td>
<td></td>
</tr>
<tr>
<td>MICROPLANKTON OF THE BEARPAW SHALE OF MONTANA AND NORTH DAKOTA - Cretaceous Period, Fine-grained Clastics, Microfossils, North Dakota, planktonic - Floating, ...</td>
<td>5.0249</td>
</tr>
<tr>
<td>Motivation and Instinct</td>
<td></td>
</tr>
<tr>
<td>Emotional States</td>
<td></td>
</tr>
<tr>
<td>Aggression</td>
<td></td>
</tr>
<tr>
<td>MOTIVATIONAL ANALYSIS OF COURTSHIP BEHAVIOR - Behavior, Social Behavior, Tilapia, Cichlids, ...</td>
<td>5.0231</td>
</tr>
<tr>
<td>COMPARATIVE ETHOLOGY OF FISHES OF THE GENUS MACROPODUS - Behavior, Fish -other, Social Behavior, ...</td>
<td>5.0266</td>
</tr>
<tr>
<td>Locomotion</td>
<td></td>
</tr>
<tr>
<td>Orientation</td>
<td></td>
</tr>
<tr>
<td>SPATIAL ORIENTATION OF FISHES AND ITS SENSORY BASES - Behavior, Environmental Physiology, Fish - non-specific, Migration, Sensory Organs, ...</td>
<td>5.0338</td>
</tr>
<tr>
<td>ACOUSTICO-LATERAL FUNCTION IN FISH ORIENTATION AND COMMUNICATION - Auditory, Behavior, Fish - non-specific, Sensory Organs, Signal Detection, ...</td>
<td>5.0289</td>
</tr>
<tr>
<td>DISTANT GOAL ORIENTATION - Biological Rhythms, Birds - non-specific, Locomotion -animal, Magnetic Impulses, Mark, Tag Or Capture -other, ...</td>
<td>5.0169</td>
</tr>
<tr>
<td>ORIENTATION CUES AND PATTERNS OF LONG-DISTANCE TRAVEL OF MARINE TURTLES - Biological Rhythms, Environmental Physiology, Migration, Turtles, Terrapins, Tortoises, ...</td>
<td>5.0102</td>
</tr>
<tr>
<td>ACOUSTICAL COMMUNICATION IN AQUATIC ORGANISMS - Auditory, Biological Rhythms, Central Nervous System, Sound Production, ...</td>
<td>5.0318</td>
</tr>
<tr>
<td>Parental Care</td>
<td></td>
</tr>
<tr>
<td>EXPERIMENTAL STUDIES OF BEHAVIOR IN A CICHLID FISH - Behavior, Sex, Size, Tilapia, Cichlids, ...</td>
<td>5.0232</td>
</tr>
</tbody>
</table>

600
SUBJECT INDEX

Naval Architecture


PRELIMINARY CALCULATION OF THE LIFT AND DRAG ANGLE OF ATTACK FOR SUBMerged HYDROFOILS—Computer Applications, Drag, Lift, ...8.0275


Life-support-system

ENVIRONMENTAL PHYSIOLOGY—Diving and Scuba, Medical Studies, Pressure, Submersibles, Underwater-laboratory, ...

DEEP SEA SUBMERSIBLES—Control-systems, Hull, Marine Propulsion, Mooring, ...8.0029

SUBMARINE MEDICINE—Naval Personnel, Occupational Hazards, Ordnance, Safety, ...

ADVANCED DEEP OCEAN TECHNOLOGY—Engineering Studies-general, Marine Propulsion, Submersibles, ...

Marine Propulsion

ANTI-FOULING MEANS FOR MARINE PROPELLERS—Corrosion Prevention-other, Fouling, Materials Used Underwater, ...

DEEP SUBMERSION SYSTEMS—Buoyant, Flotation, Geomorphology-topography, Navigational Communication, Physical Properties, Submersibles, Welding - Other, ...

AUTOMATIC BOILER CONTROLS—Boilers, Control-systems, Steam, ...

SELF-REGULATING STEAM GENERATOR—Controls, Generators, Steam, ...

HIGH SPEED SHIP PROPULSION—Hydrofoils Crafts, ...

40,000 HORSEPOWER PLANETARY REDUCTION GEAR SYSTEM—Gearing and Power Train, Hydrofoils Crafts, Turbine-other, ...

DEEP SEA SUBMERSIBLES—Control-systems, Hull, Life-support-system, Moorings, Submersibles, ...

VARIABLE PRESSURE WATER TUNNEL RESEARCH—Cavity Flow, Facilities, Hydrofoils Crafts, Shock-vibration, Sound Field, Water Tunnels Tables, ...

HIGH SPEED SHIP PROPULSION—Hydrofoils Crafts, ...

40,000 HORSEPOWER PLANETARY REDUCTION GEAR SYSTEM—Gearing and Power Train, Hydrofoils Crafts, Turbine-other, ...

CONTROL OF SUPERCONDUCTING ELECTRICAL MACHINES —Electrical, Electromechanical Design, Instrumental Services, Superconducting Device, ...

THE INVERSE PROBLEM IN PROPELLER DESIGN—Computer Applications, Rotors-propellers, ...

Hydrofoils Crafts

VARIABLE PRESSURE WATER TUNNEL RESEARCH—Cavity Flow, Facilities, Marine Propulsion, Shock-vibration, Sound Field, Water Tunnels Tables, ...

HIGH SPEED SHIP PROPULSION—Marine Propulsion, ...

40,000 HORSEPOWER PLANETARY REDUCTION GEAR SYSTEM—Gearing and Power Train, Marine Propulsion, Turbine-other, ...

Merchant-ships

HULL DESIGN • MODULAR DECKHOUSE • Bridge, Prefabricated, ...

601
Naval Architecture

SEAKEEPING QUALITIES - MOTIONS AND POWERING PREDICTIONS ...Safety, Ship Resistance Stability, Waves, ...8.0039

FUNCTIONAL AND ECONOMIC ANALYSIS OF SHIP MANEUVERING SYSTEMS ...Control-systems, ...8.0324

SHIP MANEUVERING AND CONTROL ...Control-systems, ...8.0033

CONTRAROTATING PROPELLER IN JUMBOIZED MARINER ...Models, Modification-conversion, Rotors-propellers, ...8.0290

PREDICTION AND PROPULSION HULL CONFIGURATION ...Bow, Marine Propulsion, Stern, ...8.0310

INTERTRANSITIONAL CONTAINERSHIP CONCEPT ...Moderation ...

COMPETITIVE MERCHAND SHIP (BULK) DEVELOPMENTAL PLAN ...Freight, Water Vessel, ...4.0072

STATUTIVE MERCHAND SHIP (BULK) TECHNICAL INNOVATIONS ...Freight, Other-design-and-construction, Water Vessel, ...4.0064

EXPERIMENTAL COMMERCIAL OPERATION OF SAVANNAH ...Nuclear, Other-design-and-construction, Safety, ...12.0035

ADVANCED NUCLEAR CARGO SHIP ...Control-systems, Nuclear, Other-design-and-construction, Safety, ...8.0274

ROLL DISTRIBUTION OF A NUCLEAR CARGO SHIP WITH AND WITHOUT FLUME STABILIZATION ...Nuclear, Other-design-and-construction, Ship Motion & Dynamics, Ship Resistance Stability, ...8.0319

MERCHANT SHIP REACTOR PRELIMINARY SAFETY ANALYSIS ...Nuclear, Safety, ...8.0199

ECONOMICS OF NUCLAER FUEL ...Costs, Fuel, Nuclear, ...4.0178

ADVANCED NUCLEAR CARGO SHIP ...Control-systems, Nuclear, Other-design-and-construction, Safety, ...8.0274

COLLATION OF POWER PLANT STUDIES ...Diesel, Marine Propulsion, ...8.0211

THE FEASIBILITY OF REDUCED CARGO GEAR INSTALLATION ONBOARD BREAK-BULK CARGO SHIPS ...Hull, Loading/unloading, Material Handling Devices, ...8.0035

DIGEST OF THE ADVANCED NUCLEAR CARGO SHIP STUDY ...Freight, Nuclear, Other-design-and-construction, ...8.0271

A STUDY OF A TRANSITIONAL CONTAINERSHIP CONCEPT ...Freight, Naval Architecture-general, Other-design-and-construction, ...8.0277

ADVANCED MARINE TRANSPORTATION SYSTEM/ANALYSIS MODEL ...Algorithms, Consumption, Cost Analysis, Input - Output Analysis, Models, Systems Analysis, ...4.0068

ADVANCED MARINE TRANSPORTATION SYSTEM/ANALYSIS MODEL ...Algorithms, Consumption, Cost Analysis, Input - Output Analysis, Merchant-ships, Systems Analysis, ...4.0068

Moorings

SHIP MANEUVERING AND CONTROL ...Control-systems, Merchant-ships, Safety, Tankers, ...8.0313

MOORING IMPROVEMENT SYSTEM ...Safety, ...8.0211

DYNAMICS OF MOORED BUOY SYSTEMS USED IN OCEANOGRAPHY R&D AND SURVEILLANCE ...Buoy, Currents-ocean, Laboratory Analysis, Model Studies, Waves, ...8.0321

OCEAN ENGINEERING RESEARCH ...Alloys, Engineering Studies-general, Materials Used Undersea, Water, Water Properties-general, ...8.0050

BUOY ENGINEERING ...Buoy, Experiments and Tests, Water Motion, ...8.0309

TELEMETERING BUOY SYSTEM FOR OCEANOGRAPHIC RESEARCH AND ENVIRONMENTAL PREDICTION ...Buoy, Data Acquisition Systems, Meteorological Studies, Navigation Communication, Oceanography-general, Technique Development, Telemetry-other, ...8.0268

MIXING PROCESSES INFLUENCING THE OCEANIC ENVIRONMENT ...Currents-ocean, Density, Mixing, Model Studies, Underwater-construction, ...2.0054

MEASUREMENT AND INTERPRETATION OF MOTIONALLY-INDUCED ELECTRIC FIELDS IN THE SEA ...Currents-ocean, Electrical, Forecasting-prediction, Marine Environment-general, Model Studies, Water Motion Recorders, ...1.0139

OCEAN DYNAMICS EXPERIMENTS ...Buoy, Other-design-and-construction, Submersibles, Technique Development, Temperature, Water Motion Recorders, ...2.0072

OCEAN SYSTEM TELEMETRY STUDY ...Applied Electronics, Buoy, Data Acquisition, Data Transmission Systems, Telemetry-other, ...4.0099

DEEP SEA SUBMERSIBLES ...Control-systems, Hull, Life-support-system, Marine Propulsion, Submersibles, ...8.0292

OCEANOGRAPHIC RESEARCH ...Acoustical, Hydrodynamics, Instrumentation-general, Naval Architecture-general, Water Motion Recorders, ...1.0052

PRECISE RADIO NAVIGATION FOR SHIPS ...Anti-submarine-warfare, Navigation Navigation Communication, Technique Development, ...4.0069

ANCORONS AND MOORINGS ...Submersibles, Technique Development, Underwater-construction, ...9.0334

Naval Architecture-general

COLLATION OF POWER PLANT STUDIES ...Diesel, Marine Propulsion, Merchant-ships, ...8.0161

DEVELOPMENT OF A SENSOR, INSTRUMENTATION AND TELEMETRY BUOY SYSTEM FOR A DEEP OCEAN MANNED HABITAT (ATLANTIS) ...Continental Shelf, Ridges, Safety, Submersibles, Underwater-laboratory, ...8.0017

ESTIMATION OF HULL STEEL WEIGHTS FROM MIDSHIP SECTION CHARACTERISTIC ...Buoy, Engineering Studies-other, Measuring Devices-other, ...8.0303

A STUDY OF A TRANSITIONAL CONTAINERSHIP CONCEPT ...Freight, Merchant-ships, Other-design-and-construction, ...8.0277

OCEANOGRAPHIC RESEARCH ...Acoustical, Hydrodynamics, Instrumentation-general, Moorings, Water Motion Recorders, ...1.0052

EXPLORE FISHERY AND RESEARCH APPLICATIONS OF SUBMARINES ...Other-design-and-construction, Submerged Ships, Submersibles, ...8.0286

Navigation Communication

DEVELOPMENT OF A SENSOR, INSTRUMENTATION AND COMMUNICATION SYSTEM FOR A DEEP OCEAN MANNED HABITAT (ATLANTIS) ...Continental Shelf, Ridges, Safety, Submersibles, Underwater-laboratory, ...8.0017

DEEP SUBMERSION SYSTEMS ...Buoyant, Flotation, Geomorphology-topography, Marine Propulsion, Physical Properties, Submersibles, Welding - Other, ...8.0051

SATELLITE INTERROGATE ENVIRONMENTAL BUOY DEVELOPMENT ...Satellite, ...8.0308

LOOK-OUT ASSIST DEVICE ...Fog-haze-mist, Navigation, Radar, Visibility, Warning-systems, ...8.0146

INDEX

602
SUBJECT INDEX

CLAMS ...Clams, Commercial Fishing, Florida, Habitat Studies, ...8.0284

OPTIMIZATION METHODS APPLIED TO THE PRELIMINARY DESIGN OF A NAVAL AUXILIARY ...Algorithms, Cost Analysis, Engineering Studies.Other, Optimization Technique, Requirements, ...8.0297

HETEROYNE MEASUREMENTS OF ATMOSPHERIC PHASE TURBULENCE AT 6328A ...Heterodyne System, Phase, Transmission, Turbulence, ...8.0190

OPTIMIZATION METHOD APPLIED TO THE PRELIMINARY DESIGN OF A NAVAL SALVAGE TUG ...Algorithms, Design of Experiments, Operational Aspect, Optimization Technique, Random Variables, ...8.0397

A STUDY OF A TRANSITIONAL CONTAINERSHIP CONCEPT ...Freight, Merchant-ships, Naval Architecture-general, ...8.0277

SHIP DESIGN WAVE RESEARCH ...Operational Aspect, Waves, ...8.0291

DEEP RECOVERY SYSTEM ...Navigation, Communication, Operational Aspect, Recovery Vehicle, Submersibles, ...8.0267

PELAGIC TRAWL ...Nets, Oceanic - Pelagic, Special Mission Ships, ...8.0134

EXPLORE FISHERY AND RESEARCH APPLICATIONS OF SUBMARINES ...Naval Architecture-general, Submerged Ships, Submersibles, ...8.0286

Stern

PROPULSION EFFICIENCY 'U' V CSRVS 'V' STERNS ...Marine Propulsion, Shock-vibration, ...8.0238

PRESSURE AND PROPULSION HULL CONFIGURATION ...Bow, Marine Propulsion, Merchant-ships, ...8.0310

Tankers

SHIP MANEUVERING AND CONTROL ...Control-systems, Merchant-ships, Moorings, Safety, ...8.0313

SECOND HAND PRICES FOR TANKERS ...Economics, Model Studies, Price & Value, Trends,projections, ...4.0184

Shock-vibration

PROPULSION EFFICIENCY 'U' VERSUS 'V' STERNS ...Marine Propulsion, Stern, ...8.0289

VARIABLE PRESSURE WATER TUNNEL RESEARCH ...Cavity Flow, Facilities, Hydrofoils Crafts, Marine Propulsion, Sound Field, Water Tunnels Tables, ...8.0183

Special Mission Ships

AN IMPROVED MARINE VIBROSEIS INSTALLATION ...Data Acquisition, Hydrographic, Sonar, ...8.0166

MARINE DIGITAL GRAVITY PROFILING SYSTEM ...Digital Computer Applications, Field Characteristics-general, Gravity Studies, Navigation, ...8.0038

OCEANOGRAPHIC ENGINEERING ...Bathythermographs, Engineering Studies-other, Experiments and Tests, Other-design-and-construction, Platforms, ...8.0265

LENGTHENING AND INCREASING OCEANOGRAPHIC CAPABILITIES OF R/V ACONA ...Equipment Purchase Operation, Modification-conversion, Oceanography-genre, Pacific Ocean-north, Shoreline - Coastline, ...12.0082

RESEARCH VESSEL U.S.N.S ETLANTIN ...Antarctica, Equipment Purchase Operation, Geophysics-general, Scientific-service-support, Teaching and Research, ...12.0036

PRECISION MEASUREMENTS OF DISSOLVED OXYGEN, NITROGEN AND ARGON IN SEA WATER ...argon, Gases, Nitrogen, Oxygen, Particle-gas Transfer, Solubility, ...1.0092

Hudson Laboratories Ship Support ...Acoustical, Facilities, Modification-conversion, Platforms, Scientific-service-support, Ships and Cruises, ...12.0021

MECHANICAL PROPERTIES ...Environment General, Liquid, Mechanical Properties, Submersibles, Test Methods, ...8.0210

PELAGIC TRAWL ...Nets, Oceanic - Pelagic, Other-design-and-construction, ...8.0134

OPERATIONAL EVALUATION OF NSRT SYSTEM ...Equipment, Surface Environments, Temperature, ...8.0059

Submerged Ships

THE EVALUATION AND USE OF SUBMERGED RESEARCH VESSELS IN STUDYING CONTINENTAL SHELF ENVIRONMENTS ...Continental Shelf, Experiments and Tests, Operational Aspect, Submersibles, ...4.0128

Naval Architecture

COLLECTION, ANALYSIS, INTERPRETATION, AND PRESENTATION OF OCEANOGRAPHIC - GEOLoGIC DATA IN CONNECTION WITH SUBMARINE CABLE SYSTEM DEVELOPMENT ...Cables and Transmission Lines, Data Acquisition, Data Analysis - General, Transmission Lines, ...7.0043

STEP RESPONSE METHOD FOR DETERMINING HORIZONTAL COEFFICIENT FOR DEEP SUBMERSIBLES ...Models, Submersibles, ...8.0233

OCEAN DYNAMICS IN THE STRAITS OF GIBRAL4AR AND ADJACENT AREAS ...Acoustical, Anti-submarine-warfare, Computer Applications, Hydromedematics, Model Studies, Strait of Gibraltar, ...1.0141

ARCTIC SUPPORT ...Arctic, Remote Sensing-general, Scientific-service-support, Sea Ice, ...3.006

BUOYANCY MATERIALS ...Buoyant, Flotation, Materials Used Undersea, Micropelrose, Microballoon, Plastic Matrix, ...8.0214

POWER SOURCES ...Benthonic-bottom, Power Transmission Systems, Safety, Technique Development, Underwater-construction, ...8.0156

CONSTRUCTION SYSTEMS ...Benthonic-bottom, Engineering Studies-other, Equipment, Underwater-construction, ...8.0120

EXPLORE FISHERY AND RESEARCH APPLICATIONS OF SUBMARINES ...Naval Architecture-general, Other-design-and-construction, Submersibles, ...8.0286

Surface Ships

SURFACE EFFECT SHIP ECONOMIC OPPORTUNITY ...Flow, Freight, Origin-destination Studies, ...8.0218

WAVE AND SURGE ACTION STUDY FOR LOS ANGELES-LONG BEACH HARBORS ...California, Harbors, Models, Wave Action, Waves, ...2.0098

FISHING VESSEL CONSTRUCTION COSTS AND THE U.S. FISHING VESSEL CONSTRUCTION DIFFERENTIAL SUBSIDY ...Commercial Fishing, Costs, Economics, Fiscal, Other-design-and-construction, ...4.0181

Underwater-construction

STABLE OCEANIC STATION ...Engineering Studies-other, Floating Structure Stability, Platforms, ...8.0287

SEA BED INSTALLATION ...Benthonic-bottom, Deep, Diving and Scuba, Stabilization, Submersibles, ...8.0331

MIXING PROCESSES INFLUENCING THE OCEANIC ENVIRONMENT ...Currents-ocean, Density, Mixing, Model Studies, Moorings, ...2.0054

SATURATED DIVING FACILITIES FOR DIVER-SCIENTIST AND RELATED RESEARCH ...Controls, Data Acquisition, Marine Environments-general, Model Studies, Submersibles, Underwater-laboratory, ...8.0311

DEEP OCEAN SYSTEMS ...Diving and Scuba, Diving-system, Submersibles, ...8.0039

SWIMMER HIGH DEFINITION SONAR ...Diving and Scuba, Diving-system, Engineering Studies-other, Maintenance-system, Sonar, ...8.0019

POWER SOURCES ...Benthonic-bottom, Power Transmission Systems, Safety, Submerged Ships, Technique Development, ...8.0156

DESIGN AND CONSTRUCTION ...Coatings-general, Environmental Effects-geologic, Hydrodynamic Structures, Safety, Water, ...6.033

ANCHORS AND MOORINGS ...Moorings, Submersibles, Technique Development, ...8.0334

CONSTRUCTION SYSTEMS ...Benthonic-bottom, Engineering Studies-other, Equipment, Submerged Ships, ...8.0120

Underwater-laboratory

DEVELOPMENT OF A SENSOR, INSTRUMENTATION AND COMMUNICATION SYSTEM FOR A DEEP OCEAN MANED HABITAT (ATLANTIS) ...Continental Shelf, Navigation Communication, Ridges, Safety, Submersibles, ...8.0167

DEEP SUBMERSIBLE VEHICLES - DYNAMIC ANALYSES ...Data Acquisition, Experiments and Tests, Mathematical Analysis, Model Studies, Submersibles, Technique Development, ...8.0264

RESEARCH SUBMARINE BEAVER MK IV ...Control-systems, Diving and Scuba, Scientific-service-support, Submersibles, Technique Development, ...8.0265
Naval Architecture

ENVIRONMENTAL PHYSIOLOGY ...Diving and Scuba, Life-support system, Medical Studies, Pressure, Submersibles, 8.0093

SATURATED DIVING FACILITIES FOR DIVER-SCIENTIST AND RELATED RESEARCH ...Controls, Data Acquisition, Marine Environments-general, Model Studies, Submersibles, Underwater-construction, 8.0311

SHALLOW WATER OCEANOGRAPHY (SEALAB III) ...Diving and Scuba, Diving-system, Environmental Effects-geologic, Instrumentation-general, 8.0146

SUPPORTING SYSTEMS ...Facilities, 8.0338

Ventilated Flow

EXPERIMENTAL INVESTIGATION OF VENTILATED CAVITIES ...Facilities, Pulsating, Rotors-propellers, Ventilated Cavities, ...8.0185

Yards-docks

MODEL FOR PRELIMINARY EVALUATION OF TOTAL CARGO TRANSPORTATION TIME AND TRANSPORTATION COST FOR ADVANCED CARGO TRANSPORTATION SYSTEMS ...Computer Applications, Costs, Freight, Transportation Systems, 8.0067

Navigation

NAVIGATION RECEIVER ...Navigation Systems-other, Radio, Sonar, Transducers, Transponders, 8.0112

ERROR ANALYSIS OF SEVERAL BOTTOM REFERENCED NAVIGATION SYSTEMS FOR SMALL SUBMERSIBLES ...Error Analysis, Operational Aspect, Sonar, Submersibles, Subsurface Environments, Systems Analysis, 8.0111

INTEGRATION OF DOPPLER SATELLITE AND LORAC NAVIGATIONAL SERVICES ...Doppler, Loran, Satellites, 8.0110

MARINE DIGITAL GRAVITY PROFILING SYSTEM ...Digital Computer Applications, Field Characteristics-general, Gravity Studies, Special Mission Ships, 8.0038

LOOK-OUT ASSIST DEVICE ...Fog-haze-mist, Navigation Communication, Radar, Visibility, Warning-systems, 8.0146

VHF SATELLITE COMMUNICATIONS ...Range and Tracking-others, Space Crafts, Very High Frequency, 8.0105

IMPROVED STANDARDS FOR RADIO AND ELECTRONIC EQUIPMENT ...Instrumental Services, 8.0093

MARINE GRAVITY ...Gravity Studies, Gravity Surveys, Satellites, Variations, 8.0107

OCEAN CURRENT TRANSPORT ...Gulf Stream, Ocean Waves - Currents, Water Motion Recorders, 8.0016

MARINE PHYSICAL GEODESY ...Aerospatial, Caribbean Sea, Gravity Studies, Sea Level Variations, Standard Geoid, 8.0058

GRAVITY ...Anomalies, Caribbean Sea, Geophysical Equipment, Gravity, Pacific Ocean-waves, 7.0142

STUDIES OF THE TRANSPORT OF THE FLORIDA CURRENT ...British West Indies, Florida, Gulf Stream, Ocean Currents-others, Water Motion Recorders, 8.0017

MARINE GRAVITY ...Analog Computer Applications, Geophysical Equipment, Gravity Studies, Satellites, Ships and Cruises, Technique Development, 8.0126

DEVELOPMENT OF AN ADVANCED MISSILE IMPACT LOCATING SYSTEM FOR THE EASTERN TEST RANGE ...Acoustical, Area, Atlantic Ocean-north, Missile & Rockets, Sound Gear, 8.0048

INSTRUMENT DEVELOPMENT ...Oxygen, Satellites, Technique Development, 8.0065

VLF/OMEGA NAVIGATION ...Communication & Navigation, Control-systems, Navigation Communication, Satellites, 8.0106

DEVELOPMENT OF A PHOTOGRAPHIC SUT FOR STEREOPHOTOMETRIC MAPPING BY SUMBERSIBLE ...Mapping, Photography, Sonar, Submersibles, Turkey, 8.0060

BIOMETRY ...Marine Biology, Population Dynamics, Statistics-general, Temporal Distribution, 8.0019

MARINE GRAVITY ...Dynamic Gravimeters, Geophysical Equipment, Ships and Cruises, Technique Development, 8.0101

GRAVITY FIELD AT SEA ...Gravity Studies, Pacific Ocean-ships, Ships and Cruises, Variations, 8.0098

WOODS HOLE SHIPBOARD DATA PROCESSING ...Data Reduction and Analysis, Digital Computer Applications, Gravity Studies, Magnetic Studies, Real Time Systems, 8.0031

WWV BROADCASTS ...Signal Generators, 8.0089

SATELLITE TIME DISSEMINATION ...Airborne Probing, Communication & Navigation, Doppler, Signal Generators, Standards, Specifications, Time Measurements, 8.0091

WWVB-WWVL BROADCASTS ...Frequency Standards, Low Frequency, Radio, Signal Generators, Standards, Specifications, Time Measurements, Very Low Frequency, 8.0092

MICRONESIAN NAVIGATION AND SAILING ...Anthropology-other, Caroline Islands, General Ethnology, Micronesia, Navigation Communication, 8.0094

NAVIGATION SYSTEMS FOR SURVEY APPLICATIONS ...Aero, Instrumentation, Technique Development, 8.0101

PRECISE RADIO NAVIGATION FOR SHIPS ...Anti-submarine warfare, Mooring, Navigation Communication, Technique Development, 8.0099

SONIC UNDERWATER NAVIGATION FOR SHIPS ...Equipment, Instrumentation-other, Ranging, Sonar, Sound Gear, 8.0100

DIVER NAVIGATION DEVICE ...Bathymetry, Diving and Scuba, Diving-system, Technique Development, 8.0131

HARBOR DESIGN STUDIES ...Harbors, Waves, 8.0046

EVALUATION OF CONTEMPORARY PRECISION NAVIGATION SYSTEMS ...Bathymetry, Communication & Navigation, Navigation Communication, Satellites, Technique Development, 8.0087

Navigation Systems

Loran

INTEGRATION OF DOPPLER SATELLITE AND LORAC NAVIGATIONAL SERVICES ...Doppler, Loran, Satellites, 8.0110

Navigation Systems-other

NAVIGATION RECEIVER ...Navigation, Radio, Sonar, Transducers, Transponders, 8.0112

BIOLOGICAL INSTRUMENTATION ...Behavioral Ecology, Biological Sciences, Instrumental Services, Instrumentation-general, 8.0064

Nektonic - Swimming

DESIGN AND DEVELOPMENT OF NEKTON SAMPLER ...Food Supply, Organism Sampling Devices, Plankton Sampling, Tunic, Mackrel, Albucore, ...8.0129

Nematodes

Animal Nematodes -non-specific

FREEZING AND DRYING OF LIVING CELLS ...Cell Injury and Autolysis, Cell env.(non-specific & Ot.), Freeze-dry Techniques, Mollusks -non-specific & Other, Tissue Techniques, ...5.0450

Nematoda -other

MARINE NEMATODES OF THE CAPE COD AREA ...Animal Taxonomy, Collections, Habitat Studies, Northeast, ...5.0566

COMPARATIVE MORPHOLOGY OF MARINE NEMATODES ...Comparative Physiology, Histology and Cytology, Invertebrate Anatomy, Musculoskeletal System, 5.0567

WATER QUALITY AND FUNGI-NEMATODE-SEAGRASS RELATIONSHIPS ...Eelgrass, Waterweed, Thalassia, Florida, Habitat Studies, Marine Fungi (non-specific), 5.0878

Red Worms, Eye Works...

SYSTEMATIC STUDIES OF CERTAIN MARINE PARASITIC WORMS ...Animal Taxonomy, Helminths, Life History Studies, Trematoda -other, 5.0541

606
Nervous System

Basic Studies
Chem and Metab
CHEMISTRY AND FUNCTION OF BRAIN PLASMALOGENS
...Comparative Physiology, Molecular structure (gen. & Other), Phospholipids, Plasmalogens, ...5.1003
Mech of Transmission
METABOLISM OF NEUROHUMORAL TRANSMITTER SUBSTANCES IN MARINE ANIMALS
...Animal Toxins, Basic Studies, Metabolic Inhibitors, Structural Functions, ...5.0981
NEURAL MECHANISMS OF LEARNING AND BEHAVIOR
...Behavior, Brain, GastroPods -slugs,conch,snails, Learning and Retention, ...5.0845
Pathways
SENSORY PROCESSES, MARINE AND HUMAN
...Bioelectric Phenomena, Nervous System, Sensory Organs, Visual, ...5.0969
SENSORY PROCESSES
...Basic Studies, Hawaii, ...5.0595
Structure-cell-tissue
THE CETACEAN BRAIN - A COMPARATIVE STUDY
...Central Nervous System, Comparative Physiology, Mammals, ...5.0641
Nerve Effects
THE EFFECT OF SOME NEUROTRANSMITTERS ON THE CENTRAL NERVOUS SYSTEM OF LIMULUS POLYPHEMUS
...Brain, Cardiovascular, Horsehoe Or King Crab, Neuroeffectives, ...5.0847
SUPPORT FOR THE PHYSIOLOGICAL RESEARCH SHIP, R/V ALPHA HELIX
...Insecticides -non-specific, Mycorrhiza, Rain Forests, Regulation, Tropic, ...12.0011
New Hampshire
(A) ANNUAL SUPPLY OF PARTICULATE MATTER IN THE GREAT BAY ESTUARY
(B) LATE PLEISTOCENE HISTORY OF THE GREAT BAY, NEW HAMPSHIRE
...Estuaries, Geologic Maps, Lake Ontario, New York, ...Geologic Maps, Lake Ontario, Potential of Deposit, Sands and Gravels, Submergent, ...5.0824
New Jersey
CREEL CENSUS OF SUMMER FLounder SPORT FISHERY
...General Fishery, Inland Fisheries, Nettles, Temperatures, Thermal Pollution, ...5.0815
PURIFICATION OF HARD CLAMS FROM POLLUTED WATERS
...Animal Viruses (non-specific), Clams, Contamination - Water, Estuaries, Intestinal Bacteria, ...5.0847
New York
INSTANTANIZATION FOR LAKE CAYUGA HEAT RELEASE STUDY
...Electric Power Plants, Heat Flow, Lakes, Temperature, Thermal Pollution, ...5.0815
PURIFICATION OF HARD CLAMS FROM POLLUTED WATERS
...Animal Viruses (non-specific), Clams, Contamination - Water, Estuaries, Intestinal Bacteria, ...5.0847
Nitrogen
COMPARATIVE STUDY OF NITROGEN SECRETION IN FISHES
...Comparative Physiology, Fish, Metabolism, Terrestrial Anatomy, ...5.0822
DYNAMICS OF THE NITROGEN CYCLE IN THE SEA
...General Sea Water Chemistry, Nitrate, Nitrogen Fixation, Tracers, ...5.0933
ANALYSIS OF PHOSPHORUS AND NITROGEN COMPOUNDS IN TIDAL MARSHLAND DRAINAGE
...Management, Phosphate, Phosphite, Swamps-marshes, Tidal Areas, Water Properties-general, ...5.0935
NUTRIENT REQUIREMENTS OF BIVALVES
...Algal Culture, CyanoPhyta (non-specific & O1), Nutrition Studies, Phosphate, Phosphite, ...5.0706
Netherlands
A SYSTEMATIC STUDY OF ENTOCYTERID OSTRACODS
...Animal Taxonomy, Madagascar-malagasy Republic, Publications -other, Shrimps - Seed Or Mussel, South America, ...5.0492
Nicaragua
DISTRIBUTION AND MIGRATION OF CENTRAL AMERICAN FRESHWATER SLAMASOGRAPHS
...Caribbean Sea, Migration, Osmoregulation, Rays, Skates, Mantas, Sawfish, Sharks, ...5.0117
Nickel
EFFECT OF INTERFIBER SPACING ON THE HIGH TEMPERATURE DEFORMATION OF Al-13NI COMPOSITES
...Aluminum, Intermetallic Compound, Metal Matrix, Plasticity, Tensile, ...5.0823
PRODUCTION OF PLATES OF FIBER COMPOSITES BY SOLIDIFICATION, FORMING AND A COMBINATION OF BOTH
...Aluminum, Fibre, Filament, Intermetallic Compound, Metal Matrix, Orientation, ...5.0820
TEMPERATURE AND STRAIN RATE DEPENDENCE OF DEFORMATION IN Al-3NI-AL COMPOSITES
...Aluminum, Deformation - General, Intermetallic Compound, Metal Matrix, Strain Rate, ...5.0821
Nitrate, Nitrite
DYNAMICS OF THE NITROGEN CYCLE IN THE SEA
...General Sea Water Chemistry, Nitrogen, Nitrogen Fixation, Tracers, ...5.0933
ANALYSIS OF PHOSPHORUS AND NITROGEN COMPOUNDS IN TIDAL MARSHLAND DRAINAGE
...Management, Phosphate, Phosphite, Swamps-marshes, Tidal Areas, Water Properties-general, ...5.0935
NUTRIENT REQUIREMENTS OF BIVALVES
...Algal Culture, CyanoPhyta (non-specific & O1), Nutrition Studies, Phosphate, Phosphite, ...5.0706
SUBJECT INDEX

HEAVY METALS AND SEDIMENTATION PROCESS OF THE NORTH CAROLINA SHELF ...Bottom Sampling Device, Continental Shelf, Heavy Minerals, Mineralogy, Sedimentation, ...7.0021

OCEAN WIND INTRUSION INTO BACK BAY, VIRGINIA, & CURRITUCK SOUND, NORTH CAROLINA, ON THE WATERFOWL & FRESHWATER FISH HABITAT ...Habitat Studies, Virginia, Water Salinity, Waterfowl - non-specific, ...5.0897

North Dakota
MICROPLANKTON OF THE BEARPAW SHALE OF MONTANA AND NORTH DAKOTA ...Cretaceous Period, Fine-grained Clastics, Microfossils, Montana, Planktonic - Flo ...mg, ...7.0249

North Sea
OCEAN WIND WAVE GENERATION AND DISSIPATION ...Buoys, General Synoptic Observations, Velocity, Waves, Wind-water Interaction, ...2.0126

Norwegian Sea
AN INVESTIGATION OF THE OVERFLOW OF NORWEGIAN SEA WATER INTO THE NORTH ATLANTIC THROUGH DENMARK STRAIT ...Atlantic Ocean-north, Ocean Currents-other, Oceanic Fronts, ...2.0032

Nucleic Acids - non-specific
GEOCHEMISTRY OF NUCLEIC ACIDS ...Biochemical, Biogeochemical Process, Chemistry, Exobiology, Organic, ...7.0054

Nucleotides - non-specific
PROCESS-INDUCED CHANGES IN CRUSTACEAN MUSCLE TISSUE ...Crabs, Heat, Organoleptic Studies, ...5.0350

Numerical Analysis
Computers
Research - Development
GRAVITY AND MAGNETIC DATA COLLECTED DURING THE INTERNATIONAL INDIAN OCEAN EXPEDITION AND IN THE CARIBBEAN SEA ...Data Analysis - General, Data Reduction and Analysis, Digital Computer Applications, Gravity Studies, Indian Ocean-general, Magnetic Studies, ...4.0030

DIGITAL RECORDING AND PROCESSING OF IN SITU DEPTH-TEMPERATURE-SALINITY DATA ...Bathythermographs, Depth, Error Analysis, Salinity, Temperature, ...4.0025

FOSDIC APPLICATION TO CURRE'T-METER RECORDS ...Currents-ocean, Data & Statistics Storage, Recording Systems, Technique Development, Water Motion Recorders, ...4.0021

OBJECTIVE WEATHER ANALYSIS ...Technique Development, Tropic, Weather Forecasting, Wind-general, ...4.0042

Simulation
GALVESTON BAY STUDY ...Estuaries, Numerical Analysis-other, Optimization, Tides, Waste Water Treatment-general, ...4.0062

Numerical Analysis-other
CLIMATE CHANGE OVER THE POLAR OCEAN ...Arctic Ocean, Heat and Radiation Transfer, Heat Budget, Physical Climatology, ...6.0058

DETERMINATION OF TIDES IN THE REAL OCEANS ...Forecasting-prediction, Partial, Tides, ...2.0089

GALVESTON BAY STUDY ...Estuaries, Optimization, Simulation, Tides, Waste Water Treatment-general, ...4.0062

NUMERICAL WAVE PREDICTION ...Development of Models, Forecasting-prediction, Model Studies, Waves, ...2.0164

Numerical Methods
Algorithms
OPTIMIZATION METHODS APPLIED TO THE PRELIMINARY DESIGN OF A NAVAL AUXILIARY ...Cost Analysis, Engineering Studies-other, Optimization Technique, Other-design-and-construction, Requirement, ...4.0027

OPTIMIZATION METHOD APPLIED TO THE PRELIMINARY DESIGN OF A NAVAL SALVAGE TUG ...Design of Experiments, Operational Aspect, Optimization Technique, Other-design-and-construction, Random Variables, ...8.0307

ADVANCED MARINE TRANSPORTATION SYSTEM/ANALYSIS MODEL ...Consumption, Cost Analysis, Input - Output Analysis, Merchant-ships, Models, Systems Analysis, ...4.0066

Approximations
EXPLOSIVE WAVE PROPAGATION ...Explosives, Integral Equations, P-waves, Propagation, Travel Times, ...7.0126

PARTIAL DIFFERENTIAL EQUATIONS AND CONTINUUM MECHANICS ...Acoustical, Ordinary, Partial, Waves, ...8.0171

WEIGHT ANALYSIS IN FISHING BOATS ...Hull, Low Alloy Steels, Measuring Devices-other, Pressure Effects, ...8.0295

Error Analysis
ERROR ANALYSIS OF SEVERAL BOTTOM REFERENCED NAVIGATION SYSTEMS FOR SMALL SUBMERSIBLES ...Navigation, Operational Aspect, Sonar, Submersibles, Subsurface Environments, Systems Analysis, ...4.0111

DIGITAL RECORDING AND PROCESSING OF IN SITU DEPTH-TEMPERATURE-SALINITY DATA ...Bathytthermographs, Depth, Research - Development, Salinity, Temperature, ...4.0025

Finite Differences
BOTTOM CURRENTS AND DEEP SEA TIDES ...Abyssal, Acoustical, Benthonic-bottom, Currents-other, Model Studies, Tides, ...2.0004

FINITE ELEMENT TECHNIQUES ...Distribution, Mathematical Analysis, Mechanical Properties, Model Studies, Rock Mechanics, ...8.0254

Optimization Technique
OPTIMIZATION METHODS APPLIED TO THE PRELIMINARY DESIGN OF A NAVAL AUXILIARY ...Algorithms, Cost Analysis, Engineering Studies-other, Other-design-and-construction, Requirement, ...8.0297

OPTIMIZATION METHOD APPLIED TO THE PRELIMINARY DESIGN OF A NAVAL SALVAGE TUG ...Algorithms, Design of Experiments, Operational Aspect, Other-design-and-construction, Random Variables, ...8.0307

Simulation Theory
DEVELOPMENT OF PHYSICAL-NUMERICAL MODELS FOR STUDIES OF THE ATMOSPHERE-OCEAN PLANETARY BOUNDARY LAYER ...Advection, Mixing, Thermal, Turbulence, Wind-water Interaction, ...3.0010

SIMULATION MODEL FOR THE ANALYSIS OF ADVANCED MARINE SHIPPING SYSTEMS ...Transportation Systems, Water Transportations, ...4.0063

EXPERIMENTAL HYDRODYNAMICS ...Fluid Dynamics, Heat and Radiation Transfer, Hydrodynamics, Submersibles, Thermocline, ...8.0192

FIORD OCEANOGRAPHY ...Alaska, Estuaries, Fjords, Hydrodynamics, Model Studies, ...4.0040

RESIDENCE TIMES OF WATERS BEHIND BARRIER ISLANDS ...Bays, Circulation-general, Tides, Wind-water Interaction, ...2.0018

INVESTIGATION OF THE NON-LINEAR CHARACTERISTICS OF FLUID-SUSPENDED VEHICLES ...Dimensionless-parameters, Hydrofoils Crafts, Non Linear, Non-linear, Stability, ...8.0184

HURRICANES AND OTHER TROPICAL METEOROLOGICAL PROBLEMS ...Meteorologic Model Studies, Storms, Tropical Cyclones, Weather Forecasting, ...3.0066

Nutrition - Medical

Nutrition - Medical
Analysis of Foods
PREPARATION OF FISH PROTEIN HYDROLYSATES ...Chemical Analysis, Fish - non-specific, Fish Protein Concentrates, Protein, ...6.0066

Diet Components - Role
Amino Acids
BIOCHEMISTRY OF FISH AS RELATED TO HUMAN NUTRITION ...Hypoxanthine, Northeast, ...4.0053
Nutrition - Medical

Proteins
ANTIOXIDANT AND NUTRITIONAL POTENTIAL OF FERMENTED AND UNFERMENTED SOYBEANS IN COMBINATION WITH FISH ...Food Spoilage Detection, Rancidity, Soybeans, ...6.0023
UTILIZATION OF LIQUID MARINE RESOURCES AND WASTE PRODUCTS ...Fish -other, Fish Meals, Fish Protein Concentrate, Proteins and Amino Acids, Salmon & Trout - non-specific, ...6.0068
UTILIZATION AND PREPARATION OF FISH PROTEIN CONCENTRATES ...Chemical Analysis, Fish & Shellfish, Fish Proteins Concentrate, Nutritive Value, Organoleptic Studies, ...6.0125

Toxicological and Allergy
EFFECTS OF INGESTION OF RADIOACTIVE FISH AND THE NATURE AND BIOLOGY OF TOXINS IN CERTAIN FISHES ...Fish -non-specific, Food (epidemiology), Food Chains, Radioactive Isotopes, ...6.0108
APPLICATION OF RADIATION PASTEURIZATION PROCESSES TO PACIFIC CRAB AND FLounder ...Clodi- trum Botulinum, Fish - non-specific, Microbiological, ...6.0083
EXPLORATION FOR TOXIC MARINE ANIMALS IN THE TROPICAL PACIFIC ...Animal Toxins, Marine Biology (non-specific), Pacific Ocean-general, Toxic Substances - non-specific, ...6.0109
EXPLORATION FOR TOXIC MARINE ANIMALS IN THE TROPICAL PACIFIC ...Animal Toxins, Pacific Ocean-general, Toxicology, ...6.0110
STUDY OF THIAMINASE IN HAWAII FISH ...Enzyme, Enzyme Inhibitors, Fish - non-specific, Hawaii, Thiaminase, ...5.0348
EFFECTS OF HANDLING AND PROCESSING PROCEDURES IN POTENTIAL PATHOGENUS ON FISH ...Clodi- trum Botulinum, Fish - other, Legal Standards, Microbiological, Smoking, ...6.0044
TOXIC IMPURITIES IN MARINE PROTEIN CONCENTRATES ...Fish Protein Concentrate, Food Spoilage -other, Infection, In-toxicated C & P, Toxic Substances -non-specific, ...6.0009
PROGRAM PROJECT - FOOD MICROBIOLOGY ...Clostridia (non-specific & OI), Food (epidemiology), Infection, Intoxication & Poi, Microbiological, Salmonellain (non-specific & OI), ...6.0005
STUDIES ON VIBrio FOOD POISONING ...Bacteria, Bacterial Endotoxins, Food (epidemiology), Microbiological, Vasoactivity, ...6.0114
ORGANISMS RESPONSIBLE FOR TOXICITY OF ALASKAN CLAMS ...Alaska, Biological Pollutants-general, Clams, Food Spoilage Detection, Microbiological, Pollutants-general, ...5.0344

Occupations, Populations
Military Personnel
SUBMARINE MEDICINE ...Life-support-system, Occupational Hazards, Ordnance, Safety, ...8.0018

Occupations - Other Specific
Divers
MAN IN THE SEA - VISUAL ACUITY RESEARCH ...Acuity, Diving and Scuba, Experiments and Tests, Optical, Submer- bles, ...8.009
MANNED DIVING RESEARCH ...Decompression Sickness, Diving and Scuba, Liquid-breathing, Medical Studies, ...6.0096
HUMAN PERFORMANCE ...Diving and Scuba, Medical Studies, Pressure, ...6.0097
LIFE SUPPORT RESEARCH ...Diving and Scuba, Medical Studies, Submersibles, ...8.009
DECOMPRESSION TABLE DEVELOPMENT ...Decompression Sickness, Digital Computer Applications, Diving and Scuba, Mathematical Biophysics, Medical Studies, Tables, Compilations, Catalogs, ...6.0099
HUMAN PERFORMANCE IN UNUSUAL ENVIRONMENTS ...Diving and Scuba, Facilities, Medical Studies, Pressure, ...12.000
Diving Medicine ...Diffusion of Gases, Diving and Scuba, Occupatiional Hazards, Pressure, ...8.0017

SUBJECT INDEX
DEEP DIVING DECOMPRESSION EQUIPMENT AND TECHNIQUES ...Decompression Sickness, Diving and Scuba, Medical Studies, Navigation Communication, Safety, ...8.0022
SEALAB III PARTICIPATION ...Behavioral Ecology, Bio- luminescence, Diving and Scuba, Medical Studies, Submersibles, ...6.0091

Ocean History
TIME DEPENDENT VARIATIONS IN SURFACE OCEANIC CIRCULATION ...Circulation-general, Pollution Sources-general, Sedimentary History, Temperature, Waste Disposal-general, ...7.0038
THE POSTPLEISTOCENE OCEANOGRAPHY AND BIOLOGY OF THE EASTERN NORTH PACIFIC ...Climatography, Marine Biology, Pacific Ocean-east, Pacific Ocean-north, ...7.0158
SEDIMENTATION, MORPHOLOGY, AND STRUCTURE-MID- ATLANTIC RIDGE ...Atlantic Ocean-general, Distribution, Provenance Studies-other, Ridges, Sea Floor Spreading, ...7.0047
MASS SPECTROMETRIC AND MANOMETRIC STUDIES OF THE OCEANS AND THE ATMOSPHERE ...Chemical Anal- ysis (water), Gases, Mass Spectroscopy, Particle-gas Transfer, Solubility, ...1.0101
A STUDY OF THE STRUCTURAL RELATIONS BETWEEN THE MID-PACIFIC OCEANIC RIDGES AND FRACTURE ZONES ...Anomalies, Polynesia, Ridges, Structural Studies, Tectogenesis, ...7.0111
A SEDIMENTOLOGIC STUDY OF MOBILE BAY AND PER- DIDO BAY ...Alabama, Bays, Distribution, Rate of Deposition, Stratigraphy-general, ...7.0232
BIOSTRATIGRAPHY OF MID-ATLANTIC RIDGE SEDI- MENTS ...Biofacies, Biogenics, Correlation, Order Formanirella, Ridges, ...7.0209
RESOURCES OF THE BERING CONTINENTAL MARGIN ...Bering Sea, Continental Shelf, Dimensions-distribution, Geology-general, Ocean Mining, ...7.0016

Ocean Mining
APPLICATION OF NUCLEAR TECHNIQUES TO MARINE MINERALS TECHNOLOGY ...Activation Analysis, Geological Exploration, Gold, Manganese, Physical Properties, ...6.0085
AN APPROACH TO MARINE RESOURCE DEVELOPMENT IN ALASKA ...Alaska, Marine Biology (non-specific), Planning, ...7.0001
THE ECONOMIC POTENTIAL OF THE MINERAL AND BOTANICAL RESOURCES OF THE U.S. CONTINENTAL SHELF AND SLOPE ...Ag Uses of Nat. resource-other, Continental Shelf, Continental Slope, Estimates of Reserves, Potential of Deposit, ...7.0011
SYMPOSIUM ON THE MINERAL RESOURCES OF THE WORLD OCEAN ...Engineering Studies-general, Meetings, Pol- icy Making, Rhode Island, ...7.0027
FORMATION AND DEGRADATION OF MANGANESE NODULES BY MARINE BACTERIA ...Cobalt, Manganese, Marine Bacteria, Nickel, Titanium, ...7.0025
MARINE GEOLOGY OF THE CALIFORNIA CONTINENTAL BORDERLAND WITH EMPHASIS ON FUTURE ECONOMIC DEVELOPMENT AND GENERAL RESOURCE VALUE ...California, Clay Minerals-general, Continental Shelf, Heavy Elements, Mineralogy, ...7.0010
PACIFIC SALMON FISHERIES - ECONOMICS OF MANAGE- MENT ...Appraisals-general, Continental Shelf, International, Legal Preview, Legal Studies-general, Science & Technology, ...10.0006
DEEP SEA MINING PROJECT ...Dredging, Equipment, Scientific-service-support, Technique Development, ...8.0229
SEAMOUNT INVESTIGATION ...Anomalies, Data Analysis - General, Geothermal, Magnetic Studies, Seamounts-guyots, Sonar, ...7.0009
DEVELOPMENT OF OFFSHORE SOURCES OF SAND SUITA- BLE FOR BEACH RESTORATION AND NOURISHMENT ...Beach, Coring and Dredging, Mapping, Shoreline Structures, Size, ...7.0012
DISTRIBUTION OF HEAVY METALS, WESTERN GULF OF MEXICO ...Chemistry, Dimensions-distribution, Geophysics- general, Gulf of Mexico, Heavy Minerals, ...7.0013
Ocean Sediments

SUBJECT INDEX

FINITE ELEMENT TECHNIQUES: Distribution, Finite Differences, Mathematical Analysis, Model Studies, Rock Mechanics, ...8.0254

LABORATORY STUDIES TO CORRELATE ENGINEERING PROPERTIES OF MARINE PLACER MATERIALS WITH SAMPLING TOOL PERFORMANCE ...Coring and Dredging, Gold, Laboratory Analysis, Placer, Scientific-service-support, ...8.0244

Mineralogy

MARINE GEOCHEMISTRY RESEARCH ...Depth, Gases, Mineral Genesis, Radioactive Dating, Sedimentation, Thermodynamics, ...7.0055

ALTERATION OF MINERALS ...Aragonite, Chemistry, Saline Water Systems, Silicates, Solution Chemistry, ...7.0056

SUPPORT OF RESEARCH VESSELS JOHN ELLIOTT PILLBURY, GERDA, TURSIOPS ...Microfossils, Paleotemperature, Petrology, Seismic Studies, Ships and Cruises, ...12.0024

THE MARINE GEOLOGY OF THE SOUTHERN OCEAN ...Antarctic Ocean, Chemistry, Coring and Dredging, Distribution, Petrology, ...7.0067

RARE GAS STUDY OF INTERPLANETARY MATERIAL IN PELAGIC SEDIMENTS ...Chemistry, Cosmogenous, Element Ratios, Equipment Purchase Operation, Mass Spectroscopy, X-ray, ...7.0081

STRUCTURE, MINERALOGY, AND CHEMICAL COMPOSITION OF MARINE MANGANESE NODULES ...Chemistry, Manganese, Origin, Polished Sections, Precipitates, Textures-structures, ...7.0023

STABLE ISOTOPE STUDIES ON COEXISTING MINERALS IN MARINE SEDIMENTS ...Coring and Dredging, Diagnose, Genus, Relictalinae, Rea Sea, Salinity, Thermal, ...1.0106

THE GEOCHEMISTRY, MINERALOGY AND ORIGIN OF PELAGIC SEDIMENTS IN AREAS OF HIGH HEAT FLOW AND FRACTURE ZONES ...Chemistry, Diagnose, Geochemistry, Heat Flow Measurements, Origin, Sedimentation, ...7.0227

GEOCHEMICAL STUDIES OF DEEP-SEA DEPOSITS ... THEIR SOURCES AND MODES OF DEPOSITION ...Abyssal, Atlantic Ocean-general, Biogenic, Biogeochimical Process, Chemistry, Ocean Bottom, ...7.0067

GEOPHYSICAL AND GEOCHEMICAL STUDY OF RED SEA MINERAL DEPOSITS ...Coring and Dredging, Gulf of Aden, Igneous Activity - Volcanism, Red Sea, Thermal, ...7.0023

MINERALOGICAL STUDIES OF PARTICULATE MATTER SUSPENDED IN SEA WATER ...Chemistry, Suspension, Water Chemistry-other, ...1.0122

DEEP-SEA SEDIMENTS AND VOLCANIC ROCKS OF MIDDLE-OCEAN RIDGES ...Origin, Ridges, Seamounts-guyots, Structural Studies, Tectonics-general, ...7.0226

JOINT STUDY OF THE CONTINENTAL MARGIN OFF OREGON BY OREGON STATE UNIVERSITY AND THE UNITED STATES GEOLOGICAL SURVEY ...Continental Shelf, Geophysics-general, Ocean Basins, Oregon, Potential of Deposit, ...7.0046

MARINE GEOLOGY OF THE CALIFORNIA CONTINENTAL BORDERLAND WITH EMPHASIS ON FUTURE ECONOMIC DEVELOPMENT AND GENERAL RESOURCE VALUE ...California, Clay Minerals-general, Continental Shelf, Heavy Elements, Ocean Mining, ...7.0018

RESEARCH ON MINERAL STRUCTURE REVEALED BY AN ELECTRON MICROSCOPE ...Comparative Anatomy, Electron Microscopy, Geologic, Paleontology, ...7.0062

OREGON-CALIFORNIA BLACK SANDS ...Beaches, California, Heavy Mineral Analysis, Heavy Minerals, Ocean Mining, Potential of Deposit, ...7.0015

HEAVY METALS AND SEDIMENTATION PROCESS OF THE NORTH CAROLINA SHELF ...Bottom Sampling Device, Continental Shelf, Heavy Minerals, North Carolina, Sedimentation, ...7.0021

UNIVERSITY OF SOUTHERN CALIFORNIA CONTRACT - CHANNEL ISLANDS AND BASINS SOUTHERN CALIFORNIA CONTINENTAL SHELF ...California, Continental Shelf, Continental Margin, Geology, General Mineralogic Properties, Geochronology-general, ...7.0073

DEVELOPMENT OF WIRE-LINE CORING TECHNIQUE FOR SAMPLING UNCONSOLIDATED DEPOSITS ...Alaska, Bottom Sampling Device, Coring and Dredging, Mineralogy, Technique Development, ...8.0249

PRELIMINARY STUDIES TO CORRELATE SELECTED MINERALOGIC AND GEOLOGIC PROPERTIES WITH EN-
SUBJECT INDEX

Ocean Sediments

APPLICATION OF NUCLEAR TECHNIQUES TO MARINE MINERALS TECHNOLOGY ...Activation Analysis, Geologic Exploration, Gold, Manganese, Ocean Mining, ...8.0085
NUCLEAR OCEANOGRAPHIC TECHNIQUES ...Currents-ocean, Isotope Dilation, Radioactivity, Water Analysis, Water Motion Recorder ...8.0087
DEEP SEA SEDIMENT STUDIES ...Acoustical, Marine Soils, Mechanical Properties, Physical Analysis, Shear Strength, ...8.0341
ARCTIC BASIN HEAT FLOW ...Arctic, Coring and Dredging, Crust, Geothermal Gradient, Heat Flow, ...7.0105
MARINE GEOPHYSICS ...Crust, Field Characteristics-general, Gravity Studies, Gulf of Mexico, Seismic Studies, ...7.0149
MARINE SEDIMENTS ...Biology, Chemistry, Core Analysis, Sub-bottom, Textures-structures, ...7.0264
GEOTHERMAL MEASUREMENTS ...Geology, Geophysical Analysis, Geothermic Gradient, Heat Flow Measurements, Physical Analysis, Temperature, ...7.0136
A MICROPALEONTOLOGICAL STUDY OF DEEP-SEA CRETEACEOUS AND TERTIARY SEDIMENT ...Bioclasts, Distribution, Microfossils, Population - Distribution, Tertiary Period, ...7.0164
TEMPERATURE MICROSTRUCTURE AT THE OCEAN FLOOR ...Heat Flow Measurements, Instrumental Services, Oregon, Technique Development, Temperature, ...7.0188
AN INVESTIGATION OF THE MASS PHYSICAL PROPERTIES OF CARBONATE MUD SEDIMENTS ...Carbon-14, Carbonates-other, Core Analysis, Density, Porosity, ...7.0225
PROPERTIES AND ORIGIN OF SEDIMENTS ON THE CONTINENTAL MARGIN OFF WESTERN U. S. ...Erosion, Physical Properties, Sampling, Sedimentation, Shoreline - Coastline, ...7.0271
SEDIMENTS IN BAFFIN BAY AND THE EFFECTS OF AN ARCTIC ENVIRONMENT ON MARINE SEDIMENTATION ...Baffin Bay, Benthonic-bottom, Origin, Polar, Sedimentation, ...7.0265
(U) THE EFFECTS OF OCEANIC PROCESSES ON THE DEPOSITION OF RIVER SEDIMENTS ...Rate of Deposition, Sediment Relationship, Sedimentation, Stream, ...7.0197
DEEP-SEA SEDIMENTS - THEIR PROPERTIES AND PROCESSES OF FORMATION ...Acoustical, Basins, Currents-ocean, Depth, Panama, Physical Properties, ...7.0273
SEDIMENT AND VOLCANIC STUDIES ...Distribution, Pacific Ocean, Oceanography ...Basalt, Basaltic, Oceanic Ridge, Volcanic, ...7.0189
PROPERTIES AND ORIGIN OF SEDIMENTS IN THE NORTHEAST PACIFIC OCEAN ...Carbon-14, Core Analysis, Pacific Coast, Physical Properties, Washington, ...7.0257
DEEP-SEA SEDIMENTS AND VOLCANIC ROCKS OF MID-OCEAN RIDGES ...Mineralogy, Ridges, Seamounts-guyots, Structural Studies, Tectonics-general, ...7.0226
THE ORIGIN OF GRAVEL BARS IN THE INTERTIDAL ZONE, PARRSBORO HARBOUR, NOVA SCOTIA, CANADA ...Canada, Intertidal Areas, Location, Sand Bars, Size, ...7.0277
INTERPRETING THE ORIGIN AND DISTRIBUTION OF COASTAL SEDIMENTS ...Canada, Distribution, Massachusetts, Shoreline - Coastline, Size, ...7.0213
Research in Core Analyses ...Acoustical, Core Analysis, Coring and Dredging, Geomorphology-topography, Model Studies, ...7.0263
BOTTOM ENVIRONMENT-GULF OF MEXICO ...Benthonic-bottom, Biology, Chemistry, Gulf of Mexico, Ocean Currents, ...7.0045
FABRIC OF MARINE MUDS ...Fabric, Freeze, Size, Tertiary, Textures-structures, ...7.0242
SEDIMENTOLOGY AND GEOLOGICAL HISTORY OF HUMBOLDT BAY, CALIFORNIA ...Bays, California, Coring and Dredging, Geologic History-general, Pacific Ocean, ...7.0193
GEOLICAL OCEANOGRAPHY - ACOUSTICAL PROPERTIES OF SEDIMENTS ...Acoustical, Core Analyses, Geomorphology-topography, Mechanical Properties, Scattering, ...7.0101
GEOLICAL OCEANOGRAPHY - PHYSICAL PROPERTIES ...Bearing Capacity, Biology, Chemistry, Photography, Shear Strength, ...8.0337
ACOUSTIC PROPERTIES OF SEDIMENTS ...Acoustical, Correlation, Seismic Studies, Sub-bottom, Texture, ...7.0108
LABORATORY STUDIES TO DETERMINE ROCK PROPERTIES UNDER HYDROSTATIC (SEA WATER) PRESSURE ...Environmental Effects-geologic, Marine Environments-general, Rock Mechanics, Survey Studies, ...8.0330
Precipitates

STRUCTURE, MINERALOGY, AND CHEMICAL COMPOSITION OF MARINE MANGANESE NODULES ...Chemistry, Manganese, Mineralogy, Origin, Polished Sections, Textures-structures, ...7.0028

Other Sediment Type

RADIOISOTOPIC SAND TRACER STUDY, POINT CONCEPTION, SANTA BARBARA COUNTY, CALIFORNIA ...California, Ocean Waves - Currents, Seamounts, Sediment-transport general, Tracers, ...7.0194

Physical Properties

ANALYSIS OF PHYSICAL AND CHEMICAL PROPERTIES OF DEEP SEA CORES ...Chemistry, Coring and Dredging, ...7.0257
INVESTIGATE METHODOLOGY FOR MEASURING OCEANIC PROPERTIES LEADING TO THE TOTAL ENVIRONMENTAL SURVEY OF A SELECTED OCEAN AREA ...Coring and Dredging, Oceanic - Pelagic, Radioactivity, Submersibles, Technique Development, ...8.0061
DEEP SUBMERGENCE SYSTEMS ...Buoyant, Flotation, Geomorphology-topography, Marine Propulsion, Navigation Communication, Submersibles, Welding - Other, ...8.0051
SEARCH FOR FERROMAGNETICALLY TRAPPED MAGNETIC MONOPOLES OF COSMIC RAY ORIGIN ...Field Reversals, Magnetic Monopole, Magnetic Studies, Paleomagnetism, ...7.0114

GINEERING PROPERTIES ...Alaska, Engineering Geology, Petrology, Ships and Cruises, Trace Element Analysis, ...8.0169

Origin

THE CYCLE OF ORGANIC MATTER IN THE DEEP SEA ...Abysal, Adsorption, Biogenous, Distribution, Marine Bacteria, ...1.0112
SUBMARINE TOPOGRAPHY ...Bathymetry, Pacific Ocean, Physical Properties, Sedimentation, Textures-structures, ...7.0299
DATING MARINE SEDIMENTS ...Argon-potassium, Loess, Optical, Radiometric Dating, Rate of Deposition, Tertiary, ...7.0201
MARINE GEOLOGY OF THE SUB-ANTARCTIC PACIFIC REGION ...Antarctic Ocean, Core Analysis, Diagenesis, Distribution, Petrology, Sedimentary History, ...7.0049
STRUCTURE, MINERALOGY, AND CHEMICAL COMPOSITION OF MARINE MANGANESE NODULES ...Chemistry, Manganese, Mineralogy, Polished Sections, Precipitates, Textures-structures, ...7.0028
THE GEOCHEMISTRY, MINERALOGY AND ORIGIN OF PELAGIC SEDIMENTS IN AREAS OF HIGH HEAT FLOW AND FRACTURE ZONES ...Chemistry, Diagenesis, Geochemistry, Heat Flow Measurements, Mineralogy, Sedimentation, ...7.0145
PROPERTIES AND ORIGIN OF SEDIMENTS ON THE CONTINENTAL MARGIN OFF WESTERN U. S. ...Erosion, Physical Properties, Sampling, Sedimentation, Shoreline - Coastline, ...7.0271
SEDIMENTS IN BAFFIN BAY AND THE EFFECTS OF AN ARCTIC ENVIRONMENT ON MARINE SEDIMENTATION ...Baffin Bay, Benthonic-bottom, Physical Properties, Polar, Sedimentation, ...7.0265
DEEP-SEA SEDIMENTS - THEIR PROPERTIES AND PROCESSES OF FORMATION ...Acoustical, Basins, Currents-ocean, Depth, Panama, Physical Properties, ...7.0273
SEDIMENT AND VOLCANIC STUDIES ...Distribution, Pacific Ocean, Oceanography ...Basalt, Basaltic, Oceanic Ridge, Volcanic, ...7.0189
PROPERTIES AND ORIGIN OF SEDIMENTS IN THE NORTHEAST PACIFIC OCEAN ...Carbon-14, Core Analysis, Pacific coast, Physical Properties, Washington, ...7.0257
DEEP-SEA SEDIMENTS AND VOLCANIC ROCKS OF MID-OCEAN RIDGES ...Mineralogy, Ridges, Seamounts-guyots, Structural Studies, Tectonics-general, ...7.0226
THE ORIGIN OF GRAVEL BARS IN THE INTERTIDAL ZONE, PARRSBORO HARBOUR, NOVA SCOTIA, CANADA ...Canada, Intertidal Areas, Location, Sand Bars, Size, ...7.0277
INTERPRETING THE ORIGIN AND DISTRIBUTION OF COASTAL SEDIMENTS ...Canada, Distribution, Massachusetts, Shoreline - Coastline, Size, ...7.0213

615
Ocean Sediments

Catalysis and kinetics of manganous ion oxidation in aqueous solution and adsorbed on the surface of manganite. \( \ldots \) Catalysis, Manganese, Oxidation-oxidant, Oxide, Solution, \( \ldots \) .2063

Recent precipitated dolomites and associated minerals. \( \ldots \) Clay Minerals-general, Crystalline Growth, Dolomite, Mineral Type, Phase Relation-Ms, Silicate, \( \ldots \) .1096

Sedimentation

Marine geochemistry research. \( \ldots \) Depth, Gases, Mineral Geochemistry, Radioactive Dating, Thermodynamic, \( \ldots \) .70055

The geochemistry of radioactive elements in the marine environment. \( \ldots \) The geochemistry of landlocked seas. \( \ldots \) Distribution, Element Ratio, Oceans, Sea Water, Radioactive Dating, Uranium, \( \ldots \) .10095

Clay-inorganic and organic-inorganic associations in aquatic environments. \( \ldots \) Clay, Deposits, Mineral Reactivity, Suspension, Trace Elements, \( \ldots \) .70059

Radiation, dosimetry, correlation and dating of clastic deep-sea cores. \( \ldots \) Carbonate-general, Core Analysis, Correlation, Radioactive Dating, Thermoluminescence, \( \ldots \) .70051

Marine geology. \( \ldots \) California, Continental Shelf, Distribution, Ocean Waves - Currents, Submarine Canyons, \( \ldots \) .70260

Marine geology and geophysics. \( \ldots \) Continental Shelf, Crust, Geophysics-general, Ocean Basins, Textures-structures, \( \ldots \) .70048

Simulation models of shallow-water and coastal environments. \( \ldots \) Computer Applications, Gulf of Mexico, Hydrology-model, Model Studies, Shoreline - Coastline, \( \ldots \) .40065

Sedimentation. \( \ldots \) Acoustical, Gravity Tectonics, Gulf of Mexico, Mass Wasting, Mechanical Properties, \( \ldots \) .70281

Submarine topography. \( \ldots \) Bathymetry, Origin, Pacific Ocean, south, Physiography-general, Textures-structures, \( \ldots \) .70229

Sea floor topography. \( \ldots \) Abyssal, Acoustical, Geomorphology-topography, Seamounts-guyots, Structural Studies, \( \ldots \) \( \ldots \) .70242

Sand transport. \( \ldots \) Beach, Ocean Waves - Currents, Sand Bars, Submarine Canyons, Textures-structures, \( \ldots \) .70202

Abrasion plan sedimentation and stratigraphy of Oregon-A. Abrasion, Bathymetry, Coastal and Dredging, Paleoclimatology, Turbidity Currents, \( \ldots \) .70272

Relation of sediment structures and flow directions of coastal currents. \( \ldots \) Coastlines-shorelines, Current Redding, Ocean Currents-other, Paleocurrents, Textures-structures, \( \ldots \) .70276

Early diagenesis of carbonate sediments in a supratidal, evaporatic setting. \( \ldots \) Carbonates-general, Continental Shelf, Diagenesis, Origin, Persian Gulf, Sedimentary history, \( \ldots \) .70253

Carbonate sedimentation in the tongue of the ocean. Bahamas. \( \ldots \) British West Indies, Carbonates, Diagenesis, Paleoclimatology, Sea Level Variations, \( \ldots \) .70267

Support for the operation of oceanographic research vessels. \( \ldots \) Black Sea, Marine Biology, Mediterranean Sea-general, Ships and Cruises, Water Analysis-general, \( \ldots \) .70230

Symposium on research needs and priorities for marine geology of the Gulf of Mexico. \( \ldots \) Continental Shelf, Gulf of Mexico, Instrumentation-general, Mechanical Properties, Meetings, Structural Studies, \( \ldots \) .110040

Nature and velocity of currents and other flows in submarine canyons. \( \ldots \) Convection, Fans, Ocean Waves - Currents, Submarine Canyons, Turbidity Currents, Water Motion Recorders, \( \ldots \) .20008

Optical oceanography in Florida Bay, Florida strait, and Bahama bank. \( \ldots \) Distribution, Mixing, Optical, Optical Devices, Wind-water Interaction, \( \ldots \) .0163

Structure of continental rise off eastern North America. \( \ldots \) Cenozoic Era, Continental Drift, Continental Slopes, Eastern, Sedimentary History, \( \ldots \) .70117

The geochemistry, mineralogy and origin of pelagic soft sediments and areas of high heat flow and fracture zones. \( \ldots \) Chemistry, Diagenesis, Geochemistry, Heat Flow Measurements, Mineralogy, Origin, \( \ldots \) .70227

SUBJECT INDEX

Heavy metal geochemistry of Antarctic sea water and marine sediments. \( \ldots \) Antarctic Ocean, Chemistry, Circulation-general, Water Analysis-general, \( \ldots \) .10086

Depositional processes marginal to large Antarctic ice shelves. \( \ldots \) Antarctic Ocean, Core Analysis, Deposits, Environment, Sedimentary History, \( \ldots \) .70198

Collection, reduction, and interpretation of seismological and photographic data. \( \ldots \) Data Analysis, General, Distribution, Environment, Ocean Basins, Photography, Sedimentary History, Seismic Studies, \( \ldots \) .70262

Properties and origin of sediments on the continental margin off Western U.S. \( \ldots \) Erosion, Origin, Physical Properties, Sampling, Shoreline - Coastline, \( \ldots \) .70271

Sediments in Baffin Bay and the effects of an arctic environment on marine sedimentation. \( \ldots \) Baffin Bay, Benthonic-bottom, Origin, Physical Properties, Polars, \( \ldots \) .70265

(L) The effects of oceanic processes on the deposition of river sediments. \( \ldots \) Physical Properties, Rate of Deposition, Sediment Relationship, Streams, \( \ldots \) .70197

Deep sea sediments in the north Pacific from studies of their biogenic, Core Analysis, Distribution, Pacific Ocean-south, Protorexotherm, \( \ldots \) .70285

Experimental and theoretical research on turbidity currents. \( \ldots \) Currents-others, Hydraulic Structure, Laboratory Analysis, \( \ldots \) .70243

Sea-floor sediments and rock studies. \( \ldots \) Atlantic Ocean, south, Benthic-bottom, Core Analysis, Microfossils, Paleomagnetism, Petrology, Ridges, \( \ldots \) .70046

Recent sedimentation by tidal and longshore currents on a carbonate bank in lower Florida Keys. \( \ldots \) Banks, Currents-longshore, Florida, Quaternary Period, Tides, \( \ldots \) .70253

Coastal and continental shelf sedimentation. \( \ldots \) Argentina, Continental Shelf, Distribution, Sediment Transport-other, Shoreline - Coastline, \( \ldots \) .70212

Changes in sea level in northern Tunesia. \( \ldots \) Archeology, Sea Level Variations, Shoreline - Coastline, Tunisia, \( \ldots \) .70206

Sea floor studies - depositional and erosion processes. \( \ldots \) Bearing Capacity, Distribution, Erosion, Lithification-general, Stability Analysis, \( \ldots \) .70209

Sea floor studies - topography and shape of the sea floor. \( \ldots \) Acoustical, Geomorphology-topography, Photography, \( \ldots \) .70293

Great lakes research - coastal area sedimentation. \( \ldots \) Beach, Development, Energy, General Transport Effects, Great Lakes-general, Model Studies, \( \ldots \) .70124

Hydraulics and dynamics of estuaries. \( \ldots \) Erosion-general, Estuaries, Flow Characteristics, Water, Sedimentology-general, Water Level Fluctuation, Waves, \( \ldots \) .70102

Delaware estuary sedimentation study. \( \ldots \) Delaware Bay, Estuaries, Salinity, Sediment Yield, Supply Rate, \( \ldots \) .70275

Sediment movement and bottom conditions in the Delaware estuary mouth area. \( \ldots \) Bottom Sampling Device, Currents-other, Delaware Bay, Photography, Tides, \( \ldots \) .70220

Marine hydrology and geochemistry. \( \ldots \) Atlantic Continental shelf and slope. \( \ldots \) Atlantic Ocean, north, Chemistry, Continental Shelf, Continental Slope, Saline Water Intrusion, \( \ldots \) .70070

Nearshore heavy metal deposits of the Gulf of Alaska. \( \ldots \) Deposits, Distribution, Heavy Metal Content, \( \ldots \) .70019

Heavy metals and sedimentation process of the North Carolina shelf. \( \ldots \) Bottom Sampling Device, Continental Shelf, Heavy Metals, Mineral Concentration, \( \ldots \) .70021

Organic geochemistry of San Francisco Bay waters and sediments. \( \ldots \) Clays, Distribution, Organics, \( \ldots \) .10075

Quantitative and qualitative characteristics of materials contributing to sedimentation in Lake Erie. \( \ldots \) Lake Erie, Location, Organic, Organics, Rate of Deposition, \( \ldots \) .70246
Ocean Structure-geomorphology

SUBJECT INDEX

NATURE OF INTERTIDAL EROSION ON COXAL *TOLLS ...Erosion, Fossil Limestone, Intertidal Areas, Marine Biology (non-specific). ...7.0210

Banks

GEOLOGICAL AND GEOPHYSICAL INVESTIGATION OF THE BAHAMA BANK ...Bathymetry, British West Indies, Crust, Magnetic Studies, Seismic Studies. ...7.0110

RECENT SEDIMENTATION BY TIDAL AND LONGLINE CURRENTS ON A CARBONATE BANK IN LOWER FLORIDA KEYS ...Currents-longshore, Florida, Quaternary Period, Sedimentation, Tides. ...7.0253

SAMPLING CAMPAIGN ON CORONADO BANK, OFF SOUTHERN CALIFORNIA ...California, Chemistry, Coring and Dredging, Distribution, Phosphate, Phosphite. ...7.0065

Basins

SUBMARINE GEOLOGY OF GASTINEAU CHANNEL JU- NEAU, ALASKA ...Alaska, Distribution, Seismic Studies, Size, Subbottom. ...7.0191

STRUCTURE OF OCEAN BASINS ...Bathymetry, Charts, Indian Ocean-general, Ridges, Structural Studies, ...7.0092

ANALYSIS OF SEISMIC DATA COLLECTED DURING THE INDIAN OCEAN EXPEDITION AND IN THE CARIBBEAN SEA ...Data Analysis - General, Indian Ocean-general, Ridges, Seismic Reflection, Textures-structures, ...7.0119

GEOPHYSICAL INVESTIGATIONS IN THE TAIWAN-PHILIP- PINE-NEW GUINEA REGION ...Gravity Surveys, Heat Flow Measurements, Magnetic Surveys, Seismic Reflection, Submarine Surveys. ...7.0129

HEAT FLOW MEASUREMENTS ...Heat Flow Measurements, Melanisia, Philippines, Ridges, Temperature. ...7.0100

DEEP-SEA SEDIMENTS ...THEIR PROPERTIES AND PROCESSES OF FORMATION ...Acoustical, Currents-ocean, Depth, Origin, Panama, Physical Properties, ...7.0273

ROCKS OF THE OCEANIC CRUST ...Ocean Basins, Petrology. ...7.0061

WESTERN ARCTIC OCEANOGRAPHIC INVESTIGATIONS ...Arctic, Arctic Ocean, Circulation-general, Mixing. ...2.0014

Coastlines-shoreslines

RELATION OF SEDIMENT STRUCTURES AND FLOW DIRECTIONS OF COASTAL CURRENTS ...Current Bedding, Ocean Currents-other, Paleocurrents, Sedimentation, Textures-structures, ...7.0276

FLUID DYNAMICS CENTER ...Cloud Formation and Evolution, Cloud Physics, Model Studies, Satellites, Tropical Cyclones, ...8.017B

SEA SLED AND SCUBA RECONNAISSANCE OF INSHORE AND STUDIES ON EFFECT OF ARTIFICIAL SHELTERS ON STANDING CROP OF FISHES ...Diving and Scuba, Fish, non-specific, Geomorphology-topography, Hawaii, Management -other, ...9.0008

GENERAL COASTAL INLET STUDIES ...Coastal Engineering-.other, Discharge, Model Studies, Synthetic Hydrology, Tides, Water Motion, ...7.0125

Continental Shelves

MARINE GEOLOGY OF CONTINENTAL MARGINS ...Emer- gent, Mexico, Quaternary Period, Regional Structure, Wave- induced Terrace. ...7.0029

CONTINENTAL MARGIN GEOLOGY ...Bay of Bengal, Fans, Seismic Reflection, Subbottom, Textures-structures. ...7.0030

DETAILED STUDY OF THE OCEANIC CRUST BY MEANS OF DEEP SEICOC PROFILING ...Heat Flow Measurements, Seismic Studies, Subbottom, Textures-structures, Washington, ...7.0152

REFLECTION PROFILING OF THE SEA FLOOR ...Atolls, Fault Complexes, Geomorphology-topography, Pacific Ocean-general, Seismic Reflection. ...7.0091

RESEARCH VESSEL OPERATIONS ...Facilities, Oceanography-general, Oregon, Pacific Ocean-coast, Ships and Cruises, ...12.0041


PUERTO RICO OFF NOKA PASSAGE ...Land Economics, Mine Wastes, Oil - Petroleum, Potential of Deposit, Puerto Rico, Sands and Gravels. ...7.0034

Continental Slopes

STRUCTURE OF CONTINENTAL RISE OFF EASTERN NORTH AMERICA ...Cenozoic Era-general, Continental Drift, Eastern, Sedimentary History, Sedimentation. ...7.0117

Deltas

ENVIRONMENT OF DEPOSITION OF ARGILLOACEOUS SEDI- MENTS ...Adosorption Capacity, Benton, Chemistry, Clays, Mississippi River, ...7.0240

MISSISSIPPI DELTA ...Distribution, Heavy Minerals, Mississippi, Ocean Mining, Potential of Deposit, Sedimentary History, ...7.0014

Fans

CONTINENTAL MARGIN GEOLOGY ...Bay of Bengal, Continental Shelves, Seismic Reflection, Subbottom, Textures-structures, ...7.0030

NATURE AND VELOCITY OF CURRENTS AND OTHER FLOWS IN SUBMARINE CANYONS ...Correlation, Ocean Waves - Currents, Sedimentation, Submarine Canyons, Turbidity-Currents, Water Motion Recorders. ...2.0008

SEDIMENT DISPERSAL PATTERNS IN SUBMARINE CANYONS AND SURSEA FANS ...Distribution, Geologic Maps, North America, Submarine Canyons, Textures-structures, ...7.0215

Faults

CONTINUITY OF CLIPPERTON AND CLARIÓN FRACTURE ZONES ...Costa Rica, Geomorphology-topography, Gravity Studies, Seismic Reflection, Structural Studies. ...7.0090

Geomorphology-topography

DEEP SUBMERGENCE SYSTEMS ...Buoyant, Ficticious, Marine Propulsion, Navigation Communication, Physical Properties, Submersibles, Welding - Other. ...8.0061

FEASIBILITY STUDY FOR SYNTHETIC APERTURE ARRAY ACoustIC BOTTOM MAPPING SYSTEM ...Acoustic, Charts - topoher, Mapping. ...4.0061

VISIBLE REGION INSTRUMENTATION FOR OCEANO- GRAPHIC SATELLITES ...Currents-ocean, Mapping, Photog- raphy, Satellites, Shoals. ...8.0088

MARINE GEOLOGY ...Acoustical, Bathymetry, Magnetic Studies, Mapping, Sea Floor Spreading. ...7.0041

ARCTIC RESEARCH ...Acoustical, Arctic Ocean, Currents-ocean, Magnetic Studies, Sea ice, ...4.0049

SEA FLOOR TOPOGRAPHY ... Abyssal, Acoustical, Seamounts-guyots, Sedimentation, Structural Studies, ...7.0294

MARINE GEOPHYSICS ...Caribbean Sea, Geophysical Equipment,Heat Flow Measurements, Magnetic Studies, Structural Studies, ...7.0115

GEOTHERMAL MEASUREMENTS ...Geothermal Gradient, Heat Flow Measurements, Physical Analysis, Physical Properties, Temperature, ...7.0136

NORTH ATLANTIC CIRCULATION ...Atlantic Ocean-north, Circulation-general, Gulf Stream, Hydrodynamics, Oceanic Fronts. ...2.0031

SUBMARINE CANYONS ...California, Development, Erosional Features, Photography, Submarine Canyons, ...7.0298

SUPPORT OF UNIVERSITY OF GEORGIA MARINE INSTI- TUTE RESEARCH VESSEL OPERATION ... Continental Shelf, Continental Slope, Distribution, Environmental Ecology, Estuaries, Marine Biology, Pollution Sources-general, Ships and Cruises, Textures-structures, ...12.0026

REDUCTION AND INTERPRETATION OF PHYSIOGRAPHIC DATA ACQUIRED ABOARO LAMONT DEEP-SEA RESEARCH VES- SELS ...Data Analysis - General, Data Reduction and Analysis, Geology-general, Ocean Basins, Physiography-general. ...7.0500

DEEP FLOW, WATER CHARACTERISTICS, TOPOGRAPHY AND SEDIMENTS IN THE CENTRAL PACIFIC AREA ...Abyssal, Currents-bottom, Distribution, Pacific Ocean-general, Structural Studies, Water Motion Recorders. ...7.0032

REFLECTION PROFILING OF THE ATLANTIC FLOOR ... Atolls, Continental Shelves, Fault Complexes, Pacific Ocean-general, Seismic Reflection. ...7.0091

OPERATION OF R/V TRIDENT ... Phytoplankton, Sea Floor Spreading, Ships and Cruises, Sound Production, Subbottom, Vertical Distribution. ...12.0048

THEORETICAL STUDIES OF TSUNAMI PROPAGATION ...Depth, Environmental Effects-geologic, Forecasting-predict- ion, Tsunami, Waves. ...2.0122
Ocean Structure-geomorphology

SUBJECT INDEX

Seamounts-quivuts

SEA FLOOR TOPOGRAPHY ...Abyssal, Acoustical, Geomorphology-topography, Sedimentation, Structural Studies, ...7.0294
RECENT AND ANCIENT FAUNAS OF A DROWNED ISLAND CHAIN (MID-PACIFIC MOUNTAINS) ...Benthic Fauna, Biofacies, Coring and Dredging, Hawaii, ...5.0063
GEOPHYSICAL AND GELOGICAL STUDY OF THE DARK-WIN RISE ...Bathymetry, Coring and Dredging, Geophysics-general, Gravity Studies, Magnetic Studies, Ocean Basins, Pacific Ocean-west, Photography, Refraction, Ridges, ...7.0112
THE MAGNETIZATION OF SUBMARINE BASALTS AND ITS EFFECT ON MARINE MAGNETIC ANOMALIES ...Anomalies, Extrusives, Field Reversals, Magnetic Studies, Paleomagnetism, ...7.0153
DEEP-SEA SEDIMENTS AND VOLCANIC ROCKS OF MID-OCEAN RIDGES ...Mineralogy, Origin, Ridges, Structural Studies, Tectonics-general, ...7.0266
SEA USE ...General Synoptic Observations, Marine Biology, Oceanography-general, Pacific Ocean-east, Platforms, ...7.0363
SEAMOUNT IN ESTIMATION ...Anomalies, Data Analysis - General, Geothermal, Magnetic Studies, Ocean Mining, Sonar, ...7.0107

Structural Studies

STUDY OF EARTH NOISE ON LAND AND SEA BOTTOM ...Microrheins - Background, Ocean Basins, Propagation, Seismic Studies, ...7.0094
SEA FLOOR TOPOGRAPHY ...Abyssal, Acoustical, Geomorphology-topography, Seamounts-quivuts, Sedimentation, ...7.0294
MARINE GEOPHYSICS ...Caribbean Sea, Geomorphology-topography, Geophysical Equipment, Heat Flow Measurements, Magnetic Studies, ...7.0115
STRUCTURE OF OCEAN BASINS ...Basins, Bathymetry, Charts, Indian Ocean-general, Ridges, ...7.0092
ANALYSIS OF ROCKS COLLECTED IN THE INDIAN AND ATLANTIC OCEANS ...Atlantic Ocean-general, Crust, Indian Ocean-general, Ocean Basins, Petrology, ...7.0073
OPERATIONAL SUPPORT OF OCEANOGRAPHIC RESEARCH VESSELS ...Facilities, Geophysics-general, Hawaii, Sediments-general, ...12.0027
DEEP FLOW, WATER CHARACTERISTICS, TOPOGRAPHY AND SEDIMENTS IN THE CENTRAL PACIFIC AREA ...Abyssal, Currents-bottom, Distribution, Geomorphology-topography, Pacific Ocean-general, Water Motion Recorders, ...7.0032
TECTONIC AND GEOLOGICAL HISTORY OF THE SOUTHWEST PACIFIC REGION ...Gases, Geophysics-general, Island Arcs, Oceans - Sea Water, Pacific Ocean-south, Tectonics-general, ...7.0031
SYMPOSIUM ON RESEARCH NEEDS AND PRIORITIES FOR MARINE GEOLOGY OF THE GULF OF MEXICO ...Continental Shelf, Gulf of Mexico, Instrumentation-general, Mechanical Properties, Meetings, Sedimentation, ...11.0040
GEOPHYSICAL INVESTIGATIONS IN THE CORAL SEA ...Biosys, Coral Sea, Crust, Regional Structure, Seismic Refraction, ...7.0130
A STUDY OF THE STRUCTURAL RELATIONS BETWEEN THE MID-PACIFIC OCEANIC RIDGES AND FRACTURE ZONES ...Anomalies, Ocean History, Paleomagnetism, Ridges, Tectogenesis, ...7.0111
UNDERWATER CAMERA SYSTEM ...Equipment Purchase Operation, Pacific Ocean-north, Photography, Sedimentation-general, ...8.0154
CONTINUITY OF CLIPPERTON AND CLARION FRACTURE ZONES ...Anomalies, Ocean History, Paleomagnetism, Ridges, Tectogenesis, ...7.0111
GEOLOGICAL INVESTIGATIONS IN THE CORAL SEA ...Biosys, Coral Sea, Crust, Regional Structure, Seismic Refraction, ...7.0130
A STUDY OF THE STRUCTURAL RELATIONS BETWEEN THE MID-PACIFIC OCEANIC RIDGES AND FRACTURE ZONES ...Anomalies, Ocean History, Paleomagnetism, Ridges, Tectogenesis, ...7.0111
SEAFLOOR OBSERVATIONS DURING THE 1969 CRUSTAL ORIENTA...
SUBJECT INDEX

DEEP OCEAN RESEARCH AND DEEP OCEAN ENGINEERING

MARBLED CANYONS

DEEP OCEAN RESEARCH AND DEEP OCEAN ENGINEERING

MARINE GEOLOGY OF THE SAN FRANCISCO BAY

CENTRAL CALIFORNIA CONTINENTAL MARGIN

Subbottom

EXPERIMENTAL HIGH RESOLUTION SUB-BOTTOM PROFILING SYSTEM

MARINE GEOLOGY OF OCEAN FLOOR CHUCKU CAMERON CHANNEL JUKINS, ALASKA

MARINE GEOLoGY OF THE SOUTHWEST MARGIN OF JAPAN

SUBMARINE SEDIMENTS

MARINE SEDIMENTS

MARINE SEDIMENTS

MARINE SEDIMENTS

MARINE SEDIMENTS

MARINE SEDIMENTS

MARINE SEDIMENTS

MARINE SEDIMENTS

MARINE SEDIMENTS

MARINE SEDIMENTS

MARINE SEDIMENTS

MARINE SEDIMENTS

MARINE SEDIMENTS

SUBMARINE CANOYS

MARINE GEOLOGY

SAND TRANSPORT

SUBMARINE CANYONS

NATURE AND VELOCITY OF CURRENTS AND OTHER FLOWS IN SUBMARINE CANOYS

GEOLoGICAL SURVEY OF MARIBO CANYON

OCEAN CIRCULATION

OCEAN CIRCULATION

OCEAN CIRCULATION

OCEAN CIRCULATION

OCEAN CIRCULATION

OCEAN CIRCULATION

OCEAN CIRCULATION

OCEAN CIRCULATION

Ocean Fronts

COlumbIA RIVER EFFECTS IN THE NORTHEAST PACIFIC

RADIOELEMENT STUDIES IN THE OCEANS - LANTHANIDES IN SEA WATER AND THEIR INTERACTIONS WITH MARINE SEDIMENTS AND SUSPENSIONS

ATLANTIC OCEAN-GENERAL, LANTHANIDE SERIES, RADIOCHEMICAL ANALYSIS, TRACE ELEMENTS, WATER ANALYSIS

OCEAN CIRCULATION, AND CONTROLLING FACTORS FOR PREDICTION

Ocean Fronts

OCEAN CIRCULATION

OCEAN CIRCULATION

OCEAN CIRCULATION

OCEAN CIRCULATION

OCEAN CIRCULATION

OCEAN CIRCULATION
OCEANIC FRONTS

SUBJECT INDEX

NORTH ATLANTIC CIRCULATION ...Atlantic Ocean-north, Circulation-topography, Gulf Stream, Hydrodynamics, ...0.0031

INDUCTION IN THE OCEAN ...Cord, Currents-ocean, ...0.0137

CIRCULATION OF THE PACIFIC ...Circulation-density, Pacific Ocean-general, Sampling, Subs ...face Environments, ...2.0007

OCEAN-ATMOSPHERE STUDIES WITH STABLE ISOTOPES AND DISSOLVED GASES ...Air-sea boundary-general, Equilibrium - Chemical, Gases, Mixing, Particle-gas Transfer, Tracers, ...3.0005

PHYSICAL AND CHEMICAL PROPERTIES OF THE SHELF AND SLOPE WATERS OFF NORTH CAROLINA ...Atlantic Ocean-north, Continental Shelf, General Sea Water Chemistry, North Carolina, Water Properties-general, ...1.0156

AN INVESTIGATION OF THE OVERFLOW OF NORWEGIAN SEA WATER INTO THE NORTH ATLANTIC THROUGH DENMARK STRAIT ...Atlantic Ocean-north, Norwegian Sea, Ocean Currents-other, ...2.0032

AIRBORNE SEA SURFACE MEASUREMENTS IN THE EQUATORIAL PACIFIC ...Atolls, Humidity, Infrared Radiation, Mapping, Radiation Detection, Temperature, ...1.0190

FORMATION OF ANTARCTIC BOTTOM WATERS ...Buoys, Hydrodynamics, Salinity, Temperature, Weddell Sea, ...1.0152

STRATIGRAPHY OF UNCONSOLIDATED SEDIMENTS ON THE CONTINENTAL SHELFS OF THE CHUKCHI AND NORTHEASTERN BERING SEAS ...Sea Floor, Chukchi Sea, Continental Shelf, Core Analysis, Correlation, Sedimentary History, ...7.0286

HYDROLOGIC OPTICS - SPACELIGHT SPECTROSCOPY ...Attenuation, Intensity, Optical, Phytoplankton, Radiograph, Radiometer, Scattering, Spectrophotometer, ...4.0139

WATER MASSES, CURRENTS AND ORIGIN OF THE ATLANTIC BOTTOM WATER IN THE WEDDEL SEA, ANTARCTICA ...Currents-bottom, Depth, Salinity, Sampling, Temperature, Weddell Sea, ...4.0134

CHEMICAL FEATURES OF THE SUBARCTIC BOUNDARY IN THE NORTHERN PACIFIC OCEAN ...Carbon Dioxide, Circulation-general, Gases, Mixing, Pacific Ocean-north, Sub-Polar, ...1.0125

RESEARCH IN OCEANIC PHYSICS ...Atlantic Ocean-south, Convection, Mixing, Thermodynamics, Wind-water Interaction, ...2.0095

CURRENTS AND WATER MASSES IN THE SOUTHWEST ATLANTIC ...Circulation-general, Currents-ocean, Subsurface Environment, ...2.0041

NATURAL RADIOCARBON MEASUREMENTS ...Carbon-14, Facilities, Mixing, Pacific Ocean-general, Radioactivity, ...1.0084

THE OPTICAL PROPERTIES OF SEA WATER AND THEIR USE IN OCEANOGRAPHIC RESEARCH & DEVELOPMENT ...Attenuation, Optical, Oregon, Salinity, Suspension, Temperature, ...1.0091

DIRECT AND INDIRECT DETERMINATION OF OCEANIC WATER MASS MOTION ON ALL SCALES ...Buoys, Currents-ocean, Pacific Ocean-east, Salinity, Temperature, ...2.0092

CHEMICAL PROPERTIES OF SEA WATER AND THEIR USE IN STUDIES OF WATER MASSES AND MIXING ...Chemical Reactions, Gases, Mixing, Pacific Ocean-east, Water Analysis, ...1.0126

CHARACTERISTICS, CAUSES, AND PREDICTION OF UPPWELLING WATER MASS OFF OREGON ...Forecasting-prediction, Mixing, Oregon, Pacific Ocean-east, Water Motion Recorders, ...2.0062

CIRCULATION IN THE GULF OF MEXICO ...Circulation-general, Currents-ocean, Gulf of Mexico, Infrared Radiation, Mapping, ...2.0022

ORGANIC MATTER ...Atlantic Ocean-general, Mixing, Organics, Oxygen, Sampling, Ships and Cruises, ...1.0111

ELEMENT CHEMISTRY ...Atomic Absorption, Element Ratios, Industrial Wastes, Water Chemistry-other, ...1.0113

OCEANOGRAPHIC PROCESSES IN ESTUARINE AND COASTAL WATERS ...Pacific Ocean-east, Puget Sound, Shoreline - coastline, Washington, Water Properties-general, ...2.0000

NUMERICAL OCEANOGRAPHIC MODEL DEVELOPMENT FOR ENVIRONMENTAL PREDICTION ...Forecasting-prediction, Marine Environments-general, Meteorological Studies, Model Studies, Weather Forecasting, ...4.0077

CHEMICAL STUDIES OF THE OCEANIC ENVIRONMENT ...Chemical Reactions, Marine Environments-general, Pacific Ocean-east, Trace Elements, Water Analysis-general, ...1.0136

FINE STRUCTURE FEATURES OF TEMPERATURE AND SALINITY AT WATER MASS BOUNDARIES IN PACIFIC ...Circulation-general, Mixing, Pacific Ocean-north, Salinity, Temperature, ...2.0046

CHEMICAL OCEANOGRAPHY ...Arctic, Circulation-general, Isotope Tracer-other, Tracers, Water Analysis-general, ...1.0072

ARCTIC PLANKTON ECOLOGY ...Acoustical, Arctic, Marine Biology, (non-specific), Plankton (non-specific), Population Dynamics, ...1.0017

WATER MASS TRACERS ...Acoustical, Circulation-general, Currents-ocean, Tracers, ...2.0060

VERTICAL OCEAN CIRCULATION ...Circulation-general, Convection, Model Studies, Subsurface Environments, ...2.0036

DRIFT-STATION BIOLOGY ...Alaska, Animal Taxonomy, Arctic Ocean, Productivity - Food Chain, Species Life History, ...5.0210

SYSTEMATICS, BIOLOGY, AND HYDROGRAPHIC RELATIONS OF SOME SPECIES OF CALANUS (CRUSTACEAE, CALANIDAE) ...Arctic, Animal Taxonomy, Marine Invertebrates, Invertebrate Anatomy, Vertical Distribution, ...6.0367

WOODS HOLE ENVIRONMENTAL STUDIES IN PHYSICAL OCEANOGRAPHY ...Acoustical, Bathytethermographs, Salinity, Temperature, Velocity, ...1.0066

STUDY OF NORTH AND EQUATORIAL ATLANTIC PLANKTONIC FORAMINIFERA ...Foraminifera, Number Or Density, Organisms Sampling Devices, Vertical Distribution, ...7.0764

EFFECTS OF HOT WATER MASSES ON MARINE FISHES ...Atlantic Ocean-north, Behavior, Fish (non-specific), High Temp., ...5.0310

BRISTOL BAY ESTUARINE ECOLOGY ...Alaska, Estuaries, Fishing Gear, Life History Studies, Migration, Salmon - colo-chinook, sockeye, ...5.0064

INVESTIGATE FACTORS DETERMINING DISTRIBUTION OF PHYSICAL AND CHEMICAL PROPERTIES OF THE PACIFIC OCEAN ...Currents-ocean, Hawaii, Mathematical Analysis, Model Studies, Pacific Ocean-general, ...5.0088

INVESTIGATE SEASONAL VARIATIONS, SURFACE WATER TYPES, HAWAIIAN AREA (KOKO HEAD) ...Commercial Fishing, Hawaii, Heat and Radiation Transfer, Salinity, Temperature, Tuna, Mackert, Albacore, ...1.0148

GLPI STUDY OF LIMITED PORTION OF TRADE WIND ZONE OCEANOGRAPHY (DATA AND DESCRIPTIVE REPORTS) ...Environmental Changes, Pacific Ocean-north, Technique Development, Water Properties-general, ...4.0129

ANALYZE AND PUBLISH BASIC DATA: FROM PILOT STUDY ...Environmental Changes, Pacific Ocean-general, Salinity, Technique Development, Thermal, ...4.0024

SPECIES LIFE HISTORY AND DISTRIBUTION ...California Current, Fish (non-specific), Life History Studies, Maturity & Growth Stages, Number Or Density, ...5.0037

OCEANOGRAPHY-GENERAL

STUDY OF OCEANOGRAPHIC MARKETS ...Consumption, Economics, Manufacturing, Trends,projections, ...4.0176

FISHERIES OCEANOGRAPHY AND ENVIRONMENTAL ASSESSMENT AND PREDICTION ...Commercial Fishing, Convection, Spacecraft Sensory Devices, Thermal, ...4.0159

ARCTIC BIBLIOGRAPHY PROJECT ...Arctic, Bibliography, Geophysics-general, Meteorological Studies-general, ...11.0013

SUPPORT OF THE NATIONAL OCEANOGRAPHIC DATA CENTER ...Data & Statistics Storage, Documents & Literature, ...12.0017

COMMITTEE ON OCEANOGRAPHY ...Air-sea Boundary-general, Committee-support, Marine Environments-general, Radioactivity-general, ...11.0016

LAW OF THE SEA ...Laws-studies, general, ...10.0004

RESEARCH TRAINING IN MARINE BIOLOGY, PALEONTOLOGY AND SYSTEMATIC ZOOLOGY ...Animal Taxonomy, Invertebrates (non-specific), Paleontology, Training Grants, Fellowship, ...11.0003

RESEARCH-TRAINING COURSE IN OCEANOGRAPHY IN SOUTHEAST ALASKA ...Alaska, Teaching and Research, ...12.0001

UNDERGRADUATE RESEARCH PARTICIPATION ...Teaching and Research, ...11.0017

622
# SUBJECT INDEX

## Optics
- **Concurrency Limit Standards for Signal Colors**
  - Air Traffic Control-Other, Filter, Navigation Communication, Standards, Specifications, Traffic Control, ...4.0096
- **Application of ICS-NBS Centroid Colors and Method of Designation Colors**
  - Dyes and Coloring, Paint General, Photography-chemistry, Pigments, Standards, Specifications, ...4.0097
- **Naval Aircraft Lighting**
  - Aircraft, Equipment-instruments, Lighting, Standards, Specifications, ...8.0080

## Frequency Range
- **Visible**
  - Research in Air-Energy Exchange ...Heat and Radiation Transfer, Lasers and Masers, Optical, Thermal, ...3.0038
- **Psychophysical Effects of Xenon Flashtubes**
  - Electronic-flash-lights, Navigation Communication, Optical Sources, Lamps, Xenon, ...8.0053

## Heterodyne System
- **Heterodyne Measurements of Atmospheric Phase Turbulence at 6328A**
  - Other-design-and-construction, Phase, Transmission, Turbulence, ...8.0190

## Holography
- **Holographic Instrumentation for Marine Plankton Studies**
  - Lasers and Masers, Photography, Zooplankton, ...8.0066
- **Underwater Acoustic Holographic Display**
  - Acoustical, Detectors, Instrumental Services, Photography, Recognition Systems, ...8.0137
- **Underwater Holographic Imaging**
  - Imaging, Photography, Technique Development, ...8.0069
- **Acoustic Holography**
  - Acoustical, Diffraction, Liquids, Ocean Mining, ...8.0255

## Imaging
- **Underwater Holographic Imaging**
  - Holography, Photography, Technique Development, ...8.0069
- **Photographic Image Evaluation**
  - Cybernetics, Photography-chemistry, Statistical Information Theory, ...4.0053
- **Experimental Sea Ice Observational Techniques**
  - Data Acquisition, Instrumental Services, Ku.uge and Tracking-Other, Satellites, Sea Ice, ...4.0186

## Intensity
- **Hydrologic Optics - Spacelight Spectroscopy**
  - Attenuation, Oceanic Fronts, Optical, Photoplankton, Radiograph, Radiometer, Scattering, Spectrophotometer, ...4.0139

## Interferometry
- **Reflectivity and Emissivity Standards**
  - Atmosphere Radiation, Infrared Radiation, Radiation, Radiation-General, Standards, Specifications, ...4.0142

## Microscopy
- **Computer Processing of Microscope Imagery**
  - Computer Applications, Resolution, ...8.0063

## Optical Sources, Lamps
- **Psychophysical Effects of Xenon Flashtubes**
  - Electronic-flash-lights, Navigation Communication, Visible, Xenon, ...8.0053

## Optical Systems
- **An Optical Method of Measuring the Form of the Free Surface of a Fluid**
  - Fluid Dynamics, Free Surface Waves, Models, Optical, Watersheds, Waves, ...2.0124
- **Oceanographic Research**
  - Absorption Spectrum, Depth, Neal-specific, Optical, Optical Devices, ...1.0167

## Phase
- **Heterodyne Measurements of Atmospheric Phase Turbulence at 6328A**
  - Heterodyne System, Other-design-and-construction, Transmission, Turbulence, ...8.0190

## Photography
- **Holographic Instrumentation for Marine Plankton Studies**
  - Lasers and Masers, Zooplankton, ...8.0066
- **Photographic Standards**
  - Photography-chemistry, Standards, Specifications, ...8.0077

## Radiograph, Radiometer
- **X-Radiographic and Electronic Fluoroscopic Equipment**
  - Core Analysis, Equipment Purchase Operation, Instrumental Services, X Ray Tubes, ...8.0094
- **Hydrologic Optics - Spacelight Spectroscopy**
  - Attenuation, Intensity, Oceanic Fronts, Optical, Photoplankton, Scattering, Spectrophotometer, ...4.0139

## Refraction
- **Hydrogen Properties**
  - Density, Dielectric Properties, Fuel Cell-other, Hydrogen, Marine Propulsion, ...8.0157

## Index of Refraction
- **Light in the Sea**
  - Optical, Scattering, Tracers, Water Analysis-General, Water Motion, ...1.0168

## Resolution
- **Computer Processing of Microscope Imagery**
  - Computer Applications, Microscopy, ...8.0063

## Scattering
- **Light in the Sea**
  - Index of Refraction, Optical, Tracers, Water Analysis-General, Water Motion, ...1.0168
- **Hydrologic Optics - Spacelight Spectroscopy**
  - Attenuation, Intensity, Oceanic Fronts, Optical, Photoplankton, Radiograph, Radiometer, Spectrophotometer, ...4.0139
- **Measurement of Water Velocity by Optical Methods in the MIT Propeller Tunnel**
  - Rotors-propellers, Velocimeter, Water Tunnels Tables, ...8.0182

## Spectrophotometer
- **Hydrologic Optics - Spacelight Spectroscopy**
  - Attenuation, Intensity, Oceanic Fronts, Optical, Photoplankton, Radiograph, Radiometer, Scattering, ...4.0139

## Transmission
- **Heterodyne Measurements of Atmospheric Phase Turbulence at 6328A**
  - Heterodyne System, Other-design-and-construction, Phase, Turbulence, ...8.0190

## Oregon
- **Research in Marine Ben-thic Ecology Off Oregon**
  - Benthic Fauna, Environmental Ecology, Number or Density, Vertical Distribution, ...5.0916
- **Population Studies on Intertidal Invertebrates**
  - Australia, Gastropods -slugs,conch,snails, Growth Rate, Loneliness, Sturries, ...5.1021
- **Student Research at the Marine Science Center**
  - Facilities, Intertidal Animals, Physiology, Invertebrates -non-specific, Training Grants, Fellowships, ...11.0039
- **Fluxes of Dissolved Gases and Nutrients Relation to Biochemical and Aeration Processes Off the Oregon Coast**
  - Chemical Analysis (water), Gases, Organics, Particle-gas Transfer, Phosphate, Phosphite, ...3.0037
- **Modern Foraminifera Off Oregon**
  - Continental Shelf, Foraminifera, Pacific Ocean-General, Vertical Distribution, ...5.0020
SUBJECT INDEX

STUDY OF NORTH AND EQUATORIAL ATLANTIC PLANKTIC FORAMINIFERA ...Foraminifera, Number Or Density, Oceanic Fronts, Vertical Distribution, ...6.0764

PRE-CONSTRUCTION ENVIRONMENTAL SURVEY ...Construction Land Use Effects, Construction Sites, Continental Shelf, Environmental Ecology, Reefs, ...5.0907

DESIGN AND DEVELOPMENT OF NEKTON SAMPLER ...Food Supply, Nektonic - Swimming, Plankton Sampling, Tuna, Mackerel, Albacore, ...8.0129

PRODUCTIVITY MEASURES ...Number Or Density, Ocean Currents-other, Pacific Oceanic, Primary Productivity, Productivity - Food Chain, Zooplankton, ...5.0940

Oxygen

OXYGEN RESOURCES OF TIDAL WATERS ...Autotrophic, Carbon Dioxide Fixation in Heterotrophic Organisms, ...5.0033

CARBON DIOXIDE FIXATION IN HETEROTROPHIC ORG... ...Benthic Flora, Oxygen Content -water, Puget Sound, ...5.1363

STABLE ISOTOPE FRACTIONATION IN ECHINODERM CALCITE ...Animal Taxonomy, Biogeochemical Process, Calcite, Carbon, Living Organisms, Marine Organisms, Sea Feathers-ssa Lilly, ...7.0085

LIGHT ISOTOPE STUDIES ...Chemical Reacti-ns, Circulation-general, Deuterium, Isotope-tracer other, Mixing, Particle-gas Transfer, ...8.0097

RELATIONSHIP OF PHOTOSYNTHESIS TO RESPIRATION OF OCEANIC MICROALGAE ...Light, Marine Plants, Mass Spectroscopy, Photosynthesis, Respiration, ...5.0774

MEASUREMENTS OF OXYGEN CONSUMPTION BY THE SEA BED IN DEEP WATER OF PUGET SOUND ...Benthic Flora, Chemistry, Oxygen Content -water, Puget Sound, ...5.1363

STABLE ISOTOPE FRACTIONATION IN ECHINODERM CALCITE ...Animal Taxonomy, Biogeochemical Process, Calcite, Carbon, Living Organisms, Marine Organisms, Sea Feathers-ssa Lilly, ...7.0085

DEVELOPMENT OF AN INSTRUMENT FOR MEASURING THE CONCENTRATION OF DISSOLVED OXYGEN IN SEA WATER IN SITU ...Chemical Analysis (water), Gases, Instrumental Services, Technique Development, Telemetry-other, ...8.0092

STABLE CARBON AND OXYGEN ISOTOPE RATIO VARIATIONS IN THE FLOW TO CARBON AND OXYGEN THROUGH NORTHERN PACIFIC OCEANIC SYSTEMS ...Carbon, Element Ratios, Organic-general, Pollutants -Path of, Sewage Services-other, Water Analysis, ...1.0132

INSTRUMENT DEVELOPMENT ...Navigation, Satellites, Technique Development, ...6.0065

PRECISION MEASUREMENTS OF DISSOLVED OXYGEN, NITROGEN AND ARGON IN SEA WATER ...Argon, Gases, Nitrogen, Particle-gas Transfer, Solubility, Special Mission Ships, ...1.0092

ORGANIC MATTER ...Atlantic Ocean-general, Mixing, Oceanic Fronts, Organics, Sampling, Ships and Cruises, ...1.1011

MICROBIOLOGICAL CONTROL IN NAVY AND MARINE CORPS OPERATING ENVIRONMENTS ...Fouling, Medical Studies, Microorganisms (non-specific), ...5.0740

A STOCHEMICAL MODEL FOR POLLUTION IN ESTUARIES ...Estuaries, Ions and Gases, Model Studies, Water Quality Control-general, Water Quality-general, ...6.0188

DEEP SUBMERSIBLE DISSOLVED OXYGEN ...TRANS-DUCER- ...Gases, Instrumental Services, Submersibles, Transducers, ...8.0057

THE THERMODYNAMIC PROPERTIES OF NITROGEN-OXYGEN MIXTURES ...Critical, Entropy, Enthalpy, Nitrogen, State Equations, Survey Studies, ...6.0025

CARBON DIOXIDE FIXATION IN HETEROTROPHIC ORGANISMS III THE BREAKDOWN OF GLYCOGEN IN MARINE INVERTEBRATES ...Alkaline, Carbon Dioxide Fixation, Catabolism and Degradation, Glyco... ...5.1073

OXYGEN RESOURCES OF TIDAL WATERS ...Autotrophic, Marine Biology (non-specific), Oxygen Content -water, Pollution Sources-general, Tides, ...1.0119

OXYGEN RESOURCES OF TIDAL WATERS ...Autotrophic, Marine Biology (non-specific), Oxygen Content -water, Pollution Sources-general, Tides, ...1.0119

OXYGEN PROPERTIES ...Density, Liquid Propellant Rock, Oxidizers, Specific Heat, State Equations, Thermodynamic Relation, ...8.0174

CHEMISTRY OF THE HYPOXIMNION OF LAKE ERIE ...Chemical-general, Ions and Gases, Lake Erie, Oxygen, Stratification, ...1.0115

DETERMINATION OF SELECTED ENVIRONMENTAL REQUIREMENTS OF IMPORTANT SPECIES OF MARINE ZOOPLANKTON ...Copepods, Water Salinity, Water Temperature-non-specific, Zooplankton, ...5.0835

OXYGEN RESOURCES OF TIDAL WATERS ...Autotrophic, Marine Biology (non-specific), Oxygen Content -water, Pollution Sources-general, Tides, ...1.0119

OXYGEN RESOURCES OF TIDAL WATERS ...Autotrophic, Marine Biology (non-specific), Oxygen Content -water, Pollution Sources-general, Tides, ...1.0119

OXYGEN PROPERTIES ...Density, Liquid Propellant Rock, Oxidizers, Specific Heat, State Equations, Thermodynamic Relation, ...8.0174

CHEMISTRY OF THE HYPOXIMNION OF LAKE ERIE ...Chemical-general, Ions and Gases, Lake Erie, Oxygen, Stratification, ...1.0115

DETERMINATION OF SELECTED ENVIRONMENTAL REQUIREMENTS OF IMPORTANT SPECIES OF MARINE ZOOPLANKTON ...Copepods, Water Salinity, Water Temperature-non-specific, Zooplankton, ...5.0835

Pacific Ocean

OXYGEN PROPERTIES ...Density, Liquid Propellant Rock, Oxidizers, Specific Heat, State Equations, Thermodynamic Relation, ...8.0174

CHEMISTRY OF THE HYPOXIMNION OF LAKE ERIE ...Chemical-general, Ions and Gases, Lake Erie, Oxygen, Stratification, ...1.0115

DETERMINATION OF SELECTED ENVIRONMENTAL REQUIREMENTS OF IMPORTANT SPECIES OF MARINE ZOOPLANKTON ...Copepods, Water Salinity, Water Temperature-non-specific, Zooplankton, ...5.0835

Pacific Ocean

OXYGEN PROPERTIES ...Density, Liquid Propellant Rock, Oxidizers, Specific Heat, State Equations, Thermodynamic Relation, ...8.0174

CHEMISTRY OF THE HYPOXIMNION OF LAKE ERIE ...Chemical-general, Ions and Gases, Lake Erie, Oxygen, Stratification, ...1.0115

DETERMINATION OF SELECTED ENVIRONMENTAL REQUIREMENTS OF IMPORTANT SPECIES OF MARINE ZOOPLANKTON ...Copepods, Water Salinity, Water Temperature-non-specific, Zooplankton, ...5.0835

Pacific Ocean

OXYGEN PROPERTIES ...Density, Liquid Propellant Rock, Oxidizers, Specific Heat, State Equations, Thermodynamic Relation, ...8.0174

CHEMISTRY OF THE HYPOXIMNION OF LAKE ERIE ...Chemical-general, Ions and Gases, Lake Erie, Oxygen, Stratification, ...1.0115

DETERMINATION OF SELECTED ENVIRONMENTAL REQUIREMENTS OF IMPORTANT SPECIES OF MARINE ZOOPLANKTON ...Copepods, Water Salinity, Water Temperature-non-specific, Zooplankton, ...5.0835

Pacific Ocean

OXYGEN PROPERTIES ...Density, Liquid Propellant Rock, Oxidizers, Specific Heat, State Equations, Thermodynamic Relation, ...8.0174

CHEMISTRY OF THE HYPOXIMNION OF LAKE ERIE ...Chemical-general, Ions and Gases, Lake Erie, Oxygen, Stratification, ...1.0115

DETERMINATION OF SELECTED ENVIRONMENTAL REQUIREMENTS OF IMPORTANT SPECIES OF MARINE ZOOPLANKTON ...Copepods, Water Salinity, Water Temperature-non-specific, Zooplankton, ...5.0835

Pacific Ocean

OXYGEN PROPERTIES ...Density, Liquid Propellant Rock, Oxidizers, Specific Heat, State Equations, Thermodynamic Relation, ...8.0174

CHEMISTRY OF THE HYPOXIMNION OF LAKE ERIE ...Chemical-general, Ions and Gases, Lake Erie, Oxygen, Stratification, ...1.0115

DETERMINATION OF SELECTED ENVIRONMENTAL REQUIREMENTS OF IMPORTANT SPECIES OF MARINE ZOOPLANKTON ...Copepods, Water Salinity, Water Temperature-non-specific, Zooplankton, ...5.0835
### SUBJECT INDEX

| Subpopulations | Anchovies, Commercial Fishing, Population Dynamics | .5.0122 |
| Pacific Biological Research | Buildings, Mycobacterium Leprae, Pharmacognosy | .6.0112 |
| New Drugs from the Sea, Especially Antibiotics | Antibiotics, Caribbean Sea, Maris's Plants | .6.0112 |
| Marine Toxins of the Tropical Pacific | Algal Metabolites (non-specific), Fish - non-specific, Polynertia, Toxicology, Toxins | .6.0113 |

### Paleoenvironments

#### Pacific Ocean-North

**STUDY OF THE DISTRIBUTION OF RADIONUCLIDES IN THE OCEAN** Detailed Exploration of Cs137 in the Ocean, Cesium, Chemical Analysis (water), Circulation-general, Convection, Reactivity | .5.0130

**ECOLOGICAL STUDIES OF RADIOACTIVITY IN THE COLUMBIA RIVER ESTUARY AND ADJACENT PACIFIC OCEAN** Columbia River, Contamination - Water, Organism Sampling Devices, Pollutants - Path of, Reactivity-general, Water Quality, Reactivity-general | .6.0113

**PACIFIC GRAVITY** Anomalies, Crust, Earth Interior, Geophysical Equipment, Gravity Studies | .7.0144

**CONVEXTIVE STUDIES** Convection, Sonar, Thermal | .7.0111

**WAVES** Thermal, Waves, Waves-internal | .7.0117

**MOHOLE SITE STUDIES** Coring and Dredging, Earth Interior | .7.0117

**Springs** | .7.0117

**POSTPLEISTOCENE OCEANOGRAPHY AND BIOLOGY** of the Eastern North Pacific | .7.0115

**The Contribution of Advection and Local Heating to the Maintenance of the Thermal Structure in the North Pacific Ocean** | .7.0113

**STUDY OF RADIOLARIA IN SURFACE SEDIMENTS OF THE NORTHEAST PACIFIC** Animal Taxonomy, Biogenous, Protozoa - other, Vertical Distribution | .7.0117

**LENGTHENING AND INCREASING OCEANOGRAPHIC CAPABILITIES OF R/V ACONA** | .7.0117

**OCEANOGRAPHIC VESSEL OPERATIONS** Equipment Purchase Operation, Geology-general, Plankton (non-specific), Plant Food (non-specific), Ships and Cruises | .7.0113

**CHEMICAL FEATURES OF THE SUBARCtIC BOUNDARY IN THE NORTHERN PACIFIC OCEAN** Carbon Dioxide, Circulation-general, Gases, Mixing, Oceanic Fronts, Sub-Polar | .7.0125

**RADIOLARIA IN PACIFIC SEDIMENTS** Arctic, Biogenous, Classification - Taxonomy, Order Radiolaria, Population - Distribution | .7.0117

**UNDERWATER CAMERA SYSTEM** Equipment Purchase Operation, Photography, Sediments-general, Structural Studies | .7.0117

**SEDIMENT AND VOLCANIC STUDIES** Distribution, Origins, Sedimentary Petrology, Stratigraphy-general, Volcanic | .7.0117

**DEEP SEA SEDIMENTS IN THE NORTH PACIFIC FROM STUDIES OF THEIR RADIOLARIAN CONTENT** Biogenous, Core Analysis, Distribution, Protozoa - other, Sedimentation | .7.0285

**FINE STRUCTURE FEATURES OF TEMPERATURE AND SALINITY AT WATER MASS BOUNDARIES IN PACIFIC** Circulation-general, Mixing, Oceanic Fronts, Salinity, Thermometry | .7.0206

**LARGE-SCALE INTERACTIONS** Acoustical, Air-sea Boundary-general, Buoy, Temperature, Thermal | .7.0206

**INTRODUCTION OF MARINE GAME FISHES FROM AREAS IN THE PACIFIC** Diving and Scuba, Hawaii, Stocking of Fish & Shellfish | .7.0206

**ECONOMICS OF MARKETING DUNGENES CRAB** Crabs, Marketing, Price & Value | .7.0206

**APPLICATIONS OF RADIOLOGICAL CHEMISTRY OF OCEAN SOLUTIONS** Chemical Reactions, Octopus, Squid, Cuttlefish, Radioactive Fallout, Reactivity-general, Tracers | .7.0113

### Paleoenvironments

- **TAXONOMY AND ECOTOLOGY OF NEARSHORE MARINE ORGANISMS** | .7.0285

---

**PACIFIC OCEAN-SOUTH**

**SUBMARINE TOPOGRAPHY** Bathymetry, Origin, Physiography-general, Sedimentation, Textures-structures | .7.0129

**INVESTIGATION OF QUATERNARY SEA LEVEL CHANGES IN THE CAROLINE AND MARSHALL ISLANDS** Carbon-14, Quaternary Period, Reefs, Sea Level Variations | .7.0159

**INDIAN OCEAN FORAMINIFERA AND SEDIMENTS** Bioclasts, Geographical Relations, Indian Ocean-general, Quaternary Period, Foraminifera, Sedimentology-general | .7.0159

**TECTONIC AND GEOLOGICAL HISTORY OF THE SOUTHWEST PACIFIC REGION** | .7.0159

**GRAVITY FIELD AT SEA** Gravity Studies, Navigation, Ships and Cruises, Variations | .7.0159

**PACIFIC OCEAN-WEST**

**GRAVITY** Anomalies, Caribbean Sea, Geophysical Equipment, Gravity, Navigation | .7.0142

**ROCK SAMPLING AND GEOPHYSICAL STUDIES IN THE TONGA KERMADEC TRENCH SOUTHWEST PACIFIC** American Samoa, Coring and Dredging, Equipment Purchase Operation, Photography, Seismic Reflection, Trenches | .7.0093

**GEOPHYSICAL AND GEOLOGICAL STUDY OF THE DARWIN RISE** Bathymetry, Coring and Dredging, Geophysics-general, Gravity Studies, Magnetic Studies, Ocean Basins, Photography, Refraction, Ridges, Seamounts-guyots | .7.0112

### Packaging

- **TRANSDUCER RESEARCH** Sealant, Submersibles, Transducers | .7.0105

- **CHEMICAL EXPLOSIONS, PACKAGING AND HANDLING AT SEA** Ammonia, Durability, Detonation, Explosions, Safety | .7.0105

---

**UPGRADING CONVENTIONAL FISHING TECHNIQUES** Commercial Fishing, Fishing Gear, Nets, Sonar, Telemetry, Water Currents | .7.0105

**HISTORICAL CHARTS AND INTERPRETATION OF CHANGES IN SEA SURFACE TEMPERATURE IN THE NORTH PACIFIC OCEAN** Air-sea Boundary-general, Atlantic Oceans, Circulation-general, Commercial Fishing, Temperature | .7.0142

**MONITORING SURVEY AND TIME-SERIES ANALYSIS OF SUBSURFACE TEMPERATURE IN THE NORTH PACIFIC OCEAN** Subsurface Environments, Temperature, Thermocline, Water Temperature-non-specific | .7.0142

**PILOT STUDY OF LIMITED PORTION OF TRADE WIND ZONE OCEANOGRAPHY (DATA AND DESCRIPTIVE REPORTS)** El Niño, Sedimentation Changes, Oceanic Fronts, Technique Development, Water Properties-general | .7.0129

**INTERNATIONAL NORTH PACIFIC FISHERIES COMMISSION SUBARCTIC OCEANOGRAPHY** Currents-ocean, Depth, Range Or Territorial District, Salmon-salmon, Chinook-sockeye, Temperature | .7.0159

**INPEC BIOLOGICAL OCEANOGRAPHY** Phytoplankton and Zooplankton Research | .7.0159

**PHYSICAL OCEANOGRAPHY** Buoy, Instrumentation-general, Model Studies | .7.0159

**ANALYSIS OF JAPANESE CATCH STATISTICS** Commercial Fishing, Japan, Number Of Density, Salmon - coho, Chinook-sockeye | .7.0159

**POPULATION DYNAMICS (BIOMETRICS) OF EXPLOITED FISH GROUPS OF THE NORTH PACIFIC OCEAN AND PACIFIC COAST** Marine Biology, Meteorological Studies, Model Studies, Number Or Density, Population Dynamics | .7.0142

**TIME-SERIES OBSERVATIONS OF TEMPERATURE AND SALINITY (NORTH ATLANTIC AND NORTH PACIFIC OCEAN STATIONS)** Atlantic Ocean-south, Depth, Salinity, Sampling, Temperature | .7.0093

---

629
Paleoenvironments

SUBJECT INDEX

Paleontology

REASSESSMENT OF TAXONOMY AND EVOLUTION OF ECHINODERMS ...Abyssal, Classification - Taxonomy, Internal Structure, Modern Organisms, Phylum Echinodermata, Precambrian, ...5.0613

RESEARCH TRAINING IN MARINE BIOLOGY, PALEONTOLOGY AND SYSTEMATIC ZOOLOGY ...Animal Taxonomy, Invertebrates -non-specific, Oceanography-general, Training Grants, Fellowships, ...7.0003

BIOFACIES STUDY OF BENTHIC FORAMINIFERA IN OCEAN SEDIMENT CORES ...Bioclasts, Core Analysis, External Structure, Order Foraminifera, Population - Distribution, ...7.0175

GEOLOGY OF PACIFIC FAUNAS ...Evolutionary Studies, General, Geochronology-general, Pacific Ocean-general, Paleontography, Sea Level Changes, ...7.0156

PALEONTOLOGY OF LATE CENOZOIC ANATOLIAN RADIOLARIA AND DIATOMS ...Antarctic Ocean, Antarctica, Correlation, Order Radiolaria, Paleontology, Ratio of Deposition, ...7.0185

STRATIGRAPHY AND PALEOCOLOGY OF FOSSIL SILICICLASTIC SEAS FROM ANTARCTIC DEEP-SEA CORES ...Antarctic Ocean, Antarctic, Core Analysis, Correlation, Field Reversals, Internal Structure, Population - Distribution, ...7.0169

TAXONOMY AND STRATIGRAPHY OF CALKAREOUS NANNOPLANKTON IN MARINE SEDIMENT SEQUENCES ...Bioclasts, Classification - Taxonomy, Correlation, Fossil Limestone, Paleontology, Number Or Density, Population - Distribution, ...7.0168

MEASURING PAST OCEANOGRAPHIC CONDITIONS ...Internal Structure, Paleontology, Salinity, Temperature, Tracings, ...7.0180

Classification - Taxonomy

REASSESSMENT OF TAXONOMY AND EVOLUTION OF ECHINODERMS ...Abyssal, Internal Structure, Modern Organisms, Phylum Echinodermata, Precambrian, ...5.0613

BIOGENESIS OF CARBONATE SEDIMENTS, BAHAMA ISLANDS ...Bioclasts, Biogenesis, Bioclasts, Biogeomorphological Process, British West Indies, Sedimentary Petrogenesis, ...7.0241

ELECTRON MICROSCOPY OF CALKAREOUS AND SILICICLASTIC PLANKTON FOR PALEOECOLOGICAL AND PALEOCOLOGICAL STUDIES ...Electron, Core Analysis, Foraminifera, Paleontology, Paleoclimatology, Phylogeny, Phylogeny, Phylogeny, ...7.0183

RADIOLARIA IN PACIFIC SEDIMENTS ...Arctic, Biogenous, Order Radiolariophyta, Pacific Ocean-north, Population - Distribution, ...7.0284

TAXONOMY AND STRATIGRAPHY OF CALKAREOUS NANNOPLANKTON IN MARINE SEDIMENT SEQUENCES ...Bioclasts, Correlation, Fossil Limestone, Microfossils, Order Foraminifera, Paleoclimatology, ...7.0168

A SYSTEMATIC REVIEW OF THE HOLOTHURIAN FAMILY PSOLIDAE - ECHINODERMATA - HOLOTHURIOIDEA ...Animal Taxonomy, Comparative Anatomy, Modern Organisms, Nomenclature, Classification, Sea Cucumber, ...5.0572

Comparative Studies

Comparative Studies-other

PALEONTOLOGICAL EVIDENCE OF CYCLES IN THE EARTH-MOON SYSTEM ...Environmental Changes, Invertebrates, Origin, Earth, Thin Sections, Tides, ...7.0167

Geographical Relations

STRATIGRAPHIC STUDY OF RADIOLARIA IN DEEP SEA QUAYTERNARY SEDIMENTS ...Collections, Core Analysis, Correlation, Order Radiolaria, Quaternary Period, ...7.0178

INDIAN OCEAN FORAMINIFERA AND SEDIMENTS ...Bioclasts, Indian Ocean-general, Order Foraminifera, Pacific Ocean-south, Paleontology-general, ...7.0195

PLEISTOCENE OCEANOGRAPHY AS RECORDED IN DEEP SEA SEDIMENT CORES ...Core Analysis, Correlation, Paleoclimatology, Paleotemperature, Quaternary Period, ...7.0165

PATTERNS OF SPECIES DIVERSITY - TERTIARY-RECENT ...Cenozoic Era-general, Foraminifera, Number Or Density, Population - Distribution, Speciation, ...5.0564

Modern Organisms

REASSESSMENT OF TAXONOMY AND EVOLUTION OF ECHINODERMS ...Abyssal, Classification - Taxonomy, Internal Structure, Modern Organisms, Phylum Echinodermata, Precambrian, ...5.0613

A SYSTEMATIC REVIEW OF THE HOLOTHURIAN FAMILY PSOLIDAE - ECHINODERMATA - HOLOTHURIOIDEA ...Animal Taxonomy, Classification - Taxonomy, Comparative Anatomy, Nomenclature, Classification, Sea Cucumber, ...5.0572

Phylogenies

PHYLOGENETIC RELATIONS OF FOSSIL AND LIVING FORAMINIFERAE ...Bryozoans, Correlation, Foraminifera, Sea Level Changes, ...7.0177

NORTH AMERICAN POST-Oligocene CYHERID DIOECY ...Animal Taxonomy, Invertebrate Anatomy, Life History Studies, Neartic, Shrimps - Seed Or Mussel, ...7.0179

Description of Fossils

STUDY OF FOSSIL SEA TURTLE COLLECTION AT THE INSTITUT ROYAL DES SCIENCES NATURALES, BRUSSELS, BELGIUM ...Belgium, Collections, Internal Structure, Reptiles, Tertiary Period, ...7.0177

MIocene FISHES AND FISH FAUNAS AS DETERMINED FROM A STUDY OF FOSSIL OTOLITHS ...Bioclasts, Bony Fish, California, Paleoclimatology, Tertiary Period, ...7.0170

Evolutionary Studies

Evolutionary Studies-general

COMPARATIVE STUDIES OF LATE MESOZOIC AND EARLY CENOZOIC HERPETOFAUNAS ...Annelids, Cenozoic Era-general, Ecological Zones, Mesoico Era-general, ...7.0181

PALAEONTOLOGICAL CONCLUSIONS ...Annelids, Correlation, Echinodermata, Geochronology-general, Pacific Ocean-general, Paleontology, Paleogeography, Tertiary Period, ...7.0156

NITROGEN METABOLISM IN MOLLUSCIDS ...Bioclasts, Biogenesis, Bioclasts, Biogeomorphological Process, British West Indies, Sedimentary Petrogenesis, ...7.0156

Extinction

MAGNETIC PROPERTIES OF ANTAGONIC MARINE SEDIMENTS AND ROCKS ...Antarctic, Core Analysis, Field Reversals, Rock & Mineral Magnetics, ...7.0133

Fossil Age Studies

LA JOLLA MARINE GEOLOGY LABORATORY ...Electron, Microfossils, Optical, Paleoclimatology, Plants, ...7.0174
Invertebrates

PALEONTOLOGICAL EVIDENCE OF CYCLES IN THE EARTH-MOON SYSTEM...Comparative Studies-other, Environmental Changes, Origins, Shells, Thin Sections, Tides,...7.0167

Microfossils

LIVING AND FOSSIL ZOOPLANKTON, AND RELATED PROBLEMS OF PALEOLIMNOLOGY...Aquatic Ecology, Biology, Ecological, Paleocology, Zooplankton,...7.0171

SUPPORT OF RESEARCH VESSELS JOHN ELLIOTT PILLSBURY, GERDA, TURSIOPS...Mineralogy, Paleotemperature, Petrology, Seismic Studies, Ships and Cruises,...12.0024

A MICROPALEONTOLOGICAL STUDY OF DEEP-SEA CRETACEOUS AND TERTIARY SEDIMENT...Biofacies, Distribution, Physical Properties, Population - Distribution, Tertiary Period,...7.0184

SHIPBOARD WORK ABOARD THE OCEANOGRAPHER...Ships and Cruises, Travel Grants,...7.0004

POTASSIUM/ARGON DATING OF DEEP-SEA SAMPLES...Argon, Argon-potassium, Geologic Age Relations, Radiometric Dating, Sea Floor Spreading, Tertiary Period,...7.0066

CALCAREOUS NONNANOFOSILS FROM PALEOCENE - EOCENE DEPOSITS...Biogenous, Fossil Limestone, Fossil Zones, Standards, Specifications, Tertiary Period,...7.0176

TAXONOMY AND STRATIGRAPHY OF CALCAREOUS NANOFOSILS, ANKTON IN MARINE SEDIMENT SEQUENCES...Bior-nous, Classification - Taxonomy, Correlation, Fossil Limestones, Order Foraminifera, Paleontology,...7.0168

SEA-FLOOR SEDIMENTS AND ROCK STUDIES...Atlantic Ocean, Bioturbation, Core Analysis, Paleomagnetism, Petrology, Ridge, Sedimentation,...7.0040

MICROPLANKTON OF THE BEARPAW SHALE OF MONTANA AND NORTH DAKOTA...Calcified Clastics, Montana, North Dakota, planktonic - Floating,...7.0249

LA JOLLA MARINE GEOLOGY LABORATORY...Electron, Fossil Age Studies, Optical, Paleoecology, Plants,...7.0174

Paleoecology

LIVING AND FOSSIL ZOOPLANKTON, AND RELATED PROBLEMS OF PALEOLIMNOLOGY...Aquatic Ecology, Biology, Ecological, Microfossils, Zooplankton,...7.0171

MIocene FISHES AND FISH FAUNAS AS DETERMINED FROM A STUDY OF FOSSIL OOTOLITHS...Biofacies, Boney Fish, California, Description of Fossils, Tertiary Period,...7.0176

ELECTRON MICROSCOPY OF CALCAREOUS AND SILICEOUS PLANKTON FOR PALEOECOLOGICAL AND PALEOCLIMATIC STUDIES...Classification - Taxonomy, Electron, Electron Microscope, Foraminifera, Paleolimnology, Phyllum Polyzoa, Zoogiraphic Environments,...7.0018

CARBONATE SEDIMENTATION IN THE TONGUE OF THE OCEAN...Baja California, British West Indies, Carbonate, Diagenesis, Sea Level Variations, Sedimentation,...7.0267

GEOLOGIC HISTORY OF PACIFIC FAUNAS...Evolutionary Studies-General, Geochronology-general, Pacific Ocean-general, Paleontology, Sea Level Changes,...7.0156

LA JOLLA MARINE GEOLOGY LABORATORY...Electron, Fossil Age Studies, Microfossils, Optical, Plants,...7.0174

Biofacies

TAXONOMY AND ECOLOGY OF NEARSHORE MARINE OSS TRACODA...Animal Taxonomy, Class Ostracoda, Ecological, Environmental Ecology, Paleoenvironments, Shrimps - Seed Shrimp,...7.0488

QUATERNARY ENVIRONMENTS AND BIOTAS...Intertidal Areas, Paleotemperature, Population - Distribution, Quaternary Period, Western,...7.0157

MIocene FISHES AND FISH FAUNAS AS DETERMINED FROM A STUDY OF FOSSIL OOTOLITHS...Boney Fish, California, Description of Fossils, Paleocology, Tertiary Period,...7.0170

RECENT AND ANCIENT FAUNAS OF A DROWNED ISLAND CHAIN (MID-PACIFIC MOUNTAINS)...Benthic Fauna, Coral and Dredging, Hawaii, Seamounts-guyots,...5.0583

BIOGENESIS OF CARBONATE SEDIMENTS, BAHAMA ISLANDS...Biogenic Limestone, Biogeochemical Process, British West Indies, Classification - Taxonomy, Sedimentary Petrogenesis,...7.0241

SUBJECT INDEX

Paleontology

A MICROPALEONTOLOGICAL STUDY OF DEEP-SEA CRETACEOUS AND TERTIARY SEDIMENT...Distribution, Microfossils, Physical Properties, Population - Distribution, Tertiary Period,...7.0184

BIOFACIES STUDY OF BENTHONIC FORAMINIFERA IN OCEAN SEDIMENT CORES...Core Analysis, External Structure, Order Foraminifera, Paleontology, Population - Distribution,...7.0175

INDIAN OCEAN FORAMINIFERA AND SEDIMENTS...Geographical Relations, Indian Ocean, Order Foraminifera, Pacific Ocean-south, Sedimentology-general,...7.0185

BIOSTRATIGAPHY OF MID-ATLANTIC RIDGE SEDMENTS...Biogenous, Correlation, Ocean History, Order Foraminifera, Ridges,...7.0249

Fossil Zones

CALCAREOUS NANNOFOSILS FROM PALEOCENE - EOCENE DEPOSITS...Biogenous, Fossil Limestone, Microfossils, Standards, Specifications, Tertiary Period,...7.0176

STRATIGRAPHY AND PALEOECOLOGY OF FOSSIL SILICOFLAGELLATES FROM ANTARCTIC DEEP-SEA CORES...Antarctic Ocean, Core Analysis, Correlation, Field Expeditions, Paleontology, Paleotemperature, Phyllum Protozoa,...7.0169

Population - Distribution

RADIOLARIA IN SEDIMENTS...Biogenous, Core Analysis, Order Radiolaria, Pacific Ocean-general, Tertiary Period,...7.0168

QUATERNARY ENVIRONMENTS AND BIOTAS...Biofacies, Intertidal Areas, Paleotemperature, Quaternary Period, Western,...7.0157

MULTIVARIATE ANALYSIS OF MICROPALEONTOLOGICAL DATA FROM DEEP-SEA CORES...Core Analysis, Data Reduction and Analysis, Development of Models, Multivariate Analysis, Order Foraminifera, Paleotemperature,...5.0827

A MICROPALEONTOLOGICAL STUDY OF DEEP-SEA CRETACEOUS AND TERTIARY SEDIMENT...Biofacies, Distribution, Microfossils, Physical Properties, Tertiary Period,...7.0184

BIOFACIES STUDY OF BENTHONIC FORAMINIFERA IN OCEAN SEDIMENT CORES...Biofacies, Core Analysis, External Structure, Order Foraminifera, Paleontology,...7.0175

RADIOLARIA IN PACIFIC SEDIMENTS...Arctic, Biogenous, Classification - Taxonomy, Order Radiolaria, Pacific Ocean-north,...7.0284

PATTERNS OF SPECIES DIVERSITY - TERTIARY-RECENT...Cenozoic Era-general, Foraminifera, Geographical Relations, Number Or Density, Speciation,...5.0564

EVALUATION OF PROVINCIAL DISTRIBUTION PATTERNS IN CHILOSTOME BRYOZOA...Bryozoa, Geologic, Order Chilostomatidae, Paleontology, Tertiary Period,...7.0173

Plants

PALEOBOTANICAL RESEARCH AT YALE UNIVERSITY...Growth Rate, Isolation From Nat. environ., Marine Bacteria, Plant Succession, Sulfur Bacteria,...7.0052

LA JOLLA MARINE GEOLOGY LABORATORY...Electron, Fossil Age Studies, Microfossils, Optical, Paleoecology,...7.0174

Pollen

FEASIBILITY OF THE APPLICATION OF PALYNONOGICAL INVESTIGATION OF DEEP-SEA SEDIMENTS TO MAJOR GEOLOGICAL PROBLEMS...Biologie, Circulation-general, Paleocology, Pollen, Spores,...7.0260

Preservation

Borings - Tracks - Trails
ECOLOGY OF MARINE ENDOLITHIC ALGAE...Algae-General, Calcium, Habitat Studies, Niches, Textures-structures,...5.0690

Sporae

BIOLOGY AND PALEOECOLOGY OF MARINE DINOFLAGELLATES AND HISTRICHOSPHERES...Algae-Dinoflagellates, Algal Culture, Cell Cycle, Plant Developmental Biology, Range Or Territorial Distr.. Vertical Distribution,...5.0799

631
Paleontology

Structure

External Structure

BIOFACIES STUDY OF BENTHONIC FORAMINIFERA IN OCEAN SEDIMENT CORES ...Biofacies, Core Analysis, Order Foraminifera, Paleontology, Population - Distribution, ...7.0175

Internal Structure

REASSESSMENT OF TAXONOMY AND EVOLUTION OF ECHINODERMS ...Abyssal, Classification - Taxonomy, Modern Organisms, Paleontology, Phylum Echinodermata, Precambrian, ...5.0613

STUDY OF FOSSIL SEA TURTLE COLLECTION AT THE INSTITUT ROYAL DES SCIENCES NATURELLES, BRUSSELS, BELGIUM ...Belgium, Collections, Description of Fossils, Reptiles, Tertiary Period, ...7.0177

MEASURING PAST OCEANOGRAPHIC CONDITIONS ...Paleoenvironments, Paleontology, Salinity, Temperature, Tracers, ...7.0180

Shells

PALEONTOLOGICAL EVIDENCE OF CYCLES IN THE EARTH-MOON SYSTEM ...Comparative Studies-other, Environmental Changes, Invertebrates, Origins, Thin Sections, Tides, ...7.0167

Structure-general

STRATIGRAPHIC AND TAXONOMIC-PHYLOGENETIC STUDIES ON PLANKTONIC FORAMINIFERA ...Core Analysis, Cretaceous Period, Interglacial Stratigraphy, Order Foraminifera, Tertiary Period, ...7.0182

Paleontology-invertebrates

Phylum Arthropoda

Class Ostracoda

TAXONOMY AND ECOLOGY OF NEARSHORE MARINE OSTRACODA ...Animal Taxonomy, Biofacies, Ecological, Environmental Ecology, Paleoenvironments, Shrimps - Seed Or Mussels, ...5.0707

Phylum Bryozoa

Order Cheilostomata

EVOLUTION OF PROVINCIAL DISTRIBUTION PATTERNS IN CHEILOSTOME BRYOZOA ...Bryozoa, Geologic, Paleontology, Population - Distribution, Tertiary Period, ...7.0173

Other Bryozoa

PHYLOGENETIC RELATIONS OF FOSSIL AND LIVING GYMNOAELAMATES ...Bryozoa, Foulung, Geologic, Phylogenetics, ...5.0665

Phylum Echinodermata

REASSESSMENT OF TAXONOMY AND EVOLUTION OF ECHINODERMATA ...Abyssal, Classification - Taxonomy, Internal Structure, Modern Organisms, Paleontology, Precambrian, ...5.0613

Phylum Protozoa

ELECTRON MICROSCOPE OF CALCAREOUS AND SILICEOUS PLANKTON FOR PALEOECOLOGIC AND PALEOClimatic Studies ...Classification - Taxonomy, Electron, Order Foraminifera, Paleoclimatology, Paleontology, Zoogeographic Environments, ...7.0183

STRATIGRAPHY AND PALEOECOLOGY OF FOSSIL SILICEOUS FLAGELLATES FROM ANTARTIC DEEP-SEA CORES ...Antarctic Ocean, Core Analysis, Correlation, Field Reversals, Fossil Zones, Paleontology, Paleotemperature, ...7.0169

Order Foraminifera

MULTIVARIATE ANALYSIS OF MICROPALAEONTOLOGICAL DATA FROM DEEP-SEA CORES ...Core Analysis, Data Reduction and Analysis, Development of Models, Multivariate Analysis, Paleotemperature, Population - Distribution, ...7.0169

STRATIGRAPHIC AND TAXONOMIC-PHYLOGENETIC STUDIES ON PLANKTONIC FORAMINIFERA ...Core Analysis, Cretaceous Period, Interglacial Stratigraphy, Structure-general, Tertiary Period, ...7.0182

ELECTRON MICROSCOPE OF CALCAREOUS AND SILICEOUS PLANKTON FOR PALEOECOLOGIC AND PALEOClimatic Studies ...Classification - Taxonomy, Electron, Paleoclimatology, Paleocology, Phylum Protozoa, Zoogeographic Environments, ...7.0183

BIOFACIES STUDY OF BENTHONIC FORAMINIFERA IN OCEAN SEDIMENT CORES ...Biofacies, Core Analysis, External Structure, Paleontology, Population - Distribution, ...7.0175

INDIAN OCEAN FORAMINIFERA AND SEDIMENTS ...Biofacies, Geographical Relations, Indian Ocean-general, Pacific Ocean-south, Sedimentology-general, ...7.0195

PALEOTEMPERATURE RESEARCH ...Core Analysis, Marine Organisms, Paleotemperature, Quaternary Period, ...7.0161

TAXONOMY AND STRATIGRAPHY OF CALCAREOUS NANNOPLANKTON IN MARINE SEDIMENT SEQUENCES ...Biogenic, Classification - Taxonomy, Correlation, Fossil Limestones, Microfossils, Paleontology, ...7.0168

BIOSTRATIGRAPHY OF MID-ATLANTIC RIDGE SEDIMENTS ...Biofacies, Biogenic, Correlation, Ocean History, Ridges, ...7.0209

Order Radiolaria

RADIOLARIA IN SEDIMENTS ...Biogenic, Core Analysis, Pacific Ocean-general, Population - Distribution, Tertiary Period, ...7.0166

STRATIGRAPHIC STUDY OF RADIOLARIA IN DEEP SEA QUATERNARY SEDIMENTS ...Collections, Core Analysis, Correlation, Geographical Relations, Quaternary Period, ...7.0179

RADIOLARIA IN PACIFIC SEDIMENTS ...Arctic, Biogenic, Classification - Taxonomy, Pacific Ocean-north, Population - Distribution, ...7.0284

PALEONTOLOGY OF LATE CENOZOIC ANTARCTIC RADIOLARIA AND DIATOMS ...Antarctic Ocean, Antarctic, Class Algae, Correlation, Ocean Basins, Paleomagnetism, Paleontology, Rate of Deposition, ...7.0185

Paleontology-plants

Phylum Thalassiphya

Class Algae

PALEONTOLOGY OF LATE CENOZOIC ANTARCTIC RADIOLARIA AND DIATOMS ...Antarctic Ocean, Antarctic, Correlation, Ocean Basins, Order Radiolaria, Paleomagnetism, Paleontology, Rate of Deposition, ...7.0185

Paleontology-vertebrates

Amphibians

COMPARATIVE STUDIES OF LATE MESOZOIC AND EARLY CENOZOIC HERPETOFAUNAS ...Cenozoic Era-general, Evolutionary Studies-general, Geologic, Lizards, Mesozoic Era-general, ...7.0181

Boney Fish

MICROFISHES AND FISH FAUNAS AS DETERMINED FROM A STUDY OF FOSSIL OTOLITHS ...Biofacies, California, Description of Fossils, Paleocology, Tertiary Period, ...7.0170

Reptiles

STUDY OF FOSSIL SEA TURTLE COLLECTION AT THE INSTITUT ROYAL DES SCIENCES NATURELLES, BRUSSELS, BELGIUM ...Belgium, Collections, Description of Fossils, Paleontology, Tertiary Period, ...7.0177

Lizards

COMPARATIVE STUDIES OF LATE MESOZOIC AND EARLY CENOZOIC HERPETOFAUNAS ...Amphibians, Cenozoic Era-general, Evolutionary Studies-general, Geologic, Mesozoic Era-general, ...7.0181

Panama

ECOLOGY OF THE PORITES FURCATA REEF-FLAT COMMUNITY ...Anthozoa, Productivity - Food Chain, Puerto Rico, Reefs, ...5.0867

DEEP-SEA SEDIMENTS - THEIR PROPERTIES AND PROCESSES OF FORMATION ...Acoustical, Basins, Currents-ocean, Depth, Origin, Physical Properties, ...7.0273
Subject Index

Pesticides

REPRODUCTIVE ISOLATING MECHANISMS IN PANAMANI-
AN INSHORE MARINE FISHES ...Behavioral Ecology, Com-
parative Physiology, Fish -non-specific, Reproduction Studies
(general), ...5.0906

ECOLOGY OF PANAMANIAN REEF COMMUNITIES
...Behavioral Ecology, Invertebrates -non-specific, Productivity -
Food Chain, Reefs, Tropic, ...5.0866

Particle Detectors

Neutron Detectors
OCEAN RADIOACTIVITY ...Depth, Detectors and Sensors, Pro-
portional Counters, Radioactivity, ...1.0089

Proportional Counters
OCEAN RADIOACTIVITY ...Depth, Detectors and Sensors, Neutron
Detectors, Radioactivity, ...1.0089

Persian Gulf

EARLY DIAGENESIS OF CARBONATE SEDIMENTS IN A
SUPRATIDAL EVAPORITIC SETTING ...Carbonates-general,
Continental Shelf-evaporitic, Origin, Sedimentary History,
Sedimentation, ...7.0252

Persistence of Residues

EFFECTS OF PESTICIDES ON ESTUARINE PRODUCTIVITY
...Aquatic Ecology, Estuaries, Mass Activities, Pesticides -non-
specific, Pollution - Effects of, Population Dynamics, Standing
Crops, ...5.0880

EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS
...Bioassay, Estuaries, Pollution - Effects of, Sevin, Swamps-
mashes, ...5.0918

PESTICIDES ...Aquatic Or Soil-aquatic Cycles, Bioassay, Fish,
Pesticides -non-specific, Pollution Effects, ...5.0881

PESTICIDE MONITORING PROGRAM ...Bioindicators, Estu-
aries, Gas Chromatography, Monitoring Systems, Oysters,
...6.0147

Pesticides

Chlorinated Hydrocarbons
CHEMICAL ANALYSES ...Chemical Analysis (water), Estuaries,
Substances Or Chemicals, ...6.0149

MECHANISMS OF PESTICIDE ACCUMULATION IN
AQUATIC ORGANISMS ...Food Chains, Animal And/or Man,
Insecticides -non-specific, Pollution Effects, Productivity - Food
Chain, ...6.0155

DDT
RATE OF ABSORPTION OF ENDRIN BY BLUEGILL SUNF-
ISH ...Bioassay, Bluegills, Bream, Endrin, Metabolism, Mode of
Action -animal, ...5.0263

Dursban
EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS
...Estuaries, Mode of Action -animal, Model Studies, Pollution -
Effects of, Sevin, ...5.0919

Endrin
RATE OF ABSORPTION OF ENDRIN BY BLUEGILL SUNF-
ISH ...Bioassay, Bluegills, Bream, DDT, Metabolism, Mode of
Action -animal, ...5.0263

PESTICIDE RESISTANT FISH IN NATURAL ECOSYSTEMS
...Animal Resistance -other, Fish, Food Chains, Animal And/or
Man, Pollution Effects, Rates, Doses, Concentrations, ...5.0277

Herbicides

Diguet
EFFECT OF EURASIAN WATERMILFOIL CONTROL
PROCEDURES ON WILDLIFE AND OTHER ORGANISMS
IN AQUATIC ENVIRONMENTS ...Contamination - Water,
Evaluation, Water Milfoil, Waterweed ...2.4-d, ...5.0706

Herbicides -non-specific
TOXICANT TOLERANCE STUDIES - SCREENING OF PESTI-
CIDES AND AQUATIC INVERTEBRATES AT TIBURON
...California, Insecticides -non-specific, Laboratory Animals,
Screening Potential Pesticides, ...5.0906

MESO WIND PATTERNS IN THE CENTRAL CALIFORNIA
VALLEY ...Atmospheric Pollution-general, California, Drift
(pesticide), Land-sea Breezes, Wind Erosion, ...3.0056

2,4-d
EFFECT OF EURASIAN WATERMILFOIL CONTROL
PROCEDURES ON WILDLIFE AND OTHER ORGANISMS
IN AQUATIC ENVIRONMENTS ...Contamination - Water,
Diquat, Evaluation, Water Milfoil, Waterweed, ...5.0700

Insecticides -non-specific

SUPPORT FOR THE PHYSIOLOGICAL RESEARCH SHIP, R/V
ALPHA HELIX ...Myrcorrhiza, Nerve Effects, Rain Forests,
Regulation, Tropic, ...1.0011

TOXICANT TOLERANCE STUDIES - SCREENING OF PESTI-
CIDES AND AQUATIC INVERTEBRATES ...Aquatic Or Soil-
aquatic Cycles, Bioassay, Fish, Pesticides -non-specific, Pollution
Effects, ...5.0881

MONITORING OF PESTICIDE LEVELS IN THE GREAT
LAKES ...Fish -non-specific, Great Lakes-general, Monitoring
Systems, Pollutants-general, Sampling, ...6.0120

RATES OF PESTICIDE BUILDUP IN SALMONIDS
RECENTLY INTRODUCED IN THE GREAT LAKES ...Fish,
Lake Michigan, Lake Superior, Lake Trout, Brook Trout, Pollu-
tion Effects, Salmon -coho,chinook,sockeye, ...6.0154

MECHANISMS OF PESTICIDE ACCUMULATION IN
AQUATIC ORGANISMS ...Chlorinated Hydrocarbons, Food
Chains, Animal And/or Man, Pollution Effects, Productivity -
Food Chain, ...6.0115

PESTICIDE KINETICS ...Aquatic Or Soil-aquatic Cycles,
Degradation, Estuaries, Marine Biology (non-specific), Pollu-
tants - Path of, ...6.0148

Pesticides -non-specific

EFFECTS OF PESTICIDES ON ESTUARINE PRODUCTIVITY
...Aquatic Ecology, Estuaries, Mass Activities, Persistence of
Residues, Pollution - Effects of, Population Dynamics, Stand-
ing Crops, ...5.0880

IMPACT AND RATE OF POLLUTION IN ESTUARIAL
WATERS ...Degradation, Estuaries, Massachusetts, Pollutants -
Path of, Pollution Effects, ...6.0153

EXPLORATORY COLLECTION AND CARE OF AQUATIC
INVERTEBRATES FOR TESTING AT TIBURON ...Bioassay,
Brackish Water, Captive Rearing, Invertebrates -non-specific, ...
5.0905

TOXICANT TOLERANCE STUDIES - SCREENING OF PESTI-
CIDES AND FISH AT TIBURON ...California, Fish -non-
specific, Laboratory Animals, Screening Potential Pesticides, ...
5.0906

PESTICIDES ...Aquatic Or Soil-aquatic Cycles, Bioassay, Fish,
Persistence of Residues, Pollution Effects, ...5.0881

ARTIFICIAL SELECTION - FISH ...Female Gametes, Fish -non-
specific, Genetic Resistance, Pollution, Persistence of Effects - 
Selection & Breeding, ...5.0256

Petroleum Cpd's -non-specific

EVALUATION OF EFFECTS OF SATURATED HYDROCAR-
BONS ON PRESERVATIVE QUALITY OF CREOSOTE
...Creosote, Fouling, Isopods, Preservatives, Waxes, Paraffin,
Wood Preservatives-non-specific, ...6.0198

Piscicides

Piscicides -non-specific
BIOASSAY ...Animal Pollutant Sources, Evaluation, Lamprays,
Streama, Water Properties-general, ...5.0832

Sevin
EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS
...Bioassay, Estuaries, Persistence of Residues, Pollution - Ef-
fects of, Swamps-mashes, ...5.0918

EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS
...Dursban, Estuaries, Mode of Action -animal, Model Studies,
Pollution - Effects of, ...5.0919
Pesticides
Wood Preservatives
Creosote
MOBILITY OF OIL-TYPE PRESERVATIVES IN IMMERSED WOOD ...Evaluation, Forestry, Liquid - Solid Interactions, Marine Biology (non-specific), Wood Preservatives-non-specific, ...8.0238
EVALUATION OF EFFECTS OF SATURATED HYDROCARBONS ON PRESERVATIVE QUALITY OF CREOSOTE ...Fouling, Isopods, Petroleum CpdS. - non-specific, Preservation, Waxes, Paraffin, Wood Preservatives-non-specific, ...8.0198
Wood Preservatives-non-specific.
MICROBIOLOGICAL INVESTIGATIONS OF THRESHOLD PANELS ...Catabolism and Degradation, Degradation, Freshwater Munels, Scallops, Marine Bacteria, Marine Fungi (non-specific), Wood, ...8.0243
MOBILITY OF OIL-TYPE PRESERVATIVES IN IMMERSED WOOD ...Creosote, Evaluation, Forestry, Liquid - Solid Interactions, Marine Biology (non-specific), ...8.0238
CHEMICAL WOOD PRESERVATIVE TREATMENTS ...Biological, Corrosion Prevention-other, Creosote, Fouling, ...8.0197
EVALUATION OF EFFECTS OF SATURATED HYDROCARBONS ON PRESERVATIVE QUALITY OF CREOSOTE ...Creosote, Fouling, Isopods, Petroleum CpdS. - non-specific, Preservatives, Waxes, Paraffin, ...8.0198

Petrography
THE FORMATION OF DOLOSTONE AND CHERT IN THE UPPER MIDDLE CAMPBRIAN OF THE GREAT BASIN ...Cambrian Period, Chert, Diagenesis, Dolomite, Great Basin, ...7.0283
GEOMICROBIOLOGICAL WEATHERING PHENOMENA OFF ANVER ISLANDS ...Antarctica, Habitat Studies, Identification, Marine Bacteria, Weathering, ...7.0232
PETROLOGY AND GEOCHEMISTRY OF IGNEOUS ROCKS FROM THE OCEAN FLOOR ...Argon-potassium, Extrusive, ...7.0064
PETROLOGY
SUPPORT OF RESEARCH VESSELS JOHN ELLIOTT PILSBURY, GERDA, TURSIPS ...Microfossils, Mineralogy, Paleotemperature, Sedimentary Studies, Ships and Cruises, ...12.0024
ANALYSES OF ROCKS COLLECTED IN THE INDIAN AND ATLANTIC OCEANS ...Atlantic Ocean-general, Crust, Indian Ocean-general, Ocean Basins, Structural Studies, ...7.0073
THE MARINE GEOLOGY OF THE SOUTHERN OCEAN ...Antarctic Ocean, Chemistry, Coring and Dredging, Distribution, Mineralogy, ...7.0067
MARINE GEOLOGY OF THE SUB-ANTARCTIC PACIFIC REGION ...Antarctic Ocean, Core Analysis, Diagenesis, Distribution, Origin, Sedimentary History, ...7.0049
ISOPTIC AND TRACE ELEMENT STUDIES IN OCEANIC VOLCANIC ROCKS ...Igneous Rocks, Lead, Magma, Magmas, ...7.0075
PETROLOGY AND GEOCHEMISTRY OF IGNEOUS ROCKS FROM THE OCEAN FLOOR ...Argon-potassium, Extrusives, Pacific Ocean-east, Petrology, Ridges, ...7.0064
CONTRACT FOR-PROCESSING OF USARP ROCK SAMPLES ...Antarctica, Classifications, Collections, Coring and Dredging, Sampling, Ships and Cruises, Thin Sections, ...7.0060
UPPER MANTLE OF OCEAN REGIONS ...Earth Interior, Extrusives, High Pressure Research, High Temperature Research, Lava, Ridges, ...7.0053
SEA-FLOOR SEDIMENTS AND ROCK STUDIES ...Atlantic Ocean-east, Black smoker, Core Analysis, Microfossils, Paleomagnetism, Ridges, Sedimentation, ...7.0040
IGNEOUS AND SEDIMENTARY ROCKS FROM THE NORTH WALL OF THE PUERTO RICO TRENCH ...Igneous Rocks, Puerto Rico, Sedimentary Rocks, Trenches, ...7.0083
ROCKS OF OCEANIC CRUST AND UPPER MANTLE EQUATORIAL ATLANTIC ...Atlantic Ocean-general, Crust, Earth Interior, Ocean Basins, Petrogenesis-general, Stability Fields, ...7.0059
ROCKS OF THE OCEANIC CRUST ...Basins, Ocean Basins, ...7.0061
WESTERN PACIFIC ISLANDS ...Arizona, Igneous Activity - Volcanism, Lava, Mapping, Sea Level Changes, ...7.0104

SUBJECT INDEX
PRELIMINARY STUDIES TO CORRELATE SELECTED MINERALOGIC AND GEOLOGIC PROPERTIES WITH ENGINEERING PROPERTIES ...Alaska, Engineering Geology, Mineralogy, Ships and Cruises, Trace Element Analysis, ...8.0169
Igneous Rocks
IGNEOUS AND SEDIMENTARY ROCKS FROM THE NORTH WALL OF THE PUERTO RICO TRENCH ...Petrology, Puerto Rico, Sedimentary Rocks, Trenches, ...7.0083
Crystalline
HIGH PRESSURE ROCK STUDIES ...Attenuation, High Pressure Research, High Temperature Research, Rock Mechanics, ...8.0330
Extrusives
SIGNIFICANCE OF FLUORIDE VARIATIONS IN SEA WATER ...Atlantic Ocean-general, Chloride, Element Ratios, Fluoride, Water Analysis-general, ...7.0103
PETROLOGY AND GEOCHEMISTRY OF IGNEOUS ROCKS FROM THE OCEAN FLOOR ...Argon-potassium, Pacific Ocean-east, Petrography, Petrology, Ridges, ...7.0064
THE MAGNETIZATION OF SUBMARINE BASALTALS AND ITS EFFECT ON MARINE MAGNETIC ANOMALIES ...Anomalies, Field Reversals, Magnetic Studies, Paleomagnetism, Seamounts-pygots, ...7.0153
UPPER MANTLE OF OCEAN REGIONS ...Earth Interior, High Pressure Research, High Temperature Research, Lava, Petrology, Ridges, ...7.0053
ALPINE LIMNOLOGY PROJECT ...Core Analysis, Dust - Particulate Matter, Hawaii, Lakes, Mountains-alpine, Volcanoes, ...7.0236
CORRELATION OF SUBMARINE VOLCANIC ASH BY CATHODO-LUMINESCENCE ...Correlation, Geochronology-general, Luminescence, Qualitative, Size, ...7.0055
AGE RELATIONS OF IGNEOUS ROCKS FROM THE MID-ATLANTIC RIDGE ...Foliated Rocks, Geologic Age Relations, Rare Earth Studies, Ridges, Trace Element Analysis, ...7.0080
Lava
UPPER MANTLE OF OCEAN REGIONS ...Earth Interior, Extrusives, High Pressure Research, High Temperature Research, Petrology, Ridges, ...7.0053
WESTERN PACIFIC ISLANDS ...Hawaii, Igneous Activity - Volcanism, Mapping, Petrology, Sea Level Changes, ...7.0104
Magma
ISOTOPIC AND TRACE ELEMENT STUDIES IN OCEANIC VOLCANIC ROCKS ...Igneous Rocks, Lead, Magma, Magmas, Rare Earth Studies, Strontium, Trace Element Analysis, Volcanic, ...7.0075
PETROLOGY AND GEOCHEMISTRY OF IGNEOUS ROCKS FROM THE OCEAN FLOOR ...Argon-potassium, Extrusives, Pacific Ocean-east, Petrography, Ridges, ...7.0064
SIMA
PETROLOGY AND GEOCHEMISTRY OF IGNEOUS ROCKS FROM THE OCEAN FLOOR ...Argon-potassium, Extrusives, Pacific Ocean-east, Petrography, Ridges, ...7.0064
Plutonic
GEOLIGI INVESTIGATIONS IN PUERTO RICO & THE CARIBBEAN ...Caribbean Sea, Element Ratios, Puerto Rico, Sedimentary Petrology, Volcanic, ...7.0065
AZORES VOLCANIC STUDY ...Atlantic Ocean-general, Azores, Element Ratios, Igneous Activity - Volcanism, Ridges, ...7.0015
VOLCANIC STUDIES TO CORRELATE SELECTED MINERALOGIC AND GEOLOGIC PROPERTIES WITH ENGINEERING PROPERTIES ...Alaska, Engineering Geology, Mineralogy, Ships and Cruises, Trace Element Analysis, ...8.0169
Metamorphic Rocks
 Foliated Rocks
AGE RELATIONS OF IGNEOUS ROCKS FROM THE MID-ATLANTIC RIDGE ...Extrusives, Geologic Age Relations, Rare Earth Studies, Ridges, Trace Element Analysis, ...7.0080
Phosphate, Phosphite

RELATIONSHIPS BETWEEN PHOSPHATE AND OTHER CHEMICALS AT THE WATERSUBSTRATE INTERFACE IN WESTERN LAKE ERIE ...Culicid Oviposition, Chemical, Chemical-geological, Lake Erie, Sediments, ...7.0078

SAMPLING CAMPAIGN ON CORONADO BANK, OFF SOUTHERN CALIFORNIA ...Banks, California, Chemistry, Coring and Dredging, Distribution, ...7.0003

NUTRIENT REQUIREMENTS OF ALGAE ...Algal Culture, Cyanophyta (non-specific & Ol), Nitrate, Nitrite, Nutrition Studies, ...5.0766

Phosphorus

DISSOLVED ORGANIC PHOSPHORUS' IN AL WATERS ...Lower Plants, Phytoplankton, ...4.0123

BIOLOGICAL AND CHEMICAL STUDY OF VIRGINIA'S ESTUARIES ...Estuaries, Nitrogen, Phytoplankton, Population Dynamics, Primary Productivity, Virginia, ...5.0158

NUTRIENT ASSIMILATION RATES - FIELD STUDIES ...Estuaries, Nitrogen, Nitrogen Cycle, Nutrients, Tracers, ...5.0990

STUDIES ON INORGANIC NUTRIENT ASSIMILATION RATES IN ESTUARINE PONDS ...Estuaries, Mineral Content-water, Nitrogen, Nutrients, Self-purification, ...2.0991

TIDE MARSH ECOLOGY AND WILDLIFE ...Management, Microorganisms (non-specific), Nitrogen Cycle, Nutrients, Primary Productivity, Swamp-marshes, ...5.0876

INTERACTION OF MARINE NUTRIENT COMPLEXES ...Iron, Marine Plants, Nutrients, Phytoplankton, Tracers, ...5.0956

Photography

GRANT FOR STUDY OF SEA FLOOR CORES AND PHOTOS ...Core Analysis, Coring and Dredging, ...7.0258

FEASIBILITY STUDY FOR A GATED-LASER, IMAGE-AMPLIFIER UNDERWATER VISION SYSTEM ...Electric Lighting Systems, Image Converters, Lasers-masers, Optical Devices, Technique Development, ...8.0168

VISIBLE REGION INSTRUMENTATION FOR OCEANOGRAPHIC SATELLITES ...Currents-ocean, Geomorphology-topography, Mapping, Satellites, Shoals, ...5.0088

OPTICAL MEASUREMENTS ...Benthonic-bottom, Currents-ocean, Optical, Subsurface Environments, ...5.0170

SUBMARINE CANYONS ...California, Development, Erosional Features, Geomorphology-topography, Submarine Canyons, ...7.0295

DEEP WATER BENTHIC POLYCHAETES ...Benthic Fauna, Biology, Lugworms, Marine Segmentedworms, Vertical Distribution, ...5.0840

HOLOGRAPHIC INSTRUMENTATION FOR MARINE PLANKTON STUDIES ...Lasers and Masers, Zooplankton, ...8.0066

DEEP-SEA AUTONOMOUS VEHICLES, INSTRUMENTS, BASIC CONTROL DEVICES, AND SPECIAL COLLECTING GEAR ...Abyssal, Bottom Sampling Device, Organism Sampling Devices, Sampling, Submersibles, Water Motion Recorders, ...8.0112

ROCK SAMPLING AND GEOPHYSICAL STUDIES IN THE TONGA KERMADE TRENCH SOUTHWEST PACIFIC ...American Samoa, Coring and Dredging, Equipment Purchase Operation, Pacific Ocean-west, Seismic Reflection, Trenches, ...7.0093

ANTARCTIC PHYSICAL OCEANOGRAPHY ...Antarctic Ocean, Currents-ocean, Depth, Salinity, Temperature, ...4.0133

COLLECTION, REDUCTION, AND INTERPRETATION OF SEISMOLOGIC AND PHOTOGRAPHIC DATA ...Data Analysis, General, Distribution, Environment, Ocean Basins, Sedimentary History, Sedimentation Studies, ...7.0252

HEAT FLOW MEASUREMENTS ...Atlantic Ocean-general, Geophysical Equipment, Heat Flow Measurements, Technique Development, Water Motion Recorders, ...7.0138

GEOPHYSICAL AND GEOLOGICAL STUDY OF THE DARWIN RISE ...Bathymetry, Coring and Dredging, Geophysical-gravity, Gravity Studies, Magnetic Studies, Ocean Basins, Pacific Ocean-west, Refraction, Ridges, Seamounts-gyotai, ...7.0112

UNDERWATER CAMERA SYSTEM ...Equipment Purchase Operation, Pacific Ocean-north, Sediments-general, Structural Studies, ...6.0114

DEEP SEA PHOTOGRAPHIC SYSTEM AND A BOX CORER ...Abyssal, Benthonic-bottom, Coring and Dredging, ...8.0141

DEVELOPMENT OF A PHOTOGRAPHIC SUIT FOR STEREOPHOTOGRAMMETRIC MAPPING BY SUMBERSLIE ...Mapping, Navigation, Sonar, Submersibles, Turkey, ...4.0066

MULTISPECTRAL SENSING OF COASTAL ENVIRONMENTS ...Aerial Photography, Beaches, Depth, EM Radiation-general, Geomorphology-topography, Shoreline - Coastline, ...4.0166

UNDERWATER ACOUSTIC HOLOGRAPHIC DISPLAY ...Acoustical, Detectors, Holography, Instrumental Services, Recognition Systems, ...8.0137

UNDERWATER GEOLOGY IN THE OSWEGO AREA OF LAKE ONTARIO ...Erosional Features, Erosional Features-general, Geology-general, Lake Ontario, Sedimentary Structures, ...7.0044

SEA FLOOR STUDIES - TOPOGRAPHY AND SHAPE OF THE SEA FLOOR ...Geological, Geomorphology-topography, Sedimentation, ...7.0295

GEOLOGICAL OCEANOGRAPHY - PHYSICAL PROPERTIES ...Bearing Capacity, Biology, Chemistry, Physical Properties, Shear Strength, ...8.0133

SPACECRAFT OCEANOGRAPHY ...Instrumentation, Instrumentation-general, Management, Satellites, Unmanned Satellite, ...4.0157

AIRBORNE REMOTE SENSING OCEANOGRAPHY PROJECT ...Aircraft, Data Acquisition, Instrumental Services, Radar, Satellites, ...4.0155

SEDIMENT MOVEMENT AND BOTTOM CONDITIONS IN THE DELAWARE ESTUARY MOUTH AREA ...Bottom Sampling Device, Currents-other, Delaware Bay, Sedimentation, Tides, ...7.0220

ANALYSIS AND INTERPRETATION OF DATA FROM GEOPHYSICAL AND PHOTOBARG SURVEY OF CORONADO BANK, OFF SOUTHERN CALIFORNIA ...California, Ocean Mining, Potential of Deposit, ...7.0004

DEVELOPMENT OF NEW FISHING TECHNIQUES ...Commercial Fishing, Fishing Gear, Geomorphology-topography, Mark, Tag Or Capture -other, Temperature, ...8.0151

WEST GREENLAND GLACIER SURVEY ...Glacial Environment, Greenland, Icebergs, Movement, Types, ...3.0007

Aerial Photography

OIL LEAKS AND SLICKS ...Aircraft, Oil, Pollutants-other, Satellites, Technique Development, ...4.0145

FISHERIES RESOURCES IDENTIFICATION AND ASSESSMENT ...Behavioral Ecology, Commercial Fishing, Fish -non-specific, Optical, Spectral Reflectance, ...4.0149

POPULATION DYNAMICS OF ANTARCTIC SEALS ...Antarctica, Migration, Population Dynamics, Seals, ...5.0634

DRAINAGE PATTERN DEVELOPMENT ON TIDAL MARSHES ...Drainage, Swamps-marshes, Tides, ...7.0291

MULTISPECTRAL SENSING OF COASTAL ENVIRONMENTS ...Beaches, Depth, EM Radiation-general, Geomorphology-topography, Photography, Shoreline - Coastline, ...4.0166

REMOTE SENSOR OCEANOGRAPHY ...Cloud Temperature, Gulf of Mexico, Infrared Radiation, Satellites, Surface Environments, Temperature, ...4.0170

PRODUCTIVITY STUDIES IN NORTH CAROLINA SALT MARSHES ...Mapping, North Carolina, Primary Productivity, Productivity - Food Chain, Swamps-marshes, Tidalwater Areas, ...5.0107

A RECONNAISSANCE OF COASTAL EROSION IN NORTH CAROLINA ...Beach, Development, Erosional Features, North Carolina, Photography, Reconnaissance, Shoreline - Coastline, Waves, ...7.0268

PROJECT AQUA-MAP - DEVELOPMENT OF AERIAL PHOTOGRAPHY AS AN AID TO WATER QUALITY
SUBJECT INDEX

MANAGEMENT ...Effluents-waste Water, Management, Model Studies, New York, Pollutants-other, ...4.0167

GREAT LAKES RESEARCH - ICE CHARACTERISTICS ...Lake Superior, Micrometeorology, Origin, Petiofuhrics, Radiation-terrestrial, Sea Ice, ...3.0062

GREAT LAKES RESEARCH - ICE COVER DISTRIBUTION ...Aerospatial, Alteration, Great Lakes-general, Petrofabrics, Sea Ice, ...3.0083

REMOTE SENSING OF ESTUARINE WATER AND VEGETATION, MARYLAND ...Bioindicatores, ChemicaI-general, Estuaries, Physical-general, Remote Sensing -other, ...4.0144

COORDINATION OF ESTUARINE REMOTE SENSING IN ATLANTIC COAST REGION ...Atlantic Ocean-general, Estuaries, Satellites, ...4.0169

Cinematography
FILM PROJECT (KELP FORESTS) ...California, Fishery Development -other, Habitat Studies, Laminariforme (non-spec.), ...5.0478

Time-lapse Photography
MECHANICAL PROPERTIES OF MAMMALIAN CELLS ...Blood Cells, Cellular Membranes (non-spec.), Flow Metering Techniques, Suspension Culture, ...5.0992

Holography
HOLOGRAPHIC STUDIES OF MARINE ORGANISMS ...Acoustical, Lasers-masers, Plankton (non-specific), Plant Prod. (non specific), Sampling, ...8.0060

Motion Pictures -non-specific
DISTRIBUTION OF LIFE WITH DEPTH ...Continental Shelf, North Carolina, Photography, Vertical Distribution, ...5.0085

Photography-chemistry
PHOTOGRAPHIC STANDARDS ...Photography, Standards, Specifications, ...8.0077
APPLICATION OF ISCC-NBS CENTROID COLORS AND METHOD OF DESIGNATION COLORS ...Colorimetry, Dyes and Coloring, Paint - General, Pigments, Standards, Specifications, ...4.0097
PHOTOGRAPHIC IMAGE EVALUATION ...Cybernetics, Imaging, Statistical Information Theory, ...4.0053

Physical Analysis
DEEP SEA SEDIMENT STUDIES ...Acoustical, Marine Soils, Mechanical Properties, Physical Properties, Shear Strength, ...8.0341

DESIGN AND DEVELOPMENT OF OCEANOGRAPHIC INSTRUMENTATION ...Bottom Sampling Device, Technique Development, Water Motion Recorders, ...6.0090

LONG RANGE SOFAR FLOATS ...Acoustical, Currents-ocean, Subsurface Environments, Water Motion, Water Motion Recorders, ...2.0052

INERTIAL TECHNIQUES ...Acoustical, Currents-ocean, Hydrodynamics, ...8.0099

GEOTHERMAL MEASUREMENTS ...Geomorphology-topography, Geothermal Gradient, Heat Flow Measurements, Physical Properties, Temperature, ...1.0136

PROPERTIES OF SEA WATER ...Compresibility-gas-liq, Conductivity, Density, Electrical, Expansion, Thermal, ...1.0153

A STUDY OF THE TEMPERATURE MICROSTRUCTURE AND EDDY TRANSPORT IN THE OCEAN FLOOR BOUNDARY LAYER ...Benthonic-bottom, Geothermal, Heat Flow Measurements, Temperature, Thermodynamics, ...1.0189

THERMAL PROPERTIES OF SEA WATER AT LOW TEMPERATURE AND HIGH PRESSURE ...Acoustical, Conduction, Expansion, Hydrodynamics, Thermal, ...1.0177

THERMAL WAKE STUDIES ...Thermal, Thermocline, Turbulence - Sea Water, Waves-internal, ...1.0174

Physical Forces
Electrical Fields
CORRELATION BETWEEN ELECTRICAL PATTERNS AND MORPHOGENETIC PATTERNS DURING REGENERATION ...Developmental Physiology, Hydra, Portuguese Man-of-war, Regeneration and Wound, ...5.0062

637

Gravitational Fields
SIMULATED WEIGHTLESSNESS IN FISH ...Behavior, Cardiovascular System, Fish -non-specific, Gravity, Proprioceptors, ...5.0275

Pressure & Mech Stress
HYDROSTATIC PRESSURE-TEMPERATURE, AS ENVIRONMENTAL PARAMETERS, ON GROWTH, BIOCHEMISTRY AND PHYSIOLOGY OF MICROORGANISMS ...Growth (non-specific & OR), Marine Biology (non-specific), Microorganisms (non-specific), Temperature, ...5.0021

COMPARATIVE PHYSIOLOGY OF BAROPHILIC BACTERIA ...Ionic Effect, Isolation From Nat. environ, Marine Bacteria, Nutrition, Temperature, ...5.0162

Physiology
Erosion
PROPERTIES AND ORIGIN OF SEDIMENTS ON THE CONTINENTAL MARGIN OFF WESTERN U. S. ...Origin, Physical Properties, Sampling, Sedimentation, Shoreline - Coastline, ...7.0071

LITTORAL ENVIRONMENT OBSERVATION PROGRAM ...California, Development, Inter tidal Areas, ...7.0089

ANALYSIS OF AN ATTEMPT TO CONTROL BEACH EROSION AT SCIENTISTS CLIFFS, MARYLAND ...Beaches, Chesapeake Bay, Engineering Studies-other, Groin, Maryland, ...8.0038

NATURE OF INTERTIDAL EROSION ON CORAL ATLORLS ...Atolls, Fossil Limestone, Inter tidal Areas, Marine Biology (non-specific), ...7.0110

SEA FLOOR STUDIES - DEPOSITIONAL AND EROSION PROCESSES ...Bearing Capacity, Distribution, Lithification-general, Sedimentation, Stability Analysis, ...7.0050

Physical Features-general
PHYSICAL GEOGRAPHY OF TROPICAL COASTAL LOWLANDS ...Development, Geography-physical, Physical, Shore Features-general, Tropic, ...7.0028

Physiography-general
SUBMARINE TOPOGRAPHY ...Bathymetry, Origin, Pacific Ocean-south, Sedimentation, Textures-structures, ...7.0099

REDUCTION AND INTERPRETATION OF PHYSIOGRAPHIC DATA ACQUIRED ABOARD LAMONT RESEARCH VESSELS ...Data Analysis - General, Data Reduction and Analysis, Geology-general, Geomorphology-topography, Ocean Basins, ...7.0030

Terrain Analysis
ARCTIC RESEARCH LABORATORY ...Acoustical, Alaska, Arctic Ocean, Drift Stations, Seismic Studies, ...12.0003

Pigments - Animal-non-specific
CAROTENOIDES, CAROTENOID CHROMOPROTEINS, AND ASSOCIATED LIPIDS IN ANIMALS ...Carotenoid Pigments, Catabolism and Degradation, Metabolism, ...5.0944

Pilot Plant
MODEL ADVANCED WASTE-TREATMENT PLANT ...Activated Carbon, Lime Treatment, Material Recovery Wastes, Process Design, Solid Waste, ...8.0036

Plankton
Phytoplankton
MICROBIOLOGICAL ASSAYS OF SEAWATER USING RADIOISOTOPES ...Aquatic Ecology, Ciliates, Climates, Environmental Ecology, Environmental Physiology, Food Chains, Productivity - Food Chain, Thiamine, ...5.0811

BIOLOGY AND CHEMISTRY OF MARINE PLANKTON POPULATIONS ...Buoys, Chlorophyll, Vertical Distribution. Zooplankton, ...5.0879

PHYSICAL AND BIOLOGICAL OCEANOGRAPHY OF A LUMINOUS BAY ...Bays, Bioluminescence, Circulationgeneral, Jamaica, Model Studies, ...5.0976
Plankton

THE BIOLOGY AND CHEMISTRY OF TRACE ELEMENTS IN MARINE AND ESTUARINE WATERS...Chesapeake Bay, Estuaries, Productivity - Food Chain, Trace Element Analysis, Zooplankton, ...5.0875

DISSOLVED ORGANIC PHOSPHORUS IN NATURAL WATERS...Lower Plants, Phosphorus, Water Analysis, ...1.013

BIOLOGICAL PRODUCTIVITY IN THE SARGASSO SEA, THE GULF STREAM AND IN THE ATLANTIC COASTAL WATERS OFF CAPE HATTERAS...Estuarine Shelf, Primary Productivity, Productivity - Food Chain, Proteins, ...5.1005

C-14 UPTAKE, LIMITING FACTORS AND EXCRETION PRODUCTS OF ANTARCTIC PHYTOPLANKTON...Antarctic Ocean, Carbon, Carbon Cycle, Productivity, Productivity - Food Chain, ...5.0813

AN ECOLOGICAL STUDY OF SOUTH BISCAYNE BAY IN THE THEOCHEMICAL CONSEQUENCES OF PHYTOPLANKTON...Caribbean Sea, Range Or Territorial Dist., Sub-Tropic, Temporal Distribution, Vertical Distribution, ...5.0778

ECOLOGY OF PHYTOPLANKTON IN SEMI-TROPICAL ENVIRONMENTS...Caribbean Sea, Range Or Territorial Dist., Sub-Tropic, Temporal Distribution, Vertical Distribution, ...5.0778

MARINE PHYTOPLANKTON RESEARCH...Algal Culture, Indian Ocean-general, Nutrition Studies, Pacific Ocean-general, Symbiosis, ...5.0847

LANGMUIR CIRCULATION AND PLANKTON ECOLOGY...Circulation-general, Range Or Territorial Dist., Vertical Distribution, Water Movement, Currents, Storm Or Air Movement, Zooplankton, ...5.0794

ENVIRONMENTAL EFFECTS ON THE METABOLISM OF MARINE ALGAE...Enzymes, Marine Plants, Nutrients, Laminariaceae (non-specific), Light, Marine Plants, Responses to Growth, ...5.0702

NUTRITIONAL STUDIES ON MARINE ORGANISMS...Crustacea, non-specific, Invertebrate Nutrition, Nutrition Studies, Organisms, ...5.1001

THE CHARACTERISTICS, MECHANISMS AND BIOGENIC CONSEQUENCES OF PHYTOPLANKTON FLATION...Organics, Plant Lipids, Silicon, Size, Vertical Distribution, ...5.0826

STUDIES OF THE EFFECTS OF NUTRIENTS ON THE GROWTH OF PHYTOPLANKTON IN THE TROPICAL PACIFIC OCEAN...Algal Culture, Growth Rate, Nutrition, Pacific Ocean-general, Tropic, ...5.0944

RELATIONSHIPS BETWEEN PHYTOPLANKTON AND ZOOPLANKTON IN THE CARIBBEAN SEA...Caribbean Sea, Intertidal Bioclimate (non-specific), Sargassum, Vertical Distribution, Zooplankton, ...5.0779

STANFORD BIOLOGICAL OCEANOGRAPHY...Marine Biology, Primary Productivity, Productivity - Food Chain, Shrimp and Crustaceans, Shrimp and Crustaceans, Zooplankton, ...5.0731

LACUSTRINE AND ESTUARINE FUNGI...Aquatic Fungi (non-specific), Host-parasite Interactions, Marine Fungi (non-specific), Plant Morphology, Plant Taxonomy, Range Or Territorial Dist., ...5.0731

NUTRIENT LIMITATION AND SOURCES OF NITROGEN FOR MARINE PRIMARY PRODUCTIO...Marine Plants, Mathematical Biophysics, Nitrogen Fixation, Other Models, Primary Productivity, ...5.0845

ARCTIC BIOLOGICAL OCEANOGRAPHY...Adaptation, Arctic Ocean, Growth and Differentiation, Potamogeton, Ruppia, Zostera, Water - Light Qual. & Quant., Water Temperature - other, ...5.0853

LIPID COMPOSITION OF ANTARCTIC MARINE ORGANISMS AND SEA WATER...Antarctic Ocean, Fish (non-specific), Gulf of Mexico, Lipids, Low Temp., but Above 32F, Productivity - Food Chain, Zooplankton, ...5.1031

BIOLOGICAL PRODUCTIVITY INVESTIGATIONS OF THE WATERS SURROUNDING ANTARCTICA...Optical, Organisms, Primary Productivity, Standing Crops, Weddel Sea, ...5.1039

OPERATION OF R/V TRIDENT...Geomorphology-topography, Sea Floor Spreading, Ships and Cruises, Sound Production, Subbottom, Vertical Distribution, ...11.0045

HYDROLOGIC OPTICS - SPACECRAFT SPECTROSCOPY...Attenuation, Intensity, Oceanic Fronts, Optical, Radiograph, Radiometer, Scattering, Spectrophotometer, ...4.0139

PREDICTION OF BIOLOGICAL POPULATIONS FROM THE PHYSICAL OCEANIC ENVIRONMENT...Marine Environment-general, Range Or Territorial Dist., Ships and Cruises, Temporal Distribution, Vertical Distribution, ...5.0844

BIOLOGICAL OCEANOGRAPHY...Arctic, Organisms, Temporal Distribution, ...5.1038

BIOLOGICAL AND CHEMICAL STUDY OF VIRGINIA'S ESTUARIES...Estuaries, Nitrogen, Phosphorus, Population Dynamics, Primary Productivity, Virginia, ...5.0816

ANNUAL PHYTOPLANKTON RESEARCH IN PUGET SOUND WATERS...Copepods, Invertebrate Culture, Puget Sound, Standing Crops, Tides, ...5.0831

PLANKTON ECOLOGY OF BAR-BUILT ESTUARIES...Estuaries, North Carolina, Primary Productivity, Productivity - Food Chain, Zooplankton, ...5.0816

CHANGES IN THE LIMITING NUTRIENT DUE TO TEMPORAL, GEOGRAPHIC, AND DEPTH VARIATIONS...Depth, New York, Nutrients, Sub-Tropic, Water Depth, Water Levels, ...5.1004

ECOLOGY OF EELGRASS...Alaska, Bering Sea, Food Webs, Potamogeton, Ruppia, Zostera, Primary Productivity, ...5.0677

ENERGY AND ELEMENT TRANSFER IN LOWER MARINE TROPIC LEVELS...Copepods, Energy Budgets, Oregon, ...5.0823

BIOCHEMISTRY OF MARINE ORGANISMS...Adsorption & Interface, Bioluminescence, Foul, Plant Succession, Spectroscopy, ...5.0766

PHYSIOLOGICAL AND BIOCHEMICAL REQUIREMENTS OF PHYTOPLANKTON SPECIES...Algal Culture, Marine Plants, Media, Nutrition Studies, Planktonic - Floating, ...5.0995

PRODUCTIVITY OF ESTUARINE AND MARINE ECOSYSTEMS (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION)...Algae, Estuaries, Marine Plants, Primary Productivity, Standing Crops, ...5.1010

INPEC BIOLOGICAL OCEANOGRAPHY - (PHYTOPLANKTON AND ZOOPLANKTON) FOR SELECTED ENVIRONMENTAL REQUIREMENTS OF ESTUARINE AND MARINE ORGANISMS FOR EVALUATING THE QUALITY OF WATER...Biosystems, Estuaries, Pollution - Effects of, Pollution Effects, Zooplankton, ...5.0833

EFFECTS OF PETROLEUM AND PETROLEUM WASTES UPON IMPORTANT SPECIES OF ESTUARINE PHYTOPLANKTON AND ZOOPLANKTON...Contamination - Water, Contamination, Pollution-water, Estuaries, Oil, Oil and Natural Gas - Sulfur, Zooplankton, ...5.0830

INTEGRATED FIELD AND LABORATORY SYSTEM FOR ASAYING THE EFFECT OF POLLUTANTS AND TOXICANTS UPON WATER QUALITY...Algal Culture, Axenic Culture, Pollution - Effects of, Responses to Growth, ...5.0831

EFFECT OF NITRILOTRIC ACID (NTA) UPON THE TOXICITY OF METALS TO SELECTED SPECIES OF ESTUARINE PHYTOPLANKTON...Acids, Carbon, Chemicals (incl. algalides), Estuaries, Isotope Tracer-other, ...5.0829

DEVELOPMENT OF A METHOD FOR CHRONIC TOXICITY BIOASSAY USING MARINE PLANKTONIC ALGAE...Algal Culture, Bioassays, Marine Plants, Microbiological Analysis, Monitoring (long Term Studies), Technique Development, Toxicology, ...5.0726

STANDING STOCK AND GROWTH OF BACTERIA IN THE SEA...Sea X Amino Triphosphate, Carbohydrates, Growth (non-specific & Ot.), Marine Biology, Standing Crops, ...5.0734

Plankton (non-specific)

MARINE COMMUNITIES...Benthic Organisms (non-specific), Environmental Ecology, Life History Studies, Model Studies, ...5.0864

638
Plankton

SUBJECT INDEX

PLANKTON ECOLOGY OF CAR-BUILT ESTUARIES ...Estuaries, North Carolina, Phytoplankton, Primary Productivity, Productivity - Food Chain, ...5.0816

ZOOPLANKTON STUDIES IN BIG LAGOON, CALIFORNIA ...California, Lagoons, Plankton Sampling, Temporal Distribution, Vertical Distribution, ...5.0739

ZOOPLANKTON DISTRIBUTION OF THE GULF OF MAINE ...Atlantic Ocean-north, Plankton Sampling, Population Dynamics, Vertical Distribution, ...5.0789

MARINE BIOLOGICAL INVESTIGATIONS - NEKTON OF INSIDE WATERS OF SOUTHEASTERN ALASKA ...Alaska, Plankton Sampling, Population Dynamics, Temporal Distribution, ...5.0521

MARINE BIOLOGICAL INVESTIGATIONS - SURFACE ZOOPLANKTON PROJECT ...Alaska, Number Or Density, Plankton Sampling, Vertical Distribution, ...5.0737

INPEC BIOLOGICAL OCEANOGRAPHY - (PHYTOPLANKTON AND ZOOPLANKTON RESEARCH) ...Food Supply, Pacific Ocean-north, Phytoplankton, Primary Productivity, Temporal Distribution, ...5.0843

ZOOPLANKTON DISTRIBUTION IN THE TROPICAL ATLANTIC ...Atlantic Ocean-general, Plankton Sampling, Range Or Territorial Distr. , Temperature, Tropic, Vertical Distribution, ...5.0771

PRODUCTIVITY MEASURES ...Number Or Density, Ocean Currents-other, Organism Sampling Devices, Pacific Ocean-east, Primary Productivity, Productivity - Food Chain, ...5.0940

USE OF MARINE PLANKTONIC ORGANISMS FOR EVALUATING THE QUALITY OF MARINE AND ESTUARINE WATERS ...Biosassays, Estuaries, Phytoplankton, Pollution - Effects of, Pollution Effects, ...5.0832

DEVELOPMENT OF CULTURE METHODS FOR ECLOGICALLY IMPORTANT MARINE ZOOPLANKTON SPECIES ...Aquatic Ecology, Copepods, Environmental Physiology, Intertidal Culture, ...5.0834

DETERMINATION OF SELECTED ENVIRONMENTAL REQUIREMENTS OF IMPORTANT SPECIES OF MARINE ZOOPLANKTON ...Copepods, Oxygen, Water Salinity, Water Temperature-non-specific, ...5.0835

EFFECTS OF PETROLEUM AND PETROLEUM WASTES UPON IMPORTANT SPECIES OF ESTUARINE PHYTOPLANKTON AND ZOOPLANKTON ...Contamination - Water, Contamination, Pollution-water, Estuaries, Oil, Gill and Natural Gas - Sulfur, Phytoplankton, ...5.0836

Plankton Sampling

ECOLOGY OF PLANKTONIC FORAMINIFERA AND RELATED STUDIES ...Dinoflagellates, Foraminifera, Gas-tropods-slug,conch,snails, Vertical Distribution, ...5.0812

PLANKTON ECOLOGY ...Aquatic Ecology, Copepods, Lake Michigan, Ships and Cruises, Zooplankton, ...5.0803

LARVAL STUDY OF THE LOBSTER ...Atlantic Ocean-north, Habitat Studies, Lobsters, Long Island Sound, Mark, Tag Or Capture -other, Maturity & Growth Stages, ...5.0371

LAKE BORGNO-CHANDELEUR SOUND SYSTEM ...Benthic Fauna, Louisiana, Number Or Density, River Deltas, Vertical Distribution, ...5.0091

TIMBALIER - TERREBONNE BAYS SYSTEM ...Benthic Fauna, Louisiana, Number Or Density, River Deltas, Vertical Distribution, ...5.0092

BRETON SOUND - MOUTH OF MISSISSIPPI RIVER SYSTEM ...Benthic Fauna, Louisiana, Number Or Density, River Deltas, Vertical Distribution, ...5.0093

VERMILION - CALCASIEU - SABINE SYSTEM ...Benthic Fauna, Louisiana, Number Or Density, Salinity, Tides, Vertical Distribution, ...5.0094

ATCHAFALAYA RIVER - GAILOU LAKE SYSTEM ...Benthic Fauna, Lakes, Louisiana, Number Or Density, Vertical Distribution, ...5.0095

LAKE BORGNO - CHANDELEUR SOUND SYSTEM ...Data Acquisition, Gulf of Mexico, Maturity & Growth Stages, Nets, Population Dynamics, Shrimps - Common, ...5.0434

A STUDY OF THE OPEN WATER DISTRIBUTION AND ABUNDANCE OF NET-PLANKTON AS AN INDEX OF EUROTYPHICITY IN LAKE SUPERIOR ...Boid indicators, Data Acquisition, Eutrophication, Lake Superior, Zooplankton, ...6.0160

ZOOPLANKTON STUDIES IN BIG LAGOON, CALIFORNIA ...California, Lagoons, Temporal Distribution, Vertical Distribution, Zooplankton, ...5.0739

RELECT COPEPODS FROM LAKE TUBORG, ELLESMERE ISLAND ...Brackish Water, Canada, Carbon-14, Copepods, Lakes, ...5.0838

ZOOPLANKTON OF THE GULF OF MAINE ...Atlantic Ocean-north, Population Dynamics, Vertical Distribution, Zooplankton, ...5.0789

MARINE BIOLOGICAL INVESTIGATIONS - NEKTON OF INSIDE WATERS OF SOUTHEASTERN ALASKA ...Alaska, Population Dynamics, Temporal Distribution, Zooplankton, ...5.0521

ROUTINE SAMPLING AT SEVEN INDEX STATIONS ...Bottom Sampling, Data Acquisition, Fish - non-specific, Lake Erie, Sampling, ...5.0214

MARINE BIOLOGICAL INVESTIGATIONS - SURFACE ZOOPLANKTON PROJECT ...Alaska, Number Or Density, Vertical Distribution, Zooplankton, ...5.0737

ZOOPLANKTON DISTRIBUTION IN THE TROPICAL ATLANTIC ...Atlantic Ocean-general, Range Or Territorial Distr., Temperature, Tropic, Vertical Distribution, Zooplankton, ...5.0771

DESIGN AND DEVELOPMENT OF NEKTON SAMPLER ...Food Supply, Nektonic - Swimming, Organism Sampling Devices, Tuna, Mackeral, Albacores, ...5.0129

Planktonic Floating

MICROPLANKTON OF THE BEARPAW SHALE OF MONTANA AND NORTH DAKOTA ...Cretaceous Period, Fine-grained Clastics, Microfossils, Montana, North Dakota, ...7.0249

PHYSIOLOGICAL AND BIOCHEMICAL REQUIREMENTS OF PHYTOPLANKTON SPECIES ...Algal Culture, Marine Plants, Media, Nutrition Studies, Phytoplankton, ...5.0995

Planning

AN APPROACH TO MARINE RESOURCE DEVELOPMENT IN ALASKA ...Alaska, Marine Biology (non-specific), ...7.0001

SCIENCE AND ENGINEERING GOALS FOR THE INTERNATIONAL DECADE OF OCEAN EXPLORATION ...Economics, Oceanography-general, Project Review, Science & Technology, ...5.0118

STREAM IMPROVEMENT PLANNING ...Benefit-cost Analysis, Engineering Structures-general, Fish - non-specific, Management -other, Streams, ...5.0230

TECHNIQUES OF PLANNING ...Application, Control Systems, Management, Mathematical Analysis, Operations Research, Southern, Systems Analysis, ...9.0017

Plant Alkaloids

ORGANIC CHEMICAL STUDIES ON ANIMAL AND PLANT TOXIN ...Algal Toxins, Animal Toxins, Biochemical Analysis, Medicinal Plants, Plant Toxins, ...6.0115

Plant Characteristics

Adaptation

MACROMOLECULAR BASIS FOR ADAPTATION TO SALINITY CHANGES IN PRYMNESIUM PARVUM ...Growth Rate, Ionic Effect, Permeability, Prymnesium, Water Salinity, ...5.1012

ARCTIC BIOLOGICAL OCEANOGRAPHY ...Arctic Ocean, Growth and Differentiation, Phytoplankton, Foraminogor, Rup- pia, Zostera ...Water - Light Qual. & Quant. , Water Temperature -other, ...5.0853

Growth Rate

MICROBIAL ACTIVITY IN NON AQUEOUS SYSTEMS ...Range Or Territorial Distr., ...5.0782

Size

THE CHARACTERISTICS, MECHANISMS AND BIOGEOCHEMICAL CONSEQUENCES OF PHYTOPLANKTON FLOTATION ...Organics, Phytoplankton, Plant Lipids, Silicon, Vertical Distribution, ...5.0826
SUBJECT INDEX

Plant Developmental Biology

MORPHOGENESIS OF THE DIATOM SHELL ...Algae-
Diatoms, Cellular Membranes (non-spec.), Silica, Structural
Functions, ...5.0734

MORPHOGENESIS OF THE DIATOM SHELL ...Algae-
Diatoms, Cellular Membranes (non-spec.), Intracellular Local-
ization, Organelle & Membrane Formation, Silica, ...5.0712

GROWTH AND CELLULAR MORPHOGENESIS IN NITELLA ...
...Elongation of Cell, Growth and Differentiation, Manometers,
Nitella, Water Movement, ...5.0721

PRELIMINARY INVESTIGATION OF GROWTH AND DIFFER-
ENTIATION IN MARINE COENOCTIC ALGAE, CAU-
LERPA PROLIFERA ...Caulerpa, Differentiation Mechanism,
Growth and Differentiation, Growth Rate, ...5.0711

DEVELOPMENT OF POLARITY IN THE FUCACEAN
ZYGOTE ...Cellular Physiology, Differentiation Mechanism,
Fucus, Polarity, Reproductive Physiology, ...5.0792

BIOLOGY AND PALEONTOLOGY OF MARINE
DINOFLAGELLATES AND HYSTRICHOSPHERES ...Algae-
Dinoflagellates, Algal Culture, Cell Cycle, Range Or Territories 
Distr., Spores, Vertical Distribution, ...5.0799

EXPERIMENTAL BIOLOGY OF LOWER MARINE FUNGI ...
...Habitat Studies, Marine Fungi (non-specific), Phycomycete, ...5.0808

RED TIDE TOXICITY ...Algal Toxins, Biochemical Analysis, Gas
Chromatography, Gymnodinium, Pollution Sources-other, ...5.0780

BIOCHEMICAL STUDIES ON SILICEOUS SKELETAL FORM-
ATION ...Algae- Diatoms, Cell Wall, Golgi Apparatus, Histochemistry - Cytochem, Silica, ...5.0750

STRUCTURAL AND FUNCTIONAL ORGANELLE INTERAC-
TIONS ...Differentiation Mechanism, Marine Plants, Organelle & Membrane Formation, Structural Functions, Tissue Techniques, ...5.0689

BIOLOGICAL ACTIVITIES OF MARINE FUNGI ...End-
deparatis - other, Host-parasite Interactions, Invertebrate Pathology, Marine Fungi (non-specific), Oysters, Pathological Physiology, ...5.0699

Plant Morphology

TAXONOMY OF CALCAREOUS GREEN ALGAE ...
Chlorophyceae (non-specific), Indian Ocean-general, Plant
Taxonomy, Range Or Territorial Distr., Reproductive Physiolo-
y, ...5.0671

MORPHOLOGY AND TAXONOMY OF MARINE FUNGI ...
...Habitat Studies, Mangroves, Marine Fungi (non-specific), Plant Taxonomy, Sub- Tropical, Tropic, ...5.0716

LACUSTRINE AND ESTUARINE FUNGI ...Aquatic Fungi (non-
specific), Host-parasite Interactions, Marine Fungi (non-
specific), Phytoplankton, Plant Taxonomy, Range Or Territorial Distr. ...5.0731

Plant Morphology Parameters

Roots
MARINE ALGAE OF THE MANGROVE ROOT COMMUNITY ...
...Algae- General, Habitat Studies, Mangroves, Marine Plants, 
Puerto Rico, ...5.0723

Spires
FEASIBILITY OF THE APPLICATION OF PALYNOLOGICAL INVESTIGATIONS OF DEEP-SEA SEDIMENTS TO MAJOR GEOLOGICAL PROBLEMS ...Palaeoclimatology, Palaeontology, Pollen, Pollens, ...5.0686

Plant Pathology

CONTROL OF PLANT PATHOGENS USING ACTIVE AN-
TIMICROBIAL SUBSTANCES ISOLATED FROM MARINE
ALGAE ...Endogenous Biological Extracts, Fungi - non-specific, 
Growth Substances, Marine Plants, Nutrition in Disease, ...6.0127

Fungi - non-specific
CONTROL OF PLANT PATHOGENS USING ACTIVE AN-
TIMICROBIAL SUBSTANCES ISOLATED FROM MARINE
ALGAE ...Bacteria, Endogenous Biological Extracts, Growth 
Substances, Marine Plants, Nutrition in Disease, ...6.0127

Host-parasite Interactions

LACUSTRINE AND ESTUARINE FUNGI ...Aquatic Fungi (non-
specific), Marine Fungi (non-specific), Phytoplankton, Plant
Taxonomy, Range Or Territorial Distr. , ...5.0721

ULTRASTRUCTURAL STUDIES OF PARASITIC AND
SAPROPHYTIC FUNGI AND PROTOZOA ASSOCIATED WITH MARINE INVERTEBRATES ...Cell Cycle, Electron 
Microscopy, Myxomycetes, Protozoa, ...5.0839

BIOLOGICAL ACTIVITIES OF MARINE FUNGI ...End-
deparatis - other, Invertebrate Pathology, Marine Fungi (non-
specific), Oyster, Pathological Physiology, Plant Development-
mental Biology, ...5.0699

Nutrition in Disease

CONTROL OF PLANT PATHOGENS USING ACTIVE AN-
TIMICROBIAL SUBSTANCES ISOLATED FROM MARINE
ALGAE ...Bacteria, Endogenous Biological Extracts, Fungi -
non-specific, Growth Substances, Marine Plants, ...6.0127

Plant Physiology

Metabolism
Translocation
ECOLOGICAL STUDIES OF THE SOUTHEASTERN FLORIDA 
SEA GRASS COMMUNITY - PRIMARY PRODUCTION BY 
THALASSIA TESTUDINUM KONIG ...Elodii, Waterweed, 
Thalassia, Florida, Primary Productivity, Submerged Plants, 
Tropic, ...5.0695

Plant Resistance to ....
Heat Resistance
THERMAL DESTRUCTION OF TYPE E CLOSTRIDIUM 
BOTULINUM ...Clostridium Botulinum, Differentiation 
Mechanism, Food (epidemiology), Microbiological, Spore Studies, ...6.0006

Plant Taxonomy

THE MARINE ALGAE OF VIRGINIA ...Algae- General, 
Benthonic-bottom, Chesapeake Bay, Marine Plants, Virginia, ...5.0698

SYSTEMATICS, MORPHOLOGY, AND ECOLOGICAL 
DISTRIBUTION OF ALGAE AND WOOD-INHABITING MARINE 
AND FRESHWATER FUNGI OF SURTSEY AND ICELAND ...
...Aquatic Fungi (non-specific), Iceland, Islands, Marine Fungi (non-
specific), Range Or Territorial Distr, ...5.0714

TAXONOMY OF CALCAREOUS GREEN ALGAE ...
Chlorophyceae (non-specific), Indian Ocean-general, Plant 
Taxonomy, Range Or Territorial Distr., Reproductive Physiology, ...5.0718

YEAR-ROUND PROGRAM OF RESEARCH IN MARINE 
ECOLOGY ...Annelida Taxonomy, Aquatic Ecology, Marine 
Biology (non-specific), Plant Ecology (non-specific), Training 
Grants, Fellowships, ...5.0699

MORPHOLOGY AND TAXONOMY OF MARINE FUNGI ...
...Habitat Studies, Mangroves, Marine Fungi (non-specific), 
Plant Morphology, Sub- Tropical, Tropic, ...5.0716

SYSTEMATICS AND ECOLOGY OF SUBTIDAL BENTHIC 
MARINE ALGAE ...Algae- General, Benthic Flora, Benthonic-
bottom, Habitat Studies, Marine Plants, Range Or Territories 
Distr., ...5.0701

LACUSTRINE AND ESTUARINE FUNGI ...Aquatic Fungi (non-
specific), Host-parasite Interactions, Marine Fungi (non-
specific), Phytoplankton, Plant Morphology, Range Or Territorial 
Distr., ...5.0731

PHYSIOLOGY AND ECOLOGY OF MARINE DIATOMS ...
Algae- Diatoms, Algal Culture, Habitat Studies, Marine Plants, 
Nutrition Studies, Physiological Ecology, ...5.0735
SUBJECT INDEX

**Pollution - Effects of**

1. EFFECTS OF HEATED WATER DISCHARGE ON THE MARINE ENVIRONMENT  ... Marine Environments-general, Pollution Sources-other, Thermal Pollution  ... 6.0142
2. CALORIC - AN INVESTIGATION OF HEAT RELEASE PATTERNS ASSOCIATED WITH PRESENT AND PLANNED LAKESHORE ELECTRICAL POWER PLANTS  ... Electric Power Plants, Lake Erie, Model Studies, Nuclear Power, Temperature, Thermal Pollution  ... 6.0141
3. ECOLOGICAL EFFECTS OF ENVIRONMENTAL & LOW LEVEL POLLUTION STRESSES ON METABOLIC REQUIREMENTS FOR GROWTH OF GULF COAST FISHES  ... Environmental Ecology, Gulf of Mexico, Metabolism, Pollution Effects, Pollution Sources-general, Stress  ... 5.0328
4. OPTIMUM ECOLOGICAL DESIGNS FOR ESTUARINE SYSTEMS OF NORTH CAROLINA  ... Marine Biology (non-specific), North Carolina, Pollution Effects, Productivity - Food Chain  ... 5.0913
5. EFFECTS OF PESTICIDES ON ESTUARINE PRODUCTIVITY  ... Aquatic Ecology, Bays, Mammal Activities, Persistence of Residues, Pesticides (non-specific), Population Dynamics, Standing Crops  ... 5.0914
6. DETERMINATION OF SAFE LEVELS OF POLLUTION IN PUERTO RICO  ... Bays, Contamination - Water, Meteorological Studies-general, Puerto Rico, Recreation Sites, Water Properties-general  ... 5.0915
7. A STUDY OF SELECTED CHEMICAL, AND BIOLOGICAL CONDITIONS OF THE LOWER TRINITY RIVER AND THE UPPER TRINITY BAY  ... Commercial Fishing, Estuaries, Mammal Activities, Spawning & Nesting Sites, Texas  ... 5.0916
8. CHANGES DURING EUTRIFICATION OF AN ESTUARY  ... Estuaries, Eutrophication, North Carolina, Plankton (non-specific)  ... 5.0917
9. EFFECTS OF THERMAL POLLUTION ON PRODUCTIVITY AND STABILITY OF ESTUARINE COMMUNITIES  ... Aquatic Ecology, Estuaries, Plant Prod. (non-specific), Thermal Pollution  ... 5.0918
10. WATER QUALITY - BENTHIC INVERTEBRATE RELATIONSHIPS IN ESTUARIES  ... Benthos-bottom, Estuaries, Marine Pollution Effects  ... 5.0919
11. INFLUENCE OF SUSPENDED MICROSCOPIC SUBSTANCES ON THE METABOLISM OF MICROORGANISMS RESPONSIBLE FOR BIOLOGICAL ENRICHMENT OF WATER  ... Adsorption Capacity, Chemical, Eutrophication, Lake Erie, Microorganisms (non-specific), Sediments  ... 5.0920
12. THE ECOLOGIC IMPACT OF THE INTERACTIONS AMONG MICROORGANISMS AND AQUATIC CONTAMINANTS IN LAKE ERIE  ... Lake Erie, Primary Productivity, Responses to Growth, Sediments, Water Bacteria  ... 5.0921
13. THE BIOLOGY OF THE INFAUNA OF A TROPICAL SOFT BOTTOM AREA  ... Aquatic Ecology, Benthic Fauna, Estuaries, Florida, Intertidal Areas  ... 5.0922
14. ENVIRONMENTAL BIOLOGY OF TOMALES BAY DAY  ... Aquatic Ecology, Bays, Benthic Fauna, California, Mammal Activities  ... 5.0923
15. DEMONSTRATION OF THE LIMITATIONS AND EFFECTS OF WASTE DISPOSAL ON AN OCEAN SHELF  ... Marine Plants, Ocean, Outlet, Pollution Effects, Sewers  ... 5.0924
16. EFFECTS OF WASTE POLLUTION IN SAN FRANCISCO BAY  ... Bays, Economic Impact, Recreation Sites, San Francisco Bay, Social Aspects, Water Utilization -domestic, Welfare Economics  ... 5.0925
17. A SURVEY OF THE MARINE ENVIRONMENT FROM PERT ROSS, SONOMA COUNTY, TO POINT LOBOSS, MONTEREY COUNTY  ... California, Effluents-waste Water, Marine Environments-general, Pollution Effects  ... 5.0926
18. ECOLOGY OF KRAFT PAPER MILL EFFLUENT IN SAPELO & ST. CATHERINES SOUNDS, GA  ... Aquatic Ecology, Georgia, Pollution Effects, Pulp, Paper, and Logging, Streams  ... 5.0927
19. AN ENVIRONMENTAL SURVEY OF THE DAMARISSCOTTA RIVER ESTUARY, LINCOLN COUNTY, MAINE  ... Circulation -water, Estuaries, Nutrients, Salinity, Sedimentology-general  ... 5.0928
20. EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS  ... Bays, Estuaries, Persistence of Residues, Sevins, Swamp-marshes  ... 5.0929
21. EFFECTS OF KRAFT PAPER MILL EFFLUENTS ON THE GROWTH AND PRODUCTION OF FISH  ... Contamination - Water, Industrial Pollution, Pollution Effects, Pollution Sources-general, Stress  ... 5.0930

**Pollution - Effects of Chemical Identification**

STEROLS AND LIPIDS IN WATER POLLUTION  ... Effluents-waste Water, Lipid Hydroperoxides, Pollutants - Path of, Sewage, Sterols  ... 6.0186
USE OF MARINE PLANKTONIC ORGANISMS FOR EVALUATING THE QUALITY OF MARINE AND ESTUARINE WATERS  ... Bioassays, Marine Biology (non-specific), Plankton (non-specific), Pollution Effects of  ... 6.0183

**Pollution - Effects of Physical Parameters**

ULTRAVIOLET ABSORPTION IN COASTAL WATERS  ... Biological, Marine Plants, Plant Prod. (non-specific), Sewage, Total Organic Carbon, Ultra - Violet Radiation  ... 6.0138

**Pollutants -general**

EFFECTS OF RIVERS ON THE METABOLISM OF TEXAS BAYS  ... Bays, Nutrients, Primary Productivity, Streams, Texas, Water Quality-general  ... 6.0187
REMOTE SENSING OF DELAWARE ESTUARY  ... Aircraft, Delaware, Estuaries  ... 6.0188
MONITORING OF PESTICIDE LEVELS IN THE GREAT LAKES  ... Fish (non-specific), Great Lakes-general, Insecticides (non-specific), Monitoring Systems, Sampling  ... 6.0190
ORGANISMS RESPONSIBLE FOR TOXICITY OF ALASKAN CLAMS  ... Alaska, Biological Pollutants-general, Clams, Food Spoilage Detection, Microbiological  ... 6.0144

**Pollutants-other**

OIL LEAKS AND SLICKS  ... Aerial Photography, Aircraft, Oil, Satellites, Technique Development  ... 6.0168
PROJECT AQUA-MAP - DEVELOPMENT OF AERIAL PHOTOGRAPHY AS AN AID TO WATER QUALITY MANAGEMENT  ... Aerial Photography, Effluent-waste Water, Management, Model Studies, New York  ... 6.0167

**Pollutants - Path of**

ECOLOGICAL STUDIES OF RADIOACTIVITY IN THE COLUMBIA RIVER ESTUARY AND ADJACENT PACIFIC OCEAN  ... Columbia River, Contamination - Water, Organism Sampling Devices, Pacific Ocean-north, Radioactivity-general  ... 6.0172
STABLE CARBON AND OXYGEN ISOTOPE RATIO VARIATIONS IN THE FLOW TO CARBON AND OXYGEN THROUGH NORMAL AND POLLUTED AQUATIC SYSTEMS  ... Carbon, Element Ratios, Organic-general, Oxygen, Sewage Systems-other, Water Analysis  ... 6.0132
IMPACT AND FATE OF POLLUTION IN ESTUARIAL WATERS  ... Degradation, Estuaries, Massachusetts, Pesticides (non-specific), Pollution Effects  ... 6.0189
EDDY DIFFUSION AND BACTERIAL REDUCTION IN WASTE FIELDS  ... Bacterial Pollutant Sources, Diffusion, Dispersion -water, Dyes, Mixing, Sewers  ... 6.0137
STEROLS AND LIPIDS IN WATER POLLUTION  ... Chemical Identification, Effluents-waste Water, Lipid Hydroperoxides, Sewage, Sterols  ... 6.0186
RADIONUCLIDES IN THE SAVANNAH RIVER ESTUARY AND ADJACENT COASTAL WATERS  ... South Carolina  ... 6.0185
MOVEMENT OF RADIONUCLIDES IN THE LOWER COLUMBIA RIVER  ... Absorbed Load, Adsorption Capacity, Columbia River, Estuaries, Radioactivity-general  ... 6.0178
THE MOVEMENT OF RADIONUCLIDES IN THE COLUMBIA RIVER ESTUARY  ... Absorbed Load, Adsorption Capacity, Columbia River, Estuaries, Radioactivity-general  ... 6.0180
PESTICIDE KINETICS  ... Aquatic Or Soil-aquatic Cycles, Degradation, Estuaries, Insecticides (non-specific), Marine Biology (non-specific)  ... 6.0148
FATE OF INLAND DERIVED POLLUTANTS IN AN ESTUARY  ... Estuaries, Pollution - Effects of Pollution Abatement, Pollution Sources-general, Systems Analysis  ... 6.0133
ESTUARINE DIFFUSION OF POLLUTANTS  ... Dilution-other, Estuaries, Oregon, Salinity, Stratification  ... 6.0173

**Pollution - Effects of**

ECOLOGICAL SURVEY OF EFFLUENT DISCHARGE AT TWO PULP MILLS IN HUMBOLDT COUNTY, CALIFORNIA  ... California, Chemical Analysis (water), Effluents-waste Water, Pollution Effects, Pulp, Paper, and Logging  ... 5.0858
SUBJECT INDEX

Pollution - Effects of
GREAT LAKES RESEARCH - SOIL DISPOSAL EFFECTS ...Dispersal, Great Lakes-general, Sediments, Spill Banks, Suspension, Water Properties-general, ...6.0157
STUDY OF EFFECTS OF OIL CYCLE DUMPING ...Circulation-general, Dispersion, Oil, Water, Engineering-water, Pollution-other, Pollution Sources-other, Shoreline - Coastline, ...6.0144
EFFECTS OF HEAT DUMPING IN A TIDAL ESTUARY ...Estuaries, Electric Power Plants, Pollution Effects, Thermal Pollution, Tidal Streams, Water Properties-general, ...6.0145
INFLUENCE OF INDUSTRIAL AND MUNICIPAL WASTES ON ESTUARINE AND OFF SHORE WATER QUALITY ...Domestic Wastes-general, Estuaries, Industrial Wastes, Washington, ...6.0192
SAN PABLO BAY STUDY ...Bays, Benthic Fauna, Bottom Sampling Device, Excavation, Spill Banks, ...6.0136
MEASUREMENT OF RADIONUCLIDES IN ESTUARINE AND MARINE ENVIRONMENTS (A COOPERATIVE AGREEMENT WITH THE ATOMIC ENERGY COMMISSION) ...Estuaries, Marine Environments-general, Pollution Effects, Radioactivity-general, Reactor Sites & Rad Waste, ...5.0912
THE EFFECTS OF ENVIRONMENTAL CONDITIONS ON THE SPAWNING AND SURVIVAL OF FRY OF THE WALLEYE ...Environmental Factors-water, Eutrophication, Lake Erie, Temperature, Walleyes, ...5.0299
ARTIFICIAL SELECTION - FISH ...Female Gametes, Fish - non-specific, Genetic Resistance, Pesticides - non-specific, Selection & Breeding, ...5.0256
LABORATORY BIOASSAYS ...Contamination - Water, Fish, Laboratory, Laboratory Animals, Pollution Sources-general, ...5.0882
RELATION OF RIVER-RUN IMPOUNDMENTS TO SALMON PRODUCTION ...Biological Ecology, Enginering Structures-general, Environmental Changes, Environmental Ecology, Mans Activities, Salmon & Trout - Non-specific, ...5.0222
ESTUARINE ECOLOGICAL SYSTEMS ...Aquatic Ecosystems, Estuaries, Pesticides, Pollution Effects, Population Dynamics, ...5.0883
EFFECTS OF INDUSTRIAL EXPANSION ON THE AQUATIC ENVIRONMENT OF ESTUARINE AREAS ...Columbia River, Estuaries, Salmon & Trout - Non-specific, ...5.0226
ECOLOGY OF WESTERN GULF ESTUARIES (ESTUARINE PROGRAM) ...Coastal Engineering-other, Estuaries, Gulf of Mexico, Habitat Studies, Mans Activities, ...5.0928
DISPOSAL TO MARINE WATERS ...Circulation-general, Model Studies, Monitoring (long Term Studies), Pollution Sources-general, ...6.0177
RELATIONSHIP BETWEEN GLACIAL FLOUR POLLUTION AND POLLUTANTS FROM OTHER SOURCES ...Aerosol, Adsorption Capacity, Alaska, Estuaries, Glacial Clastics, Pulp, Paper, and Logging, Size, ...6.0134
FATE OF INLAND DERIVED POLLUTANTS IN AN ESTUARY ...Estuaries, Pollutants - Path of, Pollution Abatement, Pollution Sources-general, Systems Analysis, ...6.0133
ENVIRONMENTAL CONDITIONS AND POPULATION DYNAMICS IN SELECTED U.S. ESTUARIAL AND COASTAL AREAS ...Aquatic Ecology, Contaminant-water, Habitat Studies, Marine Biology (non-specific), Toxic Substances - non-specific, ...6.0922
USE OF MARINE PLANKTONIC ORGANISMS FOR EVALUATING THE QUALITY OF MARINE AND ESTUARIAL WATERS ...Biological Ecology, Engineering Structures-general, Marine Biology (non-specific), Plankton (non-specific), ...6.0183
MARINE BIOLOGICAL ASSESSMENT OF POLLUTIONAL FATE ...Circulation - Water, Crustacea - non-specific, Fish - non-specific, Nets, ...6.0176
HISTOPATHOLOGIC EFFECTS OF POLLUTANTS ON CELLS AND TISSUES OF MARINE FISHES ...Contamination - Water, Killifishes - Cyprinodon, Pathology, Pollution Effects, ...5.0333
HISTOPATHOLOGIC EFFECTS OF POLLUTANTS ON CELLS AND TISSUES OF MARINE INVERTEBRATES ...Clams, Contamination - Water, Invertebrate Pathology, Pathology, Pollution Effects, Pollution Sources-other, ...6.0497
USE OF MARINE PLANKTONIC ORGANISMS FOR EVALUATING THE QUALITY OF MARINE AND ESTUARIAL WATERS ...Bioassays, Estuaries, Phytoplankton, Pollution Effects, Zooplankton, ...5.0832
INTEGRATED FIELD AND LABORATORY SYSTEM FOR ASSESSING POLLUTANTS AND TOXICANTS UPON WATER QUALITY ...Algal Culture, Culture, Phytoplankton, Responses to Growth, ...5.0831
STUDY OF NITROGEN METABOLISM IN MARINE ALGAE ...Bioindicators, Marine Plants, Microbiological Analysis, Quantitative & Qualitative, ...5.0977
EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS ...Drsbun, Estuaries, Mode of Action - Animal, Model Studies, Sevin, ...5.0919

Pollution Sources
Algal Pollutant Sources
CLADOPHORA AS RELATED TO POLLUTION IN WESTERN LAKE ERIE ...Bioindicators, Chemical Analysis, Cladophora, Lake Erie, Mapping, ...6.0170
Animal Pollutant Sources
LAKE MICHIGAN CHEMICAL CONTROL OF SEA LAMPEY ...Control of Nuisance Species, Evaluation, Lake Michigan, Lampreys, Larvicides, ...6.0158
BIOASSAY ...Evaluation, Lampreys, Piscicides - non-specific, Streams, Water Properties-general, ...5.0632
Bacterial Pollutant Sources
BACTERIOLOGICAL AND ESTHETIC OF PLEASURE BOAT WASTE DISCHARGE ON SMALL HARBORS ...Beautification, Harbors, Mans Ship Wastes, Water Analysis, ...6.0191
EDDY DIFFUSION AND BACTERIAL REDUCTION IN WASTE FIELDS ...Diffusion, Eddy's, Water - Waste, Dyes, Mixing, Pollutants - Path of, Sewers, ...6.0137
ENTERIC BACTERIA AND VIRUSES IN SEWAGE, WATER, AND SHELLFISH ...Californium (non-specific), Oysters, Pollution Effects, Sewage, Viral Pollutant Sources, ...6.0052
DISTRIBUTION OF C. BOTULINUM IN COMMERCIAL SMOKED FISH ...Clostridium Botulinum, Fish - non-specific, Food (epidemiology), Microbiological, Smoking, ...5.0337
Biological Pollutants - general
ORGANISMS RESPONSIBLE FOR TOXICITY OF ALASKAN CLAMS ...Alaska, Clams, Food Spoilage Detection, Microbiological, Pollutants-general, ...5.0344
Domestic Wastes-general
OPTIMUM ECOLOGICAL DESIGNS FOR ESTUARINE SYSTEMS OF NORTH CAROLINA ...Estuaries, Marine Biology (non-specific), North Carolina, Pollution - Effects of, Pollution Effects, Productivity - Food Chain, ...5.0913
INFLUENCE OF INDUSTRIAL AND MUNICIPAL WASTES ON ESTUARINE AND OFF SHORE WATER QUALITY ...Estuaries, Industrial Wastes, Pollution - Effects of, Washington, ...6.0192
Effluents-waste Water
ECOLOGICAL SURVEY OF EFFLUENT DISCHARGE AT TWO PULP MILLS IN HUMBOLDT COUNTY, CALIFORNIA ...Chemical Analysis (water), Pollution - Effects of, Pollution Effects, Pulp, Paper - and Logging, ...5.0858
STEROLS AND LIPIDS IN WATER POLLUTION ...Chemical Identification, Lipid Hydroperoxides, Pollutants - Path of, Sewage, Sterols, ...6.0186
BIG EDDIES AND MIXING PROCESSES IN THE GREAT LAKES ...Circulation - Water, Dispersion - Water, Great Lakes-general, Mixing, Water Motion, ...5.0052
A SURVEY OF THE MARINE ENVIRONMENT FROM FORT ROSS, SONOMA COUNTY, TO POINT LOBOS, MONTEREY COUNTY ...California, Marine Environments-general, Pollution - Effects of, Pollution Effects, ...9.0003
PROJECT AQUA-MAP ...DEVELOPMENT OF AERIAL PHOTOGRAPHY AS AN AID TO WATER QUALITY MANAGEMENT ...Aerial Photography, Management, Model Studies, New York, Pollutants-other, ...6.0187
Industrial Wastes
THE INSTITUTE FOR THE DEVELOPMENT OF RIVERINE AND ESTUARINE SYSTEMS (IDRES) ...Delaware River, Estuaries, Waste Disposal-general, ...12.0043
ELEMENT CHEMISTRY ...Atomic Absorption, Element Ratios, Oceanic Fronts, Water Chemistry-other, ...6.0113
EFFECTS OF KRAFT PULP MILL EFFLUENTS ON THE GROWTH AND PRODUCTION OF FISH ...Contamination - Water, Pollution - Effects of, Pollution Effects, Population
SUBJECT INDEX

Pollution Sources

Oil

- WATER SEPARATOR ...Filtration, Separation-flow-other, .8.0124
- MONITOR INSTRUMENTATION ...Chemical Analysis (water), Infrared Spectroscopy, .8.0093
- LEAKS AND SLICKS ...Aerial Photography, Aircraft, Pollutants-other, Satellites, Technique Development, .4.0145
- SPECTRAL SIGNATURES OF FISH SKIN IDENTIFICATION ...Atomic Absorption, Fish -non-specific, Oils - fats, Spectral Reflectance, .4.0151

DETECTION AND CLASSIFICATION OF FISH AND MINERAL OIL SLICKS BY REMOTE SENSING FROM ORBITAL ALTITUDE ...Fish -non-specific, Oils - fats, Spectral Reflectance, Ultra - Violet Radiation, .4.0140

REMOTE SENSING ...Currents-ocean, Gases, Microwave Radiation, Mixing, Salinity, Temperature, .4.0171

OIL CONTAMINATION OF OYSTERS FROM OIL WELL DRILLING MUDS ...Fluid Properties, Infection, Host interaction & Protection, Oil and Natural Gas - Sulfur, Organodeposite Studies, Oysters, .6.0431

EFFECTS OF CRUDE OILS AND THEIR EMMISIONS TO MARINE ORGANISMS ...Chemical Analysis (water), Organic Contaminants-other, Oil and Natural Gas - Sulfur, Poisons-other, Removal-organic, .5.0924

EFFECTS OF PETROLEUM AND PETROLEUM WASTES UPON IMPORTANT SPECIES OF ESTUARINE PHYTOPLANKTON AND ZOOPLANKTON ...Contamination Water, Contamination of Polluted-water, Estuaries, Oil and Natural Gas - Sulfur, Phytoplankton, Zooplankton, .5.0830

Organic Matter

A SYMPOSIUM ENTITLED ORGANIC CHEMISTRY OF NATURAL WATERS ...Alaska, Chemical-general, Meetings, Organic-general, Organic-gases, Organics-general, Polar, Sulfates, Water Analysis, Water Chemistry, .5.0895

FACTORS EFFECTING RATES OF ORGANIC DEPOSITION AND QUALITY OF WATER ...Clays, Lake Ontario, Organic Digestion, Rate of Deposition, Swamps-marshes, .7.6261

ORGANIC DEBRIS ON CONNECTICUT BEACHES AND SHORES ...Catabolism and Degradation, Connecticut, Identification, Physical-general, Shoreline - Coastline, .6.0143

Pesticides

ESTUARINE ECOSYSTEMS ...Aquatic Ecology, Estuaries, Pollution - Effects of, Pollution Effects, Population Dynamics, .5.0883

Pollution Sources-general

OCEANOGRAPHIC DATA SYSTEMS ...Acoustical, Data & Statistics Storage, Engineering Studies-other, Hydrodynamics, Instrumentation-general, .4.0613

TIME DEPENDENT VARIATIONS IN SURFACE OCEANIC CIRCULATION ...Circulation-general, Ocean History, Sedimentary History, Temperature, Water Disposal-general, .2.0038

SUPPON OF UNIVERSITY OF GEORGIA MARINE INSTITUTE RESEARCH VESSEL OPERATION ...Continental Shelf, Continental Slope, Distribution, Environmental Ecology, Estuaries, Geomorphology-topography, Marine Biology, Ships & Crustaceans, Textures-structures, .12.0026

ECOLOGICAL EFFECTS OF ENVIRONMENTAL & LOW LEVEL POLLUTION STRESSES ON METABOLIC REQUIREMENTS FOR GROWTH OF GULF COAST FISHES ...Environmental Ecology, Gulf of Mexico, Metabolism, Pollution - Effects of, Pollution Effects, Stress, .3.0238

RESEARCH AND GRADUATE TRAINING IN TOXIC FOOD AND DRUGS FROM THE SEA, AND MARINE POLLUTION ...Antimicrobial, Carcinostatic, Chemistry, Fish Protein Concentrate, Training Grants, Fellowships, .6.0060

OXYGEN RESOURCES OF TIDAL WATERS ...Autorespiration, Marine Biology (non-specific), Oxygen, Oxygen Content-water, Tides, .1.0119

LABORATORY BIOASSAYS ...Contamination - Water, Fish, Laboratory, Laboratory Animals, Pollution - Effects of, .5.0882

DISPOSAL TO MARINE WATERS ...Circulation-general, Model Studies, Monitoring (long Term Studies), Pollution - Effects of, Shoreline - Coastline, .6.0177

Mans Activities

ECOLOGICAL STUDY OF CHARLOTTE HARBOR ESTUARY AND SHARK PROGRAM OF MOTE MARINE LAB ...Estuaries, Florida, Sharks, .5.0884

EFFECTS OF PESTICIDES ON ESTUARINE PRODUCTIVITY ...Aquatic Ecology, Estuaries, Persistence of Residues, Pesticides -non-specific, Pollution - Effects of, Population Dynamics, Standing Crops, .5.0880

EFFECTS OF LOG RAFTING ON DUNGENESS CRABS ...Contamination - Water, Crabs, Diving and Scuba, Forestry, Pulp, Paper, and Logging, .5.0347

A STUDY OF SELECTED CHEMICAL AND BIOLOGICAL CONSEQUENCES OF THE LOWER TRINITY RIVER AND THE UPPER TRINITY BAY ...Commercial Fishing, Estuaries, Pollution - Effects of, Spawning & Nesting Sites, Texas, .5.0926

ENVIRONMENTAL BIOLOGY OF TOMALES BAY ...Aquatic Ecology, Bays, Benthic Fauna, California, Pollution - Effects of, .5.0860

RELATION OF RIVER-RUN IMPOUNDMENTS TO SALMON PRODUCTION ...Aquatic Ecology, Engineering Structures-general, Environmental Changes, Environmental Ecology, Pollution - Effects of, Salmon & Trout - Non-specific, .5.0822

ECOLOGY OF WESTERN GULF ESTUARIES (ESTUARINE PROGRAM) ...Coastal Engineering-other, Estuaries, Gulf of Mexico, Habitat Studies, Pollution - Effects of, .5.0928

Nutrients

EFFECTS OF RIVERS ON THE METABOLISM OF TEXAS BAY ...Bays, Pollutants-general, Primary Productivity, Streams, Texas, Water Quality-general, .5.0187

EUROTROPHICATION OF TIDAL WATERS ...Eutrophication, Growth and Differentiation, Model Studies, Photosynthesis, Tidewater Areas, .5.0999

NUTRIENT ASSIMILATION RATES - FIELD STUDIES ...Estuaries, Nitrogen, Nitrogen Cycle, Phosphorus, Tracers-general, .5.0990

CHANGES IN THE LIMITING NUTRIENT DUE TO TEMPORAL, GEOGRAPHIC, AND DEPTH VARIATIONS ...Depth, New York, Phytoplankton, Sub - Tropic, Water Depth, Water Levels, .5.0804

STUDIES ON INORGANIC NUTRIENT ASSIMILATION RATES IN ESTUARINE PONDS ...Estuaries, Mineral Content-water, Nitrogen, Phosphorus, Self-purification, .5.0991

TIDE MARSH ECOLOGY AND WILDLIFE ...Management, Microorganisms (non-specific), Nitrogen Cycle, Phosphorus, Primary Productivity, Swamps-marshes, .5.0870

AN ENVIRONMENTAL SURVEY OF THE DAMARISCOTTA RIVER ESTUARY, LINCOLN COUNTY, MAINE ...Circulation -water, Estuaries, Pollution - Effects of, Salinity, Sedimentology -geo., .5.0895

WATER QUALITY AND NUTRIENTS, SACRAMENTO-SAN JOAQUIN RIVER SYSTEM ...Environmental Ecology, Eutrophication, Fish -non-specific, Plankton (non-specific), Water Quality-general, .6.0139

ENVIRONMENTAL CHANGES IN LAKE ERIE ...Aquatic Ecology, Environmental Changes, Environmental Ecology, Ions and Gases, Lake Erie, .5.0900

CHEMICAL CHARACTERISTICS OF THE GREAT LAKES ...Chemical Analysis (water), Great Lakes-general, Productivity - Food Chain, Water Quality-general, .10.0116

INTERACTIONS OF MARINE NUTRIENT COMPLEXES ...Iron, Marine Plants, Phosphorus, Phytoplankton, Tracers, .5.0956

645
Power Systems

Compressors
INVESTIGATION OF METHODS TO REDUCE SUCTION AND DISCHARGE LOSSES OF A PERIPHERAL COMPRESSOR...High Pressure, Pumps, Resistance-other,...8.0131

Engines
Closed-cycle
PROPELLION FOR SWIMMER VEHICLES...Diving and Scuba, Marine Propulsion, Submersibles,...8.0159

Diesel
COLLATION OF POWER PLANT STUDIES...Marine Propulsion; Merchant-ships, Naval Architecture-general,...8.0161

Fluid Devices
Hydraulic Equipment
VISCO-ELASTIC DYNAMIC VIBRATION ABSORBER...Analytical, Close Channel, Drag, Energy Dissipators, Vibrating Systems-other, Viscous,...8.0188

Tanks
INTERCOMPARISON OF TOWING TANK AND WATER TUNNEL CALIBRATION OF CURRENT METERS...Gaging, Turbulent Flow, Water Tunnels Tables,...8.0074

FEASIBILITY STUDY ON HORIZONTAL TEST TANK FOR MODEL STUDIES AND COMPONENT TESTING...Consultants, Advisory Services, Dredging, Equipment, Model Studies, Ocean Mining,...12.0007

Heat and Cooling Devices
Boilers
AUTOMATIC BOILER CONTROLS...Control-systems, Marine Propulsion, Steam,...8.0164

A PILOT PLANT STUDY OF LOW EXCESS AIR COMBUSTION - ITS EFFECT ON FIRESIDE PROBLEMS IN OIL FIRED BOILERS...Combustion Products, Combustion-other, Funds, Maintenance-system,...8.0166

Distilling Units
A UNIFIED APPROACH TO WATER, FOOD AND POWER IN A COASTAL DESERT COMMUNITY...Arid and Desert, Desalination, Deserts, Distilling Units, Electric Power Plants, Greenhouse, Use of Impaired Water,...7.0002

Heat Exchangers
PHYSICAL PROPERTIES OF SEA WATER AT PRESSURE...Pressure, Thermal, Viscosity,...1.0149

Heating
ADVANCES HEAT SOURCES AND THERMAL INSULATION MATERIALS FOR SWIMMER HEATING...Diving and Scuba, Diving-system, Heat Transfer, Thermal, Thermal Insulators,...8.0021

Thermal Insulators
ADVANCES HEAT SOURCES AND THERMAL INSULATION MATERIALS FOR SWIMMER HEATING...Diving and Scuba, Diving-system, Heat Transfer, Heating, Thermal,...8.0021

Material Handling Devices
THE FEASIBILITY OF REDUCED CARGO GEAR INSTALLATION ONBOARD BREAK-BULK CARGO SHIPS...Hull, Loading/unloading, Merchant-ships,...8.0035

Mechanical Devices
Connectors
TRANSOCEAN TUG-BARGE FEASIBILITY...Barges-towboats, Freight, Other-design-and-construction,...8.0020

Controls
SELF-REGULATING STEAM GENERATOR...Generators, Marine Propulsion, Steam,...8.0125

SUGAR DIVING FACILITIES FOR DIVER-SCIENTIST...Self-Regulating Steam Generators, Viscosity,...8.0155

OCEANOGRAPHIC INVESTIGATION OF NUCLEAR THERMIONIC POWER FOR MARINE APPLICATIONS...Electron Emission, Marine Environments-general, Power Conversion Systems, Thermoelectric,...8.0074

OCEANOGRAPHIC FACTORS IN THE FUNCTIONAL DESIGN OF WASTE DISPOSAL SYSTEMS...Jet Flow-other, Mixing, Outlet, Process Design, Sewers,...8.0325

NUCLEAR FUEL COST ANALYSIS MODEL...Applications, Cost Analysis, Fuel,...4.0070

Propagation
Electrical
A DESIGN PROGRAM FOR SUPERCONDUCTING ELECTRICAL MACHINES...Electromechanical Design, Instrumental Services, Marine Propulsion, Superconductive Device,...8.0132
SUBJECT INDEX

Liquid Propellant Rock
OXYGEN PROPERTIES ...Density, Oxidizers, Oxygen, Specific Heat, State Equations, Thermodynamic Relation, ...8.0174

Nuclear
EXPERIMENTAL COMMERCIAL OPERATION OF SAVANNAH ...Merchant-ships, Other-design-and-construction, Safety, ...12.0035
ADVANCED NUCLEAR CARGO SHIP ...Control-systems, Merchant-ships, Other-design-and-construction, Safety, ...8.0274
ROLL DISTRIBUTION OF A NUCLEAR CARGO SHIP WITH AND WITHOUT FLUME STABILIZATION ...Merchant-ships, Other-design-and-construction, Ship Motion & Dynamics, Ship Resistance Stability, ...8.0319
MERCHANT SHIP REACTOR PRELIMINARY SAFETY ANALYSIS ...Merchant-ships, Safety, ...8.0167
ECONOMICS OF NUCLEAR FUEL ...Costs, Fuel, Merchant-ships, ...4.0178
DIGEST OF THE ADVANCED NUCLEAR CARGO SHIP STUDY ...Freight, Merchant-ships, Other-design-and-construction, ...8.0275

Pumps
INVESTIGATION OF METHODS TO REDUCE SUCTION AND DISCHARGE LOSSES OF A PERIPHERAL COMPRESSOR ...Compressors, High Pressure, Resistance-other, ...8.0131

Turbines
Steam
AUTOMATIC BOILER CONTROLS ...Boilers, Control-systems, Marine Propulsion, ...8.0164
SELF-REGULATING STEAM GENERATOR ...Controls, Generators, Marine Propulsion, ...8.0125

Turbine-other
40,000 HORSEPOWER PLANETARY REDUCTION GEAR SYSTEM ...Gearings and Power Train, Hydrofoils Crafts, Marine Propulsion, ...8.0314

Pre-impoundment Sites
ADULT MIGRATION RATES ...Columbia River, Environmental Ecology, Management -other, Migration, Salmon -coho,chinook,sockeye, ...5.0173
ADULT SALMON BEHAVIOR STUDIES IN RIVERS AND AT DAMS 8%SONIC TRACKING40 ...Columbia River, Construction Land Use Effects, Migration, Salmon & Trout -Non-specific, Telemetry, ...5.0169

Precipitation
Precipitation-general
Amount
GREAT LAKES RESEARCH - LAKE PRECIPITATION ...Forecasting, Great Lakes-general, Lake Erie, Lake Michigan, Meteorological Studies, ...3.0065
Forecasting
GREAT LAKES RESEARCH - LAKE PRECIPITATION ...Amount, Great Lakes-general, Lake Erie, Lake Michigan, Meteorological Studies, ...3.0065
Patterns
SEVERE STORM CLIMATOLOGY ...Tropical Cyclones, ...3.0054

Precipitation-general
RADIOSTRONTIUM DEPOSITION OVER THE OCEAN ...Circulation-general, Nuclear Explosions -Fallout, Radioactive Dating, Radioactivity, Strontium, ...6.0165

Precipitation-other
AN INVESTIGATION OF TRITIUM IN RAIN WATER ...Atmosphere Composition, Humidity, Particle-gas Transfer, Rainother, Tritium, ...1.0'

Probability and Statistics
Rain
Forecasting
PACIFIC OCEAN INFLUENCE UPON CALIFORNIA RAINFALL ...California, Pacific Ocean-general, Patterns, Rain-other, Temperature, ...3.0057
Rain-general
HYDROGRAPHY OF APPALACHEE BAY ...Bays, Currents-ocean, Salinity, Sunshine, Temperature, ...1.0147
Rain-other
AN INVESTIGATION OF TRITIUM IN RAIN WATER ...Atmosphere Composition, Humidity, Particle-gas Transfer, Precipitation-other, Tritium, ...1.0130
PACIFIC OCEAN INFLUENCE UPON CALIFORNIA RAINFALL ...California, Forecasting, Pacific Ocean-general, Patterns, Temperature, ...3.0057

Snow
Modification
LAKE EFFECT SNOWSTORM STUDY ...Direction, Great Lakes-general, Nucleation Physics, Orographic Effects, Patterns, ...3.0052

Patterns
LAKE EFFECT SNOWSTORM STUDY ...Direction, Great Lakes-general, Modification, Nucleation Physics, Orographic Effects, ...3.0052

Pressure Effects
WEIGHT ANALYSIS IN FISHING BOATS ...Approximations, Hull, Low Alloy Steels, Measuring Devices-other, ...8.0295

Probability and Statistics
Probability
Random Variables
OPTIMIZATION METHOD APPLIED TO THE PRELIMINARY DESIGN OF A NAVAL SALVAGE TUG ...Algorithms, Design of Experiments, Operational Aspect, Optimization Technique, Other-design-and-construction, ...8.0307

Statistics
Multivariate Analysis
MULTIVARIATE ANALYSIS OF MICROPALAEONTOLOGICAL DATA FROM DEEP-SEA CORES ...Core Analysis, Data Reduction and Analysis, Development of Models, Order Foraminifera, Paleotemperature, Population - Distribution, ...5.0827

Prediction
SPECTRAL ANALYSIS OF TIDAL CURRENTS ...Currents-other, Hawaii, Integral Transformers, Tides, Time Series Analysis, ...2.0063
NUMERICAL PREDICTION ...Computer Applications, Data Reduction and Analysis, Meteorological Studies, Weather Display Systems, Weather Forecasting, ...4.0041

Reliability Theory
EXPANSION OF CURRENT AND DEVELOPMENT OF ADDITIONAL COMMERCIAL FISHERIES CATCH, PRODUCTION AND GEAR STATISTICS ...Alaska, Censusing, Commercial Fishing, Fish -non-specific, Fish -other, ...5.0018

Sampling
USES OF STATISTICAL INFERENCE AND EXPERIMENTAL DESIGN FOR EFFICIENT COLLECTION OF OCEAN DATA ...Data & Statistics Storage, Information Retrieval Methods, ...4.0015

Spectral Analysis
DIGITIZING SYSTEM FOR OCEANOGRAPHIC DATA ...Analog-digital Converters, Applied Electronics, Bathymetry, Digital Computers, Instrumental Services, Seismic Studies, ...4.0039
SPECTRAL ANALYSIS ...Data Reduction and Analysis, Forecasting-prediction, Handbooks, Oceanography-general, ...11.0032

649
Probability and Statistics

SUBJECT INDEX

Antigen

IMMUNE MECHANISMS AND RESISTANCE FACTORS IN MARINE FISHES...Fish -other, Histochemical Test, Serology and Immunology,...5.0255

ANTIGEN DISTRIBUTION OF DEVELOPING SEA URCHIN EMBRYOS...Basic Embryology, Immunity, Interspecific Genetic Related...RNA, Sea Urchins & Other Echinoderm,...5.0855

MODE OF ACTION OF MARINE TOXINS...Animal Toxins, Blood Globulins, Enzyme-substrate, Sea Urchins & Other Echinoderm,...6.0103

Blood Globulins

MODE OF ACTION OF MARINE TOXINS...Animal Toxins, Antigen, Enzyme-substrate, Sea Urchins & Other Echinoderm,...6.0103

Blood Proteins -non-specific

COMPARATIVE BIOCHEMISTRY OF PROTEINS FROM GULF FISH...Drums, Gel Electrophoresis, Hemoglobin, Shrimps -Common,...5.0326

INVESTIGATE TUNA SUBPOPULATIONS THROUGH THE USE OF BLOOD GROUPS AND INHERITED PROTEINS...Blood Typing Studies, Pacific Ocean général, Population Dynamics, Tuna, Mackerel, Albacore,...5.0076

Collagen

MORPHOLOGIC REGULATORY MECHANISMS IN TERRESTRIAL AND MARINE ORGANISMS...Amphibia -non-specific & Other, Developmental Physiology, Fish -other, Metabolism, Porifera,...5.0982

Globin -incl. myoglobin

INTERACTION OF PROTEINS WITH METAL AND HYDROGEN IONS...Inhibitors, Metallic Ions, Neurophysin, Photocoagulation, Ribonucleic Acid,...5.0999

PRIMARY STRUCTURE OF INVERTEBRATE HEMOGLOBINS...Biochemical, Chitons, Configuration, Gastropods -slugs,conch,snails,...5.0610

Hemerythrin

STUDIES ON THE STRUCTURE OF HEMERYTHRIN...Biochemical, Comparative Physiology, Configuration, Invertebrates -non-specific,...5.0993

Hemoglobin

PHYSIOLOGICAL STUDIES ON FISHES LACKING HEMOGLOBIN...Adaptation, Cardiovascular System, Fish, Fish -other, Metabolism, Polar,...5.0241

COMPARATIVE BIOCHEMISTRY OF PROTEINS FROM GULF FISH...Blood Proteins -non-specific, Drums, Gel Electrophoresis, Shrimps -Common,...5.0326

HEMOGLOBIN VARIATIONS AS INDICATORS OF BLUEFISH RACES...Animal Taxonomy, Bluefish, Polymorphism, Reproduction Studies (general),...5.0320

HEMOGLOBIN VARIATIONS AS INDICATORS OF WHITE MARLIN RACES...Marlin, Billfishes, Sailfish,...Morphological Action,...5.0322

STRUCTURE AND REACTIVITY OF PROTEINS AND LIPOPROTEINS...Configuration, Physical State, 5.0327

GENETIC REGULATION OF HEMOGLOBIN SYNTHESIS IN ARTEMIA...Environmental Physiology, Marker, Mutagens, Shrimps -Brine Or Fairy,...5.0365

Lens Proteins

CEPHALOPOD LENS DEVELOPMENT...Basic Embryology, Differentiation Mechanism, Microtubules, Octopus, Squid, Cuttlefish,...Visual Organs,...5.0424

Microorganism Proteins

MORPHOGENESIS OF THE BACTERIOPHAGE...Composition, Electron Microscopy, Escherichia Coli, Metabolite-biochemical Genes, Morphological Action,...5.0792

Mucoproteins

HISTOCHEMICAL STUDIES OF MUCOSUBSTANCES IN THE MANTLE OF THE NORTHERN QUAHOG...MERCENARIA MERCENARIA...Caliculation, Clams, Derivatives, Histochemistry -Cytochem, Mucopoly saccharides,...5.0455

650
Muscle Proteins
EFFECT OF STORAGE ON FISH MUSCLE PROTEINS...Fish & Shellfish, Fish -non-specific, Food Raw Quality, Organoleptic Studies, Protein...5.0962

Neurophysin
INTERACTION OF PROTEINS WITH METAL AND HYDROGEN IONS...Globin -incl. myoglobin, Inhibitors, Metallic ions, Photochemistry, Ribonuclease...5.0999

Polypeptides
EXCITED STATES MECHANISMS IN PHOTOBIOLOGY...Bioluminescence, Chemiluminescence, Energy Conversion, Photochemical-other...4.0162

POLYPEPTIDE INTERACTIONS ON A STERILE SEASHORE...Biochemical, Light-catalyzed, Melatonin, Origin of Life...5.0942

Proteins -non-specific
GRANT FOR RESEARCH IN ISOLATION OF MARINE PROTEINS...Fish, Fish -non-specific, Proteins and Amino Acids...5.0998

AMINO ACID & PROTEIN METABOLISM IN SCHISTOSOMA...Amino Acids -non-specific, Flukes, Helminths, Metabolism...5.0621

NUTRITIVE VALUE OF FISH AND OTHER MARINE PRODUCTS...Amino Acid, Fish -non-specific, Nutritive Value, Paper Chromatography, Thimidine...6.0054

Protozoa
Ciliates
MICROBIOLOGICAL ASSAYS OF SEAWATER USING RADIOISOTOPES...Aquatic Ecology, Environmental Ecology, Environmental Physiology, Fish, Phytoplankton, Productivity - Food Chain, Thimidine...5.0811

CHONOTRICH CILIATE PROTOZOANS...Age, Animal Taxonomy, Invertebrate Anatomy, Life History Studies, Range Or Territorial Dist...5.0742

A COMPARATIVE SYSTEMATIC INVESTIGATION OF MARINE CILIATES IN THE HOLOTRICHOS PROTOZOA ORDER HYMENOSTOMATIDA...Animal Taxonomy, Cilia and Flagellae, Comparative Physiology, Invertebrate Anatomy...5.0840

SYSTEMATICS OF ANTARCTIC HYMENOSTOMATIDA (PROTOZOA)...Animal Taxonomy, Antarctica, Aquatic Ecology, Habitat Studies...5.0815

PARASITOLOGY...Crabs, Oysters, Pathology, Protozoa, Protozoa -other...5.0440

Flagellates
ECOLOGY OF SKELETAL PLANKTON...Animal Taxonomy, Collections, Gastropods -slug,conch,snails, Paleoenvironments, Temporal Distribution, Vertical Distribution...5.0977

ECOLOGY OF PLANKTONIC FORAMINIFERA AND RELATED STudies...Derivatives, Foraminifera, Gastropods -slug,conch,snails, Plankton Sampling, Vertical Distribution...5.0812

Foraminifera
A NEW APPROACH TO NUTRITION, PHYSIOLOGY, AND MINERAL CYCLING OF FORAMINIFERA...Axenite Culture, Invertebrate Nutrition, Metabolism, Productivity - Food Chain...5.0809

RADIOELEMENT STUDIES IN THE OCEANS-PLANKTON DISTRIBUTION STUDIES...Chemical Reactions, Number Or Density, Protozoa -other, Vertical Distribution...5.0795

ECOLOGY AND SEDIMENTARY PATTERNS OF FORAMINIFERA...Chemistry, Environmental Ecology, Environmental Effects-geologic, Vertical Distribution...5.0746

ULTRASTRUCTURAL AND AUTORADIOGRAPHIC INVESTIGATION OF CALCIFICATION IN FORAMINIFER...Calcification, Cell Wall, Cell organ. & Organoids-at, Histology and Cytology, Invertebrate Culture...5.0786

ECOLOGY OF PLANKTONIC FORAMINIFERA AND RELATED STUDIES...Derivatives, Flagellates, Gastropods -slug,conch,snails, Plankton Sampling, Vertical Distribution...5.0812

MODERN FORAMINIFERA OFF OREGON...Continental Shelf, Oregon, Pacific Ocean-general, Vertical Distribution...5.0820

ECOLOGY OF MARSH FORAMINIFERA...Lagoons, Productivity - Food Chain, Rate of Position, Swamps-marshes...5.0747

FORAMINIFERA FROM HEDLEY HARBOR, MASSACHUSETTS...Environmental Ecology, Harbors, Massachusetts, Number Or Density, Vertical Distribution...5.0853

STUDY OF NORTH AND EQUATORIAL ATLANTIC PLANKTONIC FORAMINIFERA...Number Or Density, Oceanic Fronts, Organism Sampling Devices, Vertical Distribution...5.0764

PATTERNS OF SPECIES DIVERSITY - TERTIARY-RECENT...Concetric Era-general, Geographical Relations, Number Or Density, Population - Distribution, Speciation...5.0854

Protozoa -other
RADIOELEMENT STUDIES IN THE OCEANS-PLANKTON DISTRIBUTION STUDIES...Chemical Reactions, Foraminifera, Number Or Density, Vertical Distribution...5.0795

STUDY OF RADIOLARIA IN SURFACE SEDIMENTS OF THE NORTHEAST PACIFIC OCEAN...Animal Taxonomy, Biogenic, Pacific Ocean-north, Vertical Distribution...5.0187

DEEP SEA SEDIMENTS IN THE NORTH PACIFIC FROM STUDIES OF THEIR RADIOLARIAN CONTENT...Biogenic, Core Analysis, Distribution, Pacific Ocean-north, Sedimentation...5.0285

TAXONOMY AND ECOLOGY OF INSHORE MARINE MICROBIOTA...Algae, General, Animal Taxonomy, Aquatic Ecology, Plant Taxonomy, Range Or Territorial Dist...5.0708

OCCURRENCE OF THE PROTOZOAN PARASITE CERATOMYXUS IN ADULT PACIFIC SALMON AND STEELHEAD TROUT...Infectious Conditions and Dis, Pathology, Protozoa, Rainbow Trout, Steelhead Trout, Vertebrate Pathology...5.0308

INFECTIOUS DISEASES OF SALMONID FISHES...Bacteria (non-specific), Infectious Conditions and Dis, Mode Of Transmission, Pathology, Salmon & Trout - Non-specific...5.0302

PATHOLOGY - EPIZOOTIOLOGY...Epizootiology, Mortality Rates, Oysters, Pathology, Protozoa...5.0441

PARASITOLOGY...Crustacea, Oysters, Pathology, Protozoa, Protozoa -other...5.0440

Public Health
ARGONNE MICROMETEOROLOGICAL MODELING FACILITY PROPOSAL...Diffusion, Meteorologic Model Studies, Micrometeorology, Turbulence, Wind Tunnels...5.0071

Publications
Art Work-Illustrations-etc
SHORE FISHES OF ANNABONG AND FERNANDO POO...Atlantic Ocean-general, Collections, Fish -non-specific, Museum...5.0067

Bibliography
ARCTIC BIBLIOGRAPHY PROJECT...Arctic, Geophysics-general, Meteorological Studies-general, Oceanography-general...5.0113

ARCTIC FIELD RESEARCH...Arctic Ocean, Environmental Effects-geologic, Geophysics-general, Russia...5.0101

ARCTIC ADVISORY SERVICE...Arctic Ocean, Ice Properties-general, Library, Sea Ice...5.0112

USE OF TIDAL POWER AND OTHER OCEAN ENERGY SOURCES...Economics, Engineering Studies-other, Mechanical Power-other, Survey Studies, Tides...5.0084

A BIBLIOGRAPHY OF THE MARINE MOLLUSKS OF THE INDO-PACIFIC REGION...Animal Taxonomy, Asia, Computer Methods-general, Mollusks -non-specific & Other...5.0398

CORAL ATOLL ECOLOGY...Anthozoa, Atolls, Data Analysis - General, Productivity - Food Chain...5.0872

GREAT LAKES RESEARCH - GREAT LAKES DEICING...Al- teration, Great Lakes-general, Ice Properties-general, Origin, Sea Ice...5.0084

LARVAL DEVELOPMENT OF DECAPOD CRUSTACEA...Animal Taxonomy, Basic Embryology, Crabs, Decapoda - Non-specific, Lobsters...5.0840

651
Publications

Handbooks

REVISION OF THE CLASSIFICATION AND PHYLOGENY OF THE SURODER BALANOMORPHA (CIRRIPEDEA - THORACICA) ...Animal Taxonomy, Baras-les, Collections, Nomenclature, Classification, Vertical Distribution, ...5.0704.

SPECTRAL ANALYSIS ...Data Reduction and Analysis, Spectral Analysis, ...11.0632.

HANDBOOK OF MARINE TECHNOLOGY ...Engineering Studies, General, Sea Water Chemistry, Geology-general, Marine Biology, Meteorological Studies, Submersibles, ...11.0014.

TAXONOMY AND DISTRIBUTION OF CLupeoids AND REVISION OF THE GENUS ILISHA OF THE FAMILY CLupeoidei ...Alewife, menhaden, shad, herring, Animal Taxonomy, Indian Ocean-general, Nomenclature, Classification, Range Or Territorial Dist, ...5.0688.

SYSTEMATICS AND ECOLOGY OF MARINE BIRDS ...Animal Taxonomy, Range Or Territorial Dist, Shorebirds-gulls, terns, skimmer, World Wide, ...5.0852.

INVENTORY AND ATLAS OF GULF COAST SPORT FISHING FACILITIES ...Maps, Fishing, Gulf of Mexico, Management-other, ...5.0006.

INVENTORY AND ATLAS OF MARINE SPORT-FISHING FACILITIES ...Atlantic Ocean-north, Eastern, Fishing, Recreation Sites, ...5.0612.

ATLAS OF MARINE FAUNA ...Atlantic Ocean-north, Crustacea -non-specific, Fish -non-specific, Mollusks -non-specific & Other, ...5.0101.

INVESTIGATION OF THE BIOLOGY AND POPULATION STRUCTURE OF GULF MENHADEN ...Alewife, menhaden, shad, herring, Bone, Gulf of Mexico, Population Dynamics, Vertebrate Anatomy, ...5.0128.

TAXONOMY AND BIOLOGY OF CLupeoid FISHES ...Alewife, menhaden, shad, herring, Anchovies, Animal Taxonomy, Atlantic Ocean-general, ...5.0560.

SYSTEMATICS OF CARANGID FISHES ...Animal Taxonomy, Collections, Maturity & Growth Stage, Pompanos, Scads, Jacks, Species, Comparison of, ...5.0661.

Periodicals

DISSEMINATION OF COMMERCIAL FISHERIES STATISTICS ...Commercial Fishing, Massachusetts, ...4.0029.

REPORT DISTRIBUTION ...Commercial Fishing, Fats - Lips & Oils, Oysters, Spawning & Nesting Sites, ...11.0041.

Publications -other

CONTINUED STUDIES OF THE SYSTEMATICS AND ZOOGEOGRAPHY OF WESTERN ATLANTIC CAEIDAE ...Animal Taxonomy, Atlantic Ocean-general, Derivatives, Gastropods -slugs, snails, Invertebrate Anatomy, ...5.0096.

THE ALPHEID SHRIMP OF AUSTRALIA ...Animal Taxonomy, Australia, Collections, Shrimps - Crustacea, ...5.0425.

MONOGRAPH OF THE CEPHALOPODS OF THE NORTH ATLANTIC ...Animal Taxonomy, Atlantic Ocean-north, Depth, Nomenclature, Classification, Optical, Salinity, Temperature, ...5.0411.

A SYSTEMATIC STUDY OF ENTOCYHERID OSTRACODS ...Animal Taxonomy, Madagascar-malagasy Republic, New Zealand, Shrimps - Seed Or Mussel, South America, ...5.0492.

MONOGRAPH OF THE FISHES OF THE ORDER PLECOTGD NATH: ...Animal Taxonomy, Bone, Comparative Anatomy, Fish -other, Vertebrate Anatomy, ...5.0146.

REVISION OF GENERA AND SUBGENERA OF WATER MITES OF THE WORLD ...Animal Taxonomy, Growth, Moult- ing & Metamorph, Nomenclature, Classification, Ticks & Mites, ...5.0627.

SUPPORT OF THE COMMITTEE ON OCEANOGRAPHY OF THE NATIONAL ACADEMY OF SCIENCES ...Committee-support, Oceanography-general, ...12.0032.

SYSTEMATICS AND ZOOGEOGRAPHY OF ANTARCTIC CEPHALOPODS ...Animal Taxonomy, Antarctic Ocean, Austral, Octopus, Squid, Conchifish, ...5.0412.

STUDIES ON ANACANTHINE FISHES ...Animal Taxonomy, Atlantic Ocean-north, Continental Shelf, Fish -other, ...5.0048.

DESCRIPTIONS OF NEW SHARKS ...Animal Taxonomy, Collections, Nomenclature, Classification, Sharks, ...5.0057.

Tables, Compilations, Catalogs

DECOMPRESSION TABLE DEVELOPMENT ...Decompression Sickness, Diving, Mathematical Biophysics, Medical Studies, ...6.0098.

NITROGEN-OXYGEN DECOMPRESSION TABLES FOR ALTITUDE FLIGHT ...Decompression Sickness, Diving, Man-made Satellite, Safety, Space Medicine, ...6.0099.

CONFERENCE REPORTS ...Geophysics-general, Marine Biology, Meetings, ...11.0034.

THERMAL STRUCTURE ...Data Reduction and Analysis, Salinity, Sea Level Variations, ...1.0184.

MARINE ZOOGEOGRAPHY ...Fish -non-specific, ...5.0593.

INTERNATIONAL INDIAN OCEAN EXPEDITION PHYSICAL AND CHEMICAL ATLAS ...Data & Statistics Storage, Data Analysis - General, General Sea Water Chemistry, Indian Ocean-general, Water Properties-general, ...4.0130.

OCEANOGRAPHIC RESEARCH ...Abyssal, Benthonic-bottom, Fouling, Geomorphology-topography, Marine Soils, ...8.0343.

A GLOBAL DIRECTORY OF TIDAL CONSTANTS ...Arcs, Maps-other, Tides, ...2.0679.

HYDRAULIC BULLETIN ...Current Research Projects, Hydraul- ic Engineering-other, Hydraulics-general, ...8.0177.

THREE-DIMENSIONAL GLOBAL CLIMATOLOGY ...Air Motion-general, Applied Climatology, General Movement, Patterns, Spectral Analysis, ...8.0167.

PUBLICATION OF OPPORTUNITIES IN OCEANOGRAPHY ...Oceanography-general, ...11.0028.

TAXONOMIC REVISION OF BATHYLAGIDAE ...Animal Taxonomy, Deepsea Smelts, Temperate, ...5.0585.

SURVIVAL CRIFT DRIFT AND LEEWAY ...Air Motion Instruments, Buys, Currents-ocean, Equipment, Ocean-lakes, Operational Aspect, ...6.0129.

Puerto Rico

MARINE ALGAE OF THE MANGROVE ROOT COMMUNITY ...Algae-general, Habitat Studies, Mangroves, Marine Plants, Roots, ...5.0723.

ECOLOGY OF THE PORITIS FURCATA RIFF-FLAT COMMUNITY ...Algae - Porites, Panama, Productivity - Food Chain, ...5.0667.

DETERMINATION OF SAFE LEVELS OF POLLUTION IN PUERTO RICO ...Bays, Contamination - Water, Meteorological Studies-general, Pollution - Effects of, Recreation Sites, Water Properties-general, ...6.0181.

IGNEOUS AND SEDIMENTARY ROCKS FROM THE NORTH WALL OF THE PUERTO RICO TRENCH ...Igneous Rocks, Petrology, Sedimentary Rocks, Trenches, ...7.0063.

GEOLoGIC INVESTIGATIONS IN PUERTO RICO & THE CARIBBEAN ...Caribbean Sea, Element Ratios, Plutonic, Sedimentary Petrology, Volcanic, ...7.0042.

MARINE BIOLOGY PROGRAM ...Distribution, Productivity - Food Chain, Radiocarbon, Rare Earths, Trace Elements, ...1.0129.

PUERTO RICO COOP ...MONA PASSAGE ...Continental Shelves, Land Economics, Mine Wastes, Oil - Petroleum, Potential of Deposit, Sands and Gravels, ...7.0034.

LABORATORY OF NEUROBIOLOGY ...Facilities, Nervous System, ...12.0044.

Puget Sound

BOTTOM CURRENTS AND THE MOVEMENT OF SEDIMENT ACROSS THE CONTINENTAL SHELF ...Red Bed, Columbia River, Continental Shelf, Sediment Transport-general, Unsteady, ...2.0047.

MEASUREMENTS OF OXYGEN CONSUMPTION BY THE SEA BED IN DEEP WATERS OF PUGET SOUND ...Benthic Flora, Chemistry, Oxygen, Oxygen Carboxygen Content-water, ...5.1036.

OCEANOGRAPHIC PROCESSES IN ESTUARINE AND COASTAL WATERS ...Oceans Fronts, Pacific Ocean-coast, Shoreline - Coadline, Washington, Water Properties-general, ...4.0030.

MASS MORTALITY OF PACIFIC OYSTERS ALONG THE WASHINGTON COAST ...Bays, Environmental Ecology, Mortality Rates, Oysters, Pathology, ...5.0510.

TAG DETECTION ...Commercial Fishing, Number Or Density, Salmons -cohoo,chinook,sockeye, ...Streams, Tugs, ...8.0148.
Range and Tracking Systems

Doppler
FEASIBILITY STUDY FOR SYNTHETIC APERTURE ARRAY ACOUSTIC BOTTOM MAPPING SYSTEM ...Acoustic, Charts, Geomorphology-topography, Mapping, ...4.0061
SATELLITE TIME DISSEMINATION ...Airborne Probing, Communication & Navigation, Navigation, Signal Generators, Standards, Specifications, Time Measurements, ...4.0091

Radar
RADAR SCATTERING ...Waves, ...4.0103
AIRBORNE REMOTE SENSING OCEANOGRAPHY PROJECT ...Aircraft, Data Acquisition, Instrumental Services, Photography, Satellites, ...4.0125

Range and Tracking-other
VHF SATELLITE COMMUNICATIONS ...Navigation, Space Crafts, Very High Frequency, ...4.0105
EXPERIMENTAL SEA ICE OBSERVATIONAL TECHNIQUES ...Data Acquisition, Imaging, Instrumental Services, Satellites, Sea Ice, ...4.0156

Rare Earths
MARINE BIOLOGY PROGRAM ...Distribution, Productivity - Food Chain, Puerto Rico, Radiocoeology, Trace Elements, ...1.0128

Rates, Doses, Concentrations
PESTICIDE RESISTANT FISH IN NATURAL ECOSYSTEMS ...Animal Resistance -other, Endrin, Fish, Food Chains, Animal And/or Man, Pollution Effects, ...5.0277

Reactors
Fuel
ECONOMICS OF NUCLAER FUEL ...Costs, Merchant-ships, Nuclear, ...4.0178
NUCLEAR FUEL COST ANALYSIS MODEL ...Applications, Cost Analysis, Nuclear Power, ...4.0070

Recognition Systems
APOLLO TEST SITE EXPERIMENT ...Aircraft, Estuaries, Hydraulics-general, Hydrology-general, Remote Sensing-general, ...4.0046
UNDERWATER ACOUSTIC HOLOGRAPHIC DISPLAY ...Acoustical, Detectors, Holography, Instrumental Services, Photography, ...8.0137

Recreation
Demand and Use
Projected Demand
HAWAII STATE COMPREHENSIVE OUTDOOR RECREATION PLAN ...Hawaii, Inventories, Methods, Recreation, Survey, User Characteristics, ...9.0009
PUBLIC INVESTMENT CRITERIA FOR WATER-SUPPLIED RECREATION IN THE LAKE ERIE BASIN ...Alternative Planning, Costs, Finance, Fiscal, Pollution Abatement, Recreation Sites, ...9.0016
ECONOMIC EVALUATION OF PRIMARY BENEFITS FOR FISHING AND HUNTING BASED ON THE NATIONAL SURVEYS OF FISHING AND HUNTING ...Fishing, Surveying, ...9.0001

Inventories
HAWAII STATE COMPREHENSIVE OUTDOOR RECREATION PLAN ...Hawaii, Inventories, Methods, Projected Demand, Recreation, Survey, User Characteristics, ...9.0009

Methods
HAWAII STATE COMPREHENSIVE OUTDOOR RECREATION PLAN ...Hawaii, Inventories, Projected Demand, Recreation, Survey, User Characteristics, ...9.0009

Recreation Activities
Boating
CRITERIA FOR EVALUATING THE QUALITY OF WATER BASED RECREATION FACILITIES ...Boating, Fishing, Marinas, Standards, Swimming, User Characteristics, Water Quality-general, ...9.0015

Fishing
STUDIES ON THE SPOTTED FISHES FOR BILL FISHERIES AND TUNAS IN THE WESTERN ATLANTIC AND SOUTHEASTERN PACIFIC OCEAN ...Atlantic Ocean-general, Pacific Ocean-general, Swordfish, Tuna, Mackerel, Albacore, ...5.0005
CRITERIA FOR EVALUATING THE QUALITY OF WATER BASED RECREATION FACILITIES ...Boating, Fishing, Marinas, Standards, Swimming, User Characteristics, Water Quality-general, ...9.0015

ECONOMIC EVALUATION OF PRIMARY BENEFITS FOR FISHING AND HUNTING BASED ON THE NATIONAL SURVEYS OF FISHING AND HUNTING ...Fishing, Projected Demand, Survey, ...9.0001

ECOLOGY OF RECREATIONALLY IMPORTANT ESTUARINE FISHES IN OREGON ...Aquatic Ecology, Environmental Ecology, Estuaries, Migration, Oregon, Population Dynamics, ...5.0216

MIGRATORY HABITS OF LARGE SHARKS ...Atlantic Ocean-north, Migration, Sharks, Tags, ...5.0147
INVENTORY AND ATLAS OF GULF COAST SPORT FISHING FACILITIES ...Atlantic Ocean-north, Eastern, Handbooks, Recreation Sites, ...9.0006
INVENTORY AND ATLAS OF MARINE SPORT-FISHING FACILITIES ...Atlantic Ocean-north, Eastern, Handbooks, Recreation Sites, ...9.0012
INVENTORY OF THE GULF ESTUARY SYSTEM ...Bays, Data Acquisition, Estuaries, Gulf of Mexico, Sedimentology-general, ...4.0047
1965 SALT-WATER ANGLING SURVEY ...Animal Taxonomy, Censusing, Fish -non-specific, ...9.0011

Hunting
ECONOMIC EVALUATION OF PRIMARY BENEFITS FOR FISHING AND HUNTING BASED ON THE NATIONAL SURVEYS OF FISHING AND HUNTING ...Fishing, Projected Demand, Survey, ...9.0001
EVALUATION OF THE ATLANTIC FLYWAY SEA DUCK KILL ...Age, Anseriformes -other, Mortality Rates, Sex -non-specific, Species, Comparison of, ...5.0006
CRITERIA FOR EVALUATING THE QUALITY OF WATER BASED RECREATION FACILITIES ...Boating, Fishing, Marinas, Standards, User Characteristics, Water Quality-general, ...9.0015

Standards
CRITERIA FOR EVALUATING THE QUALITY OF WATER BASED RECREATION FACILITIES ...Boating, Fishing, Marinas, Swimming, User Characteristics, Water Quality-general, ...9.0015

Survey
HAWAII STATE COMPREHENSIVE OUTDOOR RECREATION PLAN ...Hawaii, Inventories, Methods, Projected Demand, Recreation, Surveying, User Characteristics, ...9.0001

Types of Resources
ISLAND STUDY ...Conservation-general, Islands, Land Economics, Recreation Sites, United States-general, ...9.0005

User Characteristics
HAWAII STATE COMPREHENSIVE OUTDOOR RECREATION PLAN ...Hawaii, Inventories, Methods, Projected Demand, Recreation, Survey, ...9.0009
CRITERIA FOR EVALUATING THE QUALITY OF WATER BASED RECREATION FACILITIES ...Boating, Fishing, Marinas, Standards, Swimming, Water Quality-general, ...9.0015
SUBJECT INDEX

Remote Sensing

RECREATION SITES
Determination of Safe Levels of Pollution in Puerto Rico...9.0018
Enhancement of recreational uses of estuarine waters through study of potential control methods for stinging sea nettles...6.0105
Public investment criteria for water-oriented recreation in the lake Erie Basin...5.0053
Effects of water pollution in San Francisco Bay...5.0053
Inventory and Atlas of Marine Sport-Fishing Facilities...4.0078
Island study...6.0078
Reefs
Biology-Middle East Waters...6.0078
Stable Isotope Studies on Coexisting Minerals in Marine Sediments...5.0078
Geophysical and Geochemical Study of Red Sea...5.0078
Marine biology of Red Sea and Eastern Mediterranean...5.0078
Biota of the Red Sea and Eastern Mediterranean...5.0078
Reprints
Management of the Eniwetok Marine Biological...4.0078
Determination of the Eniwetok Marine Biological...4.0078
Trace Element and Stable Isotope Studies of Coral Reef Carbonates...4.0078
Ecology, Flora, Mapping, Population Dynamics...4.0078
Biota of the Red Sea and Eastern Mediterranean...4.0078

Regional Areas
ECONOMICS OF WATER QUALITY FOR A REGIONAL SYSTEM...6.0078
ECONOMIC ANALYSIS OF THE MARKET STRUCTURE OF THE COMMERCIAL FISHING INDUSTRY IN THE NORTHEAST...4.0078
ECONOMIC ANALYSIS OF THE MARKET STRUCTURE OF THE COMMERCIAL FISHING INDUSTRY IN THE NORTHEAST...4.0078
ECONOMIC ANALYSIS OF THE MARKET STRUCTURE OF THE COMMERCIAL FISHING INDUSTRY IN THE NORTHEAST...4.0078
ECONOMIC IMPACT OF MARINE-ORIENTED ACTIVITIES IN THE SOUTHERN NEW ENGLAND MARINE REGION...4.0078
Marine Polychaete Worms of the New England Region (Gulf of St. Lawrence to Chesapeake Bay)...4.0078
Marine Nematodes of the Cape Cod Area...4.0078
Southern
Identification and Description of Fish Larvae...4.0078
Techniques of Planning...4.0078
Remote Areas
Remote Sensing, Everglades Area, Florida...4.0078
Remote Sensing
Aircraft
Water-to-Air Retrieval...4.0078
Oil Leaks and Slicks...4.0078
Apollo Test Site Experiment...4.0078
High Frequency Ocean Waves...4.0078
655
REMOTE SENSOR OCEANOGRAPHY ...Aerial Photography, Cloud Temperature, Gulf of Mexico, Infrared Radiation, Surface Environment, Temperature, ...4.0170
SPACE-CRAFT OCEANOGRAPHY ...Instrumentation, Instrumentation- general, Management, Photography, Unmanned Satellite, ...4.0157
AIRBORNE REMOTE SENSING OCEANOGRAPHY PROJECT ...Aircraft, Data Acquisition, Instrumental Services, Photography, Radar, ...4.0155
EXPERIMENTAL SEA ICE OBSERVATIONAL TECHNIQUES ...Data Acquisition, Imaging, Instrumental Services, Range: id Tracking-other, Sea Ice, ...4.0156
COORDINATION OF ESTUARINE REMOTE SENSING IN ATLANTIC COAST REGION ...Aerial Photography, Atlantic Ocean, Estuarial, ...4.0169
EVALUATION OF CONTEMPORARY PRECISION NAVIGATION SYSTEMS ...Bathymetry, Communication & Navigation, Navigation, Navigation Communication, Technique Development, ...4.0087
SPACE APPLICATIONS TO FISHERIES OCEANOGRAPHY (GULF OCEANOGRAPHY PROGRAM) ...Commercial Fishing, Computer Applications, Forecasting-prediction, Water Environment-other, ...4.0172
Spacecraft Sensory Devices
FISHERIES OCEANOGRAPHY AND ENVIRONMENTAL ASSESSMENT AND PREDICTION ...Commercial Fishing, Convection, Oceanography-general, Thermal, ...4.0150
REMOTE SENSOR SYSTEMS INTERGRATION AND PRESENT OPERATIONS DESCRIPTION ...Commercial Fishing, Fish -non-specific, Remote Sensing -other, Spectral Reflectance, ...4.0154
Spectral Reflectance
FISHERIES RESOURCES IDENTIFICATION AND ASSESSMENT ...Aerial Photography, Behavioral Ecology, Commercial Fishing, Fish -non-specific, Optical, ...4.0149
SPECTRAL SIGNATURES OF FISH SCHOOL IDENTIFICATION ...Atomic Absorption, Fish -non-specific, Oil, Oils -fats, ...4.0151
FLIGHT TESTING OF HIGH PERFORMANCE WIDE-RANGE IMAGE SPECTROPHOTOMETER (WISP) SYSTEM ...Aircraft, Optical, Technique Development, ...4.0152
REMOTE SENSOR SYSTEMS INTERGRATION AND PRESENT OPERATIONS DESCRIPTION ...Commercial Fishing, Fish -non-specific, Remote Sensing -other, Spacecraft Sensory Devices, ...4.0154
DETECTION AND CLASSIFICATION OF FISH AND MINERAL OIL SLICKS BY REMOTE SENSING FROM ORBITAL ALTITUDE ...Fish -non-specific, Oil, Oils -fats, Ultra - Violet Radiation, ...4.0140
PACIFIC COASTAL ENVIRONMENT AS RELATED TO DISTRIBUTION AND ABUNDANCE OF GAME SPECIES - SEA SURFACE TEMPERATURE MEASUREMENTS ...Aquatic Ecology, California, Temperature, ...4.0175
Ultra - Violet Radiation
DETECTION AND CLASSIFICATION OF FISH AND MINERAL OIL SLICKS BY REMOTE SENSING FROM ORBITAL ALTITUDE ...Fish -non-specific, Oil, Oils -fats, Spectral Reflectance, ...4.0140
ULTRAVIOLET ABSORPTION IN COASTAL WATERS ...Biological, Marine Plants, Physical Parameters, Plant Prod. (non-specific), Sewage, Total Organic Carbon, ...6.0138
Visible Light
REMOTE SENSING, EVERGLADES AREA, FLORIDA ...Computer Applications, Florida, Remote Areas, Swamps-marshes, Water Properties-general, ...4.0161
Reproduction
Artificial Insemination
CRYOGENIC PRESERVATION OF VIABLE FISH SPERM ...Cellular Physiology, Fish -non-specific, Freezing Techniques, Male Gametes, ...5.0103
LIFE HISTORY OF CLUPEA HARENGUS PALLASI ...Alewife,menhaden,shad,herring, Aquaculture & Fish-farming, Life History Studies, Water Salinity, Water Temperature-non-specific, ...5.0035
Subject Index
Reproduction
INVESTIGATE SYSTEMATICS AND ECOLOGY OF TUNA LARVAE AND JUVENILES ...Animal Taxonomy, Maturity & Growth Stages, Spawning & Nesting Sites, Tuna, Mackerel, Albacore, ...5.0079
Gametes
Female Gametes
PHARMACOLOGY AND CHEMISTRY OF TOXIC MARINE ANIMALS ...Animal Toxins, Sculpins, Toxicology, ...6.0104
REPRODUCTION AND FERTILITY OF TUNAS ...Behavior, Biological Rhythms, Fertility, Tuna, Mackerel, Albacore, ...4.0159
ARTIFICIAL SE:CTION - FISH ...Fish -non-specific, Genetic Resistance, Pesticides -non-specific, Pollution - Effects of, Selection & Breeding, ...5.0026
Male Gametes
FERTILIZATION MECHANISMS AND GAMETE PHYSIOLOGY IN MARINE INVERTEBRATES ...Basic Embryology, Metabolism, Reproductive System, Sea Urchins & Other Echinoderms, ...5.0059
CRYOGENIC PRESERVATION OF VIABLE FISH SPERM ...Artificial Insemination, Cellular Physiology, Fish -non-specific, Freezing Techniques, ...5.0030
THE ROLE OF CALCIUM IONS IN THE MOTILITY OF SEA URCHIN AND OTHER SPERMATOZOA ...Artpage, Calcium, Motility and Migration, Yellow Perch, Darters, ...5.0022
CRYOGENIC PRESERVATION OF VIABLE FISH SPERM ...Fertility, Fish -non-specific, Freezing Techniques, Rapid Freeze, ...5.0021
Parturition
BREEDING AND MATERNAL BEHAVIOR AMONG THE STELLER SEA LION ...Behavior, Developmental Physiology, Seals, Spawning & Nesting Sites, ...5.0024
Pregnancy
Fertilization
BIOCHEMISTRY OF FERTILIZATION AND EARLY DEVELOPMENT ...Basic Embryology, Reproductive System, Sea Urchins & Other Echinoderms, ...5.0059
Reproduction Studies (general)
EVOLUTION OF ALL-FEMALE FISHES ...Female, Gambusia, Molly, Other, ...5.0027
THE EVOLUTION AND CAUSATION OF SOCIAL BEHAVIOR IN ANABANTOID FISHES ...Behavior, Ethological, Fish -other, Social Behavior, ...5.0030
SEAL BIOLOGY AND HABITAT ...Alaska, Environmental Ecology, Interbiotic Relat-(non-specific), Life History Studies, Seals, ...5.0022
WALRUS BIOLOGY AND POPULATION ...Behavioral Ecology, Comparative Physiology, Fish -non-specific, Panama, ...5.0024
WATER QUALITY AS RELATED TO SURVIVAL OF SALMON EGGS AND LARVAE ...Environmental Ecology, Mortality Rates, Salmon & Trout - Non-specific, Spawning & Nesting Sites, Water Quality-general, ...5.0027
REPRODUCTIVE ISOLATING MECHANISMS IN PANAMANIAN INSHORE MARINE FISHES ...Basic Embryology, Comparative Physiology, Fish -non-specific, Panama, ...5.0065
HEMOGLOBIN VARIATIONS AS INDICATORS OF BLUEFISH RACES ...Animal Taxonomy, Bluefish, Hemoglobin, Polymorphism, ...5.0030
ADMINISTRATION OF WHALING ACT, PROTECTED AND UTILIZED WHALES ...Age, Food Supply, Growth Rate, Mammals, Parasitology-other, ...5.0065
ADMINISTRATION OF WHALING ACT, PROTECTED AND NON-COMMERCIAL WHALES ...Censusing, Growth Rate, Mammals, Migration, Vertebrate Anatomy, ...5.0066
Reproductive System Male
Tests
STUDES OF FISH ENDOCRINOLOGY ...Environmental Physiology, Fresh Water, Hormone, Killifish - Gyrodinium, Thyroid, ...5.0026
Subject Index

Respiratory System

Function, Biochemistry

Control and Regulation
CARDIOVASCULAR STUDIES ON DIVING MAMMALS
...Adaptation, Basic Hemodynamics, Cardiovascular System, Heart, Locomotion -animal, Seals, ...5.0639

Diffusion of Gases
DIVING MEDICINE ...Divers, Diving and Scuba, Occupational Hazards, Pressure, ...8.0017

Liquid-breathing
MANNE DIVING RESEARCH ...Decompression Sickness, Divers, Diving and Scuba, Medical Studies, ...6.0096

Mechanics, Compliance

COMPARATIVE PHYSIOLOGY OF RESPIRATORY MECHANICS IN MAMMALS ...Comparative Physiology, Mammals, ...5.0612

Rhode Island

SYMPOSIUM ON THE MINERAL RESOURCES OF THE WORLD OCEAN ...Engineering Studies-general, Meetings, Ocean Mining, Policy Making, ...7.0027

THE RHODE ISLAND HARD CLAM -QUAHOG ...INDUSTRY ...Clams, Coasts, Fish & Shellfish, Production & Processing, ...5.0493

FINANCING OF FISHING VESSELS ...Commercial Fishing. Economics, Fish & Shellfish, Savings and Investment, ...4.0185

SOCIO-ECONOMIC STUDY OF NARRAGANSETT BAY, RHODE ISLAND ...Bays, Benefit-cost Analysis, Estuaries, Land Use, Social Aspects, Water Quality Control-general, ...5.0019

SHALLOW WATER OCEANOGRAPHY ...Acoustical, Continental Shelf, Hydrodynamics, Surface Environments, Transmission, ...1.0030

Rickettsia

Neorickettsiae Helminth

NATURAL HISTORY OF SALMON POISONING RICKETTSIAE ...Flukes, Helminths, Invertebrates, Reservoirs, ...5.0842

EPIDEMIOLOGY OF SALMON POISONING DISEASE ...Flukes, Helminths, Pathology, Salmon & Trout -Non-specific, Virulence and Pathogenicity, ...5.0307

RNA

DYNAMICS OF OCEANIC PLANKTON ...Growth Rate, Number Or Density, Productivity (agricultural), Zooplankton, ...5.0825

ANTIGEN DISTRIBUTION OF DEVELOPING SEA URCHIN EMBRYOS ...Antigen, Basic Embryology, Immunity, Interspecific Genetic Relat., Sea Urchins & Other Echinoderms, ...5.0855

Messenger RNA

BIOSYNTHETIC PROCESSES DURING DEVELOPMENT OF SEA URCHIN EGGS ...Basic Embryology, Cell Cycle, Nucleic Acids, Proteins, Sea Urchins & Other Echinoderms, ...5.0775

PHYSIOLOGY OF FERTILIZATION AND NUCLEOCYTOPLASMIC INTERACTIONS IN SEA URCHIN DEVELOPMENT ...Basic Embryology, Nucleus (non-specific & Gr.), Reproductive System, Sea Urchins & Other Echinoderms, Selection & Breeding, ...5.0673

BIOCHEMISTRY OF DEVELOPMENT ...Basic Embryology, Control and Regulation, Differentiation Mechanism, Sea Urchins & Other Echinoderms, Trypanothion Oxidase, ...5.0994

SYMBIOSIS OF TROPICAL ZOANTHIDEA AND ZOANTHELLAE ...Antihistone, Biochemistry, Symbiosis, Tropic, Zoanthellae, ...5.0842

Rocks - Bedrock

GEOLGICAL STUDIES IN NORTHERN LAKE MICHIGAN ...Deposits-others, Lake Michigan, Lakes, Submerged, Water Level Fluctuation, ...7.0164

Reptiles

Snakes

VENOMOUS FISHES AND SEA SNakes OF SOUTHEAST ASIA ...Behavior, Fish - non-specific, Southeast Asia, Venom, Vertebrate Anatomy, ...6.0101

THE MORPHOLOGY, HISTOCHEMISTRY, AND MODE OF SECRETION IN THE VENOM GLAND OF SEA SNakes ...Endocrine -other, Histochemistry -Cytoschem, Venom, Vertebrate Anatomy, ...5.0852

Turtles, Terrapins, Tortoises

THE ECOLOGY, MIGRATIONS AND BEHAVIOR OF MARINE TURTLES ...Behavioral Ecology, Migration, Reptile Studies -other, Spawning & Nesting Sites, ...5.0886

ORIENTATION CUES AND PATTERNS OF LONG-DISTANCE TRAVEL OF MARINE TURTLES ...Biological Rhythms, Environmental Physiology, Migration, Orientation, ...4.0102

THE SPECTRAL SENSITIVITY OF THE GREEN SEA TURTLE (CHELONIA MYDAS) ...Light Quality -non-specific, Visual Organs, ...5.0860

Reservoirs and Impoundments

INVESTIGATE THE FEASIBILITY OF INTRODUCING Sockeye SALMON INTO RES...AVORS ...Aquatic Ecology, Captive Rearing, Oregon, Salmon -coho,chinook,sockeye,..., Stocking of Fish & Shellfish, ...5.0141

PREDICTION OF ENVIRONMENT ...Biological-general, Columbia River, Environmental Ecology, Low Temp. -but Above 32f, Physical-general, Salmon & Trout - Non-specific, Snake River, Temperature, Thermal Pollution, ...5.0225

Residue Analysis

Bioassay

EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS ...Estuaries, Persistence of Residues, Pollution - Effects of , Sevin, Swamps-marshes, ...5.0918

EXPLORATORY COLLECTION AND CARE OF FISH FOR TESTING AT TIBURON ...California, Fish -non-specific, Laboratory Animals, San Francisco Bay, ...5.0116

EXPLORATORY COLLECTION AND CARE OF AQUATIC INVERTEBRATES FOR TESTING AT TIBURON ...Brackish Water, Captive Rearing, Invertebrates -non-specific, Pesticides -non-specific, ...5.0905

PESTICIDES ...Aquatic Or Soil-aquatic Cycles, Fish, Persistence of Residues, Pesticides -non-specific, Pollution Effects, ...5.0881

RATE OF ABSORPTION OF ENDRIN BY BLUEGILL SUNFISH ...Bluegills, Bream, DDT , Endrin, Metabolism, Mode of Action -animal, ...5.0523

Monitoring Systems

PESTICIDE MONITORING PROGRAM ...Bioindicators, Estuaries, Gas Chromatography, Oysters, Persistence of Residues, ...6.0147

MONITORING OF PESTICIDE LEVELS IN THE GREAT LAKES ...Fish - non-specific, Great Lakes-general, Invertebrates - non-specific, Pollutants-general, Sampling, ...6.0120

Resistance & Tolerance

Animal Resistance

Animal Resistance - other

PESTICIDE RESISTANT FISH IN NATURAL ECOSYSTEMS ...Endrin, Fish, Food Chains, Animal And/or Man, Pollution Effects, Rates, Doses, Concentrations, ...5.0177

Genetic Resistance

ARTIFICIAL SELECTION - FISH ...Female Gametes, Fish -non-specific, Pesticides -non-specific, Pollution - Effects of , Selection & Breeding, ...5.0256

658
SUBJECT INDEX

Sea Ice
 SYSTEMS ANALYSIS ASSISTANCE TO HEADQUARTERS U. S. COAST GUARD ...Benefit-cost Analysis, Model Studies, Ships and Cruises, Systems Analysis, ...3.0015
 SATELLITE SEA ICE STUDIES USING HRIR ...Arctic Ocean, Data Analysis - General, Infrared Radiation, Satellites, Technique Development, ...3.0075
 ARCTIC AIR, SEA AND ICE ...Arctic, Climatology, Heat and Radiation Transfer, Heat Exchange, Micrometeorology, Weather Forecasting, ...3.0088
 ELECTRICAL PROPERTIES OF ICE ...Audio Frequency, Electrical, Phase Relationships, ...3.0072
 ARCTIC RESEARCH ...Acoustical, Arctic Ocean, Currents-ocean, Geomorphology-topography, Magnetic Studies, ...4.0049
 LARGE-SCALE INERTIAL OCEAN-ATMOSPHERE RELATIONSHIPS ...Air-sea Boundary-general, Greenland Sea, Jet Streams, Patterns, Sea of Okhotsk, Weather Forecasting, ...3.0024
 EXCHANGE METEOROLOGIST WITH JAPANESE ANTARCTIC RESEARCH EXPEDITION ...Air-sea Boundary-general, Antarctic Ocean, General Synoptic Observations, Mixing, Radiosonde, ...3.0013
 SPECIALIZED RESEARCH EQUIPMENT FOR SEA ICE STUDIES ...Alteration, Equipment Purchase Operation, ...3.0086
 DISTRIBUTIONS OF CURRENTS AND PHYSICAL PROPERTIES WITHIN TIDE ARCTIC OCEAN ...Acoustical, Arctic Ocean, Currents-ocean, Heat and Radiation Transfer, Temperature, ...4.0031
 SEA ICE MOVEMENT DYNAMICS ...Charts, Forecasting-prediction, Mapping, Model Studies, Polar, ...3.0087
 ARCTIC SUB-ICE STUDY ...Acoustical, Arctic Ocean, Marine Biology, Submersibles, ...3.0074
 HF AUDIO ABSORPTION IN ICE ...Acoustical, Attenuation, Ice Acoustics, Reverberation, Salinity, ...3.0073
 DRIFT-STATION BIOLOGY ...Alaska, Animal Taxonomy, Arctic Ocean, Oceanic Fronts, Productivity - Food Chain, ...3.0743
 ENVIRONMENTAL APPLICATIONS OF PASSIVE MICROWAVE SENSORS ...Beaches, Ice-general, Microwave Radiation, Sedimentology-general, Snow-general, Soil Engineering Investigation, ...4.0136
 ARCTIC ADVISORY SERVICE ...Arctic Ocean, Bibliography, Ice Properties-general, Library, ...11.0012
 ARCTIC UNDERSEAS RESEARCH, PHYSICAL AND CHEMICAL PROPERTIES OF SEA ICE ...Arctic Ocean, Environmental Effects-geologic, Ice Properties-general, Model Studies, ...3.0079
 ARCTIC UNDERSEAS RESEARCH, JOINT USA-CANADIAN HEAT BUDGET STUDY ...Arctic, Heat and Radiation Transfer, Instrumentation-general, Physical Climatology, ...3.0071
 PREDICTION OF POLAR ICE BEHAVIOR AND DISTRIBUTION ...Arctic Ocean, Data Acquisition, Forecasting-prediction, Hydrodynamics, Ice-general, Weather Forecasting, ...3.0079
 EXPERIMENTAL SEA ICE OBSERVATIONAL TECHNIQUES ...Data Acquisition, Imaging, Instrumental Services, Range and Tracking-other, Satellites, ...4.0156

Sea of Okhotsk
 LARGE-SCALE INERTIAL OCEAN-ATMOSPHERE RELATIONSHIPS ...Air-sea Boundary-general, Greenland Sea, Jet Streams, Patterns, Sea Ice, Weather Forecasting, ...3.0024

Sea Squirts - Tunicates
 CYTOPLASMIC FILAMENTs AND CELL MOVEMENT IN DEVELOPMENT ...Basic Embryology, Filtrils and Filaments, Growth (non-specific & 01.), Motility and Migration, Proteins, ...5.1037
 STUDIES ON EMBRYONIC CELLS ...Basic Embryology, Chickens, Reproductive System, Suspension Culture, ...5.0945
 ASCIDIAN SPECIES ON THE ATLANTIC CONTINENTAL SHELF ...Animal Taxonomy, Atlantic Ocean-north, Continental Shelf, Range Or Territorial Distr., Vertical Distribution, ...5.0609
 REPRODUCTION AND EMBRYONIC SURVIVAL IN ASCIDIA NIGRA (SAVIGNY) ...Basic Embryology, Biological Rhythms, Laboratory, Reproductive System, Whole Body Culture & Rearing, ...5.0609
 MORPHOLOGY AND PHYSIOLOGY OF THE HEART OF ECTENASIDIA TURBINATA ...Bermuda, Cardiovascular, vertebrate Anatomy, ...5.0530

Sea Level Variations
 MARINE PHYSICAL GEODESY ...Aerospatial, Caribbean Sea, Gravity Studies, Navigation, Standard Geoid, ...4.0078
 THERMAL STRUCTURE ...Data Reduction and Analysis, Salinity, Temperature, Tables, Compilations, Catalogs, ...1.0184
 CARBON-14 AGE PROFILE OF A HAWAIIAN REEF ...Anchorage, Carbon-14, Coring and Dredging, Growth Rate, Hawaii, Reefs, ...7.0159
 RADIOCARBON DATING OF A HAWAIIAN REEF PROFILE ...Hawaii, Radiocarbon, Radioactive Dating, Reefs, ...7.0077
 LONG-PERIOD WAVES ...Bermuda, Pressure, Statistics-general, Waves, ...2.0085
 CHANGES IN SEA LEVEL IN NORTHERN TUNESIA ...Archeology, Sedimentation, Shoreline - Coastline, Tunisia, ...7.0208
 GREAT LAKES RESEARCH WATER-LEVEL DISTURBANCES ...Lake Erie, Lake Michigan, Model Studies, Seiches, Water Level Fluctuation, ...2.0086
 CORRELATION OF BEACH PROPERTIES AND INCIDENT WAVES ...Beach, Development, Engineering Structures-general, General Transport Effects, Shoreline Structures, Waves, ...8.0204
 INTERRELATIONS WITHIN THE PHYSICAL ENVIRONMENT ...Commercial Fishing, Density, Environmental Ecology, Temporal Distribution, ...2.0078

Sea of Ygotsk
 LARGE-SCALE INERTIAL OCEAN-ATMOSPHERE RELATIONSHIPS ...Air-sea Boundary-general, Greenland Sea, Jet Streams, Patterns, Sea Ice, Weather Forecasting, ...3.0024
<table>
<thead>
<tr>
<th>SUBJECT INDEX</th>
<th>Sediment Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sealant</strong></td>
<td>BAYOU LAFOURCHE SEDIMENTATION STUDY, LOUISIANA...Bayous, Channels, Louisiana, Morphology-general, Sediment Yield,... 9.0010</td>
</tr>
<tr>
<td><strong>Sediment Deposition</strong></td>
<td><strong>COASTAL PROCESSES - SOUTH TEXAS</strong> Depositional Features-other, Distribution, Other Transport Methods, Shoreline - Coastal Texas,... 7.0219</td>
</tr>
<tr>
<td><strong>Deposits</strong></td>
<td><strong>QUANTITATIVE AND QUALITATIVE CHARACTERISTICS OF MATERIALS CONTRIBUTING TO SEDIMENTATION IN LAKE ERIE</strong> Lake Erie, Location, Organic, Organics, Sedimentation,... 7.0246</td>
</tr>
<tr>
<td><strong>Geological Studies in Northern Lake Michigan</strong></td>
<td>LIGHT DILUTION NUCLEAR TECHNIQUES FOR DATING MARINE SEDIMENTS Argon-potassium, Optical, Original Radioactive Dating, Rate of Deposition, Terrigenous,... 7.0201</td>
</tr>
<tr>
<td><strong>Sand Bars</strong></td>
<td>LIGHT DILUTION NUCLEAR TECHNIQUES FOR DATING MARINE SEDIMENTS Argon-potassium, Optical, Original Radioactive Dating, Rate of Deposition, Terrigenous,... 7.0201</td>
</tr>
<tr>
<td><strong>Sediment Deposition Processes</strong></td>
<td><strong>EVOLUTIONARY DEVELOPMENT OF CUSPATE FORELANDS</strong> Beach, Continental Shelf, Depositional Features-other, Development, North Carolina, Shoreline - Coastal Texas,... 7.0296</td>
</tr>
<tr>
<td><strong>Loess</strong></td>
<td><strong>MACHINES OF AEA IN DEEP AND SHALLOW WATERS</strong> Currents-longshore, Geomorphology-topography, Tsunami, Waves, Waves-internal,... 7.0100</td>
</tr>
<tr>
<td><strong>Unconsolidated Deposits</strong></td>
<td><strong>DEVELOPMENT OF MARINE CHURN DRILL FOR SAMPLING UNCONSOLIDATED DEPOSITS</strong> Bottom Sampling Device, Drilling and Coring, Soil Sampling, Technique Development,... 8.0250</td>
</tr>
<tr>
<td><strong>General Deposition</strong></td>
<td><strong>ESTUARINE SEDIMENTATION PROCESSES</strong> Estuaries, Inter-tidal Areas, Morphology-general, New England Province, Tidal Streams, Tides,... 7.0224</td>
</tr>
<tr>
<td><strong>General Deposition</strong></td>
<td><strong>THE ORIGIN OF GRAVEL BARS IN THE INTERTIDAL ZONE, PARRSBORO HARBOR, NOVA SCOTIA, CANADA</strong> Canada, Inter-tidal Areas, Location, Origin, Size,... 7.0277</td>
</tr>
<tr>
<td><strong>General Deposition</strong></td>
<td><strong>Sedimentary Processes</strong> Channels, Scouring, Sediment Transport-other, Tidewater Areas, Turbulent Flow,... 7.0250</td>
</tr>
<tr>
<td><strong>General Deposition</strong></td>
<td><strong>MECHANICS OF WAVE ACTION IN DEEP AND SHALLOW WATERS</strong> Currents-longshore, Geomorphology-topography, Tsunami, Waves, Waves-internal,... 7.0100</td>
</tr>
<tr>
<td><strong>Rate of Deposition</strong></td>
<td><strong>DEVELOPMENT OF MARINE CHURN DRILL FOR SAMPLING UNCONSOLIDATED DEPOSITS</strong> Bottom Sampling Device, Drilling and Coring, Soil Sampling, Technique Development,... 8.0250</td>
</tr>
<tr>
<td><strong>Rate of Deposition</strong></td>
<td><strong>ESTUARINE SEDIMENTATION PROCESSES</strong> Estuaries, Inter-tidal Areas, Morphology-general, New England Province, Tidal Streams, Tides,... 7.0224</td>
</tr>
<tr>
<td><strong>Rate of Deposition</strong></td>
<td><strong>THE ORIGIN OF GRAVEL BARS IN THE INTERTIDAL ZONE, PARRSBORO HARBOR, NOVA SCOTIA, CANADA</strong> Canada, Inter-tidal Areas, Location, Origin, Size,... 7.0277</td>
</tr>
<tr>
<td><strong>Rate of Deposition</strong></td>
<td><strong>Sedimentary Processes</strong> Channels, Scouring, Sediment Transport-other, Tidewater Areas, Turbulent Flow,... 7.0250</td>
</tr>
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<td><strong>MECHANICS OF WAVE ACTION IN DEEP AND SHALLOW WATERS</strong> Currents-longshore, Geomorphology-topography, Tsunami, Waves, Waves-internal,... 7.0100</td>
</tr>
<tr>
<td><strong>General Mineralogic Properties</strong></td>
<td><strong>CARBONATE SEDIMENTATION IN THE TONGUE OF THE OCEAN, BAHAMAS</strong> British West Indies, Diagenesis, Paleocology, Sea Level Variations, Sedimentation,... 7.0267</td>
</tr>
<tr>
<td><strong>General Mineralogic Properties</strong></td>
<td><strong>CARBONATE SEDIMENTATION IN THE TONGUE OF THE OCEAN, BAHAMAS</strong> British West Indies, Diagenesis, Paleocology, Sea Level Variations, Sedimentation,... 7.0267</td>
</tr>
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<td><strong>General Mineralogic Properties</strong></td>
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</tr>
<tr>
<td><strong>General Mineralogic Properties</strong></td>
<td><strong>CARBONATE SEDIMENTATION IN THE TONGUE OF THE OCEAN, BAHAMAS</strong> British West Indies, Diagenesis, Paleocology, Sea Level Variations, Sedimentation,... 7.0267</td>
</tr>
</tbody>
</table>

---

661
Sediment Properties

SUBJECT INDEX

INFLUENCE OF SUSPENDED MICROSCOPIC SUBSTANCES ON THE METABOLISM OF MICROORGANISMS RESPONSIBLE FOR BIOLOGICAL ENRICHMENT OF WATER ...Chemical, Eutrophication, Lake Erie, Microorganisms (non-specific), Pollution - Effects of, Sediments, ...7.0169

ENVIRONMENT OF DEPOSITION OF ARGILLACEOUS SEDIMENTS ...Boron, Chemistry, Clays, Deltas, Mississippi River, ...7.0240

DISTRIUTION OF ELEMENTS IN FLUVIAL AND BRACKISH ENVIRONMENTS ...Adsorption, Brackish Water, Chemical Reactions, Element Ratios, Exchange Capacity, Solution, ...7.0221

MOVEMENT OF RADIONUCLIDES IN THE LOWER COLUMBIA RIVER ...Absorbed Load, Columbia River, Estuaries, Pollutants - Path of, Radioactivity-general, ...6.0178

THE MOVEMENT OF RADIONUCLIDES IN THE COLUMBIA RIVER ESTUARY ...Absorbed Load, Columbia River, Estuaries, Pollutants - Path of, Radioactivity-general, ...6.0180

RELATIONSHIP BETWEEN GLACIAL FLOUR POLLUTION AND POLLUTANTS FROM OTHER SOURCES ...Adsorption, Alaska, Estuaries, Glacial Clastics, Pollution - Effects of, Pulp, Paper, and Logging, Size, ...6.0134

Density

AN INVESTIGATION OF THE MASS PHYSICAL PROPERTIES OF CARBONATE MUD SEDIMENTS ...Carbon-14, Carbonates-other, Core Analysis, Physical Properties, Porosity, ...7.0225

Exchange Capacity

CHEMICAL EXCHANGES ACROSS SEDIMENT-WATER INTERFACES ...Chemical, Chemical-general, Estuaries, Salinity, Solution Chemistry, ...7.0279

DISTRIBUTION OF ELEMENTS IN FLUVIAL AND BRACKISH ENVIRONMENTS ...Adsorption, Adsorption Capacity, Brackish Water, Chemical Reactions, Element Ratios, Solution, ...7.0221

Fabric

FABRIC OF MARINE MUDS ...Freeze, Physical Properties, Size, Terrigenous, Textures-structures, ...7.0242

Permeability

HYDROLOGY OF UPPER OLD TAMPA BAY, FLORIDA ...Bays, Groundwater Movement, Hydrology-general, Lakes, Water Harvesting, Water Quality-general, ...6.0067

Porosity

AN INVESTIGATION OF THE MASS PHYSICAL PROPERTIES OF CARBONATE MUD SEDIMENTS ...Carbon-14, Carbonates-other, Core Analysis, Density, Physical Properties, ...7.0225

Shape

SAND RIPPLES ...Beaches, Distribution, Grain Size, Ocean Waves - Currents, Ripple Marks, ...7.0196

Size

SUBMARINE GEOLOGY OF GASTINEAU CHANNEL JUNEAU, ALASKA ...Alaska, Basins, Distribution, Sismic Studies, Subbottom, ...7.0225

FABRIC OF MARINE MUDS ...Fabric, Freeze, Physical Properties, Terrigenous, Textures-structures, ...7.0225

THE POTENTIAL SOURCE, TRANSPORT AND DEPOSITION PATTERNS OF CLASTIC SEDIMENTS IN PORTIONS OF COASTAL GEORGIA ...Beach, Currents-longshore, General Mineralogic Properties, Georgia, Microstructure, ...7.0235

CORRELATION OF SUBMARINE VOLCANIC ASH BY CATHODO-LUMINESCENCE ...Correlation, Extrusives, Geochronology-general, Luminescence, Qualitative, ...7.0235

THE ORIGIN OF GRAVEL BARS IN THE INTERTIDAL ZONE, PARRSBORO HARBOUR, NOVA SCOTIA, CANADA ...Canada, Intertidal Areas, Location, Origin, Sand Bars, ...7.0277

INTERPRETING THE ORIGIN AND DISTRIBUTION OF COASTAL SEDIMENTS ...Canada, Distribution, Massachusetts, Origin, Shoreline Structures, Wave Motion in fluids-other, Water, ...7.0225

DEVELOPMENT OF OFFSHORE SOURCES OF SAND SUITABLE FOR BEACH RESTORATION AND Nourishment ...Beach, Coring and Dredging, Meping, Ocean Mining, Shoreline Structures, ...7.0012
SUBJECT INDEX

Methods of Bypassing Sand Past Inlets...By-passing, Coastal Engineering—other, Ocean Waves—Currents, Shoreline Structures, .8.0040

Clay Chemistry...Chemical, Chemistry, Terrigenous, ...7.0063

Northern California Offshore Black Sands...California, Distribution, Heavy Minerals, Shoreline—Coastline, Terrigenous, ...7.0020

Quaternary Sedimentation at Marine-Fluvial Interface, SW Oregon...Bed Load, Geological Exploration, Heavy Minerals, Mineralogy—petrology, Quaternary Period, ...7.0197

Relationship between Glacial Floculon Pollution and Pollutants from Other Sources...Adsorption, Desorption Capacity, Alkalis, Estuaries, Glacial Clastics, Pollution—Effects of, Pulp, Paper, and Logging, ...6.0134

Texture

Acoustic Properties of Sediments...Acoustical, Correlation, Physical Properties, Seismic Studies, Subbottom, ...7.0108

Sediment Provenance Studies

Environment

Florida Coral Reef Studies...Drilling and Coring, Florida, Geologic History—general, Quaternary Period, Reefs, ...7.0162

Comparison of Ancient and Modern Coastal Clastic Sedimentary Environments...Cretaceous Period, Quaternary Period, Shoreline—Coastline, Textures—Structures, Water Deposited Clastics, ...7.0234

Depositional Processes Marginal to Large Antarctic Ice Shelves...Antarctic Ocean, Core Analysis, Deposits, Sedimentary History, Sedimentation, ...7.0198

Collection, Reduction, and Interpretation of Seismologic and Photographic Data...Data Analysis—General, Distribution, Ocean Basins, Photography, Sedimentary History, Sedimentation, Seismic Studies, ...7.0262

Kaoilinite as Related to Environment of Deposition...Dissolution, Genetic Relationships, Kaolinite, Mineral Types, ...7.0239

Location

Geochemical Studies of Continental Waters...Authigenesis, Element Ratios, Geochemical Analysis, Isotope, Isotope Trace-er—other, Pore Fluids, Radioisotopes, Water Analysis, ...7.0071

Role of Wind-Borne Continental Dust in Ocean Sedimentation Processes...Distribution, Dust—Particulate Matter, Rate of Deposition, Terrigenous, Trace Element Analysis, ...7.0230

The Origin of Gravel Bars in the Intertidal Zone, Parrsboro Harbour, Nova Scotia, Canada...Canada, Intertidal Areas, Origin, Sand Bars, Size, ...7.0277

Quantitative and Qualitative Characteristics of Materials Contributing to Sedimentation in Lake Erie...Lake Erie, Organic, Organics, Rate of Deposition, Sedimentation, ...7.0246

Mineralogy—petrology

Quaternary Sedimentation at Marine-Fluvial Interface, SW Oregon...Bed Load, Geological Exploration, Heavy Minerals, Quaternary Period, Size, ...7.0199

Provenance Studies—other

Sedimentation, Morphology, and Structure—Mid-Atlantic Ridge...Atlantic Ocean—general, Distribution, Ocean History, Ridges, Sea Floor Spreading, ...7.0047

Sediment Relationship

(U) The Effects of Oceanic Processes on the Deposition of River Sediments...Physical Properties, Rate of Deposition, Sedimentation, Streams, ...7.0197

Supply Rate

Study of Beach Nourishment Along the Southern California Coast...Beach, California, Erosional Features, Sediment Transport—general, Shoreline Structures, ...7.0292

663

Sediment Transportation

Delaware Estuary Sedimentation Study...Delaware Bay, Estuaries, Salinity, Sediment Yield, Sedimentation, ...7.0275

Weathering

GeoMicrobiological Weathering Phenomena Off Anvers Island...Antarctica, Habitat Studies, Identification, Marine Bacteria, Petrography, ...7.0232

Sediment Transportation

Agents

Ocean Waves—Currents

Columbia River Effects in the Northeast Pacific...Bed Load, Benthonic—bottom, Columbia River, Mixing, Oceanic Fronts, ...2.0056

Radioisotopic Tracer Study to Investigate the Mechanisms of Littoral Transport Around Point Conception, California...Continental Shelf, Distribution, Sediment Transport—other, Tracers, Xenon, ...7.0216

Marine Geology...California, Continental Shelf, Distribution, Sedimentation, Submarine Canyons, ...7.0260

Ocean Current Transport...Gulf Stream, Navigation, Water Motion Recorders, ...7.0216

Sand Transport...Beach, Sand Bars, Sedimentation, Submarine Canyons, Textures—Structures, ...7.0262

Sand Ripples...Beaches, Distribution, Grain Size, Ripple Marks, Shape, ...7.0196

Nature and Velocity of Currents and Other Flows in Submarine Canyons...Convection, Fans, Sedimentation, Submarine Canyons, Turbulence Currents, Water Motion Recorders, ...2.0088

Transversal Drifts in Bottom Profile...Bathymetry, Benthonic—bottom, Intertidal Areas, Waves, ...7.0224

Radioisotopic Sand Tracer Study, Point Conception, Santa Barbara County, California...California, Other Sediment Type, Sediment Transport—general, Tracers, ...7.0194

Mechanics of Sand Movement by Waves...Model Studies, Shoreline Structures, Size, Wave Motion in Fluids—other, Waves, ...7.0217

Methods of Bypassing Sand Past Inlets...By-passing, Coastal Engineering—other, Shoreline Structures, Size, ...8.0040

Turbidity Currents

Experimental and Theoretical Research on Turbidity Currents...Currents—other, Hydraulic Structures, Laboratory Analysis, Sedimentation, ...7.0243

Effects

By-passing

Methods of Bypassing Sand Past Inlets...Coastal Engineering—other, Ocean Waves—Currents, Shoreline Structures, Size, ...8.0040

Chemical Reactions

Distribution of Elements in Fluvial and Brackish Environments...Adsorption, Adsorption Capacity, Brackish Water, Element Ratios, Exchange Capacity, Solution, ...7.0221

General Transport Effects

Great Lakes Research—Coastal Area Sedimentation...Beach, Development, Energy, Great Lakes—general, Model Studies, Sedimentation, ...7.0124

Correlation of Beach Properties and Incident Waves...Beach, Development, Engineering Structures—general, Sea Level Variations, Shoreline Structures, Waves, ...8.0204

Grain Size

Sand Ripples...Beaches, Distribution, Ocean Waves—Currents, Ripple Marks, Shape, ...7.0016

Estuarine Sedimentary Models...Circulation—general, Distribution, Estuaries, Model Studies, Textures—Structures, ...8.0079

Other Transport Effects

Subaerial and Subaqueous Flow of Slurries...Sedimentation, ...7.0222

663
Sediment Transportation

SUBJECT INDEX

Methods

Absorbed Load

MOVEMENT OF RADIONUCLIDES IN THE LOWER COLUMBIA RIVER...Adsorption Capacity, Columbia River, Estuaries, Pollutants - Path of, Radioactivity-general,...6.0178

THE MOVEMENT OF RADIONUCLIDES IN THE COLUMBIA RIVER EUSTUARY...Adsorption Capacity, Columbia River, Estuaries, Pollutants - Path of, Radioactivity-general,...6.0180

Bed Load

BOTTOM CURRENTS AND THE MOVEMENT OF SEDIMENTS ACROSS THE CONTINENTAL SHELF...Columbia River, Continental Shelf, Puget Sound, Sediment Transport-general, Unsteady,...2.0047

COLUMBIA RIVER EFFECTS IN THE NORTHEAST PACIFIC...Benthonic-bottom, Columbia River, Mixing, Ocean Waves - Currents, Oceanic Fronts,...2.0065

QUATERNARY SEDIMENTATION AT MARINE-FLUVIAL INTERFACE, SW OREGON...Geological Exploration, Heavy Minerals, Mineralogy-petrology, Quaternary Period, Size,...7.0199

Other Transport Methods

COASTAL PROCESSES - SOUTH TEXAS...Depositional Features-other, Distribution, Rate of Deposition, Shoreline - Coastline, Texas,...7.0219

Solution

DISTRIBUTION OF ELEMENTS IN FLUVIAL AND BRACCIAL ENVIRONMENTS...Adsorption, Adsorption Capacity, Brackish Water, Chemical Reactions, Element Ratios, Exchange Capacity,...7.0221

Suspension

CLAY-INORGANIC AND ORGANIC-INORGANIC ASSOCIATIONS IN AQUATIC ENVIRONMENTS...Clays, Deposits, Mineral Reactions, Sedimentation, Trace Elements,...7.0500

KINETICS OF SEDIMENTS IN BREAKERS...Coastal Engineering-other, Development, Hydrodynamics, Sedimentation, Waves,...7.0237

MEASUREMENT OF SURFACE CHARGE ON PARTICLES SUSPENDED IN SEA WATER...Electrical, Water Chemistry-other, Zeta Potential,...7.0205

THE INFLUENCE OF DEPOSIT FEEDING BENTHOS ON THE STABILITY OF BOTTOM SEDIMENTS AND COMMUNITY TROPHIC STRUCTURE...Benthic Fauna, Benthonic-bottom, Massachusetts, Productivity - Food Chain,...5.0559

MINERALOGICAL STUDIES OF PARTICULATE MATTER SUSPENDED IN SEA WATER...Chemistry, Minerals, Water Chemistry-other,...1.0122

THE OPTICAL PROPERTIES OF SEA WATER AND THEIR USE IN TOPOGRAPHIC RESEARCH & DEVELOPMENT...Attenuation, Oceanic Fronts, Optical, Oregon, Salinity, Temperature,...2.0091

SEA WATER OPTICS STUDIES...Estuaries, Optical, Size Frequency Distribution,...1.0166

GREAT LAKES RESEARCH - SOIL DISPOSAL EFFECTS...Dispersion -water, Great Lakes-general, Pollution - Effects of, Sediments, Spoil Banks, Water Property-general,...6.0157

Sediment Transport-general

BOTTOM CURRENTS AND THE MOVEMENT OF SEDIMENT ACROSS THE CONTINENTAL SHELF...Bed Load, Columbia River, Continental Shelf, Puget Sound, Unsteady,...2.0047

SEDIMENT STRUCTURE...Coral Sea, Distribution, Geosynclines, Shelf Arcs, Textures-structures,...7.0204

NEARSHORE WAVE THEORY...Development, Model Studies, Shoreline - Coastline, Waves,...2.0119

SEDIMENTARY STRUCTURE...General Deposition, Other, textures-structures,...7.0280

RADIOSITOTOPIC SAND TRACER STUDY, POINT CONCEPTION, SANTA BARBARA COUNTY, CALIFORNIA...California, Ocean Waves - Currents, Other Sediment Type, Trace,...7.0194

STUDY OF BEACH NourISHMENT ALONG THE SOUTHERN CALIFORNIA COAST...Beach, California, Erosional Features, Shoreline Structures, Supply Rate,...7.0292

SALINITY INTRUSION AND RELATED PHENOMENA...General Deposition, Mixing, Ocean Currents-other, Open Channel Flow, Saline Water Intrusion,...3.0061

Sediment Yield

DELWARE ESTUARY SEDIMENTATION STUDY...Delaware Bay, Estuaries, Salinity, Sedimentation, Supply Rate,...7.0275

BAYOU LAFOURCHE SEDIMENTATION STUDY, LOUISIANA...Bayous, Channels, Louisiana, Morphology-general, Rate of Deposition,...7.0010

Sedimentary Petrogenesis

DEPOSITION RATES BY THE PROTACTINIUM METHOD...Chemical, Distribution, Element Ratios, Manganese, Thermal, Thorium, Uranium,...7.0270

BIOGENESIS OF CARBONATE SEDIMENTS, BAHAMAS ISLANDS...Bioclastic Limestone, Bioclasts, Biogeochmical Process, British West Indies, Classification - Taxonomy,...7.0241

ISOTOPIC AND CHEMICAL COMPOSITION OF ORGANIC CARBONATES...Biochemical, Chemical, Jamaica, Organic Limestone, Reefs,...7.0084

Sedimentary Petrology

SEDIMENT AND VOLCANIC STUDIES...Distribution, Origin, Pacific Ocean-north, Stratigraphy-genral, Volcanic,...7.0189

GEOLoGIC INVESTIGATIONS IN PUERTO RICO & THE CARIBBEAN...Caribbean Sea, Element Ratios, Plutonic, Puerto Rico, Volcanic,...7.0042

Sedimentary Rocks

IGNEOUS AND SEDIMENTARY ROCKS FROM THE NORTH WALL OF THE PUERTO RICO TRENCH...Igneous Rocks, Petrology, Puerto Rico, Trenches,...7.0083

Carbonates

Bioclastic Limestone

BIOGENESIS OF CARBONATE SEDIMENTS, BAHAMAS ISLANDS...Bioclasts, Biogeochmical Process, British West Indies, Classification - Taxonomy, Sedimentary Petrogenesis,...7.0241

Carbonates-general

URANIUM GEOCHEMISTRY IN (MODERN) CARBONATES USING THE FISSION TRACK METHOD...Biogeochmical Process, Chemistry, Diagenesis, Organism Sampling Devices, Uranium,...7.0076

RADIATION, DOSIMETRY, CORRELATION AND DATING OF CALCAREOUS DEEP-SEA CORES...Core Analysis, Correlation, Radioactive Dating, Sedimentation, Therrnoluminescence,...7.0251

EARLY DIAGENESIS OF CARBONATE SEDIMENTS IN A SUPRATIDAL EVAPORATIC SETTING...Continental Shelf, Diagenesis, Origin, Persian Gulf, Sedimentary History, Sedimentation,...7.0252

OCEANOGRAPHY, PLEISTOCENE GEOLOGY AND SEDIMENTS OF LITTLE BAHAMA BANK...British West Indies, Currents-bottom, Energy, Quaternary Period, Water Motion Recorders,...7.0229

DIAGENESIS OF CARBONATE SEDIMENTS...Core Analysis, Diagenesis, Geochmistry-general, Pore Fluids, Trace Element Analysis,...7.0266
Sedimentary Structures

Internal

Current Bedding
RELATION OF SEDIMENT STRUCTURES AND FLOW DIRECTIONS OF COASTAL CURRENTS ...Con-14, shorelines, Ocean Currents-thermocline, Palaeocurrents, Sedimentation, Textures-structures, ...7.0276

Ripple Marks
SAND RIPPLES ...Beaches, Distribution, Grain Size, Ocean Waves - Currents, Shells, ...7.0196

Sedimentary Structures-other
AN INVESTIGATION OF CARBONATE MUD SEDIMENTS ...Carbonates-other, Core Analysis, Density, Physical Properties, Porosity, ...7.0225

Dolomite
THE FORMATION OF DOLOSTONE AND CHERT IN THE UPPER MIDDLE CAMBRIAN OF THE GREAT BASIN ...Cambrian Period, Chert, Diagenesis, Great Basin, Petrography, ...7.0283

RECENTLY PRECIPITATED DOLOMITE AND ASSOCIATED MINERALS ...Clay Minerals-general, Crystal Growth, Mineral Type, Phase Relationships, Precipitates, Silicate-general, ...7.0096

Fossil Limestone
TRACE ELEMENT AND STABLE ISOTOPE STUDIES OF CORAL REEF CARBONATES ...Diagenesis, Element Ratios, Paleoenvironments, Reefs, Trace Element Analysis, ...7.0086

CALCAREOUS NONNOFOSSILS FROM PALEOCENE - EOCENE DEPOSITS ...Biogenic, Fossil Zones, Microfossils, Standards, Specifications, Tertiary Period, ...7.0176

TAXONOMY AND STRATIGRAPHY OF CALCAREOUS NONNOPLANKTON IN MARINE SEDIMENT SEQUENCES ...Biogenic, Classification - Taxonomy, Correlation, Microfossils, Order Foramimifera, Paleontology, ...7.0168

STRATIGRAPHIC RELATION BETWEEN ...COQUINA FACIES OF THE YORKTON FORMATION AND OVERLAPPING SEDIMENTS AT CHUCKATUCK, VIRGINIA ...Sea Level Changes, Shore Features-general, Tertiary Period, Unconformities, Virginia, ...7.0254

NATURE OF INTERTIDAL EROSION ON CORAL ATOLLS ...Atolls, Erosion, Intertidal Areas, Marine Biology (non-specific), ...7.0210

Organic Limestone
ISOTOPIC AND CHEMICAL COMPOSITION OF ORGANIC CARBONATES ...Biochemical, Chemical, Jamaica, Reefs, Sedimentary Petrogenesis, ...7.0084

Glacial Clastics
INTERSTITIAL WATER OF GLACIAL-MARINE SEDIMENT ...Alaska, Estuaries, Intertidal - Conrete Water, Water, Water Supply-general, ...7.0188

RELATIONSHIP BETWEEN GLACIAL FLOUR POLLUTION AND POLLUTANTS FROM OTHER SOURCES ...Adsorption, Adsorption Capacity, Alaska, Estuaries, Pollution - Effects of, Pulp, Paper, and Logging, Size, ...6.0134

Silicious Sediments
Chert
THE FORMATION OF DOLOSTONE AND CHERT IN THE UPPER MIDDLE CAMBRIAN OF THE GREAT BASIN ...Cambrian Period, Diagenesis, Dolomite, Great Basin, Petrography, ...7.0283

Water Deposited Clastics
COMPARISON OF ANCIENT AND MODERN COASTAL CLASTIC SEDIMENTARY ENVIRONMENTS ...Creteaceous Period, Environment, Quaternary Period, Shoreline - Coastline, Textures-structures, ...7.0234

Fine-grained Clastics
MICROPLANKTON OF THE BEARPAW SHALE OF MONTANA AND NORTH DAKOTA ...Creteaceous Period, Microfossils, Montana, North Dakota, Planktonic - Floating, ...7.0249

Varves
CORING OF THE VARVED SEDIMENTS IN SAANICH INLET ...Canada, Coring and Dredging, Geochronology-general, Local Stratigraphy, Pacific Ocean-east, ...7.0282

Sedimentary Structure-general
RECENT MARINE AND NONMARINE SEDIMENTS AND MICROFAUNA OF DELAWARE COASTAL AREAS ...Bays, Delaware, Facies, Paleoenvironments, Quaternary Period, Shoreline - Coastline, ...7.0307

Sedimentary Structures-other
UNDERWATER GEOLOGY IN THE OSWEGO AREA OF LAKE ONTARIO ...Erosional Features, Erosional Features-general, Geology-general, Lake Ontario, Photography, ...7.0044

Sedimentology-general
INDIAN OCEAN FORAMINIFERA AND SEDIMENTS ...Biofacies, Geographical Relations, Indian Ocean-general, Order Foraminifera, Pacific Ocean-south, ...7.0195

LAKE SUPERIOR CORING III ...Core Analysis, Lake Superior, Seismic Studies, Subsurface, Textures-structures, ...7.0247

INDIAN OCEAN DATA REDUCTION ...Bathymetry, Data Analysis - General, Geophysics-general, Indian Ocean-general, Ocean Basins, ...4.0034

ENVIRONMENTAL APPLICATIONS OF PASSIVE MICROWAVE SENSORS ...Beaches, Ice-general, Microwave Radiation, Sea Ice, Snow-general, Soil Engineering Investigations, ...4.0136

PRE-Delta Sedimentation in the St. Clair River DELTA AREA ...Deltas, Michigan, Sedimentary History, ...7.0248

AN ENVIRONMENTAL SURVEY of the DAMARISCOTTA RIVER ESTUARY, LINCOLN COUNTY, MAINE ...Circulation - Water, Estuaries, Nutrients, Pollution - Effects of, Salinity, ...5.0895

INVESTIGATIONS ON THE CRUSTOSE CORALLINES OF THE NORTH ATLANTIC ...Atlantic Ocean-north, Diving and Scuba, Marine Plants, Plant Taxonomy, Rhodophyta (non-specific & Ot), ...7.0172

HYDRAULICS AND DYNAMICS OF ESTUARIES ...Erosion-general, Estuaries, Flow Characteristics - Water, Sedimentation, Water Level Fluctuation, Waves, ...7.0102

INVENTORY OF THE GULF ESTUARY SYSTEM ...Estuaries, Data Acquisition, Estuaries, Fishing, Gulf of Mexico, ...4.0047

Seiches
LONG PERIOD WAVES ...Fjords, Hydrodynamics, Iceland, Tides, Waves, ...2.0108

CRITERIA FOR THE DESIGN OF SMALL CRAFT HARBORS ...Breakwaters, Coastal Engineering-other, Harbors, Marinas, Waves, ...8.0036

GREAT LAKES RESEARCH ...WATER-LEVEL DISTURBANCES ...Lake Erie, Lake Michigan, Model Studies, Sea Level Variations, Water Level Fluctuation, ...2.0086

Seismic Instruments
Seismographs
MODIFY 19 OCEAN BOTTOM SEISMOGRAPHS AND CONDUCT TESTS WITH THE DEVICE ...Benthonic-bottom, Equipment, Geophysical Equipment, ...8.0110

Seismology
Acoustics
DEVELOPMENT OF ANALYSIS TECHNIQUES FOR CLASSIFYING TRANSIENT HYDROACOUSTIC SIGNALS ...Acoustical, Geophysical Events, Signal Detection, Transient, ...1.0068

Application
Earthquake Location
THEORETICAL ACOUSTIC-GRAVITY WAVE PROPAGATION ...Earthquakes, Energy Exchange Processes, Nuclear Devices, Waves, ...2.0126
Seismology

DEEP EARTHQUAKES AND ISLAND-ARC TECTONICS AND STRUCTURE ...American Samoa, Attenuation, Earthquakes, Island-arcs, Seismic Studies, Velocity Variations, ...7.0146

STUDIES OF EARTHQUAKES IN THE CAPE MENDOCINE AREA ...Applied Electronics, Data Transmission Systems, Earthquakes, Seismic Studies, Telemetry-other, ...7.0088

Structure Location

SEISMOLOGICAL RESEARCH RELATED TO WORLD-WIDE STUDIES OF EARTHQUAKES IN THE CAPE MENDOCINE AREA ...Applied Electronics, Data Transmission Systems, Earthquakes, Seismic Studies, Telemetry-other, ...7.0088

MOHOLE SITE STUDIES ...Coring and Dredging, Earth Interior, Hawaii, Pacific Ocean-north, Seismic Studies, ...7.0097

Exploration Methods

Seismic Reflection

MARINE SEISMOLOGY ...Crust, Distribution, Earth Interior, Seismic Reflection, Textures-structures, ...7.0131

CONTINENTAL MARGIN GEOLOGY ...Bay of Bengal, Continental Shelves, Fans, Subbottom, Textures-structures, ...7.0030

ANALYSIS OF SEISMIC DATA COLLECTED DURING THE INTERNATIONAL INDIAN OCEAN EXPEDITION AND IN THE CARIBBEAN SEA ...Basins, Data Analysis - General, Indian Ocean-north, Ridges, Textures-structures, ...7.0119

ROCK SAMPLING AND GEOPHYSICAL STUDIES IN THE TONGA KERMADE TRENCH SOUTHWEST PACIFIC ...American Samoa, Coring and Dredging, Crustal Fracturing, Earthquakes, Heat Flow Measurements, ...7.0116

REFLECTION PROFILING OF THE SEA FLOOR ...Atolls, Continental Shelves, Fault Complexes, Geomorphology-topography, Pacific Ocean-general, ...7.0101

ATLANTIC OCEAN CRUSTAL STUDIES ...Atlantic Ocean-general, Bathymetry, Coring and Dredging, Crust, Heat Flow Measurements, ...7.0116

GEOPHYSICAL STUDIES FROM ELDANIN IN 1968 ...Antarctic Ocean, Gravity Surveys, Paleomagnetism, Sea Floor Spreading, Textures-structures, ...7.0133

CONTINUITY OF CLIFFERTON AND CLARION FRACTURE ZONES ...Costa Rica, Faults, Geomorphology-topography, Gravity Studies, Structural Studies, ...7.0096

RESEARCH IN OCEANOGRAPHIC SPECIAL CHARTS ...Acoustical, General Sediment Type, Geomorphology-topography, Model Studies, Seismic Studies, Subbottom, ...7.0062

Seismic Refraction

MARINE SEISMOLOGY ...Crust, Distribution, Earth Interior, Seismic Reflection, Textures-structures, ...7.0131

GEOPHYSICAL INVESTIGATIONS IN THE TAIWAN-trIPIpine-New Guinea Region ...Basins, Gravity Surveys, Heat Flow Measurements, Magnetic Surveys, Seismic Surveys, ...7.0129

GEOPHYSICAL INVESTIGATIONS IN THE CORAL SEA ...Buoys, Coral Sea, Crust, Regional Structure, Structural Studies, ...7.0130

Seismic Surveys

GEOPHYSICAL INVESTIGATIONS IN THE TAIWAN-Philippine-New Guinea Region ...Basins, Gravity Surveys, Heat Flow Measurements, Magnetic Surveys, Seismic Reflection, ...7.0129

Generation Mechanisms

Earthquakes

SEISMOLOGICAL RESEARCH RELATED TO WORLD-WIDE STUDIES OF EARTHQUAKES AND TECTONIC MOVEMENTS IN ALASKAN FAULT ZONE ...Alaska, Deformation, Earthquakes, Fault Complexes, Forecasting-prediction, ...7.0139

THEORETICAL STUDY OF OCEAN TIDES FOR PURPOSES OF WORLDWIDE PREDICTION ...Forecasting-prediction, Mediterranean Sea-other, Tides, Waves, ...7.0090

GRAVITY AND EARTH TIDES ...Antarctica, Earth Interior, General Gravimeters, Propagation, Tides, ...2.0077

Microseisms - Background

STUDY OF EARTH NOISE ON LAND AND SEA BOTTOM ...Ocean Basins, Propagation, Seismic Studies, Structural Studies, ...7.0094

Wave Characteristics

Attenuation

HIGH PRESSURE ROCK STUDIES ...Crystalline, High Pressure Research, High Temperature Research, Rock Mechanics, ...8.0036

DEEP EARTHQUAKES AND ISLAND-ARC TECTONICS AND STRUCTURE ...American Samoa, Earthquake Location, Earthquakes, Island-arcs, Seismic Studies, Velocity Variations, ...7.0140

Propagation

SEISMOLOGICAL RESEARCH RELATED TO WORLD-WIDE STUDIES OF EARTHQUAKES AND TECTONIC MOVEMENTS IN ALASKAN FAULT ZONE ...Alaska, Crustal Fracturing, Deformation, Fault Complexes, Forecasting-prediction, ...7.0139

THEORETICAL ACOUSTIC-Gravity WAVe Propagation ...Earthquake Location, Energy Exchange Processes, Nuclear Devices, Waves, ...2.0026

INELASTIC SEISMIC EFFECTS ...Model Studies, Propagation, Rock Mechanics, Surface, Wave Propagation Media, ...7.0089

GENERATION, PROPAGATION, AND COASTAL EFFECTS OF TSUNAMIS ...Hawaii, Juxtaposition, Shoreline - Coastline, Shoreline Structures, Tsunami, ...2.0095

GRAVITY AND EARTH TIDES ...Antarctica, Earth Interior, Earth Tides, General Gravimeters, Tides, ...2.0077

SEA FLOOR ROUGHNESS ...Acoustical, Attenuation, Benthonic-bottom, Bottom Sampling Device, Magnetic Studies, Transmission, ...7.0033

ARCTIC SEISMIC TRANSDUCER EVALUATION ...Applied Electronics, Arctic, Evaluation Other, Ice Acoustics, Transmission, ...8.0118
### SUBJECT INDEX

**Management and Administration**

INSTITUTIONAL ARRANGEMENTS FOR THE MARINE SCIENCES ...International Affairs, Management, Oceanography-general, Savings and Investment, ...10.0005

**Political Processes & Systems**

International Affairs

INSTITUTIONAL ARRANGEMENTS FOR THE MARINE SCIENCES ...Management, Management and Administration, Oceanography-general, Savings and Investment, ...10.0005

**Rural Sociology**

Diffusion of Information

TECHNICAL ASSISTANCE TO INDUSTRY ...Alaska, Commercial Fishing, Fishing Gear, General Information Services, ...5.0031

**Science & Technology**

SCIENCE AND ENGINEERING GOALS FOR THE INTERNATIONAL DECADE OF OCEAN EXPLORATION ...Economics, Oceanography-general, Planning, Project Review, ...4.0118

PACIFIC SALMON FISHERIES - ECONOMICS OF MANAGEMENT ...Appraisals-general, Continental Shelf, International, Legal Review, Legal Studies-general, Ocean Mining, ...10.0006

**Sodium**

INTESTINAL ADSORPTION A-ID TRANSPORT OF NUTRIENTS IN ECHINODERMS ...Active Transport, Cellula Or Intracellular, Echinodermata -other, Intestine, Metabolism, ...5.0619

NEUROENDOCRINE REGULATION ...Brain, Crustacea -non-specific, Endocrine System, Osmoregulation, Water, ...5.0426

**Soil Dynamics**

CIVIL ENGINEERING STRUCTURES IN THE OCEANS ...Coastal Engineering-other, Engineering Studies-other, Foundations-general, Model Studies, Waves, ...8.0340

**Soil Engineering Investigation**

ENVIRONMENTAL APPLICATIONS OF PASSIVE MICROWAVE SENSORS ...Beaches, Ice-general, Microwave Radiation, Sea Ice, Sedimentology-general, Soil Engineering Investigation, ...4.0136

**Soil Loads**

LABORATORY MODEL STUDIES ON PRESSURE DISTRIBUTION IN DETRITUS DURING PENETRATION ...Laboratory Analysis, Mechanical Properties, Model Studies, Pressure, ...8.0253

**Soil Properties - Other**

OCEAN-SEDIMENTS AND CRUSTAL STRUCTURES IN THE BHAMIAN-CARIBBEAN AREA ...Caribbean Sea, Continental Slope, Crust, Ocean Basins, Textures-structures, ...7.0109

**Soil Sampling**

DEVELOPMENT OF DIAMOND DRILLING TECHNIQUES, FOR PHOSPHORITE DEPOSITS, USING STANDARD TOOLS PLUS BUOYANCY TANKS ...Bottom Sampling Device, Disturbed/undisturbed, Drilling and Coring, Phosphate, Technique Development, ...8.0248

DEVELOPMENT OF MARINE CHURN DRILL FOR SAMPLING UNCONSOLIDATED DEPOSITS ...Bottom Sampling Device, Drilling and Coring, Technique Development, Unconsolidated Deposits, ...8.0250

LABORATORY MODEL STUDIES OF COMPARITIVE METHODS OF PENETRATION OF DETRITUS ...Disturbed/undisturbed, Mechanical Properties, Ocean Mining, Rock Fragmentation Methods, Sand, ...8.0257

LABORATORY MODEL STUDIES OF PENETRATION INTO A SIMULATED COHESIONLESS DETRITUS ...Coring and Dredging, Gravel, Mechanical Properties, Model Studies, Technique Development, ...8.0245

---

**Snow Studies**

**Composition**

MEASUREMENT OF COMMON LEAD IN THE EARTHS HYDROSPHERE ...Atomic Absorption, Greenland, Isotope Dilution, Lead, Other Sources, ...3.0069

**Social Aspects**

USE OF THE COASTAL ZONE FOR THE U. S. COASTLINE OF LAKE ERIE AND LAKE SUPERIOR ...Lake Erie, Lake Superior, Lakeshores-inlets, Land Use, Welfare Economics, ...9.0004

EFFECTS OF WATER POLLUTION IN SAN FRANCISCO BAY ...Bays, Economic Impact, Pollution - Effects of, Recreation Sites, San Francisco Bay, Water Utilization -domestic, Welfare Economics, ...6.0140

PRELIMINARY STUDIES OF INTERNATIONAL REGIMES FOR MARINE RESOURCES ...Economics, Legal Studies-general, Oceanography-general, ...10.0001

SOCIO-ECONOMIC STUDY OF NARRAGANSETT BAY, RHODE ISLAND ...Bays, Benefit-cost Analysis, Estuaries, Land Use, Rhode Island, Water Quality Control-general, ...9.0019

**Social Sciences**

Anthropology -other

MICRONESIAN NAVIGATION AND SAILING ...Caroline Islands, General Ethnology, Micronesia, Navigation, Navigation Communication, ...4.0094

Archaeology

CHANGES IN SEA LEVEL IN NORTHERN TUNESIA ...Sea Level Variations, Sedimentation, Shoreline - Coastline, Tunisia, ...7.0208

General Ethnology

MICRONESIAN NAVIGATION AND SAILING ...Anthropology -other, Caroline Islands, Micronesia, Navigation, Navigation Communication, ...4.0094

Government

Intergovernmental Relations

EARTHQUAKE HAZARD - A PUBLIC POLICY PROBLEM IN THE SAN FRANCISCO BAY AREA ...California, Earthquakes, Faults, Forecasting-prediction, Policy Making, San Francisco Bay, ...9.0002

Policy Making

SYMPOSIUM ON THE MINERAL RESOURCES OF THE WORLD OCEAN ...Engineering Studies-general, Meetings, Ocean Mining, Rhode Island, ...7.0027

EARTHQUAKE HAZARD - A PUBLIC POLICY PROBLEM IN THE SAN FRANCISCO BAY AREA ...California, Earthquakes, Faults, Forecasting-prediction, Intergovernmental Relations. San Francisco Bay, ...9.0002

Labor

MANPOWER

SCIENCE AND ENGINEERING GOALS FOR THE INTERNATIONAL DECADE OF OCEAN EXPLORATION ...Economics, Oceanography-general, Planning, Project Review, Science & Technology, ...6.0187
Solomon Islands

Soil Sampling

LABORATORY MODEL STUDIES ON DISTURBANCE OF DETRITUS BY PENETRATION ...Disturbed/undisturbed, Model Studies, ...8.0252

Soil Testing

Soil Testing-general

BOTTOM SOIL PROPERTIES AND FOUNDATIONS ...Bearing Capacity, Consolidation, Foundations-general, Mechanical Properties, Shear Strength, ...8.0332

Soil Types

Disturbed/undisturbed

DEVELOPMENT OF DIAMOND DRILLING TECHNIQUES, FOR PHOSPHORITE DEPOSITS, USING STANDARD TOOLS PLUS BUOYANCY TANKS ...Bottom Sampling Device, Drilling and Coring, Phosphate, Soil Sampling, Technique Development, ...8.0348

LABORATORY MODEL STUDIES OF COMPARATIVE METHODS OF PENETRATION OF DETRITUS ...Mechanical Properties, Ocean Mining, Rock Fragmentation Methods, Sand, Soil Sampling, ...8.0257

LABORATORY MODEL STUDIES ON DISTURBANCE OF DETRITUS BY PENETRATION ...Model Studies, ...8.0252

Gravel

LABORATORY MODEL STUDIES OF PENETRATION INTO A SIMULATED COHESIONLESS DETRITUS ...Coring and Dredging, Mechanical Properties, Model Studies, Soil Sampling, Technique Development, ...8.0245

Sand

LABORATORY MODEL STUDIES OF COMPARATIVE METHODS OF PENETRATION OF DETRITUS ...Disturbed/undisturbed, Mechanical Properties, Ocean Mining, Rock Fragmentation Methods, Soil Sampling, ...8.9257

Solid Waste

MODEL ADVANCED WASTE-TREATMENT PLANT ...Activated Carbon, Lime Treatment, Material Recovery Wastes, Pilot Plant, Process Design, ...8.0326

COMPARATIVE TOXICITIES OF METALS TO ESTUARINE FISHES ...Bicastsays, Estuaries, Industrial Wastes, Killifishs - Cyprinodon, Toxins -other, ...6.0184

SYSTEMS ANALYSIS FOR SHIPBORNE MUNICIPAL INCINERATION ...Distribution, Incinerators, Ocean, Pollution Sources-other, Smoke, ...8.0327

Solomon Islands

MARINE GEOPHYSICAL STUDIES IN THE PACIFIC OCEAN ...Crust, Gravity Studies, Magnetic Studies, Ocean Basins, Seismic Studies, ...7.0313

Sonar

HONEYWELL ACOUSTIC RESEARCH PROGRAM ...Acoustical, Data Acquisition, Data Analysis - General, Interfaces, Model Studies, Reverberation, ...1.0071

NAVIGATION RECEIVER ...Navigation, Navigation Systems-other, Radio, Transducers, Transponders, ...4.0112

DIGITAL OUTPUT SURVEY DEPTH SOUNDING ...Bathymetry, Coding, Digital Computer Applications, Readout Systems, Sound Gear, ...8.0123

ACOUSTIC IMAGE INVESTIGATION ...Acoustical, Reflection, Technique Development, ...1.0018

EXPERIMENTAL VERIFICATION OF WIDE SWATH OCEAN BOTTOM CONTOURING WITH SPLIT BEAM RECEIVERS ...Bathymetry, Caribbean Sea, Receivers, Technique Development, Topographic, ...7.0302

ERROR ANALYSIS OF SEVERAL BOTTOM REFERENCED NAVIGATION SYSTEMS FOR SMALL SUBMERSIBLES ...Error Analysis, Navigation, Operational Aspect, Submersibles, Subsurface Environments, Systems Analysis, ...4.0111

EXPERIMENTAL HIGH RESOLUTION SUB-BOTTOM PROFILING SYSTEM ...Amplifiers, Receivers, Sonar and Echo Sounding, Subbottom, Transducers, ...9.0109

HIGH-POWER HYDROACOUSTIC VIBRATOR DEVELOPMENT ...Generation, Liquids, Seismic Studies, ...8.0165

DEPTH CONTROLLED STREAMER DEVELOPMENT ...Control-systems, Depth, Equations, Hydroacoustics, ...8.0116

AN IMPROVED MARINE VIBRSEOS INSTALLATION ...Data Acquisition, Hydrographic, Special Mission Ships, ...8.0166

ADVANCE SONAR SYSTEMS ...Data Display, Instrumental Services, Sonar and Echo Sounding, Testing Facilities, Transducers, ...8.0096

CONVEXTIVE STUDIES ...Convection, Pacific Ocean-north, Thermal, ...2.0011

DEVELOPMENT OF A PHOTOGRAPHIC SUIT FOR STEREOPHOTOGRAPHIC NAVIGATION ...Acoustical, Navigation, Topographic, Water-borne, ...1.0047

RESEARCH IN REGIONAL TOPOGRAPHIC ANALYSIS ...Acoustical, Geology-topography, Seismic Studies, Subbottom, ...1.0063

OCEAN ENGINEERING STUDIES ...Applied Electronics, Data Acquisition, Data Processing Services, Engineering Studies-general, Instrumental Services, Laboratory Analysis, ...8.0052

SOUND TRANSMISSION IN THE SEA ...Acoustical, Signal Analysis-other, Transmission, ...1.0020

DEVELOPMENT OF UNDERWATER HORIZONTAL SONAR SCANNING EQUIPMENT AND TECHNIQUES FOR LOCATING FISH SCHOOLS ...Behavioral Ecology, Commercial Fishing, Fish -non-specific, Latkes, Nets, ...8.0139

COOK INLET ESCAPEMENT ENUMERATION STUDY ...Alaska, Censusing, Migration, Organism Sampling Devices, Salmon -coho, chinook,aookeye, Sonar and Echo Sounding, ...8.0112

AN INVESTIGATION OF ANALYSIS TECHNIQUES AND EQUIPMENT FOR CLASSIFICATION OF TRANSIENT HYDROACOUSTIC SIGNALS ...Acoustical, Real Time Systems, Technique Development, ...1.0070

OCEANOGRAPHIC RESEARCH ...Acoustical, Buoys, Currents -other, Ocean, Optical, Pressure, Reconnaissance, ...1.0070

SEAMOUNT INVESTIGATION ...Anomalies, Data Analysis-General, Geothermal, Magnetic Studies, Ocean Mining, Seamounts, ...8.0112

SWIMMER HIGH DEFINITION SONAR ...Diving and Scuba, Diving-system, Engineering Studies-other, Maintenance-system, Underwater-construction, ...8.0019

SONAR ACCURACY ...Acoustic, Acoustical, Fire Control, Instrumental Services, Platforms, Transmission, ...1.0051

BOTTOM-REFLECTED SONAR STUDIES ...Acoustical, Benthonic-bottom, Scattering, Surface Environments, Transmission, ...1.0025

SONIC UNDERWATER NAVIGATION FOR SHIPS ...Equipment, Instrumentation-other, Navigation, Ranging, Sound Gear, ...4.0109

WAVE RECORDING AND ANALYSIS ...Data Reduction and Analysis, Lasers-masers, Pressure, Radar, Statistics-general, Water Motion Recorders, Waves, ...2.0134

EVALUATION OF CONTEMPORARY ACOUSTIC, MAGNETIC AND GRAVIMETRIC METHODS FOR DETERMINING SIZE AND SHAPE OF DEPOSITS ...Geophysical Equipment, Gravity Studies, Instrumental Services, Magnetic Studies, Survey Studies, ...7.0007

TESTING AND EVALUATION OF HIGH-RESOLUTION ACOUSTIC SUBBOTTOM PROFILER THROUGH MODIFICATION OF OFF-THE-SHELF COMPONENTS ...Distribution, Electric Circuits and Networks, Evaluation Other, Field Testing, ...8.0115

UPGRADING CONVENTIONAL FISHING TECHNIQUES ...Commercial Fishing, Fishing Gear, Nets, Pacific Ocean-north, Terrestrials, ...8.0150

ECHO RANGING SIGNALS ...Captive Rearing, Echolocation, Mark, Tag Or Capture -other, Sonar and Echo Imaging, ...5.0046

South America

A SYSTEMATIC STUDY OF ENTOCYTHERID OSTRACODS ...Animal Taxonomy, Madagascar-malagasy Republic, New Zealand, Publications -other, Prawns - Seed Or Mussel ...5.0492
Standards, Specifications

HUMIDITY STANDARDS AND MEASUREMENTS ...Evaporation, Humidity, Humidity Instruments, Pressure-density, Streams, ...8.0081
DUPLEX LIMIT STANDARDS FOR SIGNAL COLORS ...Air Traffic Control-ether, Colorimetry, Filter, Navigation Communication, Traffic Control, ...4.0096
PH STANDARD REFERENCE MATERIALS FOR USE IN SEA WATER ...pH, Salinity, Water Analysis, Water Chemistry-ether, ...1.0087
APPLICATION OF ISCC-NBS CENTROID COLORS AND METHOD OF DESIGNATION COLORS ...Colorimetry, Dyes and Coloring, Paint - General, Photography-chemistry, Pigments, ...4.0097
BASIC ACOUSTICAL STANDARDS AND MICROPHONE CALIBRATION ...Acoustic, Acoustical, Audio Frequency, Calibration and Calibrators, Transducers, ...8.0076
STANDARDS FOR AUDIOMETRY ...Acoustic, Calibration and Calibrators, Sound Level Analyzers, Transducers, ...8.0127
MECHANICAL TESTS AND FORCE CALIBRATIONS ...Force, ...8.0073
HUMIDITY CALIBRATION ...Humidity, Humidity Instruments, ...8.0084
SATELLITE TIME DISSEMINATION ...Airborne Probing, Communication & Navigation, Doppler, Navigation, Signal Generators, Time Measurements, ...4.0091
WWVB-WWVL BROADCASTS ...Frequency Standards, Low Frequency, Navigation, Radio, Signal Generators, Time Measurements, Very Low Frequency, ...4.0099
VLF TIMING STUDIES ...Attenuation, Absorption, Electromagnetic Transmission, Navigation, Time Measurements, Very Low Frequency, ...4.0092
CONSULTATIVE AND ADVISORY SERVICES - BATTERY VLF TIMING STUDIES ...Attenuation, Absorption, Electromagnetic Transmission, Navigation, Time Measurements, Very Low Frequency, ...4.0092
CONSULTATIVE AND ADVISORY SERVICES - BATTERY PROBLEMS ...Battery, Consultants, Advisory Services, Instrumentation-General, ...11.0021
WATER CURRENT METERS ...Water Motion Recorders, ...8.0079
REFLECTIVITY AND EMISSIVITY STANDARDS ...Atmosphere Radiation, Infrared Radiation, Interferometry, Radiation, Radiation-general, ...4.0142
NAVAL AIRCRAFT LIGHTING ...Aircraft, Colorimetry, Equipment-instruments, Lighting, ...8.0080
SYSTEM OPERATIONS AND ACOUSTIC PHYSICS ...Acoustical, Economic Theory, Instrumentation-general, Liquids, Systems Analysis, ...12.0201
METAL ANALYSIS/TEST INSPECTION - FLAW DETECTION ...Flaw Detection - Other, Hull, Materials Used Undersea, Penetrating Ray, Ultrasonic and Sonic, ...8.0218

Steroids
Holothurin
ACTII: CHEMICAL PRINCIPLES DERIVED FROM ECHINODERMS ...Chemosenses, Marine Plants, Toxicology, ...6.0117
Sterols
STEROLS AND LIPIDS IN WATER POLLUTION ...Chemical Identification, Effluents-waste Water, Lignins, Pesticides, Pesticides, Pollutants - Path of, Sewage, ...6.0186
PHYTOCHEMISTRY OF NARCOTIC PRINCIPLES IN CAULIFERPA ...Caulerpa, Caulerpin, Phaeophyta (non-specific & Ot), ...6.0117

Storm Water
CONSTRUCTION OF A FACILITY TO DEMONSTRATE OFF-SHORE UNDERWATER TEMPORARY STORAGE OF STORM WATER OVERFLOW FROM A COMBINATION SEWER ...Combined Sewer, Elastomers, Rubber, Lake Erie, Tank, Pressure Vessel, Water Storage, ...8.0328

Strait of Gibraltar
OCEAN DYNAMICS IN THE STRAITS OF GIBRALTAR AND ADJACENT AREAS ...Acoustical, Anti-submarine-warfare, Computer Applications, Hydrodynamics, Model Studies, Submerged Ships, ...8.0141
SUBJECT INDEX

Stratigraphic Studies
Correlation
RADIATION, DOSIMETRY, CORRELATION AND DATING OF CALCAREOUS DEEP-SEA CORES ...Carbonates-general, Core Analysis, Radiocative Dating, Sedimentation, Thermoluminescence, ...7.0251
LITHOLOGICAL AND MICROPALEOENTOMOLOGICAL INVESTIGATION OF OCEAN SEDIMENT CORES ...Core Analysis, Paleoclimatology, Quaternary Period, Sedimentary History, Tertiary Period, ...7.0257
STRATIGRAPHIC STUDY OF RADIOLARIA IN DEEP SEA QUATERNARY SEDIMENTS ...Collections, Core Analysis, Geophysical Relations, Order Radiolaria, Quaternary Period, ...7.0178
STRATIGRAPHY OF UNCONSOLIDATED SEDIMENTS ON THE CONTINENTAL SHELFS OF THE CHUKCHI AND NORTHERN BERING SEAS ...Bering Sea, Chuckchi Sea, Continental Shelf, Core Analysis, Oceanic Fronts, Sedimentary History, ...7.0286
GEOLLOGIC HISTORY OF BERMUDA AND ITS RELATIONSHIP TO THE WORLD PLEISTOCENE ...Bermuda, Development, Local Stratigraphy, Quaternary Period, Sea Level Changes, ...7.0155
GEOCHEMISTRY OF MID-ATLANTIC RIDGE SEDIMENTS ...Atlantic Ocean-general, Chemistry, Core Analysis, Paleoecology-general, Ridges, ...7.0071
PALEONTOLOGY OF LATE CENOZOIC ANTARCTIC RADIOLARIA AND DIATOMS ...Antarctic Ocean, Antarctic, Clasts Algae, Ocean Basins, Order Radiolaria, Paleomagnetism, Paleontology, Rate of Deposition, ...7.0185
PLEISTOCENE OCEANOGRAPHY AS RECORDED IN DEEP SEA SEDIMENT CORES ...Core Analysis, Geographical Relations, Palaeoclimatology, Palaeotemperature, Quaternary Period, ...7.0165
STRATIGRAPHY AND PALEOECOLOGY OF FOSSIL SILICOFLAGELLATES FROM ANTARCTIC DEEP-SEA CORES ...Antarctic Ocean, Core Analysis, Field Reversals, Fossil Zones, Palaeoclimatology, Palaeotemperature, Phyth Protozoa, ...7.0169
TAXONOMY AND STRATIGRAPHY OF CALCAREOUS NANNOPLANKTON IN MARINE SEDIMENT SEQUENCES ...Biogenous, Classification - Taxonomy, Fossil Limestone, Microfossils, Order Foraminifera, Paleontology, ...7.0168
CORRELATION OF SUBMARINE VOLCANIC ASH BY CEPHALOCARINA, LUMINESCENCE ...Correlation, Geochronology-general, Luminiscence, Quaternary Period, ...7.0182
BIOSGEOGRAPHY OF MID-ATLANTIC RIDGE SEDIMENTS ...Biogenesis, Biogenous, Ocean History, Order Foraminifera, Ridges, ...7.0209
ACOUSTIC PROPERTIES OF SEDIMENTS ...Acoustical, Physical Properties, Seismic Studies, Subbottom, Texture, ...7.0108

Facies
RECENT MARINE AND NONMARINE SEDIMENTS AND MICROFAUNA OF DELAWARE COASTAL AREAS ...Bays, Delaware, Paleoecosystems, Quaternary Period, Sedimentary Structure-general, Shoreline - Coastline, ...7.0207

Intercontinental Stratigraphy
STRATIGRAPHIC AND TAXONOMIC-PHYLOGENETIC STUDIES ON PLANKTONIC FORAMINIFERA ...Core Analysis, Cretaceous Period, Order Foraminifera, Structure-general, Tertiary Period, ...7.0182

Lithology
DEEP OCEAN AS RECIPIENT OF VOLATILES AND SOLUTES ...Hydrothermal Minerals, Igneous Activity - Volcanism, Pacific Ocean-east, Ridges, Sea Floor Spreading, Thermal Features, Water Analysis-general, ...7.0095

Local Stratigraphy
GEOLLOGIC HISTORY OF BERMUDA AND ITS RELATIONSHIP TO THE WORLD PLEISTOCENE ...Bermuda, Correlation, Development, Quaternary Period, Sea Level Changes, ...7.0155
THE SEDIMENTARY AND DIAGENETIC RECORD OF ENVIRONMENTAL PARAMETERS IN RECENT BAHAMIAN
Streams

SUBJECT INDEX

Strontium
ISOJOPIC AND TRACE ELEMENT STUDIES IN OCEANIC VOLCANIC ROCKS ...Igneous Rocks, Lead, Magma, Magmas, Petrology, Rare Earth Studies, Trace Element Analysis, Volcanic ...7.0075
STRONTIUM ISOTOPE COMPOSITION AND TRACE ELEMENT CONCENTRATIONS IN LAKE HURON AND ITS PRINCIPAL TRIBUTARIES ...Chemical, Ions and Gases, Lake Huron, Rocks - Bedrock, Trace Element Analysis, ...1.0124

Radiostrontium deposition over the Ocean ...Circulation-general, Nuclear Explosions - Fallout, Precipitation-general, Radioactive Dating, Radioactivity ...6.0165

Radionuclides Aerossal scavenging by ocean spray ...Aerosols, Nuclear Explosions - Fallout, Radioactivity-general, Washout, Waves ...6.0164

Structural Geology

Fault Complexes
STUDY OF RELATIONSHIP BETWEEN EARTHQUAKES AND TECTONIC MOVEMENTS IN ALASKAN FAULT ZONE ...Alaska, Crustal Fracturing, Deformation, Earthquakes, Forecasting-prediction ...7.0139

Morfology

Tectonic Classes

Crust
MARINE SEISMOLOGY ...Distribution, Earth Interior, Seismic Reflection, Seismicity, Structure ...7.0131

Arctic basin heat flow ...Arctic, Coring and Drilling, Geothermal Gradient, Heat Flows, Physical Properties ...7.0185

Pacific Gravity ...Anomalies, Earth Interior, Geophysical Equipment, Gravity Studies, Pacific Ocean-north ...7.0144

Forest
SUBJECT INDEX

MARINE GEOLOGY AND GEOPHYSICS ...Continental Shelf, Geophysics-general, Ocean Basins, Sedimentation, Textures-structures, ...7.0048
MARINE GEOPHYSICS ...Field Characteristics-general, Gravity Studies, Gulf of Mexico, Physical Properties, Seismic Studies, ...7.0149
INDUCTION IN THE OCEAN ...Currents-ocean, Earth Interior, Fluctuations, Induction, Oceanic Fronts, ...7.0137
ANALYSES OF ROCKS COLLECTED IN THE INDIAN AND ATLANTIC OCEANS ...Atlantic Ocean-general, Indian Ocean-general, Ocean Basins, Petrology, Structural Studies, ...7.0073
ATLANTIC OCEAN CRUSTAL STUDIES ...Atlantic Ocean-general, Bathymetry, Coring and Dredging, Heat Flow Measurements, Seismic Reflection, ...7.0116
GEOPHYSICAL INVESTIGATIONS IN THE CORAL SEA ...Buoys, Coral Sea, Regional Structure, Seismic Refraction, Structural Studies, ...7.0130
GEODETICAL AND GEOFYSICAL INVESTIGATION OF THE BAHAMA BANK ...Banks, Bathymetry, British West Indies, Magnetic Studies, Seismic Studies, ...7.0010
(U) OCEANIC CRUSTAL AND MANTLE STRUCTURE - ITS ORIGIN AND EFFECT ON EXTERNAL FIELDS ...Anti-submarine-warfare, Earth Interior, Earth Magnetism, Ocean Basins, Origin, ...7.0145
MARINE GEOPHYSICAL STUDIES IN THE PACIFIC OCEAN ...Gravity Studies, Magnetic Studies, Ocean Basins, Seismic Studies, Solomon Islands, ...7.0113
OCEAN-SEDIMENTS AND CRUSTAL STRUCTURES IN THE BAHAMIAN-CARIBBEAN AREA ...Caribbean Sea, Continental Slope, Ocean Basins, Soil Properties - Other, Textures-structures, ...7.0109
SUBSURFACE RESISTIVITY ...Earth-telluric Current, Magnetic Surveys, Ocean Basins, Resistance, Texas, ...7.0147
ROCKS OF OCEANIC CRUST AND UPPER MANTLE EQUATORIAL ATLANTIC ...Atlantic Ocean-general, Earth Interior, Ocean Basins, Petrogenesis-general, Petrology, Stability Fields, ...7.0105
ROCKS OF THE OCEANIC CRUST ...Basins, Ocean Basins, Petrology, ...7.0061
Earth Interior
MARINE SEISMOLOGY ...Crust, Distribution, Seismic Reflection, Seismic Refraction, Textures-structures, ...7.0131
PACIFIC GRAVITY ...Anomalies, Crust, Geophysical Equipment, Gravity Studies, Pacific Ocean-north, ...7.0144
INDUCTION IN THE OCEAN ...Crust, Currents-ocean, Fluctuations, Induction, Oceanic Fronts, ...7.1017
MOHOLE SITE STUDIES ...Coring and Dredging, Hawaii, Pacific Ocean-north, Seismic Studies, Structure Location, ...7.0107
GEOTHERMAL STUDIES IN DEEP-SEA DRILL HOLES ...Abysal, Bathyal, Borehole Geophysics, Core Temperature, Geothermal, Heat Flow Measurements, Heat Flows, Sediments-general, Technique Development, ...7.0122
(U) OCEANIC CRUSTAL AND MANTLE STRUCTURE - ITS ORIGIN AND EFFECT ON EXTERNAL FIELDS ...Anti-submarine-warfare, Crust, Earth Magnetism, Ocean Basins, Origin, ...7.0145
UPPER MANTLE OF OCEAN REGIONS ...Extrusives, High Pressure Research, High Temperature Research, Lava, Petrology, Ridges, ...7.0145
GRAVITY AND EARTH TIDES ...Antarctica, Earth Tides, General Gravimeters, Propagation, Tides, ...7.0077
ROCKS OF OCEANIC CRUST AND UPPER MANTLE EQUATORIAL ATLANTIC ...Atlantic Ocean-general, Crust, Ocean Basins, Petrogenesis-general, Petrology, Stability Fields, ...7.0105
Geosynclines
Sediment Structure ...Coral Sea, Distribution, Sediment Transport-general, Shelf Areas, Textures-structures, ...7.0048
Island-arcs
DEEP EARTHQUAKES AND ISLAND-ARC TECTONICS AND STRUCTURE ...American Samos, Attenuation, Earthquake Location, Earthquakes, Seismic Studies, Velocity Variations, ...7.0146
Ocean Basins
STUDY OF EARTH NOISE ON LAND AND SEA BOTTOM ...Microseisms - Background, Propagation, Seismic Studies, Structural Studies, ...7.0049

Structural Geology
MARINE GEOLOGY AND GEOPHYSICS ...Continental Shelf, Crust, Geophysics-general, Sedimentation, Textures-structures, ...7.0048
GEOPHYSICAL INVESTIGATIONS OF THE SOUTHWESTERN MARGIN OF JAPAN ...Distribution, Japan, Regional Structure, Ships and Cruises, Trenches, ...7.0049
ANALYSES OF ROCKS COLLECTED IN THE INDIAN AND ATLANTIC OCEANS ...Atlantic Ocean-general, Crust, Indian Ocean-general, Petrology, Structural Studies, ...7.0073
INDIAN OCEAN DATA REDUCTION ...Bathymetry, Data Analysis - General, Geophysics-general, Indian Ocean-general, Sedimentology-general, ...7.0034
(U) OCEANIC CRUSTAL AND MANTLE STRUCTURE - ITS ORIGIN AND EFFECT ON EXTERNAL FIELDS ...Anti-submarine-warfare, Crust, Earth Interior, Earth Magnetism, Origin, ...7.0145
MARINE GEOPHYSICAL STUDIES IN THE PACIFIC OCEAN ...Crust, Gravity Studies, Magnetic Studies, Seismic Studies, Solomon Islands, ...7.0113
OCEAN-SEDIMENTS AND CRUSTAL STRUCTURES IN THE BAHAMIAN-CARIBBEAN AREA ...Caribbean Sea, Continental Slope, Crust, Soil Properties - Other, Textures-structures, ...7.0109
SUBSURFACE RESISTIVITY ...Crust, Earth-telluric Current, Magnetic Surveys, Resistance, Texas, ...7.0147
GEOPHYSICS. GULF OF MEXICO ...Gulf of Mexico, Regional Structure, Seismic Studies, Structural Studies, Trenches, ...7.0148
ROCKS OF THE OCEANIC CRUST ...Basins, Petrology, ...7.0061
Shelf Areas
SEDIMENT STRUCTURE ...Coral Sea, Distribution, Geosynclines, Sediment Transport-general, Textures-structures, ...7.0034
Volcanoes
BIOLOGICAL RESEARCH ON THE VOLCANIC ISLAND SURTSEY AND ENVIRON ...Iceland, Migration, ...5.0089
BIOLOGICAL COLONIZATION OF A RECENTLY FORMED ISLAND ...Habitat Studies, Iceland, Islands, Productivity - Food Chain, Succession, ...5.0092
ECOLOGICAL SUCCESION ON SURTSEY ...Fouling, Iceland, Plant Succession, Succession, ...5.0099
ALPINE LIMNOLOGY PROJECT ...Core Analysis, Dust - Particulate Matter, Extrusives, Hawaii, Lakes, Mountains-alpine, ...7.0336
Tectonics
Continental Drift
STRUCTURE OF CONTINENTAL RISE OFF EASTERN NORTH AMERICA ...Continental Slopes, Eastern Sedimentary History, Sedimentation, ...7.0117
DETECTION OF DEEP-SEATED ANOMALIES IN ELECTRICAL CONDUCTIVITY UNDER THE GULF OF CALIFORNIA ...Anomalies, Conductivity, Gulf of California, Heat Flows, Rift, ...7.0099
Deformation
STUDY OF RELATIONSHIP BETWEEN EARTHQUAKES AND TECTONIC MOVEMENTS IN ALASKAN FAULT ZONE ...Alaska, Crustal Fracturing, Earthquakes, Fault Complexity, Forecasting-prediction, ...7.0139
Gravity Tectonics
SEDIMENTATION ...Acoustical, Gulf of Mexico, Mass Wasting, Mechanical Properties, Sedimentation, ...7.0128
Igneous Activity - Volcanism
AZORES VOLCANIC STUDY ...Atlantic Ocean-general, Azores, Element Ratios, Ridges, Volcanic-...7.0119
DEEP OCEAN AS RECIPIENT OF VOLATILES AND SOLUTES ...Hydrothermal Minerals, Lithology, Pacific Ocean-north, Ridges, Sea Floor Spreading, Thermal Features, Water Analysis-general, ...7.0095
GEOPHYSICAL AND GEOCHEMICAL STUDY OF RED SEA MINERAL DEPOSITS ...Coring and Dredging, Gulf of Aden, Mineralogy, Red Sea, Thermal, ...7.0023
WESTERN PACIFIC ISLANDS ...Hawaii, Lava, Mapping, Petrology, Sea Level Changes, ...7.0104
Seafloor Spreading
MARINE GEOLOGY ...Acoisitcal, Bathymetry, Geomorphology-topography, Magnetic Studies, Mapping, ...7.0041

677
SUBJECT INDEX

Structural Geology

MAGNETICS...Anomalies, Atlantic Ocean-north, Pacific Ocean-
generally, Ridge, Trenches, ...7.0135

MARINE SEDIMENTS...Atlantic Ocean-south, Bathymetry, Magnetic
Studies, Ridges, Textures-surfaces, ...7.0203

HEAT FLOW AND MAGNETICS IN THE PHILIPPINE SEA...

ARCS, Heat Flow Measurements, Magnetic Studies, Philippine
Sea, Trenches, ...7.0137

SEDIMENTATION, MORPHOLOGY, AND STRUCTURE-MID-
ATLANTIC RIDGE...Atlantic Ocean-general, Distribution, Ocean
History, Provenance Studies-other, Ridges, ...7.0047

OPERATION OF R/V TRIDENT...Geomorphology-topography, Phytoplankton, Ships and Cruises, Sound Production, Subbot-
tural, Vertical Distribution, ...12.0045

POTASSIUM/ARGON DATING OF DEEP-SEA SAMPLES...

Abyssal, Argon-potassium, Geologic Age Relations, Microfoss-
sils, Radiocarbon, Tertiary Period, ...7.0066

GEOPHYSICAL STUDIES FROM ELTANIN IN 1968...Antarct-
ic Ocean, Gravity Surveys, Paleomagnetism, Seismic Reflections,
Structures-surfaces, ...7.0133

DEEP OCEAN AS RECIPIENT OF VOLATILES AND
SOLUTES...Hydrothermal Minerals, Igneous Activity - Volcan-
ism, Lithology, Pacific Ocean-est, Ridges, Thermal Features,
Water Analysis-general, ...7.0075

GEOMAGNETIC INVESTIGATIONS...Anomalies, Gravity Stud-
es, Magnetometers, Ridges, Structural Studies, ...7.0120

Tectogenesis

GEODETIC SURVEY OF MARTABAN CANYON, NORTHEASTERN INDIAN OCEAN...Andaman Sea, River Delta, Sedimentary History, Submarine Canyons, Valleys, ...7.0039

A STUDY OF THE STRUCTURAL RELATIONS BETWEEN THE MID-PACIFIC OCEANIC RIDGES AND FRACTURE ZONES...Anomalies, Ocean History, Polynesia, Ridges, Structural Studies, ...7.0111

MARINE GEOLOGY OF THE SAN FRANCISCO BAY...Bays, Geology-general, Gold, Mechanical Properties, San Francisco Bay, Structural Studies, ...7.0035

Tectonics-general

TECTONIC AND GEOLOGICAL HISTORY OF THE SOUTHWEST PACIFIC REGION...Gases, Geophysics-general, Island Arcs, Oceans - Sea Water, Pacific Ocean-south, Structural Studies, ...7.0111

DEEP-SEA SEDIMENTS AND VOLCANIC ROCKS OF MID-
OCEAN RIDGES...Mineralogy, Origin, Ridges, Seamounts-
guyots, Structural Studies, ...7.0132

SEDIMENTARY STRUCTURE...General Deposition, Other, Sediment Transport-general, Textures-surfaces, ...7.0208

RESTORATION AND REHABILITATION OF EARTHQUAKE DAMAGED PINK AND CHUM SALMON STUDIES IN PRINCE WILLIAM SOUND...Alaska, Earthquakes, Flow Characteristics -water, Salmon -coho,chinooksockeye..., Spawning & Nesting Sites, Stream Rehabilitation, ...5.0111

MARINE GEOLOGY STUDIES, GULF OF MEXICO-CARIB-
BEAN REGION...Dimensions-distribution, Distribution, Geolo-
gy-general, Gulf of Mexico, Ocean Mining, ...7.0103

SEWARD PENINSULA NEARSHORE...Bering Sea, Heavy Minerals, Potential of Deposit, Sea Level Changes, Submerged, ...7.0017

Structural Mechanics

Analysis Structural

STRESSES DEVELOPED ON THE SURFACE OF CYLINDRI-
CAL JOINTS SUBJECTED TO MULTIPLE LOADS...Geometric Configuration, Joints, Moments, Stress Concentra-
tion, Stresses, ...8.0304

Concrete

Pre-stressed

CORROSION MITIGATION...Corrosion Prevention-other, Deep,
Fouling, Low Alloy Steels, Water, ...8.0205

Joints

STRESSES DEVELOPED ON THE SURFACE OF CYLINDRI-
CAL JOINTS SUBJECTED TO MULTIPLE LOADS...Analysis
Structural, Geometric Configuration, Moments, Stress Concentra-
tion, Stresses, ...8.0304

Plates and Shells

Geometric Configuration

AN ANALYSIS OF THE RESPONSE OF CYLINDRICAL
DUCTS TO INTERNAL, ZERO MEAN FLOW, AIR-CAR-
RIED ACOUSTIC EXCITATION...Acoustic Field, Close
Channel, Response, ...8.0181

STRESSES DEVELOPED ON THE SURFACE OF CYLINDRI-
CAL JOINTS SUBJECTED TO MULTIPLE LOADS...Analysis
Structural, Joints, Moments, Stress Concentration, Stresses, ...8.0304

Prefabricated

HULL DESIGN - MODULAR DECKHOUSE...Bridge,
Merchant-ships, ...8.0318

Structures

Hydraulic Structures

EXPERIMENTAL AND THEORETICAL RESEARCH ON TUR-
BIDITY CURRENTS...Currents-other, Laboratory Analysis,
Sedimentation, ...7.0243

Hydrodynamic Structures

SHIP STRUCTURE LABORATORY TESTING AND ANALYSES...Bulkheads, Experiments and Tests, Hull, Models, ...8.0251

STRUCTURAL DESIGN CRITERIA...Flaw Detection - Otter,
Hull, Process Control, Safety, Stress Concentration-toughness,
...8.0283

WAVE UPLIFT FORCES ON HORIZONTAL PLATFORMS...
Platforms, Wave Action, Waves, ...8.0266

A STUDY OF THE INTERFACE LOCATIONS BETWEEN DIS-
SIMILAR MATERIALS AND OTHER ASPECTS OF A COM-
POSITE MIDSHIP SECTION...Bulkheads, Hull, Strength, ...8.0294

DESIGN AND CONSTRUCTION...Coatings-general, Environ-
mental Effects-geologic, Safety, Underwater-construction,
Water, ...8.0333

WAVE ACTION ON STRUCTURES...Engineering Structures-
general, Models, Shoreline Structures, Stability, Wave Action,
Waves, ...8.0175

Testing Structural

FULL Scale STRESS MEASUREMENT TESTS OF GREAT
LAKES ORE CARRIER...Great Lakes-general, Hull, Other-
design-and-construction, Waves, ...8.0320

Submersibles

ERROR ANALYSIS OF SEVERAL BOTTOM REFERENCED NAVIGATION SYSTEMS FOR SMALL SUBMERSIBLES...Error Analysis, Navigation, Operational Aspects, Sonar, Submarine Environments, Systems Analysis, ...4.0111

DEVELOPMENT OF A SENSOR, INSTRUMENTATION AND COMMUNICATION SYSTEM FOR A DEEP OCEAN MANNED HABITAT (ATLANTIS)...Continental Shelf, Navigation Communication, Ridges, Safety, Underwater-labora-
tory, ...8.0107

INVESTIGATE METHODOLOGY FOR MEASURING OCEANIC PROPERTIES LEADING TO THE TOTAL EN-
VIRONMENTAL SURVEY OF A SELECTED OCEAN AREA...
...Coring and Dredging, Oceanic - Pelagic, Physical Properties,
Radioactivity, Technique Development, ...8.0244

DEEP SUBMERSION VEHICLES - DYNAMIC ANALYSES...
...Data Acquisition, Experiments and Tests, Mathematical Anal-
ysis, Model Studies, Technique Development, Underwater-
laboratory, ...8.0264

SEA BED INSTALLATION...Benthonic-bottom, Deep, Diving and Scuba, Stabilization, Underwater-construction, ...8.0331

MAN IN THE SEA - VISUAL ACUTY RESEARCH...Acuity,
Divers, Diving and Scuba, Experiments and Tests, Optical, ...8.0089

PASSIVE BUOYANCY SYSTEMS...Buoyant, Flotation, En-
geineering Studies-general, Foam, Porous, Materials Used Un-
dersea, Other-design-and-construction, ...8.0263

RESEARCH SUBMARINE BEAVER MK IV...Control Systems,
Diving and Scuba, Scientific-service-support, Technique
Development, Underwater-laboratory, ...8.0265
### SUBJECT INDEX


**TRANSDUCER RESEARCH** Packaging, Sealant, Transducers, \(\ldots\)0.0005

**THE EVALUATION AND USE OF SUBMERGED RESEARCH VESSELS IN STUDYING CONTINENTAL SHELF ENVIRONMENTS** Continental Shelf, Experiments and Tests, Operational Aspect, Submerged Ships, \(\ldots\)4.0128

**DEEP-SEA AUTONOMOUS VEHICLES, INSTRUMENTS, BASIC CONTROL DEVICES, AND SPECIAL COLLECTING GEAR** Abysal, Bottom Sampling Device, Organism Sampling Devices, Photography, Sampling, Water Motion Recorders, \(\ldots\)8.0112

**ENVIRONMENTAL PHYSIOLOGY** Diving and Scuba, Life-support-system, Medical Studies, Pressure, Underwater-laboratory, \(\ldots\)6.0093

**DEVELOPMENT OF A PHOTOGRAPHIC SUIT FOR STEREOPHOTOMGRAMMETRIC MAPPING BY SUBMERSIBLE** Mapping, Navigation, Photography, Sonar, Turkey, \(\ldots\)4.0060

**EXPERIMENTAL HYDRODYNAMICS** Fluid Dynamics, Heat and Radiation Transfer, Hydromechanics, Simulation Theory, Thermocline, \(\ldots\)8.0192

**SATURATED DIVING FACILITIES FOR DIVER-SCIENTIST AND RELATED RESEARCH** Controls, Data Acquisition, Marine Environments-general, Model Studies, Underwater-construction, Underwater-laboratory, \(\ldots\)8.0311

**OCEAN DYNAMICS EXPERIMENTS** Buoy, Moorings, Other-design-and-construction, Technique Development, Temperature, Water Motion Recorders, \(\ldots\)6.0072

**ARCTIC SUB-ICE STUDY** Acoustical, Arctic Ocean, Marine Biology, Sea Ice, \(\ldots\)3.0074

**RESPIRATORY EXCHANGE IN FISH GILLS** Fish, Gases, \(\ldots\)5.0307

**OCEANOGRAPHIC RESEARCH** Acoustical, Forecasting-prediction, Temperature, \(\ldots\)1.0161

**HANDBOOK OF MARINE TECHNOLOGY** Engineering Studies-general, General Sea Water Chemistry, Geology-general, Handbooks, Marine Biology, Meteorological Studies, \(\ldots\)11.0014

**DEEP SEA SUBMERSIBLES** Control-systems, Hull, Life-support-system, Marine Propulsion, Moorings, \(\ldots\)8.0292

**DEEP OCEAN RESEARCH AND DEEP OCEAN ENGINEERING** Abysal, Engineering Studies-general, Geophysic-general, Marine Biology, Structural Studies, Temperature-structures, \(\ldots\)4.0121

**DEEP SUBMERGENCE OBSERVATIONAL OXYGEN TRANSDUCER** Gases, Instrumental Services, Oxygen, Transducers, \(\ldots\)8.0057

**STEP RESPONSE METHOD FOR DETERMINING HORIZONTAL COEFFICIENT FOR DEEP SUBMERSIBLES** Models, Submerged Ships, \(\ldots\)8.0293

**A DUAL MODE ROLE STABILIZATION SYSTEM** Applications, Control-systems, Development of Models, Models, Ship Resistance Stability, \(\ldots\)8.0302

**STRENGTH OF GLASS** Glass, Strength, Cohesion, Stress Rupture, \(\ldots\)8.0206

**HELMET - HEAT TRANSFER** Air, Diving and Scuba, Heat Transfer, Helmet, Temperature Effects, \(\ldots\)8.0201

**MECHANICAL PROPERTIES** Environmental General, Liquid, Mechanical Properties, Special Mission Ships, Test Methods, \(\ldots\)8.0210

**BIOLOGICAL OCEANOGRAPHY** Acoustical, Atlantic Ocean, Marine Biology, Sound Production, \(\ldots\)1.0022

**BIOLOGICAL OCEANOGRAPHY AND DETERIORATION, DEEP OCEAN-HIGH PRESSURE BACTERIA** Biological, Biology, Chemistry, Identification, Microorganisms (non-specific), \(\ldots\)8.0236

**ELECTROMAGNETIC NOISE MEASUREMENTS IN THE SEA** Benthonic-bottom, Depth, Electromagnetic, Surface Environments, \(\ldots\)1.0138

**DEEP OCEAN ACOUSTIC RESEARCH** Abysal, Acoustical, Pressure, Textures-structures, Transmission, Velocity, \(\ldots\)1.0010

**DEEP OCEAN SYSTEMS** Diving and Scuba, Diving-system, Underwater-construction, \(\ldots\)8.0359

**STRUCTURAL TITANIUM ALLOYS** -100 KSI YIELD STRENGTH Materials Used Undersea, Strength, Weight Ratio, Stress Concentration-toughness, Titanium, \(\ldots\)8.0219

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**Sulfate, Sulfite**

**SUPPORTING TECHNOLOGY AT NAVAL RESEARCH LABORATORY** Abysal, Fouling, Microorganisms (non-specific), Organics, \(\ldots\)8.0217

**DIELECTRIC MATERIALS** Dielectric Materials, Organometallic, Thermal Properties, \(\ldots\)8.0215

**DEEP RECOVERY SYSTEM** Navigation Communication, Operational Aspect, Other-design-and-construction, Recovery Vehicle, \(\ldots\)8.0267

**PROPULSION FOR SWIMMER VEHICLES** Closed-cycle, Diving and Scuba, Marine Propulsion, \(\ldots\)8.0119

**HYDROGEN-OXYGEN FUEL CELLS** Encapsulation, Fuel Cell-other, Gas Generator, Oxidants, Safety, \(\ldots\)8.0160

**ADVANCED DEEP OCEAN TECHNOLOGY** Engineering Studies-general, Life-support-system, Marine Propulsion, \(\ldots\)8.0282

**ANCHORS AND MOORINGS** Moorings, Technique Development, Underwater-construction, \(\ldots\)8.0334

**TEKTITE I** Diving and Scuba, Geologic Maps, Geology-general, Mapping, \(\ldots\)4.0054

**EXPLORE FISHERY AND RESEARCH APPLICATIONS OF SUBMARINES** Naval Architecture-general, Other-design-and-construction, Submerged Ships, \(\ldots\)8.0206

**SEALAB III PARTICIPATION** Behavior, Ecological, Ecolosize, Divers, Diving and Scuba, Medical Studies, \(\ldots\)6.0091

### Subsurface Environments

**ERROR ANALYSIS OF SEVERAL BOTTOM REFERENCED NAVIGATION SYSTEMS FOR SMALL SUBMISIBLES** Error Analysis, Navigation, Operational Aspect, Sonar, Submisible Systems, Systems Analysis, \(\ldots\)4.0111

**UNDERWATER WELDING** Helium, Inert Gas, Materials Used, Undersea, Safety, Scientific-service-support, \(\ldots\)8.0044

**LIFE SUPPORT RESEARCH** Divers, Diving and Scuba, Medical Studies, Technique Development, \(\ldots\)8.0072

**OCEAN WAVES AND TIDES** Currents-ocean, Thermal, Tides, Water Motion Recorders, Waves, \(\ldots\)2.0086

**LONG RANGE SOFAR FLOATS** Acoustical, Currents-ocean, Physical Analysis, Water Motion, Water Motion Recorders, \(\ldots\)2.0063

**OPTICAL MEASUREMENTS** Benthonic-bottom, Currents-ocean, Optical, Photography, \(\ldots\)1.0170

**CIRCULATION OF THE PACIFIC** Circulation-general, Density, Oceanic Fronts, Pacific Ocean-general, Sampling, \(\ldots\)2.0007

**STUDY OF OCEANIC TURBULENCE** Energy, Hydrodynamics, Mixing, Turbulence - Sea Water, Water Motion, \(\ldots\)2.0085

**CURRENTS AND WATER MASSES IN THE SOUTHWEST ATLANTIC** Circulation-general, Currents-ocean, Oceanic Fronts, \(\ldots\)2.0041

**VERTICAL OCEAN CIRCULATION** Circulation-general, Connection, Model Studies, Oceanic Fronts, \(\ldots\)2.0036

**SHALLOW WATER OCEANOGRAPHY** Continental Shelf, Environmental Effects-geologic, Forecasting-prediction, Pressure, Waves, \(\ldots\)1.0172

**MONITORING SURVEY AND TIME-SERIES ANALYSIS OF SUBSURFACE TEMPERATURE IN THE NORTH PACIFIC OCEAN** Pacific Ocean-north, Temperature, Thermocline, Water Temperature-not-specific, \(\ldots\)1.0176

### Sulfate, Sulfite

**EFFECT OF PRESSURE ON CONDUCTIVITY OF SOLUTIONS** Acoustical, Conductivity, Density, Electrical, Electrolytes, Pressure, Viscosity, \(\ldots\)1.0076

**EFFECT OF PRESSURE ON CONDUCTIVITY OF SOLUTIONS** Conductivity, Electrolytes, Pressure, Solution, Ultrasonic Spectroscopy, \(\ldots\)1.0079

**RESEARCH ON THE PHYSICAL CHEMISTRY OF CHEMICAL REACTIONS IN SEA WATER** Acids, Apatite-general, Carbonate, Bicarbonate, Chemical Reactions, Equilibrium Chemical, High Pressure Research, Reaction-general, Solubility, \(\ldots\)1.0127

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679
SUBJECT INDEX

Tape Recording, Audio

BIOCHEMICAL EFFECTS OF MICROORGANISMS UPON THE SALT MARSH ENVIRONMENT - Identification, Marine Bacteria, Microbiological Analysis, Salinity, Temperature - 5.0762

BIOCHEMICAL EFFECTS OF MICROORGANISMS UPON THE SALT MARSH ENVIRONMENT - Aqueous Soils, Core Analysis, Identification, Marine Bacteria, Salinity, Temperature, Water Level Fluctuation - 5.0763

PRODUCTIVITY STUDIES IN NORTH CAROLINA SALT MARSHES - Aerial Photography, Mapping, North Carolina, Primary Productivity, Productivity - Food Chain, Tidewater Areas - 5.1017

FACTOR EFFECTING RATES OF ORGANIC DEPOSITION AND QUALITY OF WATER - Clays, Lake Ontario, Organic Digestion, Organic Matter, Rate of D-position, 7.0261

ECOLOGY OF MARSH FORAMINIFERA - Foraminifera, Lagoons, Productivity - Food Chain, Rate of Deposition - 5.0747

TIDE MARSH ECOLOGY AND WILDLIFE - Management, Microorganisms (non-specific), Nitrogen Cycle, Nutrients, Phosphorus, Primary Productivity, 5.0870

PALEOSALINITY DETERMINATION BY THE BORON IN IL-LITE METHOD - Boron, Illinois, Illite, Intertidal - Connate Water, Salinity - 7.0238

EFFECTS OF MARSH MANAGEMENT STRUCTURES UPON FISHES - Alewife, menhaden, shad, herring, Crabs, Engineering Structures-general, Land Use, Shrimps - Common, Spawning & Nesting Sites - 8.0266

EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS - Bioassay, Estuaries, Persistence of Residues, Pollution - Effects of, Sevin, 5.0918

REMOTE SENSING, EVERGLADES AREA, FLORIDA - Computer Applications, Florida, Remote Areas, Visible Light, Water Properties-general, 4.0161

EVALUATION OF ENGINEERING PROJECTS AND ESTUARINE DATA (ESTUARINE PROGRAM) - Commercial Fishing, Engineering Structures-general, Estuaries, Gulf of Mexico, Habitat Studies, 9.0021

Synthetic Hydrology

DYNAMIC MODEL STUDY OF LAKE ERIE - Hydraulics-general, Inflow, Lake Erie, Model Studies, 4.0075

POLLUTION STUDY OF THE VENICE DISTRICT CANAL - California, Canals, Model Studies, Water Quality-general, 6.0141

EFFECTS OF SCALE AND OPERATING TECHNIQUE ON HARBOR MODELS - Harbors, 4.0074

GENERAL COASTAL INLET STUDIES - Coastal Engineering-other, Contour-line shorelines, Discharge, Model Studies, Tides, Water Motion, 7.0125

DISPERSION PROCESSES IN ESTUARIES AND RIVERS - Dispersion-water, Dyes, Estuaries, Streams, 2.0050

Systems Analysis

SYSTEMS ANALYSIS ASSISTANCE TO HEADQUATERS U. S. COAST GUARD - Benefic-cost Analysis, Model Studies, Sea Ice, Ships and Cruisers, 12.0015


FATE OF INLAND DERIVED POLLUTANTS IN AN ESTUAR - Estuaries, Pollutants - Path of, Pollution - Effects of, Pollution Abatement, Pollution Sources-general, 6.0135

Tank, Pressure Vessel

CONSTRUCTION OF A FACILITY TO DEMONSTRATE THE OFF-SHORE UNDERWATER TEMPORARY STORAGE OF OIL - Storage, Tides, Offshore, 9.0017

ACOUSTIC RECORDING OF MARINE MAMMALS OF NOVA SCOTIA AND NEWFOUNDLAND - Atlantic Ocean-north, Canada, Mammals, Seals, Sound Production, 5.0625

Maps

Compilation

ANALYSIS AND DISPLAY OF HYDROGRAPHIC DATA - Charts, Hydrographic, Reproduction, 4.0022

Photogrammetry

HIGH FREQUENCY OCEAN WAVES - Aircraft, Forecasting-prediction, Radar, Waves, Water-wave Interaction, 7.0211

A RECONNAISSANCE OF COASTAL EROSION IN NORTH CAROLINA - Aerial Photography, Beach, Development, Erosional Features, North Carolina, Reconnaissance, Shoreline - Coastline, Waves - 7.0268

Reproduction

ANALYSIS AND DISPLAY OF HYDROGRAPHIC DATA - Charts, Compilation, Hydrographic, 4.0022

HYDROGRAPHIC SURVEY TECHNIQUES - Bathymetry, Hydrographic, Technique Development, 8.0089

Measurements

Instrumentation

SPACECRAFT OCEANOGRAPHY - Instrumentation-general, Management, Photography, Satellites, Unmanned Satellite, 4.0057

NAVIGATION SYSTEMS FOR SURVEY APPLICATIONS - Area, Navigation, Technique Development, 4.0101

Methods

Aerospatial

MARINE PHYSICAL GEODESY - Caribbean Sea, Gravity Studies, Navigation, Sea Level Variations, Standard Geoid, 4.0058

GREAT LAKES RESEARCH - ICE COVER DISTRIBUTION - Aerial Photography, Alteration, Great Lakes-general, Petrofabrics, Sea Ice, 3.0063

Survey Types

Hydrographic

DEEP CONTROLLED STREAMER DEVELOPMENT - Control-systems, Depth, Equipment, Sonar, 8.0139

AN IMPROVED MARINE VIBROSEIS INSTALLATION - Data Acquisition, Sonar, Special Mission Ships, 8.0166

ANALYSIS AND DISPLAY OF HYDROGRAPHIC DATA - Charts, Compilation, Reproduction, 4.0022

HYDROGRAPHIC SURVEY TECHNIQUES - Bathymetry, Reproduction, Technique Development, 8.0089

Reconnaissance

A RECONNAISSANCE OF COASTAL EROSION IN NORTH CAROLINA - Aerial Photography, Beach, Development, Erosional Features, North Carolina, Photogrammetry, Shoreline - Coastline, Waves, 7.0268

Suspension-release

WATER-TO-AIR RETRIEVAL - Aircraft, Mathematical Models, Recovery Operations, 8.0276

Swamps-marshes

FIELD EXPERIMENTS ON THE FLUX OF RADIONUCLIDES THROUGH A SALT MARSH ECOSYSTEM - Chlorideae (non-specific & Ot), Georgia, Model Studies, Productivity - Food Chain, Water Cycle, 5.0696

DRAINAGE PATTERN DEVELOPMENT ON TIDAL MARSHES - Aerial Photography, Drainage, Tides, 7.0291

AN ANALYSIS OF PHOSPHORUS AND NITROGEN COMPOUNDS IN TIDAL MARSHLAND DRAINAGE - Laboratory Procedures - Chlorobiology, Computer Applications, Conductometry, Management, Nitrogen, Phosphate, Phosphite, 5.0761

AN ANALYSIS OF PHOSPHORUS AND NITROGEN COMPOUNDS IN TIDAL MARSHLAND DRAINAGE - Management, Nitrate, Nitrite, Phosphate, Phosphite, Tidewater Areas, Water Preparations-general, 5.0953

CALORIC STUDIES OF SPARTINA AND THE MARSH CRAB - Calorimetry, Chlorideae (non-specific & Ot), Crabs, Energy Budgets, 5.0380

681
SUBJECT INDEX

**Terpenes**
FORMATION AND UTILIZATION OF TERPENES, ...Anthozoa, Biosynthesis, Enzyme-substrate, Symbiosis, Zooxanthella, ...8.0097

**Testing Facilities**
ADVANCE SONAR SYSTEMS, ...Data Display, Instrumental Services, Sonar, Sonar and Echo Sounding, Transducers, ...8.0095
INSTRUMENT STUDIES, ...Electronic Components-other, Evaluation Other, Instrumental Services, ...8.0104
ENVIRONMENTAL TEST AND EVALUATION, ...Ultrasonic Technology, ...8.0128

**Texas**
SEA BREEZE INVESTIGATION, ...Data Analysis - General, Energy-general, Gulf of Mexico, Heat and Radiation Transfer, Land-sea Breezes, ...3.0040
SUBSURFACE RESISTIVITY, ...Crust, Earth-illitic Current, Magnetic Surveys, Ocean Basins, Resistance, ...7.0147
A STUDY OF SELECTED CHEMICAL AND BIOLOGICAL CONDITIONS OF THE LOWER TRINITY RIVER AND THE UPPER TRINITY BAY, ...Commercial Fishing, Estuaries, Moss Activities, Pollution - Effects of, Spawning & Nesting Sites, ...5.0926
EFFECTS OF RIVERS ON THE METABOLISM OF TEXAS BAYS, ...Bays, Nutrients, Pollutants-general, Primary Productivity, Streams, Water Quality-general, ...6.0187
STUDY OF LIFE HISTORY AND ECOLOGY OF SERPULIDAE IN TEXAS COASTAL WATERS, ...Gulf of Mexico, Life History Studies, Lugworms, Marine Segmentedworm, ...5.0656
COASTAL PROCESSES - SOUTH TEXAS, ...Depositional Features-other, Distribution, Other Transport Methods, Rate of Deposition, Shoreline - Coastline, ...7.0219

**Theoretical Analysis**
A STUDY OF PROBLEMS RELATED TO WIND-GENERATED WAVES, ...Free Surface Waves, Laminar - Turbulent, Waves, Wind-water Interaction, ...4.0088
DYNAMICAL OCEANOGRAPHY AND GEOPHYSICAL FLUID DYNAMICS, ...Acoustic Effects, Circulation-general, Forced Convection, Thermal, Water Tunnels Tables, ...2.0012
HYDRODYNAMIC EFFECTS OF SUBMERGED BODY, ...Air-sea Boundary-general, Fluid Dynamics, Model Studies, Water Tunnels Tables, ...8.0179

**Thermal Properties**
DIELECTRIC MATERIALS, ...Dielectric Materials, Organometallic, Submersibles, ...8.0215

**Critical**
THE THERMODYNAMIC PROPERTIES OF NITROGEN-OXYGEN MIXTURES, ...Enthalpy, Entropy, Nitrogen, Oxygen, State Equations, Survey Studies, ...6.0025
RESEARCH AND COMPUTATIONS ON THE THERMODYNAMIC PROPERTIES OF AIR AND RELATED GASES, ...Air, Free Energy, Hydrogen, Virial Coefficient, ...3.0014

**Expansion**
PROPERTIES OF SEA WATER, ...Compressibility-gas-liq, Conductivity, Density, Electrical, Physical Analysis, Thermal, ...1.0153
THERMAL PROPERTIES OF SEA WATER AT LOW TEMPERATURE AND HIGH PRESSURE, ...Acoustical, Conduction, Hydrodynamics, Physical Analysis, Thermal, ...1.0177

**Heat Capacity**
SPECIFIC HEAT, ...Density, Liquid Propellant Rock, Oxidizers, Oxygen, State Equations, Thermodynamic Relation, ...8.0174

**Thermal Properties-other**
ELECTROLYTE-NON-ELECTROLYTE INTERACTIONS IN SEA WATER AND RELATED SOLUTIONS, ...Alkali Metals,
Alkaline Earths, Complexes, Electrolytes, Saline Water Systems, Water Analysis-general, ...1.0107

**Thermochemical Heat**
SOLUTION, ...PHYSICOCHEMICAL AND ACOUSTIC PROPERTIES OF SEA WATER, ...Acoustical, Electrical, Saline Water Systems, Thermal, ...1.0157

**Thermodynamic Relation**
OXYGEN PROPERTIES, ...Density, Liquid Propellant Rock, Oxidizers, Oxygen Specific Heat, State Equations, ...8.0174

**Compressibility--gas-liq**
PROPERTIES OF SEA WATER, ...Conductivity, Density, Electrical, Expansion, Physical Analysis, Thermal, ...1.0153

**Entropy**
THE THERMODYNAMIC PROPERTIES OF NITROGEN-OXYGEN MIXTURES, ...Critical, Entropy, Nitrogen, Oxygen, State Equations, Survey Studies, ...8.0025

**Equations**
State Equations, ...THE THERMODYNAMIC PROPERTIES OF NITROGEN-OXYGEN MIXTURES, ...Critical, Entropy, Nitrogen, Oxygen, Survey Studies, ...8.0025
OXYGEN PROPERTIES, ...Density, Liquid Propellant Rock, Oxidizers, Oxygen Specific Heat, Thermodynamic Relation, ...8.0174

**Equilibrium - Chemical**
OCEAN ATMOSPHERE STUDIES WITH STABLE ISOTOPES AND DISSOLVED GASES, ...Air-sea Boundary-general, Gases, Mixing, Oceanic Fronts, Particulate-gas Transfer, Tracers, ...3.0085
PHASE RELATIONS OF THE HYDRATED CARBONATES OF CALCIUM AND MAGNESIUM, ...Carbonate, Bicarbonate, Surface Chemistry, ...3.0085
RESEARCH ON THE PHYSICAL CHEMISTRY OF CHEMICAL REACTIONS IN SEA WATER, ...Acids, Apatite-general, Carbonate, Bicarbonate, Chemical Reactions, High Pressure Reaction, Reaction-general, Solubility, Sulfate, Sulfite, ...1.0127
SOLUTION SILICATE REACTIONS AND EQUILIBRIA, ...Chemical Reactions, Chemistry, Groundwater, Reaction-general, Silicate-general, Solution, Solution Chemistry, ...1.0097

**Free Energy**
RESEARCH AND COMPUTATIONS ON THE THERMODYNAMIC PROPERTIES OF AIR AND RELATED GASES, ...Air, Critical, Hydrogen, Virial Coefficient, ...3.0014

**State Variables - PVT**
VISCOSITY AND VISCOELASTICITY OF LIQUIDS AND GLASSES, ...Gases, Instrumental Services, Liquid, Morphology, Viscocelasticity, Viscosity, ...8.0260

**Viscous Coefficient**
RESEARCH AND COMPUTATIONS ON THE THERMODYNAMIC PROPERTIES OF AIR AND RELATED GASES, ...Air, Critical, Free Energy, Hydrogen, ...3.0014

**Thin Sections**
PALEONTOLOGICAL EVIDENCE OF CYCLES IN THE EARTH-MOON SYSTEM, ...Comparative Studies-other, Environmental Changes, Invertebrates, Origins, Shells, Tides, ...7.0167
CONTRACT FOR PROCESSING OF USARP ROCK SAMPLES, ...Antarctica, Classifications, Collections, Coring and Dredging, Petrology, Sampling, Ships and Cruises, ...7.0060

684
Thorium

INVESTIGATIONS OF URANIUM AND THORIUM SERIES ISOTOPE DISEQUILIBRUM IN THE OCEAN AND IN PLEISTOCENE SEDIMENTS. Chemistry, Glacial History, Quaternary Period, Radioactivity, Uranium, 7.0120

DEPOSITION SITES OF THE PROTECTORIUM METHOD. Chemical, Distribution, Element Ratio, Manganese, Sedimentary Petrogenesis, Thermal, Uranium, 7.0270

Tidal Streams

ESTUARINE SEDIMENTATION PROCESSES. Estuaries, General Deposition, Intertidal Areas, Morphology-general, New England Province, Tides, 7.0244

BIOLoGY OF ANOMOBRADUS ALOIDS. Alewife, menhaden, haddock, Mortality Rates, Spawning & Nesting Sites, Streams, Virginia, 5.0150

FLUSHING PATTERN OF CERTAIN TIDAL STREAMS IN DELAWARE. Aquatic Ecology, Circulation-water, Delaware, Discharge, Industrial-general, 7.0213

EFFECTS OF COOLED WATER IN A TIDAL ESTUARY. Chesapeake Bay, Electric Power Plants, Pollution - Effects of, Pollution Effects, Thermal Pollution, Water Properties-general, 7.0270

PINK SALMON INVESTIGATIONS - INTERTIDAL ECOLOGY. Alaska, Life History Studies, Salmon -coho, chinook, sockeye, Spawning & Nesting Sites, Water Salinity, 5.0186

Tides

ECOLOGICAL STUDY OF DUXBURY BAY. Aquatic Ecology, Bays, Habitat Studies, Massachusetts, Survey Studies, 5.0089

A STUDY OF THE DEEP CIRCULATION AND DEEP FISH POPULATIONS IN THE PACIFIC OCEAN. Currents-ocean, Fish -non-specific, Pacific Ocean-general, Vertical Distribution, 2.0060

LONG PERIOD WAVES. Fjords, Hydromechanics, Iceland, Seiches, Waves, 2.0108

OCEAN WAVES AND TIDES. Currents-ocean, Subsurface Environments, Thermal, Water Motion Recorders, Waves, 2.0080

ESTUARINE SEDIMENTATION PROCESSES. Estuaries, General Deposition, Intertidal Areas, Morphology-general, New England Province, Tidal Streams, 7.0244

SUPPORT OF THE VERMILION SEA. Continental Shelf, Eastern, Meteorological Studies, Sea Level Variations, Water Motion, 2.0061

DETERMINATION OF TIDES IN THE REAL OCEANS. Forecasting-prediction, Numerical Analysis-other, Partial, 2.0089

STUDY OF LOW FREQUENCY SURFACE WAVES IN THE PACIFIC OCEAN. Meteorological Studies, Sea Level Variations, Turbulence - Sea Water, Water Motion Recorders, Waves, 2.0068

THEORETICAL STUDY OF OCEAN TIDES FOR PURPOSES OF WORLDWIDE PREDICTION. Earth Tides, Forecasting-prediction, Mediterranean Sea-other, Waves, 2.0090

FIELD DETECTION AND MEASUREMENT OF INTERNAL WAVES. Acoustical, Density, Digital Computer Applications, Temperature, Waves-vertical, 2.0125

OCEAN WAVES AND STRUCTURE. Buoy, Salinity, Thermocline, Water Motion Recorders, Waves, 2.0106

GRAVITY AND EARTH TIDES. Antarctica, Earth Interior, Earth, 6.0141 General Gravimeters, Propagation, 2.0077

BOTTOM CURRENTS AND DEEP SEA TIDES. Abyssal, Acoustical, Bottom-thermal-bottom, Currents-other, Finite Differences, Model Studies, 2.0044

INTERNAL WAVE STUDY. Acoustical, Atlantic Ocean-north, Continental Shelf, Thermal, Waves-vertical, 2.0125

OSTER LEASE CONTROL MONUMENTS - BAY ADAM-BASTIAN BAY AND SANDY POINT BAY AREAS. Commercial Fishing, Gulf of Mexico, Louisiana, Oysters, Plane, 4.0057

VERMILION-CALCASIEU-SABINE SYSTEM. Benthic Fauna, Louisiana, Number Or Density, Plankton Sampling, Salinity, Vertical Distribution, 5.0094

SUBJECT INDEX

Tierra Del Fuego

THE NET EFFECT OF WIND ON RECREATIONAL TIDAL STREAMS IN FCORDOBA. Argentina, Bassine-bay, Eutrophication - Other, Fisheries, Water Level Fluctuation, Wind-general, 7.0280

RESIDENCE TIMES OF WATER BEHIND BARRIER ISLANDS. Bays, Circulation-general, Simulation Theory, Wind-water Interaction, 7.0282

ANNUAL PHYTOPLANKTON PRODUCTION IN PUget SOUND. Other, Phytoplankton, Puget Sound, Standing Crops, 5.0931

SPECTRAL ANALYSIS OF TIDAL CURRENTS. Currents-other, Hawaii, Integral Transforms, Prediction, Time Series Analysis, 7.0283

A GLOBAL DIRECTORY OF TIDAL CONSTANTS. Arcts, Maps-other, Tables, Compilation, Catalogs, 2.0079

RECENT SEDIMENTATION BY TIDAL AND LONGSHORE CURRENTS ON A CARBONATE BANK IN LOWER FLORIDA KEYS. Banks, Currents-longshore, Florida, Quaternary Period, Sedimentation, 7.0253

USE OF TIDAL POWER AND OTHER OCEAN ENERGY SOURCES. Bibliography, Economics, Engineering Studies-other, Mechanical Power-other, Survey Studies, 2.0084

OXYGEN RESOURCES OF TIDAL WATERS. Autotrophic, Marine Biology (non-specific), Oxygen, Oxygen Content -water, Pollution Sources-general, 7.0270

GALVESTON BAY STUDY. Estuaries, Numerical Analysis-other, Optimization, Simulation, Waste Water Treatment-general, 7.0270

INTERNAL WAVE RESEARCH. Acoustical, Surface Environments, Waves, Waves-vertical, 2.0096

TIDAL FLOWS IN RIVERS AND HARBORS. Committee-support, Harbors, Hydraulics-general, Streams, 2.0087

GENERAL COASTAL INLET STUDIES. Coastal Engineering-other, Coastlines-shorelines, Discharge, Model Studies, Synthetic Hydrology, Water Motion, 7.0215

SEDIMENT MOVEMENT AND BOTTOM CONDITIONS IN THE DELAWARE ESTUARY MOUTH AREA. Bottom Sampling Device, Currents-other, Delaware Bay, Photography, Sedimentation, 7.0210

FLOW AND SALINITY IN THE HUDSON ESTUARY. New York, Estuaries, Fresh Water, Inflow, Management, Salinity, 2.0075

REMOTE SENSING, GULF COASTAL AREA. CENTRAL FLORIDA. Aircraft, Aquifers, Fresh Water, Saline Water Systems, Temperature, 4.0106

EXTENT OF BRACKISH WATER IN TIDAL RIVERS, MARYLAND. Brackish Water, Renouf, Water Utilization-general, 7.0282

EXTENT OF BRACKISH WATER IN TIDAL RIVERS, MARYLAND. Brackish Water, Renouf, Water Utilization-general, 7.0282

TIDAL DISCHARGE RESEARCH, NEW JERSEY. Data Acquisition, Data Reduction and Analysis, Discharge, Sediments, Water Quality-general, 2.0088

DESIGN, CONSTRUCTION AND LONGEVITY OF ARTIFICIAL FISHING REEFS. Atlantic Ocean-north, Currents-ocean, Reefs, 9.0013

TRACER STUDIES IN ALASKAN HARBORS. Estuaries, Flow Augmentation, Harbors, Industrial Wastes, Tracers-general, 7.0270

Tidewater Areas

AN ANALYSIS OF PHOSPHORUS AND NITROGEN COMPOUNDS IN TIDAL MARSHLAND DRAINAGE. Management, Nitrite, Nitrate, Phosphate, Phosphorus, Swamps-marshes, Water Properties-general, 5.0093

PRODUCTIVITY STUDIES IN NORTH CAROLINA SALT MARSHES. Aerial Photography, Mapping, North Carolina, Primary Productivity, Productivity - Food Chain, Swamps-marshes, 5.0101

EUTROPHICATION OF TIDAL WATERS. Eutrophication, Growth and Differentiation, Model Studies, Nutrients, Photosynthesis, 5.0099

SHOALING PROCESSES. Channels, Sand Bars, Scouring, Sediment Transport-other, Turbulent Flow, 7.0250

ESTUARINE ECOLOGY-INDIAN RIVER, DELAWARE. Delaware, Estuaries, Water Environment-other, 5.0087

Tierra Del Fuego

CETACEA OF TIERRA DEL FUEGO. Marine Mammals, Survey Studies, Travel Grants, 5.0044

685
SUBJECT INDEX

Tissue Techniques

FREEZING AND DRYING OF LIVING CELLS ...Animal Nematodes -non-specific, Cell Injury and Autolysis, Cell, env.(non-specific & Ot.), Freeze-dry Techniques, Mollusks - non-specific & Other, ... .5.0450

PHYSIOLOGICAL CHARACTERIZATION OF CERTAIN MARINE BACTERIA ...Bact. morphology (general), Bacterial Culture, Biology, Isolation From Nat. environ., Marine Bacter..ria, Metabolism (intracellular), ... .5.0784

STRUCTURAL AND FUNCTIONAL ORGANELLE INTERACTIONS ...Differentiation Mechanism, Marine Plants, Organelle & Membrane Formation, Plant Developmental Biology, Structural Functions, ... .5.0689

Tissues -biological

Composition

Chemical Analysis

RADIOPASTEURIZATION OF FISHERY PRODUCTS-OPERATION AND DEVELOPMENTAL INVESTIGATIONS ...Fish - non-specific, Microbiological, Organoleptic Studies, Radiation, Shelf Life & Storage, Shrimp, ... .6.0025

COMMERCIAL IRRADIATION OF SHELLFISH WITH A PORTABLE SHIPBOARD IRPADIATOR ...Microbiological, Organoleptic Studies, Radiation, Shelf Life & Storage, Shrimp, ... .6.0025

PREPARATION OF FISH PROTEIN HYDROLYSATES ...Analysis of Foods, Fish -non-specific, Fish Protein Concentrate, Heat, Protein, ... .6.0066

CLADOPHORA AS RELATED TO POLLUTION IN WESTERN LAKE ERIE ...Algal Pollutant Sources, Biondicators, Cladophora, Lake Erie, Mapping, ... .6.0170

LIPID OXIDATION AND ASSOCIATED BIOCHEMICAL CHANGES OCCURRING DURING THE PROCESSING AND STORABILITY OF FISH PRODUCTS ...Anti-oxidants, Fats, Fish - non-specific, Food Spoilage Detection, Rancidity, ... .6.0071

DEVELOPMENT OF RADIATION STERILIZED FISH ITEMS FOR ARMED FORCES FEEDING ...Anti-oxidants, Consumer Pref. & Consumption, Fish -non-specific, Military Rations, Radiation, ... .6.0073

UTILIZATION AND PREPARATION OF FISH PROTEIN CONCENTRATE ...Fish & Shellfish, Fish Protein Concentrate, Nutritive Value, Organoleptic Studies, Proteins, ... .6.0125

LABORATORY SCALE INVESTIGATION INTO THE FEASIBILITY OF RADIOPASTEURIZING FISH PRODUCTS ...Microbiological, Organoleptic Studies, Radiation, Shelf Life & Storage, Shrimp -non-specific, ... .6.0035

FUNDAMENTAL RADIATION CHEMISTRY RESEARCH ...Antibiotics, Fish - non-specific, Packaging, Radiation, Radiochemical Analysis, ... .6.0040

IDENTIFICATION OF SOCKEYE SALMON STOCKS BY BONE MINERALS ...Animal Taxonomy, Bone, Pacific Ocean,—Hawaiian Is., Salmon, sockeye, ... .5.0333

CONTROL OF OXIDATIVE CHANGES IN FRESHWATER FISH ...Fish -non-specific, Freezing, Fresh Water, Organoleptic Studies, Rancidity, ... .6.0045

INVESTIGATION OF FOOD PRESERVATION METHODS ...Fish - other, Food Processing -other, Food Spoilage -other, Organoleptic Studies, Physical and Chemical Change, ... .6.0016

Histochimistry - Cytochem

HISTOCHEMICAL STUDIES OF MUCOSUBSTANCES IN THE MANTELE OF THE NORTHERN QUAHOG, MERCENARIA MERCENARIA ...Calcification, Clams, Derivatives, Mucopolysaccharides, Mucoproteins, ... .5.0445

GAMETOCENSES AND FERTILIZATION IN THE BLUE CRAB, CALLINECTES SAPIDUS RATHBUN, AND OTHER CRABS ...Crabs, Electron Microscopy, Reproductive System, Structural Functions, ... .5.0476

A HISTOCHEMICAL STUDY OF THE CENTRAL NERVOUS SYSTEM OF LIMULUS POLYPHEMUS ...Cholinesterase, Horseshoe Or King Crabs, Nervous System, Organelle-enzyme Assm., ... .5.1000

THE MORPHOLOGY, HISTOCHEMISTRY, AND MODE OF SECRETION IN THE VENOM GLAND OF SEA SNakes ...Endocrine -other, Snakes, Venom, Vertebrate Anatomy, ... .5.0529

COMPARATIVE BIOCHEMICAL AND MORPHOLOGICAL CHARACTERISTICS OF MARINE FUNGI FROM SHELLFISH... .5.0529

ISH ...Endoparastises -other, Fungal Culture, Histology and Cytology, Marine Fungi (non-specific), Plant Taxonomy, ... .5.0791

HISTOLOGICAL, HISTOCHEMICAL AND HISTOPATHOLOGICAL EFFECTS OF WATER POLLUTANTS ON MARINE ORGANISMS ...Histology and Cytology, Marine Biology (non-specific), Pollution Sources-general, Toxic Substances -non-specific, ... .5.0923

BIOCHEMICAL STUDIES ON SILICEOUS SKELETAL FORMATION ...Algae- Diatoms, Cell Wall, Golgi Apparatus, Plant Developmental Biology, Silicon, ... .5.0750

STRUCTURAL ANALYSIS OF CELL DIVISION ...Basic Embryology, Cell Cycle, Nucleolus, Nucleus (non-specific & Ot.), Sea Urchins & Other Echinoderms, ... .5.0645

RENN AND ERYHINALITY ...Comparative Physiology, Kidney and Urinary System, Osmoregulation, Renin, Vertebrates - non-specific, ... .5.0791

Histology and Cytology

ULTRASTRUCTURAL AND AUTORADIOGRAPHIC INVESTIGATION OF CALCIFICATION IN FORAMINIFERS ...Calcification, Calcium, Cell Wall, Cell, organ. & Organoids of, Foraminifera, Invertebrate Culture, ... .5.0788

COMPARATIVE MORPHOLOGY OF MARINE NEMATODES ...Comparative Physiology, Invertebrate Anatomy, Microscopic Skeletal System, Nematoda, ... .5.0791

RETINAL RHYTHMS UNDER CONTROLLED LIGHT ...Blue-light, Darkness, Light Quantity -non-specific, Visual, Visual Organs, ... .5.0782

PROTOZOOLOGY ...Animal Taxonomy, Axenic Culture, Invertebrate Nutrition, Protoplan, ... .5.0443

COMPARATIVE BIOCHEMICAL AND MORPHOLOGICAL CHARACTERISTICS OF MARINE FUNGI FROM SHELLFISHISH ...Endoparastises -other, Fungal Culture, Histochimistry - Cytochim, Marine Fungi (non-specific), Plant Taxonomy, ... .5.0791

HISTOLOGICAL, HISTOCHEMICAL AND HISTOPATHOLOGICAL EFFECTS OF WATER POLLUTANTS ON MARINE ORGANISMS ...Histochimetry - Cytochim, Marine Biology (non-specific), Pollution Sources-general, Toxic Substances - non-specific, ... .5.0923

Hypertrophy - Hyperplasia

CYTOLOGY OF VIRAL NEOPLASMS OF FISH ...Dermal, Lymphocystis, Neoplasia, Yellow Perch, Darters, ... .5.0392

Pathology

HISTOPATHOLOGIC EFFECTS OF POLLUTANTS ON CELLS AND TISSUES OF MARINE FISHES ...Contamination - Water, Killfish - Cyprinodont, Pollution - Effects of, Pollution Effects, ... .5.0323

HISTOPATHOLOGIC EFFECTS OF POLLUTANTS ON CELLS AND TISSUES OF MARINE INVERTEBRATES ...Clams, Contamination - Water, Invertebrate Pathology, Pollution - Effects of, Pollution Effects, Pollution Sources-other, ... .5.0497

Transplants

DEVELOPMENTAL ANALYSIS OF FUNDULUS ...Basic Embryology, Central Nervous System, Fats, Killfish - Cyprinodont, Phospholipids, ... .5.0316

Toxic Substances

Algal Toxins

RED TIDE TOXICITY ...Biochemical Analysis, Gas Chromatography, Gymnodinium, Plant Developmental Biology, Pollution Sources-other, ... .5.0780

ORGANIC CHEMICAL STUDIES ON ANIMAL AND PLANT TOXIN ...Animal Toxins, Biochemical Analysis, Medicinal Plants, Plant Alkaloids, Plant Toxins, ... .6.0118

LABORATORY STUDIES OF TOXIC DINOFLAGELLATES ...Algal Culture, Gymnodium, Gulf of Mexico, Gymnodinium, Plant Origin, ... .5.0437

STUDY OF TOXIN SYNTHESIS IN PYRNUMESIUM PARVUM ...Axenic Culture, Biosynthesis, Gymnodium, Gymnodinium, Pyrnesiun, ... .6.0112

COMPARATIVE STUDIES OF DINOFLAGELLATE TOXINS ...Algae- Dinoflagellates, Algal Culture, Cellular Physiology, Toxocology, ... .6.0121
SUBJECT INDEX

CHEMISTRY OF ALGAL TOXINS ...Aphanizomenon, Bioassays, Biochemical Analysis, Gymnodinium, Microbiological Analysis, ...5.0709

Animal Toxins
EXPLORATION FOR TOXIC MARINE ANIMALS IN THE TROPICAL PACIFIC ...Marine Biology (non-specific), Pacific Ocean-general, Toxic Substances -non-specific, Toxicological and Allergy, ...6.0109

CHEMISTRY AND BIOLOGY OF SOME COELENTERATE NEMATOCYSTS ...Cell, organ, & Organoids -ot, Coelenterata -other, Invertebrate Physiology, Predation, ...5.0776

PHYSALIA TOXIN AND THE ACTIVITY OF BIOLOGICAL MEMBRANES ...Active Transport, Cellular Membranes (non-specific), Jelly Fish, Toxicology, ...6.0107

PHARMACOLOGY AND CHEMISTRY OF TOXIC MARINE ANIMALS ...Female Gametes, Sculpins, Toxicology, 6.0104

EXPLORATION FOR TOXIC MARINE ANIMALS IN THE TROPICAL PACIFIC ...Pacific Ocean-general, Toxicological and Allergy, Toxicology, ...6.0110

METABOLISM OF NEUROHUMORAL TRANSMITTER SUBSTANCES IN MARINE ANIMALS ...Basic Studies, Mech of Transmission, Metabolic Inhibitors, Structural Functions, ...5.0981

ORGANIC CHEMICAL STUDIES ON ANIMAL AND PLANT TOXIN ...Algal Toxins, Biochemical Analysis, Medicinal Plants, Plant Alkaloids, Plant Toxins, ...6.0115

MODE OF ACTION OF MARINE TOXINS ...Antigen, Blood Globulins, Enzyme-substrate, Sea Urchins & Other Echinoderms, ...6.0103

Bacterial Endotoxins
STUDIES ON VIBIO FOOD POISONING ...Bacteria, Food (epidemiology), Microbiological, Toxicological and Allergy, Vasomotor, ...6.0114

Bacterial Exotoxins
GROWTH AND TOXICOGENESIS OF C. BOTULINUM IN FISHERY PRODUCTS ...Antimetabolites -non-specific, Clostridium Botulinum, Fish -non-specific, Growth (non-specific & Or.), Medical Studies, Microbiological, ...6.0043

Fungal Toxins
FERMENTED PROTEIN-RICH FOODS ...Fermentation, Matting, Fish -non-specific, Milk, Peanuts, Soybeans, ...6.0055

Plant Toxins
ORGANIC CHEMICAL STUDIES ON ANIMAL AND PLANT TOXIN ...Algal Toxins, Animal Toxin, Biochemical Analysis, Medicinal Plants, Plant Alliatrioc, ...6.0115

Toxic Substances -non-specific
EXPLORATION FOR TOXIC MARINE ANIMALS IN THE TROPICAL PACIFIC ...Animal Toxin, Marine Biology (non-specific), Pacific Ocean-general, Toxicological and Allergy, ...6.0109

HISTOLOGICAL, HISTOCHEMICAL AND HISTOPATHOLOGICAL EFFECTS OF WATER POLLUTANTS ON MARINE ORGANISMS ...Histohistochemistry - Cytochemistry, Histology and Cytology, Marine Biology (non-specific), Pollution Sources-general, ...5.0923

ENVIRONMENTAL CONDITIONS AND POPULATION DYNAMICS IN SELECTED UNPOLLUTED ESTUARIAL AND COASTAL AREAS ...Aquatic Ecology, Contamination - Water, Habitat Studies, Marine Biology (non-specific), Pollution - Effects of, ...5.0922

TOXIC IMPURITIES IN MARINE PROTEIN CONCENTRATE ...FISH Protein Concentrate, Food Spoilage -other, Infection, Intoxication & Poison, Toxicological and Allergy, ...6.0009

ASPECTS OF RELATIONSHIPS BETWEEN MARINE ECOLOGY AND HUMAN HEALTH ...Environmental Ecology, Marine Biology (non-specific), Mechanism of Transmission, Public health Ecology, ...6.0182

Toxicity Or Residue in Animals

Laboratory Animals
EXPLORATORY COLLECTION AND CARE OF FISH FOR TESTING AT TIBURON ...Bioassay, California, Fish -non-specific, San Francisco Bay, ...6.0116

TOXICANT TOLERANCE STUDIES-SCREENING OF PESTICIDES AND FISH AT TIBURON ...California, Fish -non-specific, Pesticides -non-specific, Screening Potential Pesticides, ...5.0278

TOXICANT TOLERANCE STUDIES - SCREENING OF PESTICIDES AND AQUATIC INVERTEBRATES AT TIBURON ...California, Herbicides -non-specific, Insecticides -non-specific, Screening Potential Pesticides, ...5.0986

LABORATORY BIOASSAYS ...Contamination - Water, Fish, Laboratory, Pollution - Effects of, Pollution Sources-general, ...5.0832

Wildlife
Fish
PESTICIDES ...Aquatic Or Soil-aquatic Cycles, Bioassays, Persistence of Residues, Pesticides -non-specific, Pollution Effects, ...6.0081

LABORATORY BIOASSAYS ...Contamination - Water, Laboratory, Laboratory Animals, Pollution - Effects of, Pollution Sources-general, ...5.0882

RATES OF PESTICIDE BUILDUP IN SALMONIDS RECENTLY INTRODUCED IN THE GREAT LAKES ...Insecticides -non-specific, Lake Michigan, Lake Superior, Lake Trout, Brook Trout, Pollution Effects, Salmon -coho, chinook, sockeye, ...6.0154

FISH HOLDING AND LIFE STAGE SENSITIVITY STUDIES ...Contamination - Water, Environment Resistance, Fish -non-specific, Great Lakes -general, Maturity & Growth Stages, ...5.0876

PESTICIDE RESISTANT FISH IN NATURAL ECOSYSTEMS ...Animal Resistance -other, Endrin, Food Chains, Animal And/or Man, Pollution Effects, Rates, Doses, Concentrations, ...5.0977

Toxicity Or Residues in Humans

Residues in Foods
RADIATION PASTEURIZATION OF SHRIMP AND OYSTERS ...Iced Cooling and Storage, Organoleptic Studies, Oysters, Radiation, Shrimp, ...6.0024

Trace Analysis
Inorganic
BIOLOGICAL FRACTIONATION OF STABLE ISOTOPES ...Chemistry, Microbiological Analysis, Trace Elements, ...7.0052

Trace Elements
BIOLOGICAL FRACTIONATION OF STABLE ISOTOPES ...Chemistry, Inorganic, Microbiological Analysis, ...7.0052

PHYSIOLOGY OF LUMINESCENT SIGNAL SYSTEMS ...Blouminescence, Photoreception, Visual Organs, ...6.0050

STUDIES IN MARINE CHEMISTRY ...Bone, Chemistry, ...7.0068

MARINE BIOLOGY PROGRAM ...Distribution, Productivity - Food Chain, Puerto Rico, Radioecology, Rare Earths, ...1.0128

CHEMICAL OCEANOGRAPHY ...Aquatic Ecology, Circulation-General, Convection, Technique Development, ...1.0134

Tracers
RADIOSOTOPIC TRACER STUDY TO INVESTIGATE THE MECHANICS OF LITTORAL TRANSPORT AROUND POINT CONCEPTION, CALIFORNIA ...Continental Shelf, Distribution, Ocean Waves - Currents, Sediment Transport-other, Xenon, ...7.0216

LIGHT IN THE SEA ...Index of Refraction, Optical, Scattering, Water Analysis-general, Water Motion, ...1.0168

DYNAMICS OF THE NITROGEN CYCLE IN THE SEA ...General Sea Water Chemistry, Nitrate, Nitrite, Nitrogen, Nitrogen Fixation, ...5.0933
OCEAN-ATMOSPHERE STUDIES WITH STABLE ISOTOPES AND DISSOLVED GASES ...Air-sea Boundary-general, Equilibrium - Chemical, Gasses, Mixing, Oceanic Fronts, Particles, Gas Transport ... ...3.0060
TRITIUM AS A TRACER FOR MIXING PROCESSES ...Current-ocean, Mixing, Radioactivity-general, Salinity, Tritium ... ...2.0053
DETERMINATION OF TRITIUM IN NATURAL WATERS ...Nuclear Explosions - Fallout, Radioactivity, Trace Elements, Tritium ... ...1.0063
STUDY OF DEEP PACIFIC CIRCULATION USING SILICON-28 ...Carbon, Circulation-general, General Sea Water Chemistry, Pacific Ocean-general, Silicon ... ...2.0006
CHEMICAL OCEANOGRAPHY ...Aerol, Circulation-general, Isotope, Isotope-tracer-other, Oceanic Fronts, Water Analysis-general ... ...1.0072
WATER MASS TRACERS ...Acoustical, Circulation-general, Currents-ocean, Oceanic Fronts ... ...2.0020
CURRENT STUDY ON THE NEUSE RIVER AND ESTUARY ...Discharge, Dyes, Estuaries, North Carolina, Water Motion ... ...2.0027
MEASURING PAST OCEANOGRAPHIC CONDITIONS ...Internal Structure, Paleoenvironments, Paleontolgy, Salinity, Temperature ... ...7.0180
RADIOISOTOPIC SAND TRACER STUDY, POINT CONCEPTION, SANTA BARBARA COUNTY, CALIFORNIA ...California, Ocean Waves - Currents, Other Sediment Type, Sediment Transport-general ... ...7.0194
PHYSICAL AND CHEMICAL GEOPHYSIC OF OCEAN SOLUTIONS ...Chemical Reactions, Octopus, Squid, C Uttle-fish ... Pacific Ocean-north, Pacific Ocean, Radioactivity, Radioactivity-general ... ...1.0103
RADIOISOTOPE TRACERS IN OCEANOGRAPHIC RESEARCH ...Circulation, Circulation-general, Radioactivity-general, Sampling, Trace Elements ... ...2.0001
TRACE ELEMENT EQUILIBRUM STUDIES ...Adsorption, Chelating Agents, Ion Exchange, Material Recovery, Trace Elements ... ...3.0006
UTILIZATION OF RADIOACTIVE TRACERS IN BEACH STUDIES ...Fluorometry, Isotope, Isotope-tracer-other ... ...7.0218
INTERACTIONS OF MARINE NUTRIENT COMPLEXES ...Iron, Marine Plants, Nutrients, Phosphorus, Phytoplankton ... ...5.0956
DYES CURRENT STUDY ON THE NEUSE RIVER AND ESTUARY ...Discharge, Estuaries, North Carolina, Tracers, Water Motion ... ...2.0027
EDDY DIFFUSION AND BACTERIAL REDUCTION IN WASTE FIELDS ...Bacterial Pollutant Sources, Diffusion, Dispersion-water, Mixing, Pollutants - Path of, Sewers ... ...6.0137
DISPERSION PROCESSES IN ESTUARIES AND RIVERS ...Dispersion-water, Estuaries, Streams, Synthetic Hydrology ... ...2.0050
RADIOISOTOPES GEOCHEMICAL STUDIES OF CONTINENTAL WATERS ...Authigenesis, Element Ratios, Geochemical Analysis, Isotope, Isotope-tracer-other, Location, Pore Fluids, Water Analysis ... ...1.0121
TRACERS-general TURBULENT DIFFUSION STUDY ...Chesapeake Bay, Dispersion-water, Estuaries, Turbulent Flow, Water Motion ... ...2.0056
NUTRIENT ASSIMILATION RATES - FIELD STUDIES ...Nitrogen, Nitrogen Cycle, Nutrients, Phosphorus ... ...5.0990
TRACERS STUDIES IN ALASKAN HARBORS ...Estuaries, Flow, Sedimentation, Harbors, Industrial Wastes, Tides ... ...2.0047
Training Grants, Fellowships PARTIAL SUPPORT OF A PROGRAM OF EDUCATION & RESEARCH IN MARINE SEISMOLOGY AND GEOMAGNETICS ...Magnetic Studies, Seismic Studies ... ...7.0127
SUPPORT OF TRAINING PROGRAMS IN INVERTEBRATE ZOOLOGY AND MARINE BOTANY ...Invertebrates - non-specific, Marine Biology, Marine Environments-general, Marine Plants, Meetings ... ...11.0028

A TRAINING PROGRAM FOR GRADUATE STUDENTS IN MARINE SCIENCES AT THE FRIDAY HARBOR LABORATORIES ...Marine Biology, Marine Biology (non-specific), Washington ... ...11.0042
YEAR-ROUND PROGRAM OF RESEARCH IN MARINE ECOLOGY ...Animal Taxonomy, Aquatic Ecology, Marine Biology (non-specific), Plant Ecology (non-specific), Plant Taxonomy ... ...5.0899
RESEARCH TRAINING IN MARINE BIOLOGY, PALEONTOLOGY AND SYSTEMATIC ZOOLOGY ...Animal Taxonomy, Invertebrates -non-specific, Oceanography-general, Paleontology, ... ...11.0003
SUPPORT OF RESEARCH VESSEL VELERO IV ...California, Equipment Purchase Operation, Facilities, Geology-general, Instrumentation-general, Marine Biology, ... ...4.0115
STANFORD BIOLOGICAL OCEANOGRAPHY ...Marine Biology, Phytoplankton, Primary Productivity, Productivity - Food Chain, Ships and Cruises, Zooplankton ... ...11.0005
SUPPORT OF THE R/V EASTWARD ...Caribbean Sea, Continental Shelf, Cooperative-studies, Facilities, Marine Biology (non-specific), Ships and Cruises ... ...12.0039
COORDINATED RESEARCH AND TRAINING PROGRAM IN BIOLOGICAL OCEANOGRAPHY ...Caribbean Sea, Facilities, Marine Biology (non-specific), Meetings, Ships and Cruises ... ...11.0037
RESEARCH AND TRAINING IN MARINE BIOLOGY ..., Marine Biology (non-specific), North Carolina ... ...11.0038
INTERRELATIONSHIPS OF MARINE ORGANISMS AND SEDIMENTS ...Marine Biology (non-specific), Sediments-general ... ...5.0857
RESEARCHER AT THE MARINE SCIENCE CENTER ...Facilities, Intertidal Areas, Invertebrate Physiology, Invertebrates -non-specific, Oregon ... ...11.0039
RESEARCH AND GRADUATE TRAINING IN FOOD AND DRUGS FROM THE SEA, AND MARINE POLLUTION ...Antimicrobial, Carcinostatic, Chemistry, Fish Protein Concentrate, Pollution Sources-general ... ...6.0068
APPLIED MARINE ENGINEERING PROGRAM AT SCRIPPS INSTITUTION OF OCEANOGRAPHY ...California, Engineering ... ...3.0005
INVESTIGATE THE CAUSE OF MORTALITY OF PACIFIC OYSTERS ALONG THE CALIFORNIA COAST ...California, Environmental Ecology, Mortality Rates, Oysters, Pathology ... ...5.0360
SHELLFISH EMBRYOLOGY AND LARVAE DEVELOPMENT STUDY ...Basic Embryology, Captive Rearing, Crustacea ...non-specific, Mollusks ...non-specific & Other ... ...5.0358

Transportation Engineering Administration & Management RESEARCH ADVISORY SERVICES ...Freight, Loading/unloading, Scientific-service-support, Water Transportation ... ...12.0014
Economics Economic Analysis MARINE TRANSPORTATION ECONOMIC ANALYSIS ...Freight, Management Science, Production & Processing, Water Transportation ... ...4.0179
General Studies Transportation Systems SIMULATION MODEL FOR THE ANALYSIS OF ADVANCED MARINE SHIPPING SYSTEMS ...Simulation Theory, Water Transportation ... ...4.0063
COMPETITIVE MERCHANT SHIP PROJECT (BULK) DRY BULK COMMODITY FORECASTS ...Consumption, Freight, Merchant-ships ... ...8.0029
MODEL DESIGN FOR PRELIMINARY EVALUATION OF TOTAL CARGO TRANSPORTATION TIME AND TRANSPORTATION COST FOR ADVANCED CARGO TRANSPORTATION SYSTEMS ...Computer Applications, Costs, Freight, Yards-docks ... ...4.0067
Visibility LOOK-OUT ASSIST DEVICE ...Fog, haze, navigation, Navigation Communication, Radar, Warning-systems ... ...8.0146
Vertebrate Anatomy

SUBJECT INDEX

SYSTEMATIC STUDIES ON THE FAMILY SCOMBRIDAE ...Animal Taxonomy, Indian Ocean, Dissection, Stratification, Tuna, Mackeral, Albacore, ...5.0056
SYSTEMATIC STUDIES OF FISHES ...Animal Taxonomy, Developmental Physiology, Fish - non-specific, Life History Studies, ...5.0057
A REVISION OF THE CAT SHARKS, SCYLLORHINIDAE ...Animal Taxonomy, Nomenclature, Classification, Sharks, ...5.0058
STRUCTURE AND FUNCTION OF EYES ...Visual Organs, ...5.0379
PHOTOBIOLOGY OF MARINE ANIMALS ...Bioiluminescence, Fish - non-specific, Visual, Visual Organs, ...5.0327

Vertebrate Nutrition

Diet Or Ration Components

Diet Or Ration - other
NUTRITION OF SALMONID FISHES ...Captive Rearing, in Vivo - see Also Feed Rations, Purified Iets, Salmon & Trout - Non-specific, ...5.0364
Energy
PHYSIOLOGY OF MARINE ORGANISMS ...Environmental Physiology, Fish - non-specific, Food Supply, ...5.0939
Fats - Lipids
THE COMPOSITION, NUTRITIVE VALUE AND QUALITY OF FISHERY PRODUCTS WITH SPECIAL EMPHASIS ON LIPID AND ITS INTERACTION ...Anti-oxidants, Fats, Fish - non-specific, Radiation, Unsaturated Fats, ...6.0076
Proteins and Amino Acids
UTILIZATION OF LATENT MARINE RESOURCES AND WASTE PRODUCTS ...Fish - other, Fish Meals, Fish Protein Concentrate, Proteins, Salmon & Trout - Non-specific, ...6.0068

Digestive System - Dig & absorb
Biological
ACCUMULATION OF RADONUCLIDES BY VERTEBRATES ...A Cooperative Agreement with the Atomic Energy Commission ...Contamination - Water, Estuaries, Radioactivity-general, ...5.0293

Nutrition - other
NUTRITION AND PHYSIOLOGY OF MARINE FISH IN CONTROLLED GONOTROPHIC ENVIRONMENTS ...Aqua, Environmental Physiology, Fish - non-specific, Gern Free Animals, ...5.0317
THE ROLE OF COPROPHAGY IN MARINE FOOD CHAINS ...Feces, Invertebrate Nutrition, Productivity - Food Chain, ...5.0963
FUR SEAL RESEARCH, ANATOMY-BEHAVIOR-MORTALITY ...Behavior, Hair, Mortality Rates, Seals, Vertebrate Anatomy, ...5.0672

Vertebrate Pathology

INFECTIONS IN MARINE MAMMALS USED AS LABORATORY ANIMALS ...Detection, Infectious Conditions and Dis, Mammals, ...5.0049
OCURRENCE OF THE PROTOZOAN PARASITE CERATO-MYXIA IN ADULT PACIFIC SALMON AND STEELHEAD TROUT ...Infectious Conditions and Dis, Pathology, Protozoa, Protozoa - other, Rainbow Trout, Steelhead Trout, ...5.0368

Neoplasm
CYTOLOGY OF VIRAL NEOPLASMS OF FISH ...Dermal, Hypertrophy - Hyperplasia, Lymphocystis, Yellow Perch, Darters, ...5.0292

Vertebrate Physiology

Age
SAMPLING OF GROUNDFISH STOCKS ...Bone, Codfishes, Hake, Propriceptors, Righteye Flounders, Size, ...5.0160
COLLECTION OF MATERIALS AND DATA FOR AGE-GROWTH ANALYSIS ...Commercial Fishing, Fish - other, Growth Rate, ...5.0308
ANALYSIS OF SALMONID SCALES ...Animal Taxonomy, Columbia River, Growth Rate, Trout, Steelhead Trout, Salmon - coho, chinook, sockeye, ...Scales, ...5.0315
AGE DETERMINATION OF LARGE ATLANTIC SHARKS ...Atlantic Ocean, Growth Rate, ...5.0169
BIOSTATISTICS OF HERRING ...Alewife, menhaden, haddock, Atlantic Ocean, Environmental Ecology, Growth Rate, Population Dynamics, Propriceptors, ...5.0099
ADMINISTRATION OF WHALING ACT - DEVELOPMENT OF RESEARCH TOOLS ...Management - other, Mark, Tag Or Capture - other, ...5.0670

Behavior
SIMULATED WEIGHTLESSNESS IN FISH ...Cardiovascular System, Fish - non-specific, Gravitational Fields, Gravity, Propriceptors, ...5.0275
FACTORS AFFECTING THE BEHAVIOR OF SHARKS ...Sensory Organs, Sharks, ...5.0262
SPATIAL ORIENTATION OF FISHES AND ITS SENSORY BASES ...Environmental Physiology, Fish - non-specific, Migration, Orientation, Sensory Organs, ...5.0338
VISUAL CAPACITIES OF TELEOST FISHES ...Behavioral Ecology, Fish - other, Vertebrate Anatomy, Vision, Visual Organs, ...5.0209
COMPARATIVE BEHAVIOR OF HATCHERY-BRED AND WILD SALMONIDS ...Atlantic salmon, Sebago Salmon, Captive Rearing, Environmental Physiology, Lake Trout, Brook Trout, ...5.0264
RENEWAL RESEARCH PROPOSAL FOR HEARING AND ALI-LIED SENSES IN FISHES ...Auditory, Fish - non-specific, Sound Production, ...5.0284
ACOUSTICALLY-LATERALS FUNCTION IN FISH ORIENTATION AND COMMUNICATION ...Auditory, Fish - non-specific, Orientation, Sensory Organs, Signal Detection, ...5.0289
MOTIVATIONAL ANALYSIS OF COURTSHIP BEHAVIOR ...Aggression, Social Behavior, Tilapia, Cichlids, ...5.0231
AUDITORY CAPACITIES OF TELEOST FISHES ...Audition, Auditory, Fish - other, Vertebrate Anatomy, ...5.0291
SPATIAL ORIENTATION OF FISHES AND ITS SENSORY BASES ...Migration, Offactory, Salmon & Trout - Non-specific, Visual Organs, ...5.0339
EXPERIMENTAL STUDIES OF BEHAVIOR IN A CICHLID FISH ...Parental Care, Sex, Size, Tilapia, Cichlids, ...5.0232
MECHANISMS OF HOMING AND ORIENTATION OF SALMON CLARKI IN YELLOWSTONE LAKE AND ITS TRIBUTARIES ...Aquatic Ecology, Biological Rhythms, Cutthroat Trout, Wyoming, ...5.0279
THE EVOLUTION AND CAUSATION OF SOCIAL BEHAVIOR IN ANABANDOT FISHES ...Ethological, Fish - other, Reproduction Studies (general), Social Behavior, ...5.0300
SCHOOLING BEHAVIOR IN FISHES ...Fish - non-specific, Sensory Organs, Social Behavior, Visual Organs, ...5.0125
COMPARATIVE ETHOLOGY OF FISHES OF THE GENUS MACROPODUS ...Aggression, Fish - other, Social Behavior, ...5.0266
SENSORY BASIS OF NAVIGATION IN HOMING PIGEONS ...Biological Rhythms, Environmental Physiology, Locomotion - animal, Mark, Tag Or Capture - other, Pigeon, ...4.0108
EXPERIMENTAL ANALYSIS OF HEARING AND ACOUTIC ORIENTATION IN SHARKS ...Auditory, Shark Repellents, Sharks, ...5.0235
VENOMOUS FISHES AND SEA SNAKES OF SOUTHEAST ASIA ...Fish - non-specific, Snakes, Southeast Asia, Venom, Vertebrate Anatomy, ...5.0681
BREEDING AND MATERNAL BEHAVIOR AMONG THE STELLER SEA LION ...Developmental Physiology, Parturition, Seals, Spawning & Nesting Sites, ...5.0254
TEMPERATURE TOLERANCE OF MARINE ANIMALS THROUGH BEHAVIORAL RESPONSES ...Environment Resistance, Mortality Rates, Thermal, Water Temperature - non-specific, ...5.0118
THERMAL PREFERENCES OF MARINE FISHES AND IN-VERTEBRATES ...Fish - non-specific, Invertebrates - non-specific, Thermal, Water Temperature - non-specific, ...5.0265
EFFECTS OF HOT WATER MASSES ON MARINE FISHES ...Atlantic Ocean, north, Fish - non-specific, High Temp. - 85f Or Above, Oceanic Fronts, Thermal, ...5.0220
RELATION OF TEMPERATURE TO RHYTHMIC BEHAVIOR ...Biological Rhythms, Bluefish, Environmental Physiology, Locomotion - animal, Low Temp. - but Above 32f, ...5.0284

692
SUBJECT INDEX

HEMATOLOGICAL CHANGES IN F. HETEROCLITUS UPON EXPOSURE TO TOXIC METALS ...Blood Plasma and Serum, Cadmium, Killifish - Cyprinodon, Lead, Toxins -other, ...5.0325

FUNCTION OF THE INTERRENAL GLAND IN TELHOST FISHES ...Kidney and Urinary System, Osmoregulation, Phisuta- ty, Tilapia, Cichlids, Water Salinity, ...5.0223

Blood Typing Studies

BLOOD TYPES AS INDICATORS OF BLUEFISH RACES ...Blood Cells, Blood Plasma and Serum, Bluefish, Immunology, Polymorphism, ...5.0319

BLOOD TYPES AS INDICATORS OF WHITE MARLIN RACES ...Blood Plasma and Serum, Marlin, Billfishes, Sailfish, ...5.0321

RACIAL STUDIES OF HERRING ...Alewife, menhaden, shad, herring, Animal Taxonomy, Atlantic Ocean-north, Biochemical Analysis, Management -other, ...5.0265

INVESTIGATE TUNA SUBPOPULATIONS THROUGH THE USE OF BLOOD GROUPS AND INHERITED PROTEINS ...Blood Proteins -non-specific, Pacific Ocean-general, Population Dynamics, Tuna, Mackerel, Albacore, ...5.0076

PROVIDE FOR ACTIVITIES OF BLOOD GROUP CENTER ...Blood Plasma and Serum, Hawaii, Immunology Methods, Tuna, Mackerel, Albacore, ...5.0224

DEVELOP TECHNIQUES FOR CAPTURING JUVENILE TUNAS ...Nets, Population Dynamics, Tuna, Mackerel, Albacore, Vertical Distribution, ...5.0078

Hormone

STUDIES OF FISH ENDOCRINOLOGY ...Environmental Physiology, Fresh Water, Killifishs - Cyprinodon, Testes, Thyroid, ...5.0314

Protein

CHEMICAL RESPONSES BY MARINE ORGANISMS TO STRESS ...Environmental Changes, Environmental Ecology, Environmental Physiology, Salinity, Thermal, ...5.1026

Cardiovascular System

SIMULATED WEIGHTLESSNESS IN FISH ...Behavior, Fish -non-specific, Gravitational Fields, Gravity, Proprioceptors, ...5.0275

PHYSIOLOGICAL STUDIES IN THE BOTTLENOSE DOLPHIN TURSIOPS TRUNCATUS ...Adaptation, Central Nervous System, Mammals, ...5.0588

CARDIOVASCULAR ADJUSTMENT TO DIVING ASPHYXIA ...Locomotion -animal, Medical Studies, Regional Blood Flow & Volume, Seals, ...5.0552

PHYSIOLOGICAL STUDIES ON FISHES LACKING HEMOGLOBIN ...Adaptation, Fish, Fish -other, Hemoglobin, Metabolism, Polar, ...5.0214

MARINE PHYSIOLOGY ...Fish, Osmoregulation, Thermoregulation, Water Pressure, ...5.0947

CIRCULATORY REACTIONS TO ASPHYXIA ...Effects on Cardiovasc. system, Mammals, Veterinary Science, ...5.0553

CARDIOVASCULAR ADJUSTMENTS IN DIVING MAMMALS ...Adaptation, Effects on Cardiovascular system, Locomotion - animal, Mammals, ...5.0574

CARDIOVASCULAR STUDIES ON DIVING MAMMALS ...Adaptation, Basic Hemodynamics, Central and Regulation, Heart, Locomotion -animal, Seals, ...5.0639

Comparative Physiology

COMPARATIVE PHYSIOLOGY OF RESPIRATORY MECHANICS IN MAMMALS ...Mammals, ...5.0612

CHEMISTRY AND FUNCTION OF BRAIN PLASMALOGENS ...Chem and Metab, Molee, struct. (gen. & Other), Phospholipids, Plasmalogens, ...5.1003

THE CETACEAN BRAIN ...A COMPARATIVE STUDY ...Central nervous System, Mammals, Structure-cell-tiss, ...5.0641

Digestive System

Other

DIURNAL-NOCTURNAL ACTIVITY OF THE QUEENFISH, SERIPHUS POLITUS ...Aquatic Ecology, Behavioral Ecology, Biological Rhythms, Drums, Fish -other, Sound Production, ...5.0250

Endocrine System

Endocrine -other

THE MORPHOLOGY, HISTOCHEMISTRY, AND MODE OF SECRETION IN THE VENOM GLAND OF SEA SNAKES ...Histchemistry, Coag, Snakes, Venom, Vertebrate Anatomy, ...5.0529

Pituitary

ENDOCRINE REGULATED PROCESSES IN TELHOST FISHES ...Comparative Physiology, Fish -other, Hypothalamus, Osmoregulation, ...5.0286

FUNCTION OF THE INTERRENAL GLAND IN TELHOST FISHES ...Blood Cells, Kidney and Urinary System, Osmoregulation, Tilapia, Cichlids, Water Salinity, ...5.0233

PHYSIOLOGY AND ASSAY OF PROLACTIN IN FISH ...Biocas- sayes, Biochemical, Gambusia, Molloy, Immunology, Luteotropic Hormone, ...5.0329

Thyroid

STUDIES OF FISH ENDOCRINOLOGY ...Environmental Physiology, Fresh Water, Hormone, Killifishs - Cyprinodon, Testes, ...5.0246

Environmental Physiology

DEVELOPMENT OF TECHNIQUES FOR THE AQUACUL- TURE OF POMPANO & TUNA Aquaculture & Fish-farming, Florida, Maturity & Growth Stages, Pathology, Tuna, Mackerel, Albacore, ...5.0007

MICROBIOLOGICAL ASSAYS OF SEAWATER USING RADIOISOTOPES ...Aquatic Ecology, Ciliates, Environm-expl. Ecology, Food Chains, Phytoplankton, Productivity - Food Chain, Thiamine, ...5.0811

SPATIAL ORIENTATION OF FISHES AND ITS SENSORY BASES ...Behavior, Fish -non-specific, Migration, Orientation, Sensory Organs, ...5.0338

STUDIES IN THE PHYSIOLOGY AND BIOCHEMISTRY OF DEEP-SEA FISHES ...Fish -non-specific, Metabolism, Vertical Distribution, Water Pressure, ...5.0121

PHYSIOLOGY OF MARINE MAMMALS ...Mammals, Seals, ...5.0624

COMPARATIVE BEHAVIOR OF HATCHERY-READED AND WILD SALMONIDS ...Atlantic Ocean-north, Biochemical, Ciliates, Molly, Immunology, Developmental Physiology, ...5.0246

STUDIES OF FISH ENDOCRINOLOGY ...Fresh Water, Hor- mone, Killifishs - Cyprinodon, Testes, Thyroid, ...5.0246

EXPERIMENTAL AND FIJMATHEMATIC ANALYSIS OF THE PHENOMENON OF ATTACK ...Behavioral Ecology, Bongil, Bream, Computer Methods -general, Largemouth Bass, Minnows, Predation, ...5.0535

NUTRITION AND PHYSIOLOGY OF MARINE FISH IN CONTROLLED GNOTOBIOTIC ENVIRONMENTS ...Aquaria, Fish -non-specific, Gram Free Animal, Nutrition -other, ...5.0317

ZOOPHYSIOLOGY OF OCEANIC BENTHIC ANIMALS OFF THE NORT. CAROLINA COAST ...Ocean-north, Benthic fauna, Benthic-bottom, Water Temperature-non-specific, ...5.1009

THERMAL-METABOLIC RELATIONSHIPS OF STENOTHER- MAL FISHES ...Antarctica, Fish -non-specific, Proprioceptors, Thermoregulation, Water Pressure, Water Temperature-non-specific, ...5.0512

SENSORY BASIS OF NAVIGATION IN HOMING PIGEONS ...Behavior, Biological Rhythms, Locomotion -animal, Mark, Tag Or Capture -other, Pigeon, ...4.0108

ORIENTATION CUES AND PATTERNS OF LONG-DISTANCE TRAVEL OF MARINE TURTLES ...Biological Rhythms, Migration, Orientation, Turtles, Terrapins, Turtles, ...4.0107

BEHAVIOR AND SONIC ACTIVITY OF FISHES ...Behavioral Ecology, Fish -other, Sonar, Sound Production, ...1.0047

PRESSURE EFFECTS ON MARINE ORGANISMS ...Absys, Pressure, Vertical Distribution, Water Pressure, ...5.0493

ESTUARINE WATER QUALITY AND FISH DISTRIBUTION ...Contamination - Water, Estuaries, Pollution Effects, Pulp, Paper, and Logging, Salmon & Trout - non-specific, ...5.0117

CHEMICAL RESPONSES BY MARINE ORGANISMS TO STRESS ...Environmental Changes, Environmental Ecology, Protein, Salinity, Thermal, ...5.1026

THE INFLUENCE OF ENVIRONMENTAL FACTORS UPON DEVELOPING MERISTIC STRUCTURES IN THE MARINE FISH, FUNDULUS MAJALIS (WALBAUM) ...Basic Embryology, Developmental Physiology, Killifishs - Cyprinodon, Water Temperature-non-specific, ...5.0298

694
SUBJECT INDEX

**Vegetable Physiology**

FURTHER STUDIES ON A FLUORESCENT COMPOUND IN THE DOGFOSS LENS...Fluorescence, Sharks, Visual,...5.0271

RETINAL RHYTHMS UNDER CONTROLLED LIGHT...Bluefish, Darkness, Histology and Cytology, Light Quantity -non-specific, Visual,...5.0282

LIGHT AND DARK ADAPTATION IN THE RETINAE OF YOUNG BLUEFISH...Adaptation, Bluefish, Photoperiod, Retina,...5.0283

VISUAL PROJECTION IN SUBMAMMALIAN VERTEBRATES...Basic Studies, Cranial and Nuclii, Fish -other, Retina,...5.0228

STRUCTURE AND FUNCTION OF EYES...Vertebrate Anatomy,...5.0379

STUDIES ON INTEGRATIVE MECHANISMS OF NEURONS...Brain, Central Nervous System, Mathematical Biophysics,...5.0635

BEHAVIOR IN EMBRYOS AS IT RELATES TO ENCEPHALIZATION...Basic Embryology, Behavior, Bullheads, Central Nervous System, Developmental Physiology,...5.0270

PHOTOBIOLOGY OF MARINE ANIMALS...Bioluminescence, Fish -non-specific, Vertebrate Anatomy, Visual,...5.0327

PHOTOBIOLOGY OF MARINE ANIMALS...Photochemistry, Photoreception, Physical State, Visual,...5.0313

**Skin Or Special Derivatives**

CELLULAR DIFFERENTIATION...Active Transport, Basic Embryology, Differentiation Mechanism, Frogs, Ionic Effect,...5.0618

Dermal

CYTOLOGY OF VIRAL NEOPLASMS OF FISH...Hyperplasia, Lymphosarcoma, Neoplasm, Yellow Perch, Darters,...5.0292

REGULATION OF IONIC CONSTITUENTS OF PROTOPLASM...Active Transport, Ions (organic), Musculoskeletal System, Nervous System, Osmoregulation,...5.0970

Hair

FUR SEAL RESEARCH, ANATOMY-BEHAVIOR-MORTALITY...Behavior, Mortality Rates, Nutrition -other, Seals, Vertebrate Anatomy,...5.0672

**Scales**

ANALYSIS OF SALMONID SCALES...Age, Animal Taxonomy, Columbia River, Growth Rate, Rainbow Trout, Steelhead Trout, Salmon -coho,chinook,sockeye,...5.0315

AGE AND GROWTH OF BLUEFISH...Age, Atlantic Ocean-north, Bluefish, Growth Rate, Population Dynamics,...5.0315

OCEAN GROWTH AND MORTALITY OF SALMON...Growth Rate, Mortality Rates, Salmon -coho,chinook,sockeye,..., Tags,...5.0170

GULF OF ALASKA SOCKEYE SALMON SCALES, PROTOCOL AREA SOCKEYE SALMON SCAL...Protocol Area Sockeye Salmon Scales, and Gulf of Alaska Pink Salmon Scales...Animal Taxonomy, Gulf of Alaska, Life History Studies, Salmon -coho,chinook,sockeye,...5.0334

Thermoregulation

ENERGY REQUIREMENTS OF MARINE ORGANISMS...Energy, Sharks, Tuna, Mackerel, Albacore,..., Water Pressure,...5.0273

PHYSIOLOGY OF MARINE MAMMALS...Environmental Physiology, Mammals, Seals,...5.0624

THERMOMETABOLIC RELATIONSHIPS OF STENOTHERMAL FISHES...Antarctica, Environmental Physiology, Fish -non-specific, Proprioceptors, Water Pressure, Water Temperature -non-specific,...5.0312

MARINE PHYSIOLOGY...Cardiovascular System, Fish, Osmoregulation, Water Pressure,...5.0947

THE PHYSIOLOGY OF TUNA AND OTHER PELAGIC FISH...Blood -other, Environmental Physiology, Tuna, Mackerel, Albacore,...5.0272

**Spinal Orientation of Fishes and its Sensory Bases**...Behavior, Migration, Salmon & Trout -non-specific, Visual Organs,...5.0289

**Sensory Processes, Marine and Human**...Bioelectric Phenomena, Nervous System, Pathways, Visual,...5.0969

ACOUSTICO-LATERALS FUNCTION IN FISH ORIENTATION AND COMMUNICATION...Auditory, Behavior, Fish -non-specific, Orientation, Signal Detection,...5.0289

SCHOOLING BEHAVIOR IN FISHES...Behavior, Fish -non-specific, Social Behavior, Visual Organs,...5.0228

SONIC SENSITIVITY OF FISHES AND AMPHIBIA...Auditory, Comparative Physiology, Fish -non-specific, Frogs,...5.0290

FEEDING BEHAVIOR...Alevines, menhaden, shad, herring, Anchoovies, Behavior, Environmental Physiology, Food Supply,...5.0470

Auditory

PERCEPTUAL, VOCAL, AND ECHO-RANGING BEHAVIOR OF SEALS AND SEA LIONS...Echolocation, Seals, Sound Production, Visual Organs,...5.0347

RENEWAL, RESEARCH PROPOSAL FOR HEARING AND ALLIED SENSES IN FISHES...Behavior, Fish -non-specific, Sound Production,...5.0254

ACOUSTICO-LATERALS FUNCTION IN FISH ORIENTATION AND COMMUNICATION...Behavior, Fish -non-specific, Orientation, Sensory Organs, Signal Detection,...5.0289

AUDITORY CAPACITIES OF TELEST FISHES...Behavior, Fish -other, Vertebrate Anatomy,...5.0291

EXPERIMENTAL ANALYSIS OF HEARING AND ACOUSTIC ORIENTATION IN SHARKS...Behavior, Shark Repellents, Sharks,...5.0235

BEHAVIOR AND SENSORY PHYSIOLOGY OF SHARKS...Behavioral Ecology, Fish Repellents, Sharks, Tape Recording, Audio, Visual Organs,...5.0253

SONIC SENSITIVITY OF FISHES AND AMPHIBIA...Comparative Physiology, Fish -non-specific, Frogs, Sensory Organs,...5.0960

ACOUSTICAL COMMUNICATION IN AQUATIC ORGANISMS...Behavioral Ecology, Central Nervous System, Orientation, Sound Production,...5.0318

Olfactory

SPATIAL ORIENTATION OF FISHES AND ITS SENSORY BASES...Behavior, Migration, Salmon & Trout -non-specific, Visual Organs,...5.0339

INVESTIGATE PHYSIOLOGY OF TUNAS...Behavior, Blood -other, Environmental Physiology, Muscle, Tuna, Mackerel, Albacore,...5.0253

Proprioceptors

SIMULATED WEAUTLESSNESS IN FISH...Behavior, Cardiovascular System, Fish -non-specific, Gravitational Fields, Gravity,...5.0275

THERMALMETABOLIC RELATIONSHIPS OF STENOTHERMAL FISHES...Antarctica, Environmental Physiology, Fish -non-specific, Thermoregulation, Water Pressure, Water Temperature -non-specific,...5.0312

SAMPLING OF GROUNDFISH STOCKS...Age, Bone, Codfishes, Hake, Righteye Flounders, Size,...5.0160

BIOSTATISTICS OF HERRING...Age, Alevine, menhaden, shad, herring, Atlantic Ocean-north, Environmental Ecology, Growth Rate, Population Dynamics,...5.0099

Visual Organs

VISUAL CAPACITIES IN TELEOST FISHES...Behavior, Behavioral Ecology, Fish -other, Vertebrate Anatomy, Vision,...5.0290

PERCEPTUAL VOCAL, AND ECHO-RANGING BEHAVIOR OF SEALS AND SEA LIONS...Auditory, Echolocation, Seals, Sound Production,...5.0289

SPATIAL ORIENTATION OF FISHES AND ITS SENSORY BASES...Behavior, Migration, Olfactroy, Salmon & Trout -non-specific,...5.0339

SCHOOLING BEHAVIOR IN FISHES...Behavior, Fish -non-specific, Social Behavior,...5.0125

BEHAVIOR AND SENSORY PHYSIOLOGY OF SHARKS...Auditory, Behavioral Ecology, Fish Repellents, Sharks, Tape Recording, Audio,...5.0253

THE SPECTRAL SENSITIVITY OF THE GREEN SEA TURTLE (CHELONIA MYDAS)...Light Quantity -non-specific, Turtles, Terrapins, Tortoises,...5.0560

697
SUBJECT INDEX

Washington

A TRAINING PROGRAM FOR GRADUATE STUDENTS IN MARINE SCIENCES AT THE FRIDAY HARBOR LABORATORIES ...Marine Biology, Marine Biology (non-specific), Training Grants, Fellowship, ...11.0042

DETAILED STUDY OF THE OCEANIC CRUST BY MEANS OF DEEP SEISMIC PROFILING ...Continental Shelves, Heat Flow Measurements, Seismic Studies, Subbottom, Textures-structures, ...7.0152

SEISMIC, MAGNETIC, AND ACOUSTIC STUDIES ON THE CONTINENTAL MARGIN OFF WASHINGTON ...Acoustical, Continental Shelf, Mechanical Properties, Subbottom, Textures-structures, ...7.0151

PROPERTIES AND ORIGIN OF SEDIMENTS IN THE NORTHEAST PACIFIC OCEAN ...Carbon-14, Core Analysis, Origin, Pacific Ocean-east, Physical Properties, ...7.0287

OCEANOGRAPHIC PROCESSES IN ESTUARINE AND COASTAL WATERS ...Oceanic Fronts, Pacific Ocean-east, Puget Sound, Shoreline - Coastline, Water Properties-general, ...4.0050

TAGGING ENGLISH SOLE, PETRALE SOLE, AND PACIFIC COD ...Codfishes, Hake, Commercial Fishing, Migration, Righteye Flounders, Size, Tags, ...5.0158

TAG LOSS ...Captive Rearing, Salmon -coho,chinook,sockeye-, Size, Tags, Weight, ...5.0157

MEASUREMENT OF SPAWNING SUCCESS AND FRY QUALITY OF CHUM SALMON UTILIZING A SPAWNING CHANNEL AT BIG BEEF CREEK, WASHINGTON ...Management-other, Number Or Density, Quality -non-specific, Salmon -coho,chinook,sockeye- ...Spawning & Nesting Sites, ...5.0229

TAG RECOVERY, ENGLISH SOLE, PETRALE SOLE, AND PACIFIC COD ...Codfishes, Hake, Migration, Population Dynamics, Righteye Flounders, Tags, ...5.0159

INFLUENCE OF INDUSTRIAL AND MUNICIPAL WASTES ON ESTUARINE AND OFF SHORE WATER QUALITY ...Domestic Wastes-general, Estuaries, Industrial Wastes, Pollution - Effects of, ...6.0192

OREGON-WASHINGTON NEARSHORE ...Distribution, Heavy Minerals, Oregon, Shoreline - Coastline, Terrigenous, ...7.0022

Waste Disposal-general

TIME DEPENDENT VARIATIONS IN SURFACE OCEANIC CIRCULATION ...Circulation-general, Ocean History, Pollution Sources-general, Sedimentary History, Temperature, ...2.0038

THE INSTITUTE FOR THE DEVELOPMENT OF RIVERINE AND ESTUARINE SYSTEMS (IDRES) ...Delaware River, Estuaries, ...12.0043

Waste Water Treatment

Adsorption & Absorption

Activated Carbon

MODEL ADVANCED WASTE-TREATMENT PLANT ...Lime Treatment, Material Recovery Wastes, Pilot Plant, Process Design, Solid Waste, ...8.0326

Chemical Treatment

Lime Treatment

MODEL ADVANCED WASTE-TREATMENT PLANT ...Activated Carbon, Material Recovery Wastes, Pilot Plant, Process Design, Solid Waste, ...8.0326

Degradation

Biological

ULTRAVIOLET ABSORPTION IN COASTAL WATERS ...Marine Plants, Physical Parameters, Plant Prod. (non-specific), Sewage, Total Organic Carbon, Ultra - Violet Radiation, ...6.0138

Denitrification

RESEARCH ON THE ROLE OF BACTERIA IN THE OCEAN ...Elect Trans and Redox, Marine Bacteria, Microorganism Enzymes, Nitrogen Bacteria, Respiration, ...5.0783

Dilution - Self Purification

Water Chemistry

Dilution-other

ESTUARINE DIFFUSION OF POLLUTANTS ...Estuaries, Oregon, Pollutants - Path of, Salinity, Stratification, ...6.0175

Ocean

SALT WATER ENTRAINMENT FOR DILUTION IN SEWER OUTFALLS ...Conduit Flow-other, Dispersion -water, Fluid Flow-other, Pilot Plant, Solid Waste, ...8.0326

DISPERSION IN HYDROLOGIC AND COASTAL ENVIRONMENTS ...Dispersion -water, Groundwater Movement, Shoreline - Coastline, Stratified Flow, Turbulent Flow, ...2.0051

DEMONSTRATION OF THE LIMITATIONS AND EFFECTS OF WASTE DISPOSAL ON AN OCEAN SHELF ...Marine Plants, Outlet, Pollution - Effects of, Pollution Effects, Sewers, ...6.0146

COASTAL DIFFUSION OF POLLUTANTS ...Currents-other, Model Studies, Oregon, Outlet, Pulp and Paper Wastes, ...8.0174

SYSTEMS ANALYSIS FOR SHIPBORNE MUNICIPAL INCINERATION ...Distribution, Incinerators, Pollution Sources-other, Smoke, Solids Waste, ...8.0327

Plants - Systems

Process Design

MODEL ADVANCED WASTE-TREATMENT PLANT ...Activated Carbon, Lime Treatment, Material Recovery Wastes, Pilot Plant, Solid Waste, ...8.0326

OCEANOGRAPHIC FACTORS IN THE FUNCTIONAL DESIGN OF WASTE DISPOSAL SYSTEMS ...Jet Flow-other, Mixing, Nuclear Power, Outlet, Sewers, ...8.0325

Properties

Total Organic Carbon

ULTRAVIOLET ABSORPTION IN COASTAL WATERS ...Biological, Marine Plants, Physical Parameters, Plant Prod. (non-specific), Sewage, Ultra - Violet Radiation, ...6.0138

Water

NEUROENDOCRINE REGULATION ...Brain, Crustacea -non-specific, Endocrine System, Osmoregulation, Sodium, ...5.0426

PHYSICAL ACOUSTICS AND THE PROPERTIES OF WATER ...Acoustical, Cavitation, Constants, Ultrasonic Frequency, Vibroimter, Velocity, ...1.0031

Water Chemistry

A SYMPOSIUM ENTITLED ORGANIC CHEMISTRY OF NATURAL WATERS ...Alaska, Chemical-general, Meetings, Organic, Organic Matter, Organic-general, Organics, Organics-general, Polar, Sediments, Water Analysis, ...11.0001

Chemical Reactions

RADIOELEMENT STUDIES IN THE OCEANS- PLANKTON DISTRIBUTION STUDIES ...Foraminifera, Number Or Density, Protocoilus -other, Vertical Distribution, ...5.0792

CHEMICAL OCEANOGRAPHY ...Carbon, Carbon-14, Gulf of Mexico, Organics, Reaction-general, ...1.0131

LIGHT ISOPE STUDIES ...Circulation-general, Denitrification, Isotope Trace-other, Mixing, Oxygen, Particle-gas Transfer, ...1.0077

RESEARCH ON THE PHYSICAL CHEMISTRY OF CHEMICAL REACTIONS IN SEA WATER ...AciXy, Apatite-general, Carbonate, Bicarbonate, Equilibrium, Chemical, High Pressure Reactor, Reaction-general, Solubility, Sulfate, Sulfite, ...1.0127

MINERALOGICAL CONTROLS ON THE CHEMICAL COMPOSITION OF OCEAN WATER ...Clay Minerals - general, Discriptions of Minerals, Mexico, Mineralogy, Siltite-genral, ...1.0118

SOLUTION-SILICATE REACTIONS AND EQUILIBRIA ...Chemistry, Equilibrium, Chemical, Groundwater, Reaction-general, Silicate-general, Solution, Solution Chemistry, ...1.0097

CHEMICAL PROPERTIES OF SEA WATER AND THEIR USE IN STUDIES OF WATER FLOW AS SEES MIXING ...Gases,
SUBJECT INDEX

Water Chemistry

OCEANOGRAPHIC RESEARCH-INVESTIGATIONS IN SHALLOW WATER ...Acoustical, Environmental Effects-geologic, Moulal Studies, Thermal, Water Motion, ...1.0089
DELWARE ESTUARY SEDIMENTATION STUDY ...Delaware Bay, Estuaries, Sediment Yield, Sedimentation, Supply Rate, ...7.0275
SURVIVAL REQUIREMENTS OF JUVENILE AND ADULT BLUE CRABS ...Biological rhythms, Crabs, Environmental Physiology, Maturity & Growth Stages, Osmoregulation, 55%, ...5.0476
INVESTIGATE SEASONAL VARIATIONS, SURFACE WATER TYPES, HAWAIIAN AREA (KOKO HEAD) ...Commercial Fishing, Hawaii, Heat and Radiation Transfer, Oceanic Fronts, Temperature, Tuna, Mackerel, Allocaenae, Water Salinity, Water Temperature-non-specific, ...1.0146
ANALYZE AND PUBLISH BASIC DATA FROM PILOT STUDY ...Environmental Changes, Oceanic Fronts, Pacific Ocean-general, Technique Development, Thermal, ...4.0024
INTERNATIONAL NORTH PACIFIC FISHERIES COMMISSION SUBARCTIC OCEANOGRAPHY ...Currents-ocean, Depth, Pacific Ocean-north, Range Or Territorial Dist. , Salmon-oil, chum, sockeye, Temperature, ...1.0129
ESTUARINE DIFFUSION OF POLLUTANTS ...Dilution-other, Estuaries, Oregon, Pollutants - Path of , Stratification, ...6.0175

Sea Water Chemistry-other

ARCTIC EAST OCEANOGRAPHIC PROJECT (OCEANOGRAPHY OF THE BAFFIN BAY REGION) ...Baffin Bay, Circulation-general, Marine Biology, Polar, Water Properties-general, ...4.0125

Water Analysis

GEOCHEMICAL STUDIES OF CONTINENTAL WATERS ...Aurignacian, Element Ratios, Geochemical analysis, Isotope, Isotope-Tracer-other, Location, Pore Fluids, Radiotopes, ...1.0125
DISSOLVED ORGANIC PHOSPHORUS IN NATURAL WATERS ...Lower Plants, Phosphorus, Phytoplankton, ...1.0125
RADIOELEMENT STUDIES IN THE OCEANS - LANTHANEIDES IN SEA WATER AND THEIR INTERACTIONS WITH MARINE SEDIMENTS AND SUSPENSIDS ...Atlantic Ocean-general, Lanthanide Series, Oceanic Fronts, Radiochemical Analysis, Trace Elements, ...1.0164
RADIOELEMENT STUDIES IN THE OCEANS - GEOLOGY AND GEOCHEMISTRY ABOUT THE MID-ATLANTIC RIDGE ...Adsorption Capacity, Chemistry, Isotope, Removal-inorganics, Ridges, ...7.0072
NUCLEAR OCEANOGRAPHIC TECHNIQUES ...Currents-ocean, Isotope Dilution, Physical Properties, Radioactivity, Water Motion Recorders, ...8.0087

A SYMPOSIUM ON DISSOLVED ORGANIC CHEMISTRY OF NATURAL WATERS ...Alaska, Chemical-general, Meetings, Organic, Organic Matter, Organics-general, Organics-general, Polar, Sediments, Water Chemistry, ...11.0091
ORGANIC COMPOUNDS IN THE SEA AND IN MARINE SEDIMENTS ...Marine Biochemistry, Isotopes, Organic, Organics, Protactinium, ...1.0160
STABLE CARBON AND OXYGEN ISOTOPIC RATIO VARIATIONS IN THE FLOW TO CARBON AND OXYGEN THROUGH NORMAL AND POLLUTED AQUATIC SYSTEMS ...Carbon, Element Ratios, Isotope, Oxygen, Pollutants - Path of , Sewage Systems-other, ...1.0132
DETERMINATION OF VOLATILE ORGANICS IN SEA WATER ...Chemical Analysis (water), Gas Chromatography, Organic, Organics-general, Technique Development, ...1.0094
Water Chemistry

CHEMICAL PROPERTIES OF SEA WATER AND THEIR USE IN STUDIES OF WATER MASSES AND MIXING ...Chemical Reactions, Gases, Mixing, Oceanic Fronts, Pacific Ocean-east, ...1.0126

THE EFFECTS OF POTASSIUM FROM FRESH AND SALINE WATERS BY CLAY MINERALS ...Adsorption Capacity, Clay Minerals-general, Extraction, Potassium, ...1.0087

BACTERIOGEOLOGICAL AND ESTHETIC OF PLEASURE BOAT WASTE DISCHARGE ON SMALL HARBORS ...Bacterial Pollution Sources, Beautification, Harbors, Marinas, Ship Wastes, ...6.0191

PH STANDARD REFERENCE MATERIALS FOR USE IN SEA OCEAN-ATMOSPHERE STUDIES WITH STEADY ISOTOPES FLUXES OF DISSOLVED GASES AND NUTRIENTS RELATING TO BIOCHEMICAL AND AERATION PROCESSES OF THE OREGON COAST ...Chemical Analysis (water), Oregon, Organics, Particle-gas Transfer, Phosphite, Phosphite, ...3.0037

OCEAN-ATMOSPHERE STUDIES WITH STABLE ISOTOPES AND DISSOLVED GASES ...African Ocean ...Equilibrium - Chemical, Mixing, Oceanic Fronts, Particle-gas Transfer, Trace, ...5.0005

DEVELOPMENT OF AN INSTRUMENT FOR MEASURING THE CONCENTRATION OF DISSOLVED OXYGEN IN SEA WATER IN SITU ...Chemical Analysis (water), Instrumental Services, Oxygen, Technique Development, Telemetry-other, ...8.0092

MASS SPECTROMETRIC AND MANOMETRIC STUDIES OF THE OCEANS AND THE ATMOSPHERE ...Chemical Analysis (water), Mass Spectrometry, Ocean History, Particle-gas Transfer, Solubility, ...1.0101

TECTONIC AND GEOLOGICAL HISTORY OF THE SOUTHWEST PACIFIC REGION ...Geophysics-general, Island Arcs, Oceans - Sea Water, Pacific Ocean-south, Sedimentary Structural Studies, Tectonics-general, ...7.0031

CHEMICAL FEATURES OF THE SUBARCTIC BOUNDARY IN THE NORTHERN PACIFIC OCEAN ...Carbon Dioxide, Circulation-general, Mixing, Oceanic Fronts, Pacific Ocean-north, Sub-Polar, ...1.0125

STUDY OF THE EXCHANGE OF CARBON DIOXIDE BETWEEN THE ATMOSPHERE AND THE OCEANS ...Carbon-dioxide Applications, Metabolic Studies, Particle-gas Transfer, ...1.0081

DISTRIBUTION OF CARBON AND RADIUM IN THE ANTARCTIC WATERS ...Carbon, Indian Ocean-general, Radioactivity Applications, Sampling, Trace Elements, ...1.0109

CHEMICAL PROPERTIES OF SEA WATER AND THEIR USE IN STUDIES OF WATER MASSES AND MIXING ...Chemical Reactions, Mixing, Oceanic Fronts, Pacific Ocean-east, Water Analysis, ...1.0126

PRECISION MEASUREMENTS OF DISSOLVED OXYGEN, NITROGEN AND ARGON IN SEA WATER ...Argon, Nitrogen, Oxygen, Particle-gas transfer, Solubility, Special Mission Ships, ...1.0092

RESPIRATORY EXCHANGE IN FISH GILLS ...Fish, Submersibles, ...5.0267

REMOTE SENSING ...Currents-ocean, Microwave Radiation, Mixing, Oil, Salinity, Temperature, ...4.0171

DEEP SUBMERGENCE DISSOLVED OXYGEN TRANSUDER ...Instrumental Services, Oxygen, Submersibles, Transducers, ...8.0007

OCEANOGRAPHIC RESEARCH ...Acoustical, Density, Marine Biology, Thermal, Water Motion, ...1.0142

SHIPBOARD METHODS OF CHEMICAL ANALYSIS ...Caribbean Sea, Marine Biology, Meteorology, Tropical Water Analysis-general, ...1.0091

CHEMICAL PROPERTIES OF SEA WATER AT PRESSURE ...General Sea Water Chemistry, Intertidal - Conneat Water, Pressure, Solubility, Vicinity, ...1.0099

OCEANOGRAPHIC STUDY OF NORTHEASTERN U. S. COASTAL WATERS FOR INTERNATIONAL COMMISSION FOR NORTHWEST ATLANTIC FISHERIES ...Commercial Fishing, Salinity, Ships and Cruises, Temperature, ...4.0123

CARBON MONOXIDE CONTENT OF GLACIAL ICE AND THE NATURAL ATMOSPHERE ...Carbon, Composition, Dispersion - Transportation, Mono-oxide, ...3.0066

ORGANICS

(A) ANNUAL SUPPLY OF PARTICULATE MATTER IN THE GREAT BAY ESTUARY (B) LATE PLEISTOCENE HISTORY OF THE GREAT LAKES ESTUARIES, New Hampshire, Quaternary Period, Sampling, Sedimentary History, ...1.0116

ORGANIC PRODUCTION OF EPIPANTAL ORGANISMS ...Energy Budgets, Epiphytic Relationships, Marine Biology (non-specific), Plants - Ecosystems (non-specific), Primary Productivity, Reefs, ...5.1052

CHEMICAL OCEANOGRAPHY ...Biogeochemical Process, Circulation-general, Geologic, Rare Earth Studies, Trace Elements, ...1.0129

CHEMICAL OCEANOGRAPHY ...Carbon, Carbon-14, Chemical Reactions, Gulf of Mexico, Reaction-general, ...1.0131

UPTAKE AND ASSIMILATION OF ORGANIC COMPOUNDS IN MARINE ORGANISMS ...Active Transport, Invertebrates - non-specific, Metabolism, Nutrition, Productivity - Food Chain, ...5.0937

GEOCHEMICAL OCEANOGRAPHY ...Acids, Carboxylic Substance, Organic, ...1.0102

HETEROTROPHIC ACTIVITY AND PRIMARY REGENERATION IN THE OCEAN ...Atlantic Ocean-south, Biodegradation, Carbon, Gulf of Mexico, Organics-general, ...1.0114

MICROBIAL TRANSFORMATIONS IN SEA WATER ...Chemostat, Growth Rate, Marine Resource From Nat. environ., Marine Bacteria, Nutrition, ...5.0976

NUTRITIONAL STUDIES ON MARINE ORGANISMS ...Crustacea - non-specific, Invertebrate Nutrition, Nutrition Studies, Phytoplankton, ...5.1001

THE CHARACTERISTICS, MECHANISMS AND BIOGEOCHEMICAL CONSEQUENCES OF PHYTOPLANKTON FLATULATION ...Phytoplankton, Plant Lipids, Silicon, Size, Vertical Distribution, ...5.0826

A SYMPOSIUM ENTITLED ORGANIC CHEMISTRY OF NATURAL WATERS ...Alaska, Chemical-general, Meetings, Organic, Organic Matter, Organic-general, Organics-general, Polar, Sediments, Water Analysis, Water Chemistry, ...11.0001

FLUXES OF DISSOLVED GASES AND NUTRIENTS RELATING TO BIOCHEMICAL AND AERATION PROCESSES OFF THE OREGON COAST ...Chemical Analysis (water), Gases, Oregon, Particle-gas transfer, Phosphate, Phosphite, ...3.0037

ORGANIC COMPOUNDS IN THE SEA AND IN MARINE SEDIMENTS ...Marine Biology (non-specific), Organic, Plankton - (non-specific), Removal-organics, Water Analysis, ...1.0103

BIOLICAL PRODUCTIVITY INVESTIGATIONS OF THE WATERS SURROUNDING ANTARCTICA ...Optical, Phytoplankton, Primary Productivity, Standing Crops, Weddell Sea, ...5.1030

DETERMINATION OF VOLATILE ORGANICS IN SEA WATER ...Chemical Analysis (water), Gas Chromatography, Organics-general, Technique Development, Water Analysis, ...1.0101

STUDIES OF OXYGEN-FREE, SULFIDE-BEARING MARINE ENVIRONMENTS ...Chemistry, Model Studies, ...1.0135

ORGANIC MATTER - Atlantic Ocean-general, Mixing, Oceanic Fronts, Oxygen, Sampling, Ships and Cruises, ...1.0111

BIODIVERSITY MEASUREMENTS IN THE MARINE ENVIRONMENT ...Clorophytes, Energy, Energy Budgets, Productivity - Food Chain, ...1.0076

SUPPORTING TECHNOLOGY AT NAVAL RESEARCH LABORATORY ...Abyssal, Feeding, Microorganisms (non-specific), Submersibles, ...8.0217

ORGANIC GEOCHEMISTRY OF SAN FRANCISCO BAY WATERS AND SEDIMENTS ...Clays, Distribution, Sedimentation, ...5.1038

MARINE INTERFACE CHEMISTRY ...Air-sea Boundary, General, General Sea Water Chemistry, Sampling, ...1.0073

BIOCHEMICAL AND BIOPHYSICAL STUDIES OF THE MARINE ENVIRONMENT ...Copepods, Energy, Energy Budgets, Productivity - Food Chain, ...4.0126

INTERNATIONAL WEDDELL SEA OCEANOGRAPHIC EXPEDITION ...Population Dynamics, Primary Productivity, Productivity - Food Chain, Shales, Weddell Sea, ...4.0121
SUBJECT INDEX

Water Motion

CHEMICAL OCEANOGRAPHY...Arctic, Circulation-general...Isotope Tracer-other, Oceanic Fronts, Tracers, ...1.0072
SHIPBOARD METHODS OF CHEMICAL ANALYSIS...Caribbean Sea, Gases, Mass Spectrometry, Solubility, Technique Development, ...1.0091
COASTAL WATER AND INSHORE OCEANOGRAPHY...Alaska, Estuaries, Marine Biology, Shoreline - Coastline, Water Properties-general, ...5.0851
CHEMICAL METHODOLOGY - APPLICATION OF NITRATE SPECIFIC ELECTRODE TO CHEMICAL OCEANOGRAPHY...Electrode, ...1.0093

Water Chemistry-other

SEDEMON SEDIMENTOLOGY...Autogenic, Other, Precipitation, Removal-inorganics, ...7.0190
MEASUREMENT OF SURFACE CHARGE ON PARTICLES SUSPENDED IN SEA WATER...Electrical, Suspension, Zeta Potential, ...7.0205
MINERALOGICAL STUDIES OF PARTICULATE MATTER SUSPENDED IN SEA WATER...Chemistry, Mineralogy, Suspension, ...1.0112
ELEMENT CHEMISTRY...Atomic Absorption, Element Ratios, Industrial Wastes, Oceanic Fronts, ...1.0113
STABLE ISOTOPES...Atlantic Ocean-north, Atlantic Ocean-south, Carbon, Chemical Analysis (water), Sampling, ...1.0124
PH STANDARD REFERENCE MATERIALS FOR USE IN SEA WATER...pH, Salinity, Standards, Specifications, Water Analysis, ...1.0087

Water Cycle

FIELD EXPERIMENTS ON THE FLUX OF RADIONUCLIDES THROUGH A SALT MARSH ECOSYSTEM...Chlorideae (non-specific & Ot), Georgia, Model Studies, Productivity - Food Chain, Swamps-marshes, ...5.0965

Water Demand

ECONOMICS OF WATER QUALITY FOR A REGIONAL SYSTEM...Delaware River, Economic Efficiency, Estuaries, Finance, Regional Areas, Water Quality-general, ...5.0018

Water Harvesting

HYDROLOGY OF UPPER OLD TAMPA BAY, FLORIDA...Bays, Groundwater Movement, Hydrology-general, Lakes, Permeability, Water Quality-general, ...2.0067

Water Level Fluctuation

GEOLOGICAL STUDIES IN NORTHERN LAKE MICHIGAN...Deposits-other, Lake Michigan, Lakes, Rocks - Bedrock, Submerged, ...7.0164
BIOCHEMICAL EFFECTS OF MICROORGANISMS UPON THE SALT MARSH ENVIRONMENT...Aquatic Soils, Core Analysis, Identification, Marine Bacteria, Salinity, Swamps-marshes, Temperature, ...7.0763
THE NET EFFECT OF WIND ON RECREATIONAL TIDAL STREAMS IN FLORIDA...Air-sea Boundary-other, Estuaries, Florida, Tides, Wind-general, ...2.0082
GREAT LAKES RESEARCH - WATER-LEVEL DISTURBANCES...Lake Erie, Lake Michigan, Model Studies, Sea Level Variations, Seiches, ...2.0086
GREAT LAKES RESEARCH - HARBOR CURRENTS...Great Lakes-general, Harbors, Model Studies, Ocean Currents-other, Pressure-density, Water-Water Interaction, ...2.0074
HYDRAULICS AND DYNAMICS OF ESTUARIES...Erosion-general, Estuaries, Flow Characteristics -water, Sedimentation, Sedimentology-general, Waves, ...7.0102

Water Motion

GULF STREAM EDDIES...Data Analysis - General, Data Reduction and Analysis, Gulf Stream, Hydrodynamics, Temperature, ...2.0028
OCEAN KINETICS DYNAMICS...Chesapeake Bay, Circulation-general, Data Reduction and Analysis, Estuaries, Turbulent Flow, ...2.0069
TURBULENT DIFFUSION STUDY...Chesapeake Bay, Dispersion -water, Estuaries, Tracers-general, Turbulent Flow, ...2.0056
DELAY LINE COMPUTER...Acoustical, Heat and Radiation Transfer, Hybrid Computer Applications, Meteorological Studies, Model Studies, ...4.0080

Trace Elements

CLAY-INORGANIC AND ORGANIC-INORGANIC ASSOCIATIONS IN AQUATIC ENVIRONMENTS...Clays, Deposits, Mineral Reactions, Sedimentation, Suspension, ...7.0050
RADIOELEMENT STUDIES IN THE OCEANS - LANTHANE SERIES IN WATER AND THEIR INTERACTIONS WITH MARINE SEDIMENTS AND SUSPENSIDS...Atlantic Ocean-general, Lanthane Series, Oceanic Fronts, Radiochemistry, Water Analysis, ...1.0104
CHEMICAL OCEANOGRAPHY...Biogeochemical Process, Circulation-general, Geologic, Organics, Rare Earth Studies, ...1.0129
SEA WATER CHEMISTRY...Atmosphere Composition, Gases, Industrial-general, Lead, Technique Development, ...1.0076
DETERMINATION OF TRITIUM IN NATURAL WATERS...Nuclear Explosions - Fallout, Radioactivity, Tracers, Tritium, ...1.0083
DISTRIBUTION OF CARBON AND RADIUS IN THE ANTARCTIC WATERS...Carbon, Gasses, Indian Ocean-general, Radius, Sampling, ...1.0109
FACTORS INFLUENCING THE INTENSITY OF BIOLUMINESCENCE...Bioluminescence, Cell env.(non-specific & Ot.), Kinetics, Marine Biology, Optical, ...1.0169
CHEMICAL STUDIES OF THE OCEAN ENVIRONMENT...Chemical Reactions, Marine Biology, Mixing, Oceanic Fronts, Pacific Ocean-east, Water Analysis-general, ...1.0136
CHRONOLOGY OF MARINE SEDIMENTS, CIRCULATION OF WATER AND TRACE ELEMENTS...SEDIMENTARY RECORD AND CIRCUMMEDIATE ACCRETION...Circulation-general, Cosmogenous, Pacific Ocean-general, Paleoclimatology, Sedimentary History, ...1.0098

STUDIES IN MARINE CHEMISTRY...Bone, Chemistry, ...7.0068
MARINE BIOLOGY PROGRAM...Distribution, Productivity - Food Chain, Puerto Rico, Radioecology, Rare Earths, ...1.0128
FALLOUT INVENTORY OF THE OCEANS AND RELATED MECHANISMS...Activation Analysis, Radioactivity, Reactivity-activity-general, ...6.0189
RADIOISOTOPE TRACERS IN OCEANOGRAPHIC RESEARCH...Circulation-general, Radioactivity-general, Sampling, Tracers, ...2.0001
TRACE ELEMENT EQUILIBRIUM STUDIES...Adsorption, Chelating Agents, Ion Exchange, Material Recovery, Tracers, ...1.0088
OSTISPOTEOCEANOGRAPHY...Arctic Ocean, Data Acquisition, Oceans - Sea Water, Radioactivity-general, Sampling, ...1.0090
CHEMICAL OCEANOGRAPHY...Aquatic Ecology, Circulation-general, Convection, Technique Development, ...1.0134

Water Analysis-general

SEAWATER/SEDIMENT/BI OLOGY MONITORING PROGRAM...Data Acquisition, Marine Biology, Sediments-other, ...1.0144
ANALYSIS OF SEA WATER BY DIFFERENCE CHROMATOGRAPHY...Interstitial - Conserve Water, Ion Exchange, Runoff, Salinity, ...1.0110
LIGHT IN THE SEA...Index of Refraction, Optical, Scattering, Tracers, Water Motion, ...1.0168
ELECTROLYTE-NON-ELECTROLYTE INTERACTIONS IN SEA WATER AND RELATED SOLUTIONS...Alkali Metals, Alkaline Earth, Complexes, Electrolytes, Saline Water Systems, Thermal Properties-other, ...1.0107
SUPPORT FOR THE OPERATION OF OCEANOGRAPHIC RESEARCH VESSELS...Black Sea, Marine Biology, Mediterranean Sea, Oceanography, Sea, Sedimentation, Ships and Cruises, ...1.0036

PHYSICAL AND CHEMICAL ATLAS...Atlases-maps, Convecton, General, Sea Water Chemistry, Indian Ocean-general, Water Properties-general, ...4.0026
SIGNIFICANCE OF FLUORIDE VARIATIONS IN SEA WATER...Atlantic Ocean-general, Chloride, Element Ratios, Extrusives, Fluorides, ...1.0165
HEAVY METAL GEOCHEMISTRY OF ANTARCTIC SEA WATER AND MARINE SEDIMENTS...Antarctic Ocean, Chemistry, Circulation-general, Sedimentation, ...1.0066
DEEP OCEAN AS RECIPIENT OF VOLATILES AND SOLUTES...Hydrothermal Minerals, Igneous Activity - Volcanism, Marion, McMurdo, Oceanic Fronts, Ridges, Sea Floor Spreading, Thermal Features, ...7.0095
CHEMICAL STUDIES OF THE OCEANIC ENVIRONMENT...Chemical Reactions, Marine Biology, Mixing, Oceanic Fronts, Pacific Ocean-east, Trace Elements, ...1.0136
Water Motion

SUBJECT INDEX

LONG RANGE SOFAR FLOATS ...Acoustical, Currents-ocean,
Physical Analysis, Subsurface Environments, Water Motion
Recorders, ...2.0025

LIGHT IN THE SEA ...Index of Refraction, Optical, Scattering,
Tracers, Water Analysis-general, ...1.0168

STUDY OF OCEANIC TURBULENCE ...Energy, Hydrodynam-
ics, Mixing, Subsurface Environments, Turbulence - Sea Water,
...2.0055

STUDIES OF BARACLINIC TIDAL MOTIONS ON THE CONTI-
NENTAL SHELF OF THE EASTERN UNITED STATES...
...Continental Shelf, Eastern, Meteorological Studies, Sea Level
Variations, Tides, ...1.0081

STUDY OF STABILITY AND SHEAR IN THE TOP 500 METERS
OF THE OCEAN ...California Current, Density, Mixing,
Water Motion Recorders, ...1.0171

USE OF GEOMETRIC CORRELATORS FOR ENVIRONMENTAL
RESEARCH ...Acoustical, Air-sea Boundary-general, Develop-
ment of Models, Hybrid Computer Applications, Meteorological
Studies, ...1.0081

BUOY ENGINEERING ...Buys, Experiments and Tests,
Moorings, ...8.0309

INVESTIGATION OF THE CIRCULATION OF LAKE SUPERI-
OR ...Circulation-general, Lake Superior, Model Studies,
Stratified Flow, Temperature, Thermodynamics, ...2.0048

CURRENT STUDY ON THE NEUSE RIVER AND ESTUARY
...Discharge, Dyes, Estuaries, North Carolina, Tracers,
...2.0037

EXPERIMENTAL AND THEORETICAL STUDY OF THE
HYDRODYNAMICS OF DISPERSION IN RIVERS AND ESTUARIES...
...Dispersion -water, Estuaries, Flow Characteristics -water,
Model Studies, Streams, ...2.0057

BIG EDDIES AND MIXING PROCESSES IN THE GREAT
LAKES ...Circulation -water, Dispersion -water, Eddy-transport
Water, Great Lakes-general, Mixing, ...2.0052

OCEANOGRAPHIC RESEARCH ...Acoustical, Density, Gases,
Marine Biology, Density, Mixing, ...2.0048

SHALLOW WATER ACOUSTIC PROPAGATION STUDIES
(SWAPS) ...Acoustical, Geomorphology-topography, Liquids,
Collections, Thermal, ...1.0141

OCEANOGRAPHIC RESEARCH-INVESTIGATIONS IN SHAL-
LOW WATER ...Acoustical, Environmental Effects-geologic,
Modeling, Salinity, Thermal, ...1.0059

GENERAL COASTAL INLET STUDIES ...Coastal Engineering,
other, Coastlines-shorelines, Discharge, Model Studies,
Hydrodynamics, Tides, ...7.0125

GREAT LAKES RESEARCH - RIVER ICE JAMS ...Great Lakes
general, Ice Jam, Streams, Survey Studies, ...3.0081

Water Motion Recorders

NUCLEAR OCEANOGRAPHIC TECHNIQUES ...Currents-
ocean, Isotopic Dilution, Physical Properties, Radioactivity,
Water Analysis, ...8.0087

WATER WAVE DOCUMENTATION ...Buys, California,
Pacific Ocean-general, Waves, ...2.0094

OCEAN CIRCULATION STUDIES ...Acoustical, Atlantic Ocean-
north, Currents-ocean, Hydrodynamics, Statistics-general,
Waves-internal, ...2.0060

OCEAN WAVES AND TIDES ...Currents-ocean, Subsurface
Environments, Thermal, Tides, Waves, ...2.0080

DESIGN AND DEVELOPMENT OF OCEANOGRAPHIC IN-
STRUMENTATION ...Bottom Sampling Device, Physical Analysis,
Technique Development, ...8.0090

OCEAN CURRENT TRANSPORT ...Gulf Stream, Navigation,
Ocean Waves - Currents, ...2.0016

HIGH FREQUENCY WAVES ...Forecasting-prediction, Heat and
Radiation Transfer, Hydrodynamics, Waves, ...2.0113

LONG RANGE SOFAR FLOATS ...Acoustical, Currents-ocean,
Physical Analysis, Subsurface Environments, Water Motion,
...2.0025

VERTICAL MOTIONS ...Convection, Gulf Stream, Hydrodynam-
ics, ...2.0060

DEEP-SEA AUTONOMOUS VEHICLES, INSTRUMENTS,
BASE CONTROL DEVICES, AND SPECIAL COLLECTING
GEAR ...Abyssal, Bottom Sampling Device, Organism Sampling
Devices, Photography, Sampling, Submersibles, ...8.0122

STUDY OF OCEAN CURRENTS AT SEA FLOOR AND THEIR
SPATIAL CORRELATION ...Bottom-hatched, Currents-
bottom, Field Characteristics, ...2.0003

704

OCEANOGRAPHY, PLEISTOCENE GEOLOGY AND SEDI-
MENTS OF LITTLE BAHAMA BANK ...British West Indies,
Carbonates-general, Currents-bottom, Energy, Quaternary
Period, ...7.0229

DEEP FLOW, WATER CHARACTERISTICS, TOPOGRAPHY
AND SEDIMENTS IN THE CENTRAL PACIFIC AREA...
...Abyssal, Currents-bottom, Distribution, Geomorphology-
topography, Pacific Ocean-general, Structural Studies, ...7.0032

STUDIES OF THE TRANSPORT OF THE FLORIDA CUR-
RENT ...British West Indies, Florida, Gulf Stream, Navigation,
Ocean Currents-other, ...2.0017

NATURE AND VELOCITY OF CURRENTS AND OTHER
FLOWS IN SUBMARINE CANYONS ...Convection, Fans,
Ocean Waves - Currents, Sedimentation, Submarine Canyons,
Turbidity Currents, ...2.0008

GULF STREAM TRANSPORT ...Automatic Stations, Gulf
Stream, Hydrodynamics, Ships and Cruises, ...2.0029

STUDY OF LOW FREQUENCY SURFACE WAVES IN THE
PACIFIC OCEAN ...Meteorological Studies, Sea Level Varia-
tions, Tides, Turbulence - Sea Water, Waves, ...2.0068

STUDY OF STABILITY AND SHEAR IN THE TOP 500 METERS
OF THE OCEAN ...California Current, Density, Mixing,
Water Motion, ...1.0171

HEAT FLOW MEASUREMENTS ...Atlantic Ocean-general,
Geophysical Equipment, Heat Flow Measurements, Photo-
graphy, Technique Development, ...7.0138

OCEAN BOTTOM EMPLACED GEOPHYSICAL STATION
...Automatic Stations, Benthonic-bottom, Dynamic Gravimeters,
Geophysical Equipment, Gravity Studies, Instrumental Services,
Pacific Ocean-east, Temperature, ...4.0038

CHARACTERISTICS, CAUSES, AND PREDICTION OF UP-
WELLING WATER MASSES OFF OREGON ...Forecasting-
prediction, Mixing, Oceanic Fronts, Oregon, Pacific Ocean-east,
...2.0042

OCEANIC INTERNAL MOTIONS AFFECTING OPERATIONS...
...Bermuda, Buys, Military Aspects, Thermal, Waves-internal,
...2.0115

MEASUREMENT AND INTERPRETATION OF MO-
TIONALLY-INDUCED ELECTRIC FIELDS IN THE SEA...
...Currents-ocean, Electrical, Forecasting-prediction, Marine
Environments-general, Model Studies, Moorings, ...1.0139

OCEAN DYNAMICS EXPERIMENTS ...Buys, Moorings, Other-
design-and-construction, Submersibles, Technique Develop-
ment, Temperature, ...2.0072

OCEAN WAVES AND STRUCTURE ...Buys, Salinity, Ther-
modine, Tides, Waves, ...2.0106

MEASUREMENT OF SURGING IN KUHIO BAY, HILO
HAWAII ...Gaging, Harbors, Hawaii, Tsunami, Waves, ...2.0112

WAVE MEASUREMENT IN THE OPEN OCEAN ...Buys, Data
Acquisition, Oceanic - Pelagic, Profiles, Waves, ...2.0109

FODIC APPLICATION TO CURRENT-METER RECORDS...
...Currents-ocean, Data & Statistics Storage, Recording
Systems, Research - Development, Technique Development,
...4.0021

WATER CURRENT METERS ...Standards, Specifications,
...8.0079

ADVANCED RESEARCH - SATELLITE INTERROGATED EN-
VIRONMENTAL BUOY ...Acoustical, Geophysical Studies,
Navigation Communication, Satellites, ...8.0280

OCEANOGRAPHIC RESEARCH ...Acoustical, Hydrodynamics,
Instrumentation-general, Moorings, Naval Architecture-general,
...1.0052

GREAT LAKES RESEARCH - LAKE WAVES ...Great Lakes-
general, Shear, Waves, Wind-water Interaction, ...2.0118

WAVE RECORDING AND ANALYSIS ...Data Reduction and
Analysis, Lasers-masers, Pressure, Radar, Sonar, Statistics-
general, Waves, ...2.0101

RUBBLE-MOUND PROTOTYPE STUDIES ...Breakwaters, Jetty,
Shoreline Structures, Wave Action, Waves, ...8.0642

CIRCULATION ON THE CONTINENTAL SHELF ...Atlantic
Ocean-north, Circulation-general, Continental Shelf, Eastern,
...2.0027
SUBJECT INDEX

WATER PROPERTIES

Hudson Laboratories Ship Support...Facilities, Modification-conversion, Platforms, Scientific-service-support, Ships and Cruises, Special Mission Ships...

Shallow-Water Acoustics...Survey Studies, Transmission...

Ocean Acoustic Environment...Interfaces, Reverberation, Scattering, Transmission...

Woods Hole Environmental Studies of Sea Floor Properties...Benthonic-bottom, Data Acquisition, Geomorphology-topography, Gravity Studies, Subbottom...

Woods Hole Study Activities...Consultants, Advisory Services, Engineering Studies-General, General Information Services...

Woods Hole Environmental Studies in Physical Oceanography...Bathythermographs, Oceanic Fronts, Salinity, Temperature, Velocity...

Woods Hole Environmental Studies Oceanic Acoustics...Atlantic Ocean-north, Benthonic-bottom, Data Analysis-General, Reverberation, Scattering...

Ocean Sound Transmission...Transmission...

Acoustic Ambient Noise...Arctic, Liquids, Noise, Spectra...

Bi-Static Echo Ranging...Liquids, Reverberation...

Beluga Whales...Behavioral Ecology, Life History Studies, Mammals, Sound Production, Tape Recording, Audio...

Development of Analysis Techniques and Equipment for Classification of Transient Hydroacoustic Signals...Real Time Systems, Sonar, Technique Development...

Development of Analysis Techniques for Classifying Transient Hydroacoustic Signals...Acoustics, Seismic Studies, Signal Detection, Transmission...

Physical Acoustics and the Properties of Matter...Cavitation, Constants, Ultrasonic Frequency, Velocimeter, Velocity, Water...

Basic Acoustical Standards and Microphone Calibration...Acoustic, Audio Frequency, Calibration and Calibration Standards, Specifications, Transducers...

Reliable Acoustic Path...Attenuation, Bermuda, Ranging, Reverberation, Transmission...

Ultrasonics...Attenuation, Instrumentation-Non-specific, Transmission, Velocity...

Oceanographic Research...Density, Gases, Marine Biology, Thermal, Water Motion...

Microwave Acoustics...Reflection, Scattering, Sound Gear, Water Tunnel Tables...

Environmental Reverberation Studies...Bubble, Electron, Liquids, Reverberation, Scattering...

Sea-Air Interaction Research...Heat and Radiation Transfer, Hydrodynamics, Salinity, Waves...

Physicochemical and Acoustic Properties of Sea Water...Electrical, Saline Water Systems, Solution, Thermal...

Shallow Water Acoustic Propagation Studies (SWAPS)...Geomorphology-topography, Liquids, Subbottom, Thermal, Transmission, Turbulence-Sea Water, Water Motion, Waves...

Ocean Dynamics Sea Air Interaction Models...Mediterranean Hydrodynamics, Mediterranean Sea, General, Model Studies, Surface Environments, Wind-water Interaction...

Ocean Dynamics in the Straits of Gibraltar and Adjacent Areas...Anti-submarine-warfare, Computer Applications, Hydrodynamics, Model Studies, Strait of Gibraltar, Submerged Ships...

Ocean Dynamics - Oceanographic Analyses and Forecasting Models...Air-sea Boundary-general, Hydrodynamics, Model Studies, Surface Environments, Temperature...

Sea Floor Studies - Topography and Shape of the Sea Floor...Geomorphology-topography, Photography, Sedimentation...

Oceanographic Research...Hydrodynamics, Instrumentation-general, Moorings, Naval Architecture-general, Water Motion Recorders...

Oceanographic Research...Anti-submarine-warfare, California, Military Aspects, Temperature, Transmission...

Oceanographic Research - Investigations with Thermistor Chain...Forecasting-prediction, Temperature, Thermal, Transmission, Water Properties-general, Waves-internal...

Oceanographic Research-Investigations in Shallow Water...Environmental Effects-geologic, Model Studies, Salinity, Thermal, Water Motion...

Physical Oceanography...Surface Environments, Temperature, Transmission, Velocity, Waves...

Oceanometrics...Forecasting-prediction, Statistics-general, Transmission, Velocity...

Internal Wave Studies...Model Studies, Reflection, Scattering, Surface Environments, Waves-internal...

Biological Oceanography...Atlantic Ocean-north, Marine Biology, Sound Production, Submersibles...

Geological Oceanography...Acoustical Properties of Sediments...Core Analysis, Geomorphology-topography, Mechanical Properties, Physical Properties, Scattering...

Internal Wave Research...Surface Environments, Tides, Waves, Waves-internal...

Oceanographic Research...Buoys, Currents-ocean, Optic., Pressure, Seismic Studies, Sonar...

Shallow Water Oceanography...Continental Shelf, Hydrodynamics, Rhode Island, Surface Environments, Transmission...

Deep Ocean Acoustic Research...Abyssal, Pressure, Submersibles, Textures-structures, Transmission, Velocity...

Acoustic Properties of Sediments...Correlation, Physical Properties, Seismic Studies, Subbottom, Texture...

Global Volume Reverberation Limitation Studies...Atlantic Ocean-north, Reverberation, Scattering, Sound Production...

Advanced Technology and Bottom Predictions...Benthonic-bottom, Data Acquisition, Data Analysis, General, Forecasting-prediction, Model Studies, Seismic Studies...

System Operations and Acoustic Physics...Economic Theory, Instability-general, Liquids, Standards, Specifications, Systems Analysis...

Global Ocean Floor Analysis...Bathymetry, Benthonic-bottom, Currents-bottom, Geomorphology-topography, Seismic Studies, Subbottom...

Predictive Ocean Acoustics...Forecasting-prediction, Velocity...

Predictive Ocean Acoustics...Environmental Effect-geologic, Forecasting-prediction, Transmission, Velocity...

Shallow Water Propagation...Coherence, Reverberation, Shoals, Transmission, Water Properties-general...

Underwater Acoustic Analysis...Forecasting-prediction, Phase Relationships, Signal Analysis-other, Transmission, Water Properties-general...

Shallow Water Acoustic Studies...Model Studies...

Measurement and Predictive Statistics of Reverberation...Geomorphology-topography, Reverberation, Scattering, Surface Environments, Textures-structures, Velocity...

Measurement and Theory of Scattered Underwater Sound...Reflection, Scattering, Transmission...

Underwater Acoustic Signal Coherence...Coherence, Transmission...

Measurement of Underwater Acoustic Propagation...Depth, Forecasting-prediction, Intensity, Transmission...

Prediction of Sound Fields by Normal Mode and Other Theory...Attenuation, Computer Applications, Transmission...

Acoustic Propagation Studies...Instrumentation-general, Technique Development, Transmission...

Ambient Sea Noise...Buoys, Noise, Sampling, Sound Production...

Underwater Acoustics Measurements Facility...Facilities, Liquids, Transmission...
### Subject Index

**Biological-general**

<table>
<thead>
<tr>
<th>Topic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARCTIC AND COLD WEATHER SUPPORTING TECHNOLOGY</td>
<td>Ice Acoustics, Pressure, Sea Ice, Transmission, ( \ldots )0079</td>
</tr>
<tr>
<td>SONAR ACCURACY</td>
<td>Acoustic, Fire Control, Instrumental Services, Platforms, Sonar, Transmission, ( \ldots )051</td>
</tr>
<tr>
<td>BOTTOM-REFLECTED SONAR STUDIES</td>
<td>Benthonic-bottom, Scattering, Sonar, Surface Environments, Transmission, ( \ldots )055</td>
</tr>
<tr>
<td>AMBIENT NOISE RESEARCH STUDIES</td>
<td>Depth, Model Studies, Noise, Spectra, ( \ldots )023</td>
</tr>
<tr>
<td>SIGNAL COHERENCE AND ARRAY DESIGN STUDIES</td>
<td>Coherence, Reflection, Signal Analysis-other, Spectra, Waveform, ( \ldots )024</td>
</tr>
<tr>
<td>REVERBERATION RESEARCH STUDIES</td>
<td>Liquids, Reverberation, Water Properties-general, ( \ldots )027</td>
</tr>
<tr>
<td>ACOUSTIC SCATTERING STUDIES</td>
<td>Interfaces, Reflection, Scattering, ( \ldots )028</td>
</tr>
<tr>
<td>ENVIRONMENTAL SUPPORT OF SONAR DESIGN</td>
<td>Liquids, Model Studies, Ships and Cruises, Transmission, Water Properties-general, ( \ldots )015</td>
</tr>
<tr>
<td>UNDERWATER SOUND PROPAGATION STUDIES</td>
<td>Attenuation, Liquids, Transmission, Water Properties-general, ( \ldots )029</td>
</tr>
<tr>
<td>ACOUSTIC Holography</td>
<td>Diffraction, Holography, Liquids, Ocean Mining, ( \ldots )8255</td>
</tr>
</tbody>
</table>

**Depth**

### Water Properties

<table>
<thead>
<tr>
<th>Topic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEVELOPMENT OF A SIMPLE UNATTENDED Pycnocline Follower</td>
<td>Hawaii, Heat and Radiation Transfer, Wind-water Interaction, ( \ldots )091</td>
</tr>
<tr>
<td>CIRCULATION AROUND OCEANIC ISLANDS</td>
<td>Circulation-general, Islands, Mixing, Thermodynamics, Waves-internal, Wind-water Interaction, ( \ldots )010</td>
</tr>
<tr>
<td>STUDY OF STABILITY AND SHEAR IN THE TOP 500 METERS OF THE OCEAN</td>
<td>California Current, Mixing, Water Motion, Water Motion Records, ( \ldots )171</td>
</tr>
<tr>
<td>DETERMINATION OF EQUATION OF STATE, VISCOSITY AND COMPRESSIBILITY OF SEA WATER</td>
<td>Acoustical, Currents-ocean, Instrumentation-general, Salinity, Temperature, Viscosity, ( \ldots )045</td>
</tr>
<tr>
<td>MIXING PROCESSES INFLUENCING THE OCEANIC ENVIRONMENT</td>
<td>Acoustical, Gases, Marine Biology, Thermal, Water Motion, ( \ldots )6142</td>
</tr>
<tr>
<td>FIELD DETECTION AND MEASUREMENT OF INTERNAL WAVES</td>
<td>Acoustical, Digital Computer Applications, Temperature, Tides, Waves-internal, ( \ldots )0125</td>
</tr>
<tr>
<td>OCEANOGRAPHIC RESEARCH</td>
<td>Acoustical, Gases, Marine Biology, Thermal, Water Motion, ( \ldots )6142</td>
</tr>
<tr>
<td>INTERRELATIONS WITHIN THE PHYSICAL ENVIRONMENT</td>
<td>Commercial Fishing, Environmental Ecology, Sea Level Variations, Temporal Distribution, ( \ldots )078</td>
</tr>
</tbody>
</table>

### Density

<table>
<thead>
<tr>
<th>Topic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DYNAMICS OF INTERNAL WAVES AND TURBULENCE IN THE THERMOCLINE</td>
<td>Salinity, Turbulence, Turbulent Flow, ( \ldots )0093</td>
</tr>
<tr>
<td>PROPERTIES OF SEA WATER</td>
<td>Compressibility-gas-liq, Conductivity, Electrical, Expansion, Physical Analysis, Thermal, ( \ldots )0153</td>
</tr>
<tr>
<td>CIRCULATION OF THE PACIFIC</td>
<td>Circulation-general, Oceanic Fronts, Pacific Ocean-general, Sampling, Subsurface Environments, ( \ldots )007</td>
</tr>
<tr>
<td>EFFECT OF PRESSURE ON CONDUCTIVITY OF SOLUTIONS</td>
<td>Acoustical, Conductivity, Electrical, Electrolytes, Pressure, Sulfate, Sulfite, Viscosity, ( \ldots )078</td>
</tr>
</tbody>
</table>

707
**Water Properties**

**SUBJECT INDEX**

**OCEAN BOTTOM EMPL CED GEOPHYSICAL STATION**

...Automatic Stations, Benthonic-bottom, Dynamic Gravimeters, Geophysical Equipment, Gravity Studies, Instrumental Services, Pacific Ocean-east, Water Motion Recorders, ...4.0035

**HEAT FLOW MEASUREMENTS**

...Bear, Heat Flow Measurements, Oceans-Water, Philippines, Ridges, ...7.0106

**THE OPTICAL PROPERTIES OF SEA WATER AND THEIR USE IN OCEANOGRAPHIC RESEARCH & DEVELOPMENT**

...Antarctic Ocean, Oceanic Fronts, Optical, Oregon, Salinity, Suspension, ...2.0091

**DIRECT AND INDIRECT DETECTION OF OCEANIC WATER MASS MOTION ON ALL SCALES**

...Buoy, Currents-ocean, Oceanic Fronts, Pacific Ocean-east, Salinity, ...2.0092

**DETERMINATION OF EQUATION OF STATE, VISCOSITY AND COMPRESSIBILITY OF SEA WATER**

...Acoustical, Currents-other, Density, Instrumentation-general, Salinity, Viscosity, ...1.0145

**GEOTHERMAL INVESTIGATIONS IN OCEAN REGIONS**

...Atlantic Ocean-general, Heat Flow Measurements, Oceanic -Pelagic, Ridge, Salinity, Sediments-offshore, ...3.0113

**DISTRIBUTIONS OF CURRENTS AND PHYSICAL PROPERTIES WITHIN THE ARCTIC OCEAN**

...Acoustical, Arctic Ocean, Currents-ocean, Heat and Radiation Transfer, Sea Ice, ...4.0041

**AIR-SEA EXCHANGE**

...Albedo, Heat and Radiation Transfer, Infrared Radiation, Massachusetts, Towers, ...3.0026

**FINE STRUCTURE FEATURES OF TEMPERATURE AND SALINITY AT WATER MASS BOUNDARIES IN PACIFIC OCEAN**

...Circulation-general, Mixing, Oceanic Fronts, Pacific Ocean-north, Salinity, ...2.0046

**FIELD DETECTION AND MEASUREMENT OF INTERNAL WAVES**

...Acoustical, Density, Digital Computer Applications, Tides, Waves-internal, ...1.0125

**OCEAN DYNAMICS EXPERIMENTS**

...Buoy, Moorings, Other-design-and-construction, Submersibles, Technique Development, Water Motion Recorders, ...2.0072

**LARGE-SCALE INTERACTIONS**

...Acoustical, Air-sea Boundary-general, Buoy, Pacific Ocean-north, Thermal, ...3.0006

**OCEANOGRAPHIC RESEARCH**

...Acoustical, Forecasting-prediction, Submersibles, ...1.0161

**REMOTE SENSING**

...Currents-ocean, Gases, Microwave Radiations, Mixing, Oil, Salinity, ...4.0171

**REMOTE SENSOR OCEANOGRAPHY**

...Aerial Photography, Cloud Temperature, Gulf of Mexico, Infrared Radiation, Satellites, Surface Environments, ...4.0107

**BILOGIC STUDY OF THE BENTHOS OF PUERTO RICO AND THE VIRGIN ISLANDS**

...Benthic Fauna, Benthic Flora, Benthonic Equipment, Continental-shelf, Range Or Territorial Dist., Vertical Distribution, ...5.0652

**WOODS HOLE ENVIRONMENTAL STUDIES IN PHYSICAL OCEANOGRAPHY**

...Acoustical, Bathythermographs, Oceanic Fronts, Salinity, Velocity, ...1.0056

**CHEMICAL AND PHYSICAL DATA**

...Fish -non-specific, Population-general, Bumphead Parrotfish, Currents-ocean, Ridges, Salinity, ...7.0123

**TERMINAL DETERMINATION OF EQUATION OF STATE, VISCOSITY**

...Direct and Indirect, Distributions of Currents and Physical Properties, Within the Arctic Ocean, Acoustical, Arctic Ocean, Currents-ocean, Heat and Radiation Transfer, Sea Ice, ...4.0041

**MEASURING PAST OCEANOGRAPHIC CONDITIONS**

...Interdisciplinary, Marine Bacteria, Paleoenvironments, Paleoecology, Plants, Pollen, Rivers, ...8.0192

**DIGITAL RECORDING AND PROCESSING OF IN SITU DEPTH-TEMPERATURE-SALINITY DATA**

...Bathythermographs, Depth, Error Analysis, Research - Development, Salinity, ...4.0025

**MEASURING PAST OCEANOGRAPHIC CONDITIONS**

...Interdisciplinary, Marine Bacteria, Paleoecology, Plants, Pollen, Rivers, ...8.0192

**OCEANOGRAPHIC SURVEY OF CONTINENTAL SHELF WATER OFF CHEEPAKE BAY**

...Cheesapeake Bay, Continental Shelf, Marine Bacteria, Palynology, Salinity, Tracers, ...7.0106

**OCEANOGRAPHIC SURVEY OF CONTINENTAL SHELF WATER OFF CHEEPAKE BAY**

...Cheesapeake Bay, Continental Shelf, Marine Biology, Salinity, ...4.0135

**RELATIONSHIP BETWEEN WATER TEMPERATURE AND SIZE OF PARASITIC COPEPODS**

...Collections, Copepods, Host Specificity, Size, Water Temperature-non-specific, ...5.0390

**OCEAN DYNAMICS - OCEANOGRAPHIC ANALYSES AND FORECASTING MODELS**

...Acoustical, Air-sea Boundary-general, Hydrodynamics, Model Studies, Surface Environments, ...1.0004

**OCEANOGRAPHIC RESEARCH**

...Acoustical, Anti-submarine-warfare, California, Military Aspects, Transmission, ...1.0005

**OCEANOGRAPHIC RESEARCH - INVESTIGATIONS WITH THERMISTOR CHAIN**

...Acoustical, Forecasting-prediction, Thermal, Transmission, Water Properties-general, Waves-internal, ...1.0143

**PHYSICAL OCEANOGRAPHY**

...Surface Environments, Transmission, Velocity, Waves, ...1.0015

**OCEAN CURRENTS AND CIRCULATION**

...Circulation-general, Currents-ocean, Data Acquisition, Energy, Model Studies, ...2.0015

**GREAT LAKES RESEARCH - MONITORING OF WATER CHARACTERISTICS**

...Data Acquisition, Forecasting-prediction, Geophysical Analysis, Great Lakes-general, Instrumentation-general, ...1.0185

**REMOTE SENSING, GULF COASTAL AREA, CENTRAL FLORIDA**

...Aircraft, Aquifers, Fresh Water, Saline Water Systems, Tides, ...4.0160

**EFFECT OF TEMPERATURES AND CIRCULATION OF CONTINENTAL SHELF WATERS ON THE DISTRIBUTION OF FISHES**

...Continental Shelf, Fish -non-specific, Surface Environments, Water Motion, Currents, Water Temperature-non-specific, ...4.0165

**PACIFIC COASTAL ENVIRONMENT AS RELATED TO DISTRIBUTION AND ABUNDANCE OF GAME SPECIES**

...Sea Surface Temperature Measurements, Aquatic Ecology, California, Spectral Reflectance, ...1.0175

**HISTORICAL CHARTS AND INTERPRETATION OF CHANGES IN SEA SURFACE TEMPERATURE IN THE NORTH PACIFIC OCEAN**

...Air-sea Boundary-general, Atlasses-maps, Circulation-general, Commercial Fishing, Pacific Ocean-north, ...1.0179

**STUDY ASSOCIATION BETWEEN TRADE WIND SYSTEM AND NORTH PACIFIC OCEANOGRAPHIC CLIMATE**

...Climate, Coral Reefs, Paleoclimatology, Pacific Ocean-north, Thermocline, Weather Temperature-non-specific, ...1.0176

**OPERATIONAL EVALUATION OF NSRT SYSTEM**

...Equipment, Special Mission Ships, Surface Environments, ...8.0059

**INTERNATIONAL NORTH PACIFIC FISHERIES COMMISSION**

...Subarctic, Oceanochemistry, Currents-ocean, Depth, Pacific Ocean-north, Range Or Territorial Dist., Salinity, Salmon -coho,chinook,sockeye, ...1.0186

**MONITORING SURVEY AND TIME-SERIES ANALYSIS OF SUBSURFACE TEMPERATURE IN THE NORTH PACIFIC OCEAN**

...Phase Spectral, Subsurface Environments, Thermocline, Water Temperature-non-specific, ...1.0148

**THE EFFECTS OF ENVIRONMENTAL CONDITIONS ON THE SPANNING AND SURVIVAL OF FRY OF THE WALLEYE**

...Environmental Effects-geology, Eutrophication, Lake Erie, Pollution - Effects of, Walleyes, ...5.0299

**SUBSURFACE TEMPERATURE IN THE NORTH PACIFIC OCEAN**

...Pacific Ocean-north, Subsurface Environments, Thermocline, Water Temperature-non-specific, ...4.0025

**ZOOPLANKTON DISTRIBUTION IN THE TROPICAL ATLANTIC**

...Atlantic Ocean-general, Plankton Sampling, Range Or Territorial Dist., Tropic, Vertical Distribution, Zooplankton, ...5.0701

**710**
FISHERY FORECASTING - TREATMENT FISHERIES ...Circulation -general, General Synoptic Observations, Low Temp. ...but Above 32°F, Pacific Ocean-north, ...5.0197
SCRIPPS TUNA OCEANOGRAPHY RESEARCH PROGRAM ...Food Supply, Pacific Ocean -east, Tropic, Tuna, Mackeral, Al- bertas, Temperature -non-specific, ...5.0192
FIELD STUDY - CAPE COD, MASS. ...Animal Distr. (non-specific), Benthonic-bottom, Buoys, Environmental Ecology, Sedimentation, ...5.0158
STANDARD MONITORING SECTIONS (ATLANTIC AND PACIFIC OCEAN) ...California Current, Karohio Current, Labrador Current, Platform, Salinity, ...1.0001
TIME-SERIES OBSERVATIONS OF TEMPERATURE AND SALINITY (NORTH ATLANTIC AND NORTH PACIFIC OCEAN STATIONS) ...Atlantic Ocean-north, Depth, Pacific Ocean-north, Salinity, Sampling, ...1.0005
OCEANOGRAPHIC STUDY OF NORTHEASTERN U. S. COASTAL WATERS FOR INTERNATIONAL COMMISSION FOR PROTECTION OF ATOMIC OCEANOGRAPHIC EXPERIMENTS ...Commercial Fishing, Gases, Salt, Ships and Cruises, ...4.0123
AERIAL SEA SURFACE TEMPERATURE SURVEYS OF U.S. COASTAL WATERS ...Aircraft, Infrared Radiation, Migration, Productivity - Food Chain, Water Temperature -non-specific, ...4.0148
BARBADOS OCEANOGRAPHIC AND METEOROLOGICAL EXPERIMENT ...British West Indies, Depth, Ocean-lakes, Salinity, Wind-water Interaction, ...3.0015

Thermal

EFFECTS OF THERMAL MICROSTRUCTURE ON ACOUSTIC TELEMETRY ...Acoustical, Currents -other, ...1.0066
DEVELOPMENT OF PHYSICAL-NUMERICAL MODELS FOR STUDIES OF THE ATMOSPHERE-OCEAN PLANETARY BOUNDARY LAYER ...Advection, Mixing, Simulation Theory, Turbulence, Wind-water Interaction, ...1.0177
FISHERY-TECHNICAL AND ENVIRONMENTAL ASSESSMENT AND PREDICTION ...Commercial Fishing, Convection, Oceanography -general, Spacecraft Sensory Devices, ...4.0150
DEPOSITION RATES BY THE PROTACTINIUM METHOD ...Chemical, Distribution, Element Ratios, Manganese, Sedimentary Petrogenesis, Thorium, Uranium, ...3.0270
OCEAN WAVES AND TIDES ...Currents -of the ocean, Subsurface Environments, Tides, Water Motion Recorders, Waves, ...2.0080
AIR-SEA INTERACTION STUDY ...Convection, Mixing, Profiles, Thermocline, Waves, ...2.0115
AIR-SEA INTERACTION ...Air-sea Boundary-general, Currents -of the ocean, Gulf of Mexico, Tropical Cyclones, Weather Forecasting, ...1.0067
CONVECTIVE STUDIES ...Convection, Pacific Ocean-north, Sonar, ...2.0011
PHYSICAL OCEANOGRAPHY ...Convection, Hawaii, Heat and Radiation Transfer, Mixing, Wind-water Interaction, ...3.0044
PROPERTIES OF SEA WATER ...Compressibility, Gas, Liquids, Conductivity, Density, Electrical, Expansion, Physical Analysis, ...1.0153
WAVES - Pacific Ocean-north, Waves, Waves -internal, ...2.0097
MICROSTRATIFICATION OF MARINE ZOOPLANKTON ...Environmental Physiology, Growth Rate, Vertical Distribution, Zooplankton, ...3.0753
THE CONTRIBUTION OF ADVECTION AND LOCAL HEATING TO THE MAINTENANCE OF THE THERMAL STRUCTURE IN THE NORTHERN ATLANTIC OCEAN ...Circulation -general, Convection, Heat and Radiation Transfer, Mixing, Pacific Ocean-north, ...1.0183
RESEARCH IN AIR-ENERGY EXCHANGE ...Heat and Radiation Transfer, Lasers and Masers, Optical, Visible, ...3.0035
DYNAMICAL OCEANOGRAPHY AND GEOPHYSICAL FLUID DYNAMICS ...Acoustic Effects, Circulation -general, Forced Convection, Theoretical Analysis, Water Tunnels Tables, ...2.0012
STABLE ISOTOPE STUDIES ON COEXISTING MINERALS IN MAINE SEEDMEN ...Coring and Drilling, Diagenesis, Genetic Relationships, Mineralogy, Red Sea, Salinity, ...1.0106
GEOPHYSICAL AND GEOCHEMICAL STUDY OF RED SEA MINERAL DEPOSITS ...Coring and Drilling, Gulf of Aden, Igneous Activity - Volcanism, Mineralogy, Red Sea, ...7.0023
AIR-SEA INTERACTION ...Forecasting-prediction, Heat and Radiation Transfer, Meteorological Studies, Wind-water Interaction, ...3.0025

OCEANIC INTERNAL MOTIONS AFFECTING OPERATIONS ...Bermuda, Buys, Military Aspects, Water Motion Recorders, Waves-internal, ...3.0015
OCEAN DYNAMICS EXPERIMENTS ...Atlantic Ocean-north, Buys, Currents -ocean, Operational Aspect, Waves -internal, ...2.0071
TURBULENT PROCESSES AT AIR-SEA AND BOTTOM BOUNDARIES OF THE OCEAN ...Heat and Tides, Turbulence, Waves, Wind-water Interaction, ...3.0033
RADIANT ENERGY FLUX ACROSS THE AIR-SEA INTERFACE AND HEAT BUDGET OF THE OCEANS ...Air-sea Boundary-general, Forecasting-prediction, Heat and Radiation Transfer, Heat Exchange, Radiation-general, ...3.0032
TURBULENCE OVER WAVES ...Forecasting-prediction, Heat and Radiation Transfer, Heat Exchange, Meteorological Studies, Turbulence, Waves, ...3.0027
LARGE-SCALE INTERACTIONS ...Acoustical, Air-sea Boundary-general, Buys, Pacific Ocean-north, Temperature, ...3.0006
INTERNAL WAVE STUDY ...Acoustical, Atlantic Ocean-north, Continental Shelf, Tides, Waves -internal, ...2.0099
THERMAL PROPERTIES OF SEA WATER AT LOW TEMPERATURE AND HIGH PRESSURE ...Acoustical, Conduction, Expansion, Hydrodynamics, Physical Analysis, ...1.0177
CIRCULATION STUDIES ...Circulation -general, Currents -ocean, Gulf of Mexico, Model Studies, Tropical Cyclones, ...3.0044
THERMAL WAVE STUDIES ...Physical Analysis, Thermocline, Turbulence - Sea Water, Waves -internal, ...1.0174
A STUDY OF THE ICHTHYOPLANKTON ASSOCIATED WITH TWO OF NEW JERSEYS COASTAL INLETS ...Estuaries, Nets, Salinity, Water Salinity, Water Temperature -non-specific, Zooplankton, ...5.0006
CHEMICAL RESPONSES BY MARINE ORGANISMS TO STRESS ...Environmental Changes, Environmental Ecology, Environmental Physiology, Protein, Salinity, ...3.0012
OCEANOGRAPHIC RESEARCH ...Acoustical, Density, Gases, Marine Biology, Marine Motion, ...1.0142
PHYSICOCHEMICAL AND ACOUSTIC PROPERTIES OF SEA WATER ...Acoustical, Electrical, Saline Water Systems, Solutions, ...1.0157
SHALLOW WATER ACOUSTIC PROPAGATION STUDIES (SWAPS) ...Acoustical, Geomorphology, Topography, Liquids, Subbottom, Subtunusional, Turbulence - Sea Water, Water Motion, Waves, ...1.0065
OCEANOGRAPHIC RESEARCH - INVESTIGATIONS WITH THERMISTOR CHAIN ...Temperature, Transmission, Water Properties -general, Water Temperature, Waves -internal, ...1.0143
OCEANOGRAPHIC RESEARCH-INVESTIGATIONS IN SHALLOW WATER ...Acoustical, Environmental Effects -geologic, Model Studies, Salinity, Water Motion, ...1.0099
PHYSICAL PROPERTIES OF SEA WATER AT PRESSURE ...Heat Exchangers, Pressure, Viscoelasticity, ...1.0007
TEMPERATURE TOLERANCE OF MARINE ANIMALS THROUGH BEHAVIORAL RESPONSES ...Behavior, Environment Resistance, Mortality Rates, Water Temperature -non-specific, ...5.0118
THERMAL PREFERENCES OF MARINE FISHES AND INVERTEBRATES ...Behavior, Fish -non-specific, Invertebrates -non-specific, Water Temperature-non-specific, ...5.0209
EFFECTS OF HOT WATER MASSES ON MARINE FISHES ...Tropical Ocean-north, Behavior, Fish -non-specific, High Temp, ...5.05 or Above Oceanic Fronts, ...5.0210
ANALYZE AND PUBLISH BASIC DATA FROM PILOT STUDY ...Environmental Changes, Oceanic Fronts, Pacific Ocean-genera, Salinity, Technical Development, ...4.0024

Thermocline

AIR-SEA INTERACTION STUDY ...Convection, Mixing, Profiles, Thermal, Waves, ...2.0014
EXPERIMENTAL HYDRODYNAMICS ...Fluid Dynamics, Heat and Radiation Transfer, Hydraulodynamics, Simulation Theory, Submersibles, ...2.0012
OCEAN WAVES AND STRUCTURE ...Buys, Salinity, Tides, Water Motion Recorders, Waves, ...2.0016
THERMAL WAVE STUDIES ...Physical Analysis, Thermal, Turbulence - Sea Water, Waves-internal, ...1.0174
MONITORING SURVEY AND TIME- SERIES ANALYSIS OF SUBSURFACE TEMPERATURE IN THE NORTH PACIFIC OCEAN ...Pacific Ocean-north, Subsurface Environments, Temperature, Water Temperature-non-specific, ...1.0176

711
Water Properties

Thermodynamics

MARINE GEOCHEMISTRY RESEARCH ...Depth, Gases, Mineral Genesis, Meteorology, Radioactive Dating, Sedimentation, ...7.0055

A STUDY OF THE TEMPERATURE MICROSTRUCTURE AND EDDY TRANSPORT IN THE OCEAN FLOOR BOUNDARY LAYER ...Benthonic-bottom, Geothermal, Heat Flow ...Measurements, Physical Analysis, Temperature, ...1.0189

CIRCULATION AROUND OCEANIC ISLANDS ...Circulation-general, Density, Islands, Mixing, Waves-internal, Wind-water interaction, ...2.0018

RESEARCH IN OCEANIC PHYSICS ...Atlantic Ocean-south, Convex, Mixing, Oceanic Fronts, Wind-water Interaction, ...2.0059

PHYSICAL OCEANOGRAPHY IN OREGON SHELF AND SLOPE WATERS ...Continental Shelf, Continental Slope, Hydrodynamics, Mixing, Oregon, ...2.0076

THE INSTITUTE FOR THE DEVELOPMENT OF RIVERINE CIRCULATION AROUND OCEANIC ISLANDS ...Circulation-general, Environmental Changes, Gulf of Mexico, Shrimp - Common, ...2.0045

Viscosity

DETERMINATION OF EQUATION OF STATE, VISCOSITY AND COMPRESSIBILITY OF SEA WATER ...Acoustical, Currents-other, Density, Instrumentation-general, Salinity, Temperature, ...1.0145

PHYSICAL PROPERTIES OF SEA WATER AT PRESSURE ...Heat Exchangers, Pressure, Thermal, ...1.0149

Water Properties-general

CIRCULATION STUDIES ...Acoustical, Caribbean Sea, Dispersion, Ocean Currents-other, Transmission, ...1.0046

THE ECOLOGY OF CUCULITIUMROSPORIDACEAE IN THE ATLANTIC COASTAL WATERS OF THE UNITED STATES ...Atlantic Ocean-general, Continental Shelf, ...5.0841

INTERNATIONAL INDIAN CEAN EXPEDITION PHYSICAL AND CHEMICAL ATLAS ...Data & Statistics Storage Data Analysis - General, General Sea Water Chemistry, Indian Ocean-general, Tables, Compilations, Catalogs, ...4.0130

PHYSICAL AND CHEMICAL PROPERTIES OF THE SHELF AND SLOPE WATERS OFF NORTH CAROLINA ...Atlantic Ocean-north, Continental Shelf, General Sea Water Chemistry, North Carolina, Oceanic Fronts, ...1.0156

PHYSICAL AND CHEMICAL ATLAS ...Atlases-maps, Convex, General Sea Water Chemistry, Indian Ocean-general, Water Analysis-general, ...4.0026

SUPPORT OF TWO RESEARCH VESSELS ...Air-sea Boundary general, General Sea Water Chemistry, Great Lakes-general, Marine Biology, Ships and Cruises, ...12.0034

OCEAN ENGINEERING RESEARCH ...Alloys, Engineering Studies-general, Materials Used Undersea, Moorings, Water, ...8.0050

OCEANOGRAPHIC PROCESSES IN ESTUARINE AND COASTAL WATERS ...Oceanic Fronts, Pacific Ocean-east, Puget Sound, Shoreline - Coastline, Washington, ...4.0050

AN ANALYSIS OF PHOSPHORUS AND NITROGEN COMPOUNDS IN FRESH SYSTEMS AND MARINE ...Management, Nitrate, Nitrite, Phosphate, Phosphates, Swamps-marshes, Tidewater Areas, ...5.0953

DETERMINATION OF SAFE LEVELS OF POLLUTION IN PUERTO RICO ...Bays, Contamination - water, Meteorological Studies-general, Pollution - Effects of, Puerto Rico, Recreation Sites, ...6.0181

OCEANOGRAPHIC RESEARCH - INVESTIGATIONS WITH THERMISTOR CHAIN ...Acoustical, Forecasting-prediction, Temperature, Thermal, Transmission, ...1.0143

SHALLOW WATER PROPAGATION ...Acoustical, Coherence, Reverberation, Sh equals, Transmission, ...1.0035

UNDERWATER ACOUSTIC ANALYSIS ...Acoustical, Forecasting-prediction, Signal Relationships, Sound Transmission-other, Transmission, ...1.0038

REVERBERATION RESEARCH STUDIES ...Acoustical, Liquids, Reverberation, ...1.0027

SUBJECT INDEX

ENVIRONMENTAL SUPPORT OF SONAR DESIGN ...Acoustical, Liquids, Model Studies, Ships and Cruises, Transmission, ...1.0015

UNDERWATER SOUND PROPAGATION STUDIES ...Acoustical, Attenuation, Liquids, Transmission, ...1.0015

GREAT LAKES RESEARCH - SPOIL DISPOSAL EFFECTS ...Dispersion - water, Great Lakes-general, Pollution - Effects of, Spoils, Soil Banks, Suspension, ...6.0145

EFFECTS OF HEATED WATER IN A TIDAL ESTUARY ...Chesapeake Bay, Electric Power Plants, Pollution - Effects of, Pollution Effects, Thermal Pollution, Tidal Streams, ...6.0145

REMOTE SENSING, EVERGLADES AREA, FLORIDA ...Computer Applications, Florida, Remote Areas, Swamps-marshes, Visible Light, ...4.0161

COASTAL AND INSHORE OCEANOGRAPHY ...Alaska, Estuaries, Marine Biology, Shoreline - Costline, Water Analysis-general, ...5.0851

BIOASSAY ...Animal Pollutant Sources, Evaluation, Lamprays, Piscicides - non-specific, Streams, ...5.0632

PILOT STUDY OF LIMITED PORTION OF TRADE WIND ZONE OCEANOGRAPHY (DATA AND DESCRIPTIVE REPORTS) ...Environmental Changes, Oceanic Fronts, Pacific Ocean-north, Technique Development, ...12.0045

PINK SALMON INVESTIGATIONS - FRESHWATER ECOLOGY ...Alaska, Aquatic Ecology, Salmon - Coho, Chinook, Spawning & Nesting Sites, Streams, ...5.0185

SEA SURFACE SURVEILLANCE ...Caribbean Sea, Circulation-general, Environmental Changes, Gulf of Mexico, Shrimp - Common, ...2.0045

ARCTIC EAST OCEANOGRAPHIC PROJECT (OCEANOGRAPHY OF THE BAFFIN BAY REGION)...Baffin Bay, Circulation-general, Marine Biology, Polar, Sea Water Chemistry-other, ...4.0125

Water Quality Control

Adsorption

RELATIONSHIP BETWEEN GLACIAL FLOUR POLLUTION AND POLLUTANTS FROM OTHER SOURCES ...Adsorption Capacity, Alauida Estuaries, Glacial Clastics, Pollution - Effects of, Pulp, Paper , and Logging, Size, ...6.0134

Desalination

BRACKISH WATER PURIFICATION BY BIOLOGICAL FUEL CELL POWERED ELECTRODIALYSIS ...Biological, Brackish Water, Desalination Wastes, Electrodiagnosis, Industrial Recovery Wastes, Water Costs, ...6.0161

A UNIFIED APPROACH TO WATER, FOOD AND POWER IN A COASTAL DESERT COMMUNITY ...Arid and Desert, Deserts, Distilling Units, Electric Power Plants, Greenhouse, Use of Impaired Water, ...7.0002

Flow Augmentation

TRACERS STUDIES IN ALASKAN HARBORS ...Estuaries, Harbors, Industrial Wastes, Tides, Trace-elements, ...2.0049

Pollution Abatement

PUBLIC INVESTMENT CRITERIA FOR WATER-ORIENTED RECREATION IN THE LAKE ERIE BASIN ...Alternative Planning, Costs, Finance, Fiscal, Projected Demand, Recreation Sites, ...9.0016

DELWARE ESTUARY AND BAY WATER QUALITY SAMPLING AND MATHEMATICAL MODELING PROJECT ...Data Analysis - General, Delaware Bay, Mathematical Analysis, Model Studies, Technique Development, ...6.0163

FATE OF INLAND DERIVED POLLUTANTS IN AN ESTUARY ...Estuaries, Pollutants - Path of, Pollution - Effects of, Pollution Sources-general, Systems Analysis, ...6.0133

Self-purification

COLUMBIA RIVER SEDIMENT STUDIES ...Columbia River, Geochemical Analysis, Radioactivity-general, Radiocarbon Analysis, Sediments, ...6.0198

STUDIES ON INORGANIC NUTRIENT ASSIMILATION RATES IN ESTUARINE PONDS ...Estuaries, Marine Content - water, Nitrogen, Nutrients, Phosphorus, ...5.0991

712
SUBJECT INDEX

Stream Rehabilitation

RESTORATION AND REHABILITATION OF EARTHQUAKE DAMAGED SALMON STUDIES IN PRINCE WILLIAM SOUND ...Alaska, Earthquakes, Flow Characteristic -water, Salmon -coh, chinook, sockeye., Spawning & Nesting Sites, Tectonics-general, ...6.0191

Waste Water Treatment-general

GALVESTON BAY STUDY ...Estuaries, Numerical Analysis-other, Pollution, Simulation, Tides, ...4.0062
MICROBIOLOGY OF ESTUARINE AND SHEELFISH POLLUTION ...Bioindicators, Clams, Estuaries, Oysters, Pollution Efficts, Sanitation, ...6.0162

Water Quality Control-general

A STOCHASTIC MODEL FOR POLLUTION IN ESTUARIES ...Estuaries, Ions and Gases, Model Studies, Oxygen, Water Quality-general, ...6.0188
AN ECONOMIC EVALUATION OF WATER POLLUTION CONTROL, YACHAUNA BAY, OR ...Alternative Planning, Bays, Benefit-cost Analysis, Model Studies, Oregon, Systems Analysis, ...6.0173
SOCIO-ECONOMIC STUDY OF NARRAGANSSET BAY, RHODE ISLAND ...Bays, Benefit-cost Analysis, Estuaries, Land Use, Rhode Island, Social Aspects, ...9.0019

Water Quality-general

CRITERIA FOR EVALUATING THE QUALITY OF WATER BASED RECREATION FACILITIES ...Boating, Fishing, Marinas, Standards, Swimming, User Characteristics, ...9.0015
WATER QUALITY AS RELATED TO SURVIVAL OF SALMON EGGS AND LARVAE ...Environmental Ecology, Mortality Rates, Reproduction Studies (general), Salmon & Trout -Non-specific, Spawning & Nesting Sites, ...7.0007
ENHANCEMENT OF RECREATIONAL USES OF ESTUARINE WATERS THROUGH STUDY OF POTENTIAL CONTROL METHODOLOGIES ...Biological Control, Chesapeake Bay, Estuaries, Jelly Fish, Recreation Sites, ...5.0065
HORIZONTAL DISPERSION IN SHALLOW ESTUARIES OF IRREGULAR SHAPE ...Circulation -water, Dispersion -water, Estuaries, Gulf of Mexico, Model Studies, ...7.0006
SURFACE AND BOTTOM WATER POTENTIALITIES OF THE MULLICA RIVER BASIN ...Aqueducts, Conjective Use, Economic Impact, Estuaries, Systems Analysis, Water Transfer, ...6.0114
ECONOMICS OF WATER QUALITY FOR A REGIONAL SYSTEM ...Delaware River, Economic Efficiency, Estuaries, Finance, Regional Areas, Water Demand, ...9.0018
EFFECTS OF RIVERS ON THE METABOLISM OF TEXAS BAYS ...Bays, Nutrients, Pollutants-general, Primary Productivity, Streams, Texas, ...6.0187
A STOCHASTIC MODEL FOR POLLUTION IN ESTUARIES ...Estuaries, Ions and Gases, Model Studies, Oxygen, Water Quality Control-general, ...6.0186
POLLUTION STUDY OF THE VENICE DISTRICT CANAL ...California, Canals, Model Studies, Synthetic Hydrology, ...6.0141
GREAT LAKES RESEARCH - CHARACTERISTICS OF LAKE WATER ...Chemical-general, Great Lakes-general, Meteorological Studies, Ocean Currents-other, Physical-general, ...1.0154
WATER QUALITY AND NUTRIENTS, SACRAMENTO-SAN JOAQUIN RIVER SYSTEM ...Environmental Ecology, Eutrophication, Fish -non-specific, Nutrients, Plankton (non-specific), ...6.0140
HYDROLOGY OF COASTAL AREAS IN THE VICINITY OF RICEBORO, GEORGIA ...Aquifers, Artesian Flow, Dispersion -water, Georgia, Saline Water Intrusion, ...9.0067
TIDAL DISCHARGE RESEARCH, NEW JERSEY ...Data Acquisition, Data Reduction and Analysis, Discharge, Sediments, Tides, ...2.0008
HYDROLOGY OF UPPER OLD TAMPA BAY, FLORIDA ...Bays, Groundwater Movement, Hydrology-general, Lakes, Permeability, Water Harvesting, ...7.0097
CHEMICAL CHARACTERISTICS OF THE GREAT LAKES ...Chemical Analysis (water), Great Lakes-general, Nutrients, Productivity -Food Chain, ...1.0116
RESEARCH ON THE MACROBENTHOS OF THE GREAT LAKES ...Aquatic Ecology, Benthic Fauna, Earthworms, Food Supply, Great Lakes-general, ...5.0026

Waves

WAVE DYNAMICS SYSTEMS ...Braukers, Energy Dissipators, Model Studies, Shoreline Structures, Wave Action, ...8.0047
PREDICTION OF EXTREME ENVIRONMENTAL FACTORS ...Forecasting-prediction, Meteorological Extremes, Statistics-general, Technique Development, Wind-general, ...4.0048
TROPICAL STORM INVESTIGATIONS IN THE ATLANTIC, CARIBBEAN, AND GULF OF MEXICO ...Meteorological Studies, Satellites, Tropic, Tropical Cyclones, Vorticity, ...3.0048
FULL SCALE STRESS MEASUREMENT TESTS OF GREAT LAKES ORE CARRIER ...Great Lakes-general, Hull, Other-design-and-construction, Testing Structural, ...8.0030
WAVE MEASUREMENTS ...Motions and PREDICTIONS ...Merchant-ships, Safety, Ship Resistance Stability, ...8.0036
WATER WAVE DOCUMENTATION ...Buys, California, Pacific Ocean-general, Water Motion Recorders, ...2.0094
THEORETICAL ACOUSTIC-GRAVITY WAVE PROPAGATION ...Earthquake Location, Earthquakes, Energy Exchange Processes, Nuclear Devices, ...2.0126
AMBIENT SEA NOISE INVESTIGATION ...Acoustic, Acoustical, Computer Applications, Noise, Wind-water Interaction, ...1.0048
KINETICS OF SEDIMENTS IN BREAKERS ...Coastal Engineering-other, Development, Hydrodynamics, Sedimentation, Suspension, ...7.0025
LONG PERIOD WAVES ...Fjords, Hydrodynamics, Iceland, Seiches, Tides, ...2.0108
Waves

SUBJECT INDEX

HIGH FREQUENCY OCEAN WAVES ...Aircraft, Forecasting-pressures, Photogrammetry, Radar, Wind-Water Interaction, ...2.0121
OCEAN WAVES AND TIDES ...Currents-ocean, Subsurface Environments, Thermal, Tides, Water Motion Recorders, ...2.0090
AIRC/SEA STUDY ...Convection, Mixing, Profiles, Thermal, Thermocline, ...2.0116
WHITECAPping ...Meteorological Studies, Particle-gas Transfer, Temperature, Velocity, Wind-Water Interaction, ...2.0120
HIGH FREQUENCY WAVES ...Forecasting-prediction, Heat and Radiation Transfer, Hydrodynamics, Water Motion Recorders, ...2.0113
OCEAN WAVES ...Model Studies, Profiles, Temperature, Waves-internal, Wind-Water Interaction, ...2.0094
WAVES Pacific Ocean-north, Thermal, Waves-internal, ...2.0097
A STUDY OF PROBLEMS RELATED TO WIND-GENERATED WAVES ...Free Surface Waves, Laminar - Turbulent, Theoretical Analysis, Wind-Water Interaction, ...4.0088
AN OPTICAL METHOD OF MEASURING THE FORM OF THE FREE SURFACE OF A FLUID ...Fluid Dynamics, Free Surface Waves, Models, Optical, Optical Systems, Watersheds, ...2.0124
WAVE CURRENT AND STORM SURGE RESPONSE TO EXTREME WIND CONDITIONS ...Currents-ocean, Forecasting-prediction, Model Studies, Storms-general, Wind-Water Interaction, ...2.0107
WAVE UPLIFT FORCES ON HORIZONTAL PLATFORMS ...Hydrodynamic Structures, Platforms, Wave Action, ...8.0266
FORCES AND MOTIONS INDUCED BY WAVES ON OCEAN PLATFORMS ...Coastal Engineering-other, Models, Platforms, Wave Action, ...8.0312
PARTIAL DIFFERENTIAL EQUATIONS AND CONTINUUM MECHANICS ...Acoustical, Approximations, Ordinary, Partial, ...8.0171
MARINE HYDRODYNAMICS ...Antarctic Ocean, Circulation-general, Laboratory Analysis, Model Studies, Waves-internal, ...8.0196
EXPERIMENTAL STUDY OF THE INTERRELATIONS BETWEEN WIND-WAVE PROPERTIES ...Hydrodynamics, Mixing, Pressure, Turbulence - Sea Water, Wind-Water Interaction, ...2.0123
STUDY OF LOW FREQUENCY SURFACE WAVES IN THE PACIFIC OCEAN ...Meteorological Studies, Sea Level Variations, Tides, Turbulence - Sea Water, Water Motion Recorders, ...2.0085
THEORETICAL STUDIES OF TSUNAMI PROPAGATION ...Depth, Environmental Effects-geologic, Forecasting-prediction, Geomorphology-topography, Tsunami, ...3.0035
TIME FLUCTUATIONS IN OCEAN CURRENTS ...Currents-ocean, Geomorphology-topography, Model Studies, Testing of Models, ...2.0056
METEOROLOGICAL SUPPORT OF DEEP-SEA DRILLING OPERATIONS ...Coring and Dredging, Drilling and Coring, Meteorological Studies, Teaching and Research, Weather Forecasting, ...12.0013
(U) OCEAN CIRCULATION MODELS ...Circulation-general, Currents-ocean, Model Studies, Shear, Wind-Water Interaction, ...2.0024
RADAR SCATTERING ...Radar, ...4.0103
DYNAMICS OF MOORED BUOY SYSTEMS USED IN OCEANOGRAPHY ...Buoy, Currents-ocean, Laboratory Analysis, Model Studies, Moorings, ...8.0321
THEORETICAL STUDY OF OCEAN TIDES FOR PURPOSES OF WORLDWIDE PREDICTION ...Earth Tides, Forecasting-prediction, Mediterranean Sea-other, Tides, ...2.0090
OCEAN WIND WAVE GENERATION AND DISSIPATION ...Buoy, General Synoptic Observations, North Sea, Velocity, Wind-Water Interaction, ...2.0105
WAVE GENERATION BY THE TURBULENT WIND FIELD OVER THE SEA ...Platforms, Fr.-air-density, Turbulence, Velocity, Wind-Water Interaction, ...3.0088
PROGRESSION AND REFRACTION OF OCEAN WAVES IN NEAR SHORE REGIONS ...Forecasting-prediction, Mathematical Analysis, Operational Aspect, Surface Environments, ...2.0117
AIR-SEA INTERACTION (WAVES) ...British West Indies, Forecasting-prediction, Heat and Radiative Transfer, Surface Environments, Wind-Water Interaction, ...3.0016
LONG-PERIOD WAVES ...Bermuda, Prestaire, Sea Level Variations, Statistics-general, ...3.0005
TURBULENT PROCESSES AT AIR-SEA AND BOTTOM BOUNDARIES OF THE OCEAN ...Currents-bottom, Thermal, Turbulence, Wind-Water Interaction, ...2.0119
MODEL STUDIES OF REFRACTION OF SHOALING OCEAN WAVES ...Forecasting-prediction, Model Apparatus-other, Model Studies, Shoals, Wave, ...8.0194
TURBULENCE OVER WAVES ...Forecasting-prediction, Heat and Radiation Transfer, Heat Exchange, Meteorological Studies, Thermal, Turbulence, ...3.0027
OCEAN WAVES AND STRUCTURE ...Buoys, Salinity, Thermocline, Tides, Water Motion Recorders, ...2.0106
NEARSHORE WAVE THEORY ...Development, Model Studies, Sediment Transport-general, Shoreline - Coastline, ...2.0119
CRITERIA FOR THE DESIGN OF SMALL CRAFT HARBORS ...Breakwaters, Coastal Engineering-other, Harbors, Marinas, Seiches, ...8.0036
MEASUREMENT OF SURGING IN KUHIO BAY, HILO HAWAII ...Gaging, Harbors, Hawaii, Tsunami, Water Motion Recorders, ...2.0112
AN ANALYTICAL AND EXPERIMENTAL STUDY OF BED FORMS UNDER WATER WAVES ...Channel Roughness, Friction, Geomorphology-topography, Model Studies, Water Tunnels Tables, Wave Action, ...2.0110
COMPUTER SIMULATION OF THE PROPAGATION OF SURFACE WAVES ...Channel Roughness, Models, Partial, Velocity, Wave Motion in Fluids-other, ...4.0082
WAVE AND SURGE ACTION STUDY FOR LOS ANGELES-LONG BEACH HARBORS ...California, Harbors, Models, Surface Ships, Wave Action, ...2.0098
DESIGN OF RUBBLE WAVE-ABSORBER ...Beaches, Energy Dissipators, Harbors, Measuring Devices-other, Shoreline Structures, ...8.0067
PROJECT EVAPORATION ...Data Analysis - General, Evaporation, Model Studies, Oklahoma, ...3.0031
TRANSVERSAL DRIFTS IN BOTTOM PROFILE ...Bathymetry, Bentonitic-bottom, Intertidal Arcs, Ocean Waves - Currents, ...7.0224
WAVE MEASUREMENT IN THE OPEN OCEAN ...Buoys, Data Acquisition, Oceanic - Pelagic, Profiles, Water Motion Recorders, ...2.0109
CIVIL ENGINEERING STRUCTURES IN THE OCEANS ...Coastal Engineering-other, Engineering Studies-other, Foundations-general, Model Studies, Soil Dynamics, ...8.0340
WAVE FORCES ON BREAKWATERS ...Breakwaters, Hydrodynamics, Model Studies, Shoreline Structures, Wave Action, ...8.0044
A RECOGNITION OF COASTAL EROSION IN NORTH CAROLINA ...Aerial Photography, Beach, Development, Erosional Features, North Carolina, Photogrammetry, Reconnaissance, Shoreline - Coastline, ...7.0268
FLUID MECHANICS RESEARCH ...Forecasting-prediction, Hydrodynamics, Industrial Engineering, Ship Resistance Stability, ...8.0176
FUNDAMENTAL PROBLEMS IN HYDRODYNAMICS ...Convection, Hydrodynamics, Ordnance, Survey Studies, Waves-internal, ...2.0102
MODEL FOR THE PRELIMINARY DESIGN OF SURFACE EFFECT SHIPS ...Computer Applications, Drag, Hydrofoils Crafts, Marine Propulsion, Other Models, Ships and Cruises, ...8.0279
RADIOACTIVE AEROSOL SCAVENGING BY OCEAN SPRAY ...Aerosols, Nuclear Explosions - Fallout, Radioactivity-general, Strontium, Washout, ...6.0164
WAVE GENERATION ...British West Indies, Profiles, Shear, Towed, Wind-Water Interaction, ...2.0103
SEA-AIR INTERACTION RESEARCH ...Acoustical, Heat and Radiation Transfer, Hydrodynamics, Salinity, ...3.0009
SHALLOW WATER ACOUSTIC PROPAGATION STUDIES (SWAPS) ...Acoustical, Geomorphology-topography, Liquids, Subbottom, Thermal, Transmission, Turbulence - Sea Water, Water Motion, ...1.0065
PHYSICAL OCEANOGRAPHY ...Surface Environments, Temperature, Transmission, Velocity, ...1.0026
INTERNAL WAVE RESEARCH ...Acoustical, Surface Environments, Tides, Waves-internal, ...2.0096
SHIP DESIGN WAVE RESEARCH ...Operational Aspect, Other-design-and-construction, ...8.0291

714
Weather - Physical Properties

ANALYSIS OF THE MARINE LAYER - A MESO METEOROLOGICAL STUDY ...Air-sea Boundary-general, California, Diffusion, Orographic Effects, Turbulence, ...3.0001

Heat and Momentum Exchange Processes Between the Ocean and the Atmosphere ...Heat and Radiation Transfer, Meteorological Studies, Oregon, Pacific Ocean-east, Wind-water Interaction, ...2.0105

OCEAN WIND WAVE GENERATION AND DISSIPATION ...Buoys, North Sea, Velocity, Waves, Wind-water Interaction, ...3.0036

SEA USE ...Marine Biology, Oceanography-general, Pacific Ocean-east, Platforms, Seamounts-guyots, ...7.0363

Severe Storm Climatology ...Patterns, Tropical Cyclones, ...3.0054

RESEARCH FLIGHT FACILITY ...Aircraft, Equipment Purchase Operation, Technique Development, Tropical Cyclones, ...4.0158

Fishery Forecasting - Temperate Fisheries ...Circulation-general, Low Temp. -but Above 32f, Pacific Ocean-east, Temperature, ...5.0197

Mesoscale Wind Systems Around the Great Lakes ...Lake Michigan, Land-sea Breezes, Meteorologic Model Studies, Patterns, Pollution Behavior-general, ...3.0064

Humidity

An Investigation of Tritium in Rain Water ...Atmosphere Composition, Particle-gas Transfer, Precipitation-other, Rain-other, Tritium, ...1.0130

Air-Sea Interaction ...Heat Exchange, Latent Heats, Temperature, ...3.0041

Airborne Sea Surface Measurements in the Equatorial Pacific ...Atmosphere Radiation, Mapping, Oceanic Fronts, Radiation Detection, Temperature, ...1.0190

Atmospheric Effects on Incoming Solar Radiation Over Tropical Oceans ...Cloud Cover, Development of Models, Humidity, Pacific Ocean-general, Tropic, ...3.0036

Hydrography of Appalachee Bay ...Bays, Currents-ocean, Rain-general, Salinity, Temperature, ...1.0147

Temperature

The Propagation of Acoustic Waves in the Stratified Atmosphere ...Acoustics, Transmission, Waves, Wind-general, ...1.0095

Air-Sea Interaction ...Heat Exchange, Latent Heats, ...3.0041

Evaluation of Low Level Temperature Gradients over the Line Islands near the Equator ...Atmosphere Radiation, Line Islands, Radiation Balance, ...1.0180

Vertical Current Structure in the Great Lakes ...Circulation-general, Great Lakes-general, ...2.0033

Physical Oceanography ...Surface Environments, Transmission, Velocity, Waves, ...1.0026

Thermodynamics

Application of Meteorological Satellite Sensing to General Circulation Models ...Infrared Radiation, Meteorologic Model Studies, Particle-gas Transfer, Patterns, Satellites, Weather Forecasting, ...4.0137

Energy Transfer near the Earth's Surface ...Air Motion Instruments, Buoys, Heat and Radiation Transfer, Turbulence, ...3.0044

Experimental Fluid Dynamics ...Laminar - Turbulent, Model Studies, Rotating Fluids, Shear-flow, Wind-water Interaction, ...3.0021

General Synoptic Observations

An Experimental and Theoretical Study of the Marine and Continental Climates ...F Point Concept Applied to the Morro Bay Region of California ...California, Micrometeorology, Military Aspects, Shoreline - Coastline, ...3.0085

Evaluation of Low Level Temperature Gradients over the Line Islands near the Equator ...Atmosphere Radiation, Line Islands, Radiation Balance, Temperature, ...1.0180

Exchange Meteorologist with Japanese Antarctic Research Expedition ...Air-sea Boundary-general, Antarctic Ocean Mixing, Radiosonde, Sea Ice, ...3.0013

Line Islands Experiment ...Boundary Layer Studies, Line Islands, Physical Climatology, Satellites, Wind-water Interaction, ...3.0083

Heat and Momentum Exchange Processes Between the Ocean and the Atmosphere ...Heat and Radiation Transfer, Meteorological Studies, Oregon, Pacific Ocean-east, Wind-water Interaction, ...2.0105

Ocean Wind Wave Generation and Dissipation ...Buoys, North Sea, Velocity, Waves, Wind-water Interaction, ...3.0036

Sea Use ...Marine Biology, Oceanography-general, Pacific Ocean-east, Platforms, Seamounts-guyots, ...7.0363

Severe Storm Climatology ...Patterns, Tropical Cyclones, ...3.0054

Research Flight Facility ...Aircraft, Equipment Purchase Operation, Technique Development, Tropical Cyclones, ...4.0158

Fishery Forecasting - Temperate Fisheries ...Circulation-general, Low Temp.-but Above 32f, Pacific Ocean-east, Temperature, ...5.0197

Mesoscale Wind Systems Around the Great Lakes ...Lake Michigan, Land-sea Breezes, Meteorologic Model Studies, Patterns, Pollution Behavior-general, ...3.0064

Optics

Visibility

Visual Range Meters ...Distance-measuring-device, Fog-haze-mist, Guidance, Landing, Meteorological Conditions, ...8.0072

Miscellaneous Services for Federal Aviation Agency (Visual Range) ...Air-sea Boundary-general, Distance-measuring-device, Fog-haze-mist, ...3.0011

Pressure-density

Experiments in Air-Sea Interaction Involving Surface Pressure Measurements ...Air Motion-Other, Wind-other, Wind-water Interaction, ...3.0017

Wave Generation by the Turbulent Wind Field over the Sea ...Platforms, Turbulence, Velocity, Waves, Wind-water Interaction, ...3.0008

Eastern Boundary Currents ...Mixing, Ocean Currents-Other, Wind-general, Wind-water Interaction, ...2.0026

Humidity Standards and Measurements ...Evaporation, Humidity Instruments, Pressure-density, Standards, Specifications, Streams, ...8.0081

Tropical Analysis and Forecasting ...Filtering Theory, Mathematical Analysis, Meteorologic Model Studies, Tropic, Weather Forecasting, ...3.0061

Great Lakes Research - Harbor Currents ...Great Lake-Other, Harbors, Military Studies, Ocean Currents-other, Water Level Fluctuation, Wind-water Interaction, ...2.0074

Weather Charts/maps

Relation of Satellite Data to Large-Scale Atmospheric Circulation and Energy Fluxes ...Atmosphere Radiation, General Movement, Patterns, Radiation-general, Satellites, ...4.0143

Weather Display Systems

Weather Analysis and Forecasting Techniques ...Meteorological Studies, Weather Forecasting, ...4.0043

716
<table>
<thead>
<tr>
<th>Name</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aagaard, K.</td>
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<td>Anderson, A.W.</td>
<td>-5.0063*, 6.0171*</td>
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<td>Angelovic, J.W.</td>
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<td>Angelina, W.A.</td>
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<td>Anthony, V.</td>
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<td>Antoine, J.</td>
<td>-5.0013, 7.0148*</td>
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<td>Appalachian, V.C.</td>
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<td>Armstrong, J.B.</td>
<td>-5.0270*, 11.0027</td>
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<td>Armstrong, R.S.</td>
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<td>Arnold, C.R.</td>
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<td>Arnold, J.M.</td>
<td>-5.0042*, 5.0424*</td>
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<td>Aro, W.</td>
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<td>Arcan, W.L.</td>
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<td>Arcon, J.L.</td>
<td>-10.0031</td>
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<td>Arp, V.</td>
<td>-8.0201</td>
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<tr>
<td>Arvaneti, G.</td>
<td>-5.0009, 7.0095</td>
</tr>
<tr>
<td>Arvaneti, M.</td>
<td>-1.0023*</td>
</tr>
<tr>
<td>Arvillo, A.</td>
<td>-5.0297, 5.1014</td>
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<td>Arthur, R.</td>
<td>-5.0052*</td>
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<td>Ashworth, R.B.</td>
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<tr>
<td>Askew, W.H.</td>
<td>-8.0080</td>
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<tr>
<td>Astabastue, S.</td>
<td>-5.0305, 5.0733</td>
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<tr>
<td>Atbeham, N.</td>
<td>-7.0072</td>
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<tr>
<td>Atkinson, J.W.</td>
<td>-5.041igarette</td>
</tr>
<tr>
<td>Atwater, M.A.</td>
<td>-5.0369</td>
</tr>
</tbody>
</table>

- INVESTIGATOR INDEX

- INVESTIGATOR INDEX

- INVESTIGATOR INDEX

- INVESTIGATOR INDEX

- INVESTIGATOR INDEX

- INVESTIGATOR INDEX

- INVESTIGATOR INDEX
<table>
<thead>
<tr>
<th>Name</th>
<th>Index Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brodgen, S.</td>
<td>8.0101</td>
</tr>
<tr>
<td>Butler, A.B.</td>
<td>7.0204*</td>
</tr>
<tr>
<td>Billiard, V.A.</td>
<td>7.0001</td>
</tr>
<tr>
<td>Bilings, G.</td>
<td>7.0014</td>
</tr>
<tr>
<td>Billy, T.J.</td>
<td>5.0398</td>
</tr>
<tr>
<td>Binack, L.</td>
<td>5.0597*</td>
</tr>
<tr>
<td>Birke, D.G.</td>
<td>5.0186</td>
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<tr>
<td>Bischoff, J.J.</td>
<td>7.0071*</td>
</tr>
<tr>
<td>Bitterman, M.E.</td>
<td>5.0491*</td>
</tr>
<tr>
<td>Bitlen, J.I.</td>
<td>8.0199, 7.0200</td>
</tr>
<tr>
<td>Blom, J.A.</td>
<td>7.0104</td>
</tr>
<tr>
<td>Bork, F.V.</td>
<td>3.0064</td>
</tr>
<tr>
<td>Briggs, J.C.</td>
<td>5.0693*</td>
</tr>
<tr>
<td>Bridges, D.W.</td>
<td>5.0118, 5.0210</td>
</tr>
<tr>
<td>Breslow, E.M.</td>
<td>5.0999*</td>
</tr>
<tr>
<td>Bratzler, L.</td>
<td>6.0044</td>
</tr>
<tr>
<td>Bradshaw, A.L.</td>
<td>1.0153*</td>
</tr>
<tr>
<td>Boynton, R.M.</td>
<td>8.0053</td>
</tr>
<tr>
<td>Bowman, I.</td>
<td>5.0691</td>
</tr>
<tr>
<td>Bowman, E.</td>
<td>5.0107</td>
</tr>
<tr>
<td>Bowin, C.O.</td>
<td>4.0030*, 7.0114*, 8.0103*</td>
</tr>
<tr>
<td>Bowes, G.</td>
<td>5.0240</td>
</tr>
<tr>
<td>Bowen, V.T.</td>
<td>1.0104*, 5.0795*, 7.0072*</td>
</tr>
<tr>
<td>Bousefield, E.L.</td>
<td>4.0016</td>
</tr>
<tr>
<td>Booth, J.</td>
<td>5.0874</td>
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<tr>
<td>Bond, C.E.</td>
<td>5.0137*, 5.0138*</td>
</tr>
<tr>
<td>Boggs, S.</td>
<td>7.0015</td>
</tr>
<tr>
<td>Boulter, E.J.</td>
<td>5.0901*</td>
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<tr>
<td>Borel, P.</td>
<td>5.0462</td>
</tr>
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<td>Borger, B.F.</td>
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<td>Boganega, S.J.</td>
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<td>Bode, E.A.</td>
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<td>Bonati, E.L.</td>
<td>7.0044*, 7.0226*</td>
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<td>Bond, C.E.</td>
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<td>Bona, M.A.</td>
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<td>5.0476, 11.0037*, 11.0038*, 12.0039*</td>
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<tr>
<td>Bonfils, C.</td>
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<td>Bottino, N.R.</td>
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<td>Beck, G.B.</td>
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<tr>
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<tr>
<td>Bocca, T.M.</td>
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<td>Boven, S.</td>
<td>5.0355*, 5.0682*</td>
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<td>Bowden, T.</td>
<td>7.0164*, 5.0795*, 7.0072*</td>
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<td>Bowles, G.</td>
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<td>Bowles, J.C.</td>
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<td>Bowin, C.O.</td>
<td>4.0030*, 7.0116*, 8.0103*</td>
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<td>Bradley, E.</td>
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<td>Braithwaite, A.L.</td>
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<td>Braun, R.A.</td>
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*Indicates Principal Investigator

720
<table>
<thead>
<tr>
<th>Name</th>
<th>Notes</th>
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<tbody>
<tr>
<td>Morse, I.L.</td>
<td>-3.0015*</td>
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</tr>
</tbody>
</table>
INVESTIGATOR INDEX

Poprik, A.L. -7.0244
Pontecorvo, G. -10.0006
Pomeroy, P.W. -7.0141*
Plum, W.B. -8.0197
Pollard, D.D. -6.0142*
Pax, G.A. -5.0463*
Payne, W.J. -5.0783*
Pearce, J. -5.0638*
Peac, W. -6.0172
Peac, W.G. -5.1019*
Pearce, J.S. -5.0929*
Pearson, R.K. -5.0334
Pedersen, M.A. -1.0111*
Pedrick, R.A. -1.0099
Peeters, C.L. -2.0089*, 2.0712*, 7.0126*
Pelto, M. -2.0049, 6.0134
Pell, W. -6.0365
Penney, S. -5.0007*, 5.0003*
Pequegnat, W.E. -2.0043*, 5.0655*, 5.1032*, 5.0123*
Perry, W.F. -5.0514, 8.0151
Perkins, F.O. -5.0059*, 5.0659*, 5.0839*
Peterson, R.W. -1.0131*
Perret, R. -2.0058
Perry, R. -4.0088
Persson, F. -5.0479
Pesch, G.G. -5.1026
Peterson, A. -5.0106*
Petersen, A.E. -4.0010*, 4.0114*, 4.0029*, 5.0166, 5.0452*, 5.0453*
Peterson, D.H. -1.0075*, 7.0035
Peterson, M.M. -7.0056*, 7.0096*
Peterson, R.S. -5.0672
Peterson, W.K. -5.0331
Petrie, W. -6.0085
Petitbon, M.H. -5.0574*, 5.0575*, 5.0576*
Pfeiffer, H.L. -8.0178*
Pfister, R.M. -5.0819*, 6.0169*
Phelps, D.K. -1.0128
Phelps, E.A. -6.0010*
Phelps, J.D. -7.0120*
Phelps, J.F. -2.0081, 7.0250
Phelps, G.M. -2.0057, 2.0114
Phelan, R.L. -4.0054, 7.0015
Phelps, R.R. -12.0089*
Phleger, F.B. -5.0746*, 5.0747*
Pica, K.C. -8.0292*
Pickett, M.A. -5.0076
Pickell, B.L. -5.0107*, 5.0108*, 5.0109*, 5.0110*
Pickett, M.A. -5.0076
Pickell, R.A. -5.0302, 5.0308*, 5.0825* PILA, F.J. -8.0344*
Pilley, F.J. -3.0031, 3.0090
Pilkey, O.H. -4.0059*, 7.0021*, 7.0026*, 7.0027*
Pilone, M.E. -1.0129
Pinsak, A.F. -1.0154*, 1.0185*, 6.0157*
Pinsak, W.M. -7.0137
Plathcock, R. -1.0058*, 1.0070
Pollard, D.D. -6.0142*
Pollard, J.P. -8.0018
Pomeroy, R.L. -5.0595*, 5.0596*
Pomeroy, P.W. -7.0141*
Pong, G.S. -3.0012*
Pompeo, G. -6.0006
Popham, R.W. -3.0075
Popoff, P.E. -6.0112
Popprik, A.L. -7.0248*
Porter, H.J. -5.0480*
Porter, R.W. -5.0150*
Portman, D.J. -5.0207*

*INDICATES PRINCIPAL INVESTIGATOR
<table>
<thead>
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<td>Saville, T.</td>
<td>-2.0187, 2.0100*, 2.0101*, 6.0144*</td>
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### Additional Agencies and Organizations

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737
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United Engineers Constructors Inc. 5.0186.
University of California 5.0325, 9.0001, 9.0002.
University of Delaware 5.0871, 7.0206.
University of Hawaii 2.0083, 4.0025, 6.0150, 7.0236.
University of Illinois 8.0044.
University of South Florida 5.0698.
University of Texas 5.0656, 5.0657.
University of Washington 5.0179, 5.0180, 5.0228.
Westinghouse Electric Corporation 8.0051, 8.0095, 8.0096.
Whitehall Foundation 5.0460.
Wisconsin State Government 5.0337, 6.0088.
THE NATIONAL COUNCIL ON MARINE RESOURCES AND ENGINEERING DEVELOPMENT

The National Council on Marine Resources and Engineering Development was established within the Executive Office of the President in June, 1966, under Public Law 89-454, which declared it to be "the policy of the United States to develop, encourage, and maintain a coordinated, comprehensive, and long-range national program in marine science for the benefit of mankind, to assist in protection of health and property, enhancement of commerce, transportation and national security, rehabilitation of our commercial fisheries, and increased utilization of these and other resources."

The Act provided for a cabinet-level Council composed of heads of those departments and agencies having statutory missions to engage in oceanographic research and exploration, and it designated the Vice President to serve as chairman. The duties of the Council established by the Act are to assist and advise the President to:

1. Survey all significant marine science activities, including the policies, plans, programs, and accomplishments of all departments and agencies of the United States engaged in such activities;

2. Develop a comprehensive program of marine science activities, including but not limited to exploration, description and prediction of the marine environment, exploitation and conservation of the resources of the marine environment, marine engineering, studies of air-sea interaction, transmission of energy, and communications to be conducted by departments and agencies of the United States, independently or in cooperation with such non-Federal organizations as States, institutions and industry;

3. Designate and fix responsibility for the conduct of the foregoing marine science activities by departments and agencies of the United States;

4. Insure cooperation and resolve differences arising among departments and agencies of the United States with respect to marine science activities under the Act, including differences as to whether a particular project is a marine science activity;

5. Undertake a comprehensive study, by contract or otherwise, of the legal problems arising out of the management, use, development, recovery, and control of the resources of the marine environment;

6. Establish long-range studies of the potential benefits to the United States economy, security, health, and welfare to be gained from marine resources, engineering, and science, and the costs involved in obtaining such benefits;

7. Review annually all marine science activities conducted by departments and agencies of the United States in light of the policies, plans, programs and priorities developed pursuant to this Act;

8. Coordinate a program of international cooperation in work done under the Act, pursuant to agreements made by the President with the advice and consent of the Senate;

9. Prepare a report, as assigned by the President, to be transmitted to the Congress in January of each year, which shall include:
   a) a comprehensive description of the activities and the accomplishments of all agencies and departments of the United States in the field of marine science during the preceding fiscal year, and (2) an evaluation of such activities and accomplishments in terms of the objectives set forth pursuant to the Act.

Under the National Sea Grant College and Program Act of 1966, P.L. 89-688, the Council was assigned the additional responsibilities, as the President may request, to:

1. Advise the National Science Foundation, with respect to policies, procedures, and operations of the Foundation under the Act;

2. Provide policy guidance to the Foundation with respect to contracts or grants in support of the program; and

3. Submit an annual report on its activities and recommendations on this program to the Speaker of the House of Representatives, the Committee on Merchant Marine and Fisheries of the House of Representatives, the President of the Senate, and the Committee on Labor and Public Welfare of the Senate.