DOCUMENT RESUME

ED 211 339 SE 035 950

AUTHOR Sacks, Arthur E., Ed.; And Others
TITLE Current Issues in Environmental Education and Environmental Studies, Volume VII: Selected Papers from the Annual Conference of the National Association for Environmental Education (10th, Gilbertsville, Kentucky).
INSTITUTION ERIC Clearinghouse for Science, Mathematics, and Environmental Education, Columbus, Ohio.; National Association for Environmental Education, Troy, Ohio.
SPONS AGENCY National Inst. of Education (ED), Washington, D.C.
PUB DATE Oct 81
CONTRACT 400-78-0004
NOTE 227p.
AVAILABLE FROM Information Reference Center (ERIC/IRC), The Ohio State Univ., 1200 Chambers Rd., 3rd Floor, Columbus, OH 43212 ($6.50).

EDRS PRICE MF01/PC10 Plus Postage.
DESCRIPTORS Attitude Measures; *Conservation Education; Curriculum Development; Elementary Secondary Education; *Energy; *Environment; *Environmental Education; Instructional Development; Nonformal Education; Postsecondary Education; *Program Descriptions; Science Education; Surveys; Training Methods
IDENTIFIERS *Environmental Education Research

ABSTRACT

Three major sections comprise these proceedings of the 1981 Conference of the National Association for Environmental Education. Section I contains four addresses on environmental issues by guest speakers and two symposia, one on synfuels, and the other on acid rain. The twelve essays in Section II give the practitioner's perspective on environmental education programs, approaches, and issues. The final section, research and evaluation, offers seven articles reporting present analysis of environmental education research problems. (DC)

Current Issues

in Environmental Education and Environmental Studies Volume VII

Selected Papers from the Tenth Annual Conference of the National Association for Environmental Education

Edited by

Arthur B. Sacks
Louis A. Iozzi
Judith M. Schultz
Richard Wilke

with a Foreword by
S. David Freeman

The National Association for Environmental Education
P.O. Box 400
Troy, Ohio 45373

Published by

ERIC Clearinghouse for Science, Mathematics
and Environmental Education
The Ohio State University
College of Education and
School of Natural Resources
1200 Chambers Road, 3rd Floor
Columbus, Ohio 43212

October, 1981

ENVIRONMENTAL EDUCATION INFORMATION REPORTS

Environmental Education Information Reports are issued to analyze and summarize information related to the teaching and learning of environmental education. It is hoped that these reviews will provide information for personnel involved in development, ideas for teachers, and indications of trends in environmental education.

Your comments and suggestions for this series are invited.

John F. Disinger
Associate Director, ERIC/SMEAC
Environmental Education

****

Publication sponsored by the Educational Resources Information Center of the National Institute of Education and The Ohio State University.

This publication was prepared with funding from the National Institute of Education, U.S. Department of Education under contract no. 400-78-0004. The opinions expressed in this report do not necessarily reflect the positions or policies of NIE or U.S. Department of Education.

In humble praise, this volume is dedicated to the memory of Walter E. Jeske, 1929-1981

Back in 1935, a young graduate student in wildlife ecology died in a midnight cabin fire that also destroyed his accumulated notes, photographs, and manuscripts on five years of prairie chicken research.

His major professor, Aldo Leopold, wrote at the time:

> "It is by now a truism that the American frontier did not cease to exist when the covered wagons halted on the shores of the Pacific. In its wake followed a scientific frontier, which opened up the resources of the new-found lands to human understanding in quite the same sense, and in no less degree, than the geographic frontier opened them to human occupancy.
>
> "It was quite a surprise to the gold-seeking Spaniards when James Ohio Pattie arrived in their midst, seeking not gold but beavers. Just so it is now a surprise to biological scientists to discover as a fellow-explorer the conservation ecologist, seeking not new ways to squeeze wealth out of the soil, but ways to prevent the extraction of its wealth from destroying its wildlife.
>
> "Society has not withheld its gratitude from the geographical adventurer who failed to come back, nor from the scientific explorer who dies in the course of an unfinished quest. It should, I think, at least know about important fatalities in that new argosy of the intellect which seeks not the conquest, but the preservation, of nature."

In the spirit of that profound Leopold salute of long ago this volume is dedicated to Walt Jeske, who died in August of 1981 at full stride in a career of signal service to environmental education through the Soil Conservation Society of America, the USDA Soil Conservation Service, the Federal Interagency Committee on Education, the UN Conference on Environmental Education, the Alliance for Environmental Education, and, above all, as a forthright member of the Board of the National Association for Environmental Education.

Walt's untimely passing was the epitome of "an important fatality in that new argosy of the intellect--the preservation of nature."

Clay Schoenfeld,
On Behalf of Current Issues VII
and The National Association for
Environmental Education

August, 1981

PREFACE

The Tenth Annual Conference of the National Association for Environmental Education (NAEE) was held April 30 to May 5, 1981 at Kentucky Dam Village State Park, Gilbertsville, Kentucky. Approximately 175 individuals from 33 states and 3 Canadian provinces participated. The essays contained in this volume represent the best of the Conference papers submitted for editorial review.

The Current Issues series attempts to provide both environmental applications--the practitioner's perspective-- and the results of scholarly analysis and integration--the researcher's perspective. Specifically, Current Issues has a twofold mission: (1) to present to our diverse readership a high quality yearbook which presents the researcher, the scientist, and the student of environmental studies with the current year's exploration of issues and problems facing educators and environmental education; and (2) to provide both the practitioner and the scholar with a selection of the year's production of environmentally-related research and scholarship.

The make-up of the editorial staff is designed to accommodate the goals of the volume and provide broad expertise in environmental education and environmental studies areas. Two editors, Dr. Arthur Sacks and Dr. Judith Schultz, were responsible for papers broadly defined as "environmental studies," while Dr. Louis Iozzi and Dr. Richard Wilke were responsible for papers broadly defined as "environmental education." Each of the editors reviewed the papers for Section I: Environmental Education Applications--The Practitioner's Perspective, and based upon this review, selections were made. The selection of papers for Section II: Research and Evaluation--Refereed Papers, was made by the respective team of editors based upon peer review by at least two additional experts in the field.

Volume VII of Current Issues has been expanded to include an additional section, "Invited Addresses and Symposia." We are pleased to provide our readership with the addresses presented at the tenth annual conference by NAEE President, Dr. Craig Davis; by Dr. F. R. Scroggin, immediate past president of the National Wildlife Federation; by the Honorable Jackie Swigart, Secretary of Commonwealth of Kentucky's Department for Natural Resources and Environmental Protection; and by S. David Freeman, then Chairman of the Tennessee Valley Authority. We are also pleased to be able to include two invited symposia on important environmental issues, one on synfuels, the other on acid rain.

Three years ago, Current Issues began the practice of inviting a guest "Foreword." The idea of the "Foreword" was to attract a nationally prominent environmental figure to comment on current environmental issues as they relate to environmental education. Continuing in the brief history of the Foreword initiated by U.S. Senator Gaylord Nelson, followed last year by Professor Lynton K. Caldwell, this year the editors are very pleased to have secured the remarks of S. David Freeman. As noted above, Mr. Freeman also attended the Conference and addressed NAEE's membership.

The editors wish to offer their appreciation to the ERIC Clearinghouse for Science, Mathematics and Environmental Education for the outstanding effort they make with the Current Issues. We wish to especially acknowledge Dr. John Disinger, ERIC's Associate Director, whose patience, fortitude, and considerable talents are tested each year by the likes of us. We also wish to recognize with sincere appreciation the Institute for Environmental Studies of the University of Wisconsin-Madison, the Institute for Science, Technology and Social Science Education of Rutgers-the State University of New Jersey, Raymond Walters College of the University of Cincinnati, and the College of Natural Resources of the University of Wisconsin-Stevens Point, institutions which have provided substantial support in staff time, facilities, and supplies and expenses without which this volume could not have been produced.

Arthur B. Sacks
Louis A. Iozzi
Judith M. Schultz
Richard Wilke

Editors, Current Issues VII

October, 1981

Current Issues in Environmental Education and Environmental Studies, Volume VII

Editors .....Dr. Arthur B. Sacks
Administrator of Academic Programs
Institute for Environmental Studies
University of Wisconsin-Madison
70 Science Hall
Madison, WI 53706

Dr. Louis A. Iozzi
Assistant Professor of Science and Environmental Education
Cook College
Rutgers-The State University of New Jersey
New Brunswick, NJ 08903

Dr. Judith M. Schultz
Associate Professor of Biology and Environmental Studies
Raymond Walters College
University of Cincinnati
Cincinnati, OH 45236

Dr. Richard Wilke
Associate Professor of Environmental Education
Director, Central Wisconsin Environmental Station
College of Natural Resources
University of Wisconsin-Stevens Point
Stevens Point, WI 54481

Special Assistance . Ms. Nancy Brzezinski
Secretary
Education Department
Cook College
Rutgers-The State University of New Jersey

Ms. Eileen Hanneman
Departmental Secretary
Institute for Environmental Studies
University of Wisconsin-Madison

Ms. Donna Troestler
Secretary
Institute for Environmental Studies
University of Wisconsin-Madison

Reviewers

The editors would like to thank those listed below who have graciously volunteered their services as reviewers for the Current Issues series. Reviewers are selected from within NAEE ranks and from without in an attempt to bring a broad scope of scholarly and professional expertise to bear upon submitted papers.

William G. Berberet
Dean of Liberal Arts
Willamette University
Salem, OR 97301

John Baldwin
Environmental Studies
University of Oregon
Eugene, OR 97403

Barton C. Brown
Department of Chemistry
Raymond Walters College
University of Cincinnati
Cincinnati, OH 45236

James Cebula
Department of History
Raymond Walters College
University of Cincinnati
Cincinnati, OH 45236

Janey M. Y. Cheu
Institute for Science,
Technology and Social
Science Education
Rutgers-The State
University of New Jersey
New Brunswick, NJ 08903

Craig B. Davis
Environmental Studies
Iowa State University
Ames, IA 50011

Arthur Edwards
Dean of Instruction
Cook College
Rutgers-The State University
of New Jersey
New Brunswick, NJ 08903

Michael Gross
School of Education
University of Wisconsin-
Stevens Point
Stevens Point, WI 54481

Mark E. Hanson
Energy Systems and Policy
Research Programs
Energy Research Center
University of Wisconsin-
Madison
Madison, WI 53706

Marty Kanarek
Preventive Medicine and
Environmental Studies
University of Wisconsin-
Madison
Madison, WI 53706

William Kirby
School of Education
University of Wisconsin-
Stevens Point
Stevens Point, WI 54481

Richard Perrine
Environmental Science and
Technology
University of California
Los Angeles, CA 90024

R. Ben Peyton
Department of Fisheries and
Wildlife
Michigan State University
East Lansing, MI 48823

Gretchen Schoff
General Engineering and
Environmental Studies
University of Wisconsin-
Madison
Madison, WI 53706

Alan Schwartz
Environmental Studies
St. Lawrence University
Canton, NY 13617

William B. Stapp
Environmental Education
University of Michigan
Ann Arbor, MI 48109

John Steinhart
Geology and Environmental Studies
University of Wisconsin-Madison
Madison, WI 53706

Stanley Sulkes
Department of English
Raymond Walters College
University of Cincinnati
Cincinnati, OH 45236

R. Thomas Tanner
Environmental Studies
Iowa State University
Ames, IA 50011

Daniel Willard
School of Public and Environmental Affairs
Indiana University
Bloomington, IN 47401

CONTENTS

Research and Evaluation — Refereed Papers

FOREWORD

Foreword: Renewing the Environmental Commitment

Not since the formative years of the nation's environmental consciousness in the late 1960's have environmental educators faced greater challenges than they do now. The great wave of citizen indignation and concern over environmental degradation that characterized much of the last decade has not been dissipated, but it has abated somewhat. Two serious gasoline shortages have placed the specter of energy depletion in the forefront of public consciousness, partly crowding out the specters of choking smog in the air and oil on the waters, which spurred the movement's initial political successes.

This is a time, not for retreat in the face of adversity, but for renewed commitment to a just cause that remains of grave concern to many citizens. Recent setbacks should be a reason for reflection, not about the fundamental underlying goals of environmentalism--which remain as sound as ever, being based on a solid scientific concern for the future of humanity--but about the methods to be employed in achieving those goals. We cannot afford to waste time, money, and effort in pressing marginal environmental concerns or solutions to genuine concerns in an unnecessarily costly manner. Environmental protection must be pursued in a cost-effective manner. But, it must be pursued because it is cost-effective.

The essential attraction of environmentalism, and its greatest selling point in the environmental education process, is that it represents the concern of the public as a whole for the maintenance of a liveable planet. Contrary to the statements of some industry groups, the war on pollution is very far from won; our achievements to date constitute at best a partial victory in an early battle. Given the wide range of environmental challenges that remain to be met, we cannot now afford to relax our vigilance, either as environmentalists or as a nation.

On the one hand, we need to begin a process of re-education about recognized pollution threats. The costs to the nation of air pollution control devices such as scrubbers, baghouses, precipitators, and coal-washing facilities have been well publicized. People have been allowed to forget the equally tangible health benefits of reduced respiratory and heart disease. Similarly, citizens have been made aware of the substantial cost and inadequate design of some secondary and tertiary sewage treatment plants. They are less well-informed today about the cumulative benefits of cleaner water in sustaining life and making possible additional quality development.

Beyond these, the bread-and-butter environmental concerns of the 1970's, we need to turn our attention to public education about the emerging environmental threats of the 1980's. I am referring here to such menaces as the toxic chemical time bombs that are quietly ticking away in hundreds of poorly controlled dump sites around the country. The realization is growing that toxic chemicals could well be our most serious environmental problem, but the extent of the risk remains poorly understood by the public at large. The Love Canal saga went a long way toward correcting this deficiency and helped to spur valuable legislation. Now, the laws that

have been placed on the books must be enforced by effective and concerted action to clean up the hazardous waste mess.

In addition, environmental educators need to turn their attention to generating a broad-based public understanding of the continuing abuse of our land. Millions of acres of the best farm land in the country are paved over every year because the land's dollar value in producing food cannot match its value as commercial real estate. Together with poor farming practices and wind and water erosion, soil erosion is greatly reducing the productive capacity of the farmland that remains. This trend threatens to make an endangered species out of our ultimate renewable resource, which provides much of the world's daily bread.

Finally, it must be a continuing priority of environmental education to improve public understanding of the benefits of sound environmental research. We are still quite low on the learning curve of most environmental dangers. Greater knowledge can allow policy makers to target pollution control measures more precisely and effectively. Research can thus greatly reduce total costs and increase benefits. Too many people still seem to view serious environmental research efforts as mere academic boondoggles when in fact they may be the best possible investments of tax dollars available.

This, the latest volume of Current Issues in Environmental Education and Environmental Studies presents a selection of some of the best recent thinking on these and other environmental questions. The scope of topics discussed is impressive, ranging from the cosmic to the important but relatively mundane. In helping to keep the environmental debate focused on the realities of the problems facing us, these papers make a significant contribution to the public interest.

S. David Freeman
Tennessee Valley Authority

September, 1981

INVITED ADDRESSES AND SYMPOSIA

President's Address to the 1981 Conference: Porous Paradigms and Intellectual Cathedrals

Craig B. Davis[1]

At the advent of our second decade, environmental educators can look back over ten years of accomplishment. We have helped awaken the American People from environmental complacency. Recent national polls indicate that the vast majority of Americans favor environmental protection, even if such protection would involve increases in government spending and reasonable personal sacrifices. These findings assume added significance in light of the conservative messages sent to our political leaders in the recent national elections. The polls also have a message for environmental educators. The people are telling us: "O.K., we're awake now. We want to get on with the business of building an ecologically sound society. Tell us how to do that." This demand is a major challenge to environmental educators.

During the decade of the seventies we developed and practiced what we might call "first generation EE." The objective of "first generation EE" was to increase environmental awareness and sensitivity, to awaken the populace. Much of the effort during this "first generation" has been aimed at developing a new ethic, an environmental ethic. In this effort considerable use was made of some generalized concepts or paradigms borrowed from various disciplines, especially ecology. For instance, we used the paradigm of "limits" to alert our students to the dangers of over-population and pro-growth Keynesian economics. We used the "diversity begets stability" paradigm to justify efforts to protect endangered species and complex ecosystems. And we adopted the paradigm of "holism" (everything is attached to everything else) to promote the idea of the balance of nature and to encourage interdisciplinary approaches to environmental problem-solving. These paradigms served us well during the seventies. They are simplistic generalizations that were effective in raising the populace from ignorance and complacency to its present level in awareness and concern. But simplistic generalizations will not be good enough during the eighties.

Americans are concerned today and they are asking questions; questions about the desirability of development projects, about the levels of pollutants in our air and water, about the long-range implications of growth economics, and about the meaning of quality in human existence. But, they are also asking questions about the rationality of certain environmental concerns. Are we really running out of just about every resource, as some environmentalists claim? Is crowding really all that detrimental to human well being? Will CO_2 levels really alter world climates? Won't new technologies be found to fix environmental problems? And just how important is the snail darter anyway?

---

[1]Environmental Studies, Iowa State University, Ames, IA 50011.

We have helped create awareness and concern, but we have also created a certain level of sophistication. It is becoming increasingly obvious that simplistic generalizations and platitudes are no longer enough. Our students are out there on the firing line. Their opponents will look for any opportunity to disarm them, and the best way to do that is to label them as dilettantes. There will be no role in the environmental polemics of the eighties for those armed only with catch phrases, ill-framed ideas, and rightious indignation. We must provide our students with more. We must become more thorough, more rigorous.

I suggest that our first step toward a "second generation" EE effort should be a reevaluation of the paradigms that are too often treated as articles of faith within the EE community. Such a review will validate some paradigms, even strengthen them. It will also allow us to divest ourselves of inoperable and misleading paradigms and adopt new ones. All of this should increase the rigor of our conceptual base.

The National Association for Environmental Education (NAEE) can and should serve as the primary vehicle for dialog about the conceptual base of EE and the structure and goals of a "second generation" EE effort. After all, NAEE is the professional society for EE. It is our professional society, and the principal role of a professional society is the promotion of communication among its members. I would like to see the Communicator become a vehicle for the exchange of ideas. I would also like to see time set aside at our next conference for a symposium on EE's paradigms. It is only through a vigorous exchange of ideas that EE will advance and mature.

I would like to initiate this exchange by offering some observations on the dangers associated with accepting any paradigm as an article of faith; specifically, by throwing some stones at a particular ecological paradigm that, in my opinion, deserves such treatment. Let us begin!

Paradigm

A paradigm is simply a model that we use to help us understand some complex phenomenon. It is a mental construct, an abstraction. A productive paradigm can serve as a stimulus to learning. It summarizes what is already known about the system and serves as a knowledge base from which probes can be made into the unknown. It is dynamic, capable of evolving as new information becomes available. Of course, new information can also undermine a paradigm, weaken it or even destroy it. Unfortunately, paradigms seem to grow and evolve whenever new information supports them, but they rarely fall easily when new information undermines them. I call this the "cathedral syndrome."

Even though paradigms are abstractions, they do attract adherents who imbue them with an aura of reality. The paradigm can become a "school of thought." The abstraction becomes the object of study and all new information is interpreted according to the dogma of the "school." The paradigm is embellished and reinforced, gradually becoming an intellectual cathedral in which the followers congregate. No one dares chip away at the cathedral. To do so is to risk scorn and ridicule. No one ventures beyond the walls of the cathedral either. Outside, it is dark, unknown and dangerous.

Eventually, however, heretics do appear and start chipping away at the cathedral. As flaws in the superstructure are exposed, the heretics may abandon the cathedral and attempt to generate new paradigms. Unfortunately, old cathedrals continue to stand long after the departure of the heretics. The faithful, oblivious to the flaws in the superstructure, continue to come and worship.

Herein lies the danger of paradigms. They can easily become "articles of faith" and when they do, they lose their heuristic value. They become intellectual dead-ends. To the extent that we can identify our basic paradigms and use them as knowledge bases for further learning, we are functioning as educators. But, when we become followers entrenched within a paradigmal cathedral, we stagnate intellectually, forfeit our academic credibility, and become proselytes.

A Crumbling Ecological Cathedral

To illustrate the dangers of cathedral building, I could describe a number of porous paradigms in my own discipline of ecology. We could discuss holism, or succession and climax, or the idea that diversity begets stability. All are paradigms that have been converted into intellectual cathedrals; in the cases of the succession and diversity paradigms, by well-intentioned ecologists; in the case of holism, by laymen.

For now, the discussion will be limited to the "diversity begets stability" paradigm. This is a magnificent piece of dogma that grew out of observations that ecosystems with many species seem to be fairly stable, whereas ecosystems with few species seem to be unstable. In the 1950's, ecologists etched this paradigm in stone by developing mathematical models that seemed to show conclusively that food chains or webs tend to increase in stability as the number of species increases. The idea was that if one source of food became unavailable for any reason, the consumer could simply shift to another and the stability of the system would be maintained. The classic examples used to illustrate the "diversity begets stability" paradigm were the arctic tundra with its low species diversity, simple food webs and apparent instability; and the tropical rain forest with its high species diversity, complex food webs, and obvious stability.

The beauty of the "diversity begets stability" paradigm was seductive. Ecologists were quick to fall in line. Diversity was studied in just about every type of biological community. It was defined and redefined. Different types of diversity were described and each type was studied. Then the concept of stability was redefined and the various forms of stability were described. Finally, the relationships between the various types of diversity and the various forms of stability were discussed in all their permutations. The abstraction had become the object of study. The paradigm had grown into a cathedral.

The dogma was incorporated into ecology texts. Followers came to the cathedral to worship. Conservationists took up the banner and urged policy makers to preserve complex ecosystems because these ecosystems would serve as a counterbalance to man's destabilizing activities. Environmental scientists adopted diversity as a measure of the health of an ecosystem;

polluted systems were thought to decrease in species diversity as pollutant levels increased. And, environmental educators called on the "diversity begets stability" paradigm whenever they discussed endangered species or alternative energy sources, life styles, cultures, etc.

Well, ecologists still study diversity. But, I know of few who still believe that there is a direct cause-effect relationship such that increased diversity leads to increased stability. Ecologists began to flee the cathedral about ten years ago when accumulating field data cast a shadow of doubt over the paradigm. The final exodus took place just a few years ago when the mathematical underpinnings of the paradigm were shown to be faulty.

Ecologists labored diligently in the "diversity begets stability" cathedral for nearly twenty years before they recognized their errors and departed. The other followers, however, are still preaching and worshipping the same old dogma, still trying to create stability by creating diversity and complexity, and still wondering why it doesn't work.

The ecologists who fled the cathedral are now submitting alternative explanations of the relationship between diversity and stability. Perhaps the most intriguing of these is the suggestion that we had it all backwards; i.e., "stability begets diversity." This explanation makes a great deal of intuitive sense because it offers an explanation for the origin of diverse communities. The old paradigm conveniently ignored this central problem. The new suggestion says that diverse communities develop in regions where the external environment is stable over long periods of time. This stability allows for the evolution and adaptive radiation of new species to fill vacant niches in the community. Given enough time, all niches will be filled and diversity will be maximized. This scenario could occur in a region like the equatorial tropics, but it could not happen in the climatically unstable arctic tundra.

This new model has added intuitive appeal because it is easily extrapolated to human social systems. We can see that diverse and complex social systems have developed only in situations where stable conditions prevailed: stable climate, stable energy supply, and stable resource supply. Destabilize any of these factors and see what happens to the complexity of the systems -- it will decrease.

Do we have a new paradigm here? Maybe! Will we have a new cathedral? I hope NOT! Ecologists are not treating the "stability begets diversity" idea as an article of faith. We are focusing our attention on the real world, on actual ecosystems, not on the abstraction. We may emerge from these studies with a new paradigm, but we will not be building a cathedral.

Ecologists are abandoning their cathedrals, and are now trying to identify paradigms that are truly basic to their science. It is an exciting time to be an ecologist. We are striking out into the unknown. Ideas are being discussed--often heatedly. But this is how we advance and mature as scientists.

The 1980's could be an exciting time to be an environmental educator. We could have a tremendous impact during coming years. The need for a "second generation" EE effort is obviously there. Let us get on with it.

Address to the Tenth Annual Conference of the National Association for Environmental Education, 3 May 1981:

The Path Behind and the Road Ahead

F. R. Scroggin[1]

It is a real privilege and pleasure to be able to meet with you on this occasion and in such beautiful surroundings. Of course, I well may be biased in favor of my home state, Kentucky, the home of beautiful horses, Blue Grass music and bourbon whiskey.

Dr. Judith M. Schultz suggested that I share my views on the above title, "The Path Behind and the Road Ahead." With the benefit of the usual good judgment of better hindsight than foresight, I would like to begin by recalling something of the history of the environmental movement and the role of education in it.

There have been arguments, claims, and counterclaims about when the conservation/environmental movement began. Actually, it was an evolutionary thing.

As our early settlers moved out from the Eastern seaboard in the wake of explorers and fur traders, the frontier wilderness presented a threat to be faced and overcome.

Forests had to be cut and cleared to make the land available for agriculture. Wild animals killed livestock and poultry and there were vermin to be destroyed.

Streams offered the easiest and most economical way of disposing of wastes--out of sight, out of mind.

Who would think, at the turn of the century or even a while afterward, that Teddy Roosevelt and Gifford Pinchot were anything but starry-eyed visionaries when they wanted to create national forests?

Who could have imagined that opening the soil to wind erosion would create a "Dust Bowl," that flights of the passenger pigeon would disappear forever, that rivers would become open sewers which, on an infamous occasion or two, actually caught fire?

Some time in this era, in the 1920's and Dirty Thirties, the "conservation concept" was born. It called for wise use of natural resources, not merely preservation, except for those in short supply.

To some extent, it was a misnomer because many people confused "conservation" with "preservation."

---

[1]Immediate Past President, National Wildlife Federation, 1412 16th Street, NW, Washington, DC 20036.

In my early days in the movement, mostly after World War II, we were convinced that conservation education was the answer--"Inform the people and they will respond," we said. Some did, true. But many didn't.

So the problem was this: how to inform or educate an entire people? One was through newspapers and magazines and speeches and workshops and films like the old classic, "Web of Life."

But many experts also thought the only lasting answer was to teach conservation in the schools, and this involved teaching the teachers, in many cases, teaching the professors in teaching training schools. So, the emphasis was very much on making people aware.

Then, beginning in about 1960, when we were becoming increasingly concerned about pesticides and water pollution, the conservation movement started to take on new dimensions.

Chemicals choked the air and fouled the water. Solid wastes descerated our highways and byways and streams. More and more fish and wildlife, often unknowing indicators of the lack of man's concern for anything but the Almightly Dollar, disappeared. As energy sources dwindled, the costs accelerated.

Somewhere in this period, the "conservation" movement matured into the "environmental" movement. Early on, much of the impetus behind "conservation" came from sportsmen--people who were earliest to recognize that birds and mammals and fish depend upon suitable habitats.

The National Wildlife Federation, now our largest conservation/environmental organization, with 4.6 million members and supporters, came into being in 1936. Our early concerns were for clean water, losses of waterfowl wetlands, and sound enforcement of the laws protecting wildlife.

Now our concerns encompass not only professional management of soil, water and wildlife resources, but control of pollution, conservation of energy through mass transit and other means, and even population stabilization.

So, our progress has been evolutionary. You probably are better able than I to say whether we have won or lost or even held the line--or even fought a good fight.

What will future generations say of this time--the present--when clean air and water regulations are being relaxed and bows in the direction of industry, when prime farmland is being eroded away or diverted into other uses, when species of fish and wildlife and plants are going out of existence, seemingly almost every day? So much of where we have been. Where are we going?

All of us appreciate the values of a healthy environment. And all of us understand that a clean environment doesn't just happen; it is something we must work for.

All too often, "progress" has resulted in destruction. At no prior time in history have we had either the technological capacity or the human numbers to make such negative impacts on such a broad scale.

The majority of people must learn how the ecosystems function and how the technological, economic, and sociological activities of humans affect these functions, for better or for worse.

This is a task for education--creating environmentally-literate citizens. Unlike the early days, the people are aware. Our job is to get them to do something about it.

In our opinion, we cannot continue to treat the environment with a business-as-usual attitude. If we are going to solve our environmental problems, there is going to have to be a whole new generation of thinking, a new way of viewing our role in the world.

Our nation, even the world as a whole, soon must dedicate itself to evolving a new way of looking at the earth and its resources, even the numbers of people it can support in a life better than a mere existence.

Survival of the world in any recognizable form depends upon our success in achieving an environmental ethic. We all must become responsible stewards of the earth.

We know that we can progress as a society without destroying the very land on which we depend. We know, given necessary information, experience and skills, that we can make the tough environmental decisions the future will thrust upon us and not destroy our environment in the process. Learning to live with the world is what environmental education is all about.

To us, not only does environmental education seek to impart knowledge, but it also must aim to help people clarify values and take action. More than ever before, governments need informed citizens to help voice concerns and arrive at reasonable judgments on a wide array to environmental issues.

To be effective in the role of stateperson, an individual needs to understand interrelationships between environmental problems and the tradeoffs that accompany nearly every decision.

Our system involves social, psychological, economic and biological concerns. For this reason, environmental education must be multidisciplinary, borrowing from such traditional disciplines as sociology, psychology, economics, and ecology.

Environmental education must be maintained as an educational entity because it deals with problems and issues that cannot be fully understood through any single discipline.

Please note earlier that I said "all of us" when referring to responsible stewards of the earth. This is one way of issuing an urgent appeal and challenge for all of you to be active--active not only in your own specific jobs and professions but active in trying to get strong state and federal educational programs established--active, if necessary, to lobby for educational appropriations before legislative bodies--active in drumming up support from citizen groups through letters, calls, and visits.

This is no "ivory-tower" stuff--it is real world hardball, with the environment pitted against a wide range of potential despoilers. This, too, is environmental education.

You might say: "What is the National Wildlife Federation doing about it?" In an informal sense, we publish Ranger Rick's Nature Magazine monthly for more than 900,000 children.

We publish National Wildlife Magazine for 950,000 households and International Wildlife Magazine for one-half million.

We sponsor the annual observance of National Wildlife Week which featured "oceans" this year. We distribute press and radio-TV releases.

We conduct "Conservation Summits" for environmentalists interested in working on issues. We sponsor youth camps. We award $100,000 worth of Fellowships each year. We work with federal and state executive agencies on a wide range of resource issues.

We lobby at the Congress. When mitigation fails, then we litigate in court. This, too, is environmental edcation.

In a more formal sense, the National Wildlife Federation is proud of a classroom effort. With the help of a grant from the National Science Foundation, we are developing an environmental education program called THE CLASS PROJECT.

To be available by the end of this year, the word "CLASS" is an acronym for "Conservation Learning Activities for Science and Social Studies."

The goals are to help students understand environmental concepts and skills, helping them develop and use skills in investigating and solving environmental problems.

It is to involve students in community action projects. It is to help students observe, classify, measure, record, predict, communicate, and make value judgments about environmental issues. It is designed for middle and junior high school students (grades 6-9) and their teachers.

Now, more about the future, about where we may be going.

The National Wildlife Federation believes that environmental education is the principal, long-term tool for achieving an awareness and understanding among all citizens of the need for wise use and proper management of the natural resources on which we all depend.

Further, we believe it is essential that there be a strong environmental education component in our public schools at all levels.

Environmental education should be integrated into existing curricula and taught as part of classes in reading, composition, science, mathematics, social studies, and others or as a subject per se.

Further, we are convinced that state and local education agencies and private groups, such as our own, have roles to play. And, the Federal Government, too, has an important role in the support of environmental education.

Because of its national educational perspective, the Federal Government can make significant contributions toward coordinating and fostering environmental education programs throughout Federal agencies and in conjunction with state educational agencies and non-governmental groups.

With passage of the Environmental Education Act of 1970, the Federal Government went on record supporting the critical need for environmental education.

Now, in 1981, it is essential that this Federal recognition and support be reaffirmed. Unfortunately, the Environmental Education Act is in extreme jeopardy. Never adequately funded and with the Department of Education itself in a questionable status, the Environmental Education Act may fade away unless we all get busy. To be specific, the Department of Education is currently in the process of drafting legislation to authorize consolidation of available educational funds into block grant categories.

Under plans currently being considered, the Federal Government will make block educational grants to the States. The States, then, within certain guidelines, may use some of their federal funds for programs of their choosing. But the programs must be from program purposes listed as eligible by the Federal Government.

At this point, environmental education is not listed among those likely to be authorized as eligible. If you believe as we do that strong environmental education programs are vital to the wise use and proper management of all of our natural resources, and that they are vital in helping citizens gain an awareness and understanding of the need to protect environmental quality, we urge you to write and express support for including "environmental education" as one of those program purposes eligible for use of Federal funds under the block grant legislation now being prepared.

Write your members of the Congress. Write Senator Orin Hatch, Chairman, Senate Committee on Labor and Human Resources.

Write Senator Robert T. Stafford, Chairman, Senate Subcommittee on Education, Arts and Humanities.

Write Representative Carl D. Perkins of Kentucky, Chairman, House Committee on Education and Labor. Send copies to Terrel H. Bell, Secretary of Education.

So, in closing, I urge you to be vigorous, vociferous, and vocal in your support of the principle of conservation/education protection--be energetic, efficient, and emotional, when necessary. Call on the National Wildlife Federation if we can help. It is in your hands.

Thank you for your attention and best wishes.

Address to the Tenth Annual Conference of the National Association for Environmental Education, 3 May 1981:

Environmental Education in Kentucky

Jackie Swigart[1]

Environmental education in Kentucky was recognized as a legitimate function of public education institutions some time prior to the so-called environmental movement in the 1960's. In fact, the Kentucky General Assembly passed the Kentucky Conservation Bill in 1944 which empowered the Department of Education to implement an environmental education program in Kentucky schools. Special emphasis was placed upon materials relating to conservation and the preservation of soils, forests, water, minerals and wildlife. The pertinent statutory language reads as follows:

> "Instruction in all phases of environment shall be included in the curriculum of the public schools of Kentucky; and textbooks regarding the proper use and protection of forests, soils, water, minerals, wildlife and other aspects of the environment shall be prepared or selected by the State Textbook Commission for this purpose."

Throughout the 1950's and 60's, the emphasis on environmental education grew steadily, albeit slowly. The classroom instruction was greatly enhanced by the extracurricular teachings of such programs such as the 4-H Club, Conservation Camps and Forestry Camps. In the 1960's, employees of the Fish and Wildlife Camps attempted to make periodic visits to sixth grade classrooms to discuss various aspects of conservation programs.

The early effort matured during the 1960's, but did not come into full bloom until the 1970's. It was during this period that many environmental education resource centers were established throughout Kentucky. In the eastern part of the state, one can find today several resource centers including the McCreary County Environmental Education Center, the Pine Mountain Settlement School, the Rockcastle Resource Center, and the Maywoods Environmental Education Lab. To the west, one can enjoy the Center for Environmental Education at Murray State University, the John James Audubon Park, and the Land Between the Lakes Education Center. Located in central Kentucky are several outstanding centers including the Mammoth Cave Environmental Education Center, the Otter Creek Park, and Buckley Wildlife Sanctuary. Even in the most urban area of Kentucky, environmental education resource centers can be found at the Black Acres Nature Preserve and the Urban Homestead House, both in Jefferson County.

There are many factors that contribute to the success of any education effort. To have a law requiring some form of environmental education in the classrooms and the existence of geographically-disbursed resource centers does not necessarily imply a successful program. One key

---

[1]Secretary, Department for Natural Resources and Environmental Protection, Commonwealth of Kentucky, Frankfort 40601.

ingredient is the classroom teacher who must deliver the message. Another contributing factor is the degree of assistance and support that is available outside of the classroom. For example, there are many agencies at the state level which frequently provide such assistance. The Kentucky Department of Education acts as the agency responsible for coordinating formal environmental education activities within Kentucky classrooms. The Department for Natural Resources and Environmental Protection provides teacher training and support materials such as films and brochures through its Division of Forestry. Within the same department, the Division of Conservation is instrumental in developing teacher workshops and initiating use of outdoor classrooms by local school districts. The Kentucky Nature Preserves Commission is actively engaged in establishing environmental education centers and developing handbooks and other classroom materials. The Environmental Quality Commission assists in providing current environmental information to schools and co-sponsors workshops with the Department of Education. The Department of Energy also participates by providing the Department of Education with federal money to sponsor teacher workshops in energy conservation. Junior Sports Programs and Summer camps are sponsored by the Kentucky Department of Fish and Wildlife Resources. Additional support is given to the environmental education effort by the Kentucky Association of Conservation Districts, a non-profit, private corporation made up of governing bodies of Kentucky's 121 conservation district board of directors.

There are also many institutes of higher education which are involved in environmental education programs. Murray State University's Center for Environmental Education offers graduate degree programs for teachers in environmental education areas. The Center also serves as a resource bank for 15 western Kentucky school districts which make up the West Kentucky Environmental Education Consortium. Morehead State University's Center for Environmental Studies offers undergraduate degrees in environmental sciences and special courses for classroom teachers. Through several individual departments of Eastern Kentucky University, classroom teachers can sharpen their skills in environmental education. Several universities, although not specialized in environmental education programs, offer courses that enrich teacher training in this area. Those universities include the University of Kentucky, the University of Louisville and Western Kentucky University.

In addition to the support available at the state level, there are various federal agencies which are active in this area. The U.S. Soil Conservation Service cooperates with the Kentucky Department of Education in sponsoring workshops and encouraging the utilization of outdoor classroom sites. The U. S. Forest Service provides materials entitled "Investigating Your Environment" which are frequently used as workshop materials. The Tennessee Valley Authority donates financial assistance to the state which has been used to establish the Environmental Education Center at Murray and to print workshop materials.

Various private organizations are also dedicated to some aspect of improvement of the environmental education programs. Currently over 30 Kentucky organizations are involved in some degree with such efforts.

The business of educating the public on environmental matters is a continuing one. Even though there is a demonstrated interest in Kentucky

and an active effort to provide environmental education programs, there are always improvements to be made. Therefore, it is important that persons active in these fields share their experiences with colleagues in other states and in other areas of our education system. Through a cooperative spirit, it is possible to enhance the programs that are already in place.

Address to the Tenth Annual Conference of the National Association for Environmental Education, 4 May 1981:

TVA and the Environment

S. David Freeman[1]

I am here today to report on the progress TVA has made in its renewed commitment to one of the great challenges of this century. I am speaking of the need to find a way to accommodate economic development within a sensible framework of environmental protection. To me, this has always been the essence of the mission assigned to TVA by the TVA Act back in 1933, but it has never been more appropriate than in the 1980's.

I grew up in the Tennessee Valley, and nearly four years ago, I came back as a TVA Board member. I found the region still had tremendous natural and human resources waiting to be harnessed, but the valley also remained largely unspoiled by the industrial ravages that have turned other parts of the country into environmental wastelands. I saw the Tennessee Valley as a region where the dream of economic prosperity could still coexist with the dream of maintaining a liveable environment.

The Tennessee Valley, I believe, is in the process of becoming a model for the nation of sensible energy, environmental, and community development. This was TVA's original mission, one that spurred the tremendous sense of adventure that characterized the early years of TVA.

TVA in those days was regarded not just as a "yardstick" of low electricity rates, but primarily as a model of democracy in action, of what the people could do for themselves once their energy was harnessed for the good of everyone. TVA didn't build the great dams, light up the rural countryside or control the floods that had ravaged the valley since time immemorial. The people did, with TVA's help and inspiration, and they were justly proud of what they accomplished.

But 1981 is not 1933. The problems and opportunities are different. They are more complex. And we have made great strides both in economic development and in recognizing basic environmental values. It's easy to forget that a short decade ago environmental protection was expressed mainly by little old ladies with tennis shoes and binoculars and other folks who were outside the mainstream of society. Today, environmental protection has become the law of the land, and the consciousness of people everywhere has been deeply imprinted with an awareness of the fragility of our small green world.

It is perhaps worth noting that just as the technology of the industrial age helped to create the conditions that led to this new awareness, that same technology put cameras into space that allowed us to realize the preciousness of spaceship earth. Mankind's first step into space was a giant step for environmental education.

---

[1]Chairman of the Board, Tennessee Valley Authority, 400 Commerce Avenue, Knoxville, TN 37902.

The transformation of consciousness that we now know as a success story for the environmental movement has taken place in just the last 10 years. The first Earth day was held in 1970, and by 1980, a substantial body of legislation had put the American people's new awareness on the books. The Clean Air Act and its amendments, the Clean Water Act and its amendments, the National Environmental Policy Act, the Resource Conservation and Recovery Act: these and a host of lesser federal and state laws expressed the desire of the people for an end to wanton environmental abuse.

As awareness of the environmental crisis gathered force, it became more and more closely linked with an awareness of the developing energy crisis. Many people came to recognize that a high rate of energy consumption, especially wasteful energy consumption, had been responsible for a large share of the continuing environmental degradation. The images of belching power plants, uncontrolled automotive exhausts, the unreclaimed strip-mined land and miles of oil slicks mingled together and did much to make conservation of energy synonymous with saving the environment in many people's minds. Yet this linkage was by no means universally accepted, and most people were content to continue the 20th century energy joy ride.

This was no less true in the Tennessee Valley than it was elsewhere. In the Tennessee Valley, TVA had preached the virtues of low-priced electricity, but had failed to educate the public as to the costs of failing adequately to protect the environment in the production of electricity. Electric rates were kept low in part at the cost of unsafe coal mines, unreclaimed strip-mined land, air pollution, and deteriorating water quality due to the oxygen depletion in TVA's reservoirs. TVA's coal-fired power plants were putting out more than a million tons of pollutants in the form of sulfur dioxide, particulates and fly ash each year over and above what is permitted by air quality standards. TVA was the nation's largest single source of sulfur oxide pollution of the air.

The federal clean water legislation achieved a considerable improvement by removing much of the industrial waste being dumped into our lakes and rivers. But here again, TVA itself was a part of the problem rather than a part of the solution. Through the process of eutrophication, TVA dams were in large part responsible for depleting dissolved oxygen in downstream waters to the point that fish could not exist below some dams. While the Tennessee River ranked 10th in overall quality among the 25 largest rivers in the country, it ranked 23rd in dissolved oxygen levels.

At the same time, farmers in West Tennessee had turned to soybeans as a cash crop, and they were planting them more and more on marginal lands that had previously been kept out of cultivation. Deep gullies were again eating through the highly erosive soils of the area's hillsides. A farmer told me the soil melted like sugar and ran like hell. Topsoil was washing into the streams and rivers at rates that had not been seen since the 1930's. It seemed the soil conservation lessons TVA taught in that period had been forgotten.

My favorite story about TVA is the one about the French visitors being flown over the Tennessee River and remarking, "you Americans were so wise in choosing such a nice green valley for your TVA." TVA did help cover over eroded hills and valleys. But when I came back to the valley it looked like TVA had quit when it got as far as Nashville.

The TVA Act assigned the agency the task of helping to carry out the "unified development and conservation" of the Tennessee Valley. In my confirmation testimony before the U.S. Senate in August 1977, I said that "I would hope that in the years ahead, TVA will be referred to as a shining example of how to protect the environment in an effective and economical manner." In the past three years I believe TVA has rededicated itself to this overriding principle.

A first priority was to get into compliance with the air quality law, since TVA was in the unhappy position of having lost its court battle with the Environmental Protection Agency and was being sued by local citizens and the states of Kentucky and Alabama. We worked out a cost-effective compliance strategy and by working with EPA instead of fighting them, TVA was able to achieve a working relationship that has saved us a lot of money while bringing us into compliance with the law.

Today, more than half of TVA's 63 coal-fired generating units are in compliance with the terms of the consent decree and the rest are scheduled to be in compliance by 1983. Through increased use of low-sulfur coal and various pollution control technology, TVA will soon be removing a million tons of pollution from the air each year. Complying has been expensive, but the failure to comply was contrary to our legal duty. It is difficult to quantify the benefits of cleaner air, but all the evidence suggests that the money spent has been a very good investment for the people.

In the past year we have also achieved a breakthrough in water quality. TVA has developed an ingenious and inexpensive means of reinjecting oxygen into dam tailwaters. Known as "turbine-venting," this technique can be adapted to virtually all of TVA's dams. It will result in at least a doubling of the dissolved oxygen content of water below the dams in most cases. The technique is already being used successfully at Norris Dam in East Tennessee and similar units are being installed at other TVA facilities.

With regard to the land, TVA is again an active partner in solving the serious problem of soil erosion. We have joined forces with the U.S. Department of Agriculture and the state to work together in correcting erosion in West Tennessee. One of our primary tools is an educational campaign known as "Save Our Soil." It was launched in the fall of 1979, when several thousand people turned out for a one-day demonstration of good soil conservation practices in West Tennessee. The idea has steadily gained momentum. With assistance from TVA, farmers all over the area and all over the valley are relearning the importance of proper cultivation techniques such as no-till farming.

These are three specific examples of areas in which TVA has moved to deal with serious environmental concerns in the last three years. But more fundamentally, I believe TVA is an environmentally sensitive organization today.

TVA's human resources are perhaps its greatest asset in the task of environmental protection. Of all the agencies of the federal government, I would say that TVA has perhaps the broadest collection of environmentally sensitive technical talent. We have foresters, soil specialists,

ecologists, water quality specialists, and meteorologists. We are, I think, uniquely able to provide an extra dimension of technical expertise in our environmental quality efforts.

I believe this expertise is an important asset because the time has come to direct our efforts at the really serious environmental problems. Let's face the fact that environmentalists have led us down some blind alleys in the mistaken belief that any means justify a desirable end. The result has been serious damage to the credibility of the movement with the general public.

The great Snail Darter Saga is perhaps the best example of what I am talking about. There were legitimate arguments against Tellico Dam such as the loss of prime farm land and the loss of the ancestral home of the Cherokees. But the snail darter alone was not a good reason to stop the dam, and everyone knows it was just an excuse that backfired badly. Environmentalists need to concentrate on the truly important issues and not let legal expediency dominate the way public policy issues are raised.

And there are serious environmental concerns that have yet to be resolved. The control of toxic chemicals and other hazardous wastes is a particularly pressing concern. Toxic chemicals have been dumped beneath the earth's surface for decades, frequently with no precautions whatsoever and with no concern for the effect on future generations. Now, we are beginning to pay the price, and toxic chemicals are increasingly being recognized as a serious and growing menace to the public health. This is probably our most threatening environmental problem, so it is fortunate that government has begun to take heed with legislation and with action.

TVA, of course, does not have any direct responsibility for regulation of these substances, but we do have a substantial interest. We have become a whistle blower and environmental educator. Our report "Where the Water Isn't Clean Anymore" has alerted the public to some trouble spots. And we have spurred some action. For instance, TVA and the State of Virginia are very near agreement with the Olin Chemical Corporation that would result in the stabilization of large quantities of mercury deposits at an abandoned chemical plant near Saltville, Virginia. This would end the leakage of mercury into the north fork of the Holston River, which has been closed to fishing for a decade due to the pollution problem. The company knows that if agreement isn't reached very soon then we will file suit.

We are also working closely with the city of Chattanooga to develop a cleanup plan for Chattanooga Creek, in which TVA recently found 53 hazardous chemicals associated with industrial wastes. The river is so polluted that TVA researchers felt burning sensations on their hands while taking samples. The Saltville and Chattanooga cases were identified publicly by TVA as being among 10 critical water problem areas in the Tennessee Valley.

If we look at this nation's unfinished environmental agenda, the abuse of our land stands out. Of particular concern is the conversion of prime farmland to everything from shopping centers to washed out gullies, neither of which will grow food. We are losing ground fast. Every year, more than a million acres of the best crop land in the country is being turned into parking lots and bowling alleys and fast food restaurants.

Several million additional acres of farmland are converted or lost to erosion each year. No one can be sure, but if this trend continues, American's profitable food exports could well start shrinking rather than growing. And by the turn of the century the world-wide epidemic of starvation could be invading America's shores.

It has been said, and rightly so, that asphalt is the "final crop." In a very real sense this society is choosing death by starvation for people somewhere, perhaps someday even in this country, rather than giving up the pleasures of suburban sprawl. The sad fact is that almost no one sees the issues that way. It's not even being debated, much less being considered as a survival issue. Here indeed is an issue where the first step is one of environmental education.

We environmentalists all like to talk a lot about the need to make the transition to a renewable society. But how can we expect to make that transition if we don't concentrate on the renewable resource on which human life itself depends: the land on which we grow our food?

In this area, just as with toxic chemicals, TVA's role is that of an educator, an example-setter rather than a regulator. We don't have statutory authority to intervene in the decisions of private individuals, and don't seek such a role. But TVA has a responsibility to make sensible use of the land it does control, including more than 1.3 million acres of property around TVA reservoirs.

That is why we have begun a major initiative which when complete will provide a coherent system for deciding how reservoir lands should be used. We have started on a small scale, developing a comprehensive use plan for Pickwick reservoir in northern Alabama. The process has included extensive public participation, including input from recreational, industrial, and development interests. The plan is nearly complete, and similar efforts at other TVA reservoirs will be launched in coming months.

Of course, we are here today at Land Between The Lakes, and I'm sure you have seen for yourselves the excellent multiple use to which this land is now devoted. We expect LBL to be increasingly used as a place where the best way to use land for farming, foresting, wildlife, and public recreation can be demonstrated.

Let me stress the need to concentrate on the unfinished environmental agenda. The temptation is to work on the familiar issues. Cancer from toxic chemicals and starvation from lack of food are basic threats. By comparison, other concerns that get much more attention may not really matter that much. We have a substantial job of environmental education ahead of us in persuading people to place these issues at the top of the environmental agenda.

Environmental research is one of the most effective cost-cutting tools available today. Environmental protection measures are often tremendously expensive, and it is in everyone's interest to reduce the cost of achieving the required level of protection. Even small changes made possible by better knowledge can save billions of dollars of expenditures. And if more stringent controls are needed on some items the sooner we find out the better.

I believe it is also useful to recognize that in the 1970's the stress has been on implementing controls on air and water pollution to clean up a heavily polluted environment. It was a vital task that is far from completed. But in the necessary rush toward regulation we have neglected research to learn more about precisely what levels of control are needed to protect society. We need to err on the side of being cautious, but greater knowledge could save lots of money or lots of lives and property, or both.

TVA has not waited for the rest of the federal government to come up with all the research-and-development answers. The agency itself provides a unique laboratory for research into the environmental effects of energy production, and we have moved to take advantage of that fact. In fact, we receive about $2 million a year from the Environmental Protection Agency for TVA-operated research programs of national significance.

TVA research has included significant findings in the areas of air pollution standards, water quality impacts of coal storage piles, strip-mining standards, acid rain and the effects of thermal discharges from power plants. The "turbine-venting" discovery I mentioned earlier as a partial cure for low dissolved oxygen levels is an outstanding example of the beneficial effects of TVA's research effort and of environmental research and development generally.

But in a democracy such as ours the ultimate weapon in saving the environment is a well-educated public. Environmental education is vital in maintaining the momentum of the environmental movement. I have discussed the broad scope of TVA's renewed commitment to environmental protection, which of course is fundamental to TVA's role as an environmental educator.

As you are probably aware, TVA has also actively supported environmental and energy education efforts throughout the Tennessee Valley. Perhaps our best-known initiative is the cooperative program we operate in association with several regional universities. These centers in turn train public school teachers from surrounding areas to present the environmental message to their students.

But as with the rest of TVA's programs, we emphasize "doing" when it comes to environmental education. Here at Kentucky Dam Village State Park, you have access to our foremost "doing" facility in the environmental education field: Land Between the Lakes. It combines thousands of acres of rolling countryside covered with forests, fields, and ponds with energy demonstration projects reflecting the other side of the environmental coin.

Yesterday, as you know, was Sun Day, in more ways than one. As we work toward building a truly renewable society, Sun Day and Earth Day are fitting counterparts. The one symbolizes the hope of the future for a nonpolluting and inexhaustible source of energy, the other the knowledge that we live on a planet of finite limits that must be respected.

It is the challenging task of environmental educators to present those twin messages to the public. TVA is now carrying out both environmental protection and renewable energy programs. We are also demonstrating ways that society can better live with coal and nuclear power which are necessary bridges as we seek ways to harness the sun for more and more uses.

TVA has now returned to its origins as an agency concerned with saving the land and getting back as fast as feasible to renewable energy sources--the water power, the rays of the sun, the wood from the forest. We need your help in teaching people that our fossil fuels are finite and should be consumed efficiently and not wasted and that the sun offers a better hope for our future energy than any other option. We have a lot of work to do to sustain the momentum of the last decade. Let's not shrink from the task.

Synfuels Symposium Position Paper

King Coal: The Environmental, Economic, and Health Implications of the Synfuel Industry

Judith M. Schultz[1]

Alternative and synfuels energy sources have been brought into the sharp focus of national discussion since the Arab oil embargo of 1973. Synthetic fuels are properly categorized as "alternative fuels" since their basic matter is found naturally, existing throughout the world. They are not man-made from chemical derivatives. Rather, they are self-contained in coal, oil shale, tar sands, animal residues, plant materials, and solid wastes.

The American public has reacted to synfuels either as if they were a new, innovative technology or as if they awaited a major technological breakthrough. In fact, the technology for turning coal into gas has been available for two centuries, world-wide. For half a century or more, the United States has maintained the technology for converting coal to synthetic oil and gas primarily through the support of various federal agencies engaged in synthetic fuel research. In the early 1800's, London Bridge was illuminated by lights burned by coal gas. A large coal-gas industry commenced in the United States in the 1850's and flourished for 75 years. During World War II, the German war industry flew the Luftwaffe on coal-derived gasoline. The government of South Africa is currently expanding a coal-to-gas and oil plant, in operation since the 1950's, into the world's largest commercial complex.

It is the contention of this paper that the capability for synfuel production has been adequately demonstrated on a pilot and commercial basis both world-wide and in the United States. With relatively short notice, such as in wartime, or out of other political necessity, the nation could supplement current energy sources with synfuel production. At present, however, the preliminary environmental, economic, and health implications of synfuel production indicate that the federal government should not disproportionately subsidize this industry. One commercial, subsidized, well-monitored plant should be able to generate once and for all the environmental, economic, and health research data necessary to decide upon large-scale production. The prospective effects of large-scale release of carbon dioxide into the environment with the possible enhancement of the Green House effect, toxicity of coal contaminants to workers, and the competitive pricing of synfuels must be weighed against the growing economic and political vulnerability of dependence upon foreign oil. While vast amounts of oil still lie within the ground world-wide, as a practical matter, we are running out of easily obtained domestic. The United States does not have the petroleum resources to sustain the economic productivity level of the last twenty-five years. From data generated from one large-

[1]Biology and Environmental Studies, University of Cincinnati, 9555 Plainfield Road, Cincinnati, OH 45236.

scale commercial U.S. plant, and the South African plant, Congress should be able to set specific, mandatory synthetic fuel objectives from which it does not deviate, and act expeditiously, with strict oversight.

Billions of dollars from U.S. taxpapers have been poured into twelve thwarted subsidized pilot and commercial plant attempts to date. The private energy sector has not shown interest in synfuels production until recently when the oil industry purchased substantial coal holdings. They have been willing, for the most part, to support subsidized efforts with a range of only 20 percent capital input with overcost handled by the U.S. government. At present, the oil industry prefers to buy oil from foreign suppliers and world-wide reserves, rather than developing synthetic fuels from domestic sources, due to the profitability factor of pricing set by OPEC. Yet, a consortium of oil companies and U.S. banks were willing to invest nearly $5 billion in the Alaskan pipeline effort. It may well be, from this comparison, that the large oil companies are already assured for the present, at least, that synfuel production on a large scale in this nation is not economically sound. Yet, smaller-scale synfuel production is apparently proving economically feasible for individual companies.

Perhaps it will be proven for the synfuel industry that "small is beautiful." The future of synfuels may lie in a U.S. Energy Policy wherein a combination of many diverse soft and hard energy technologies carefully complement one another. Coupled with such an energy future of necessity would be a 40-50 percent cut in energy usage through the reduction of waste and inefficency, and a further reduction of per capita consumption through population stabilization.

Synfuels Symposium Response #1

Howard E. Dunn[1]

I only partially agree with the overall philosophy of the position paper. For the sake of brevity, the position paper could not cover some very important details concerning the potential hazards of commercial synfuel (coal conversion) development. The paper states that the technology for turning coal into gas has been known for two centuries, but it failed to state that elevated cancer rates have been known for the same length of time among workers in that industry. Increased scrotal cancer was associated with coal soot as early as the late 1700's. Coal carbonization workers have experienced excess cancer as compared to the general population. The Department of Health, Education and Welfare (H.E.W.) found carbonization workers experienced excess skin, lung, bladder, and kidney cancer. Doll and co-workers reported the mortality rate among gas workers in Great Britian for lung, bladder, skin, and scrotal cancer was higher than the normal populace. Kurada and Kawahata in 1936 reported excess lung cancers among coal-gas workers in Japan. Sexton studied the workers at a coal conversion pilot plant at Institute, West Virginia. He found the skin cancer rates among workers was 16 to 37 times the skin cancer rates of the normal populace. In this particular case they had even implemented a stringent hygiene and worker protection system. There is much evidence that indicates coal conversion technologies can have severe health and environmental problems.

The United States Department of Energy, H.E.W., and U.S.E.P.A. have compiled a list of 178 organic chemicals that will be emitted from coal-conversion synfuel plants. This list contains 22 carcinogens, 68 suspected carcinogens, 14 mutagens, 26 toxics, 2 caustics and 16 with disagreeable odors, and 30 irritants. This list does not include the whole host of toxic and carcinogenic trace metals or the toxic inorganic gases. Among the organic cancer-causing chemicals are benzo(a)pyrene and dibenzanthracene. The Occupational Safety and Health Administration has prescribed no "safe" exposure limits for these proven carcinogens.

In September of 1980 at a Fuel Conversion Technology-Environmental Aspects Symposium, R. K. Patterson reported on a study that was conducted at a commercial synfuel plant in Kosovo, Yugoslavia. In this study they set up five air monitors about 2 km outside the plant boundary. The monitors found a large number of organic compounds in the atmosphere. They also proved that most of the compounds were the same ones that were coming from the Lurgi gasifier.

---

[1]Indiana State University-Evansville, Department of Chemistry, 8600 University Blvd., Evansville, IN 47712.

At a point 2 km downwind from the plant they found Benzpyrene (a carcinogen) in concentrations of 1000 times over what they considered to be acceptable. Benzene (a carcinogen) was found in concentrations 10 to 100 times over the acceptable level. This plant may not be as well controlled as those proposed for the United States, but it must be remembered that the Kosovo plant is only one tenth the size of any proposed commercial plant for this country. Even if our environmental controls are as much as 90% better, then the downwind concentrations of pollutants will still be about the same as those observed at Kosovo.

Patterson and others have predicted health risks to the general public, yet no epidemiological studies have ever been done on the general public living near a commercial coal conversion (synfuel) plant. If the building of synfuel plants in this country continues as planned, then our citizens will be the subjects for the first epidemiological cancer study of this type.

Since several of the products of the coal conversion processes, products that will be transported and sold, have been found to be carcinogenic and mutagenic, I seriously question the commercial development of coal conversion processes.

Even in the draft environmental impact statement (DEIS) for the SRC-I coal conversion plant planned for Newman, Kentucky, it states that carcinogens will be released and that compliance with all existing environmental laws will not ensure the protection of the workers, the public, or the environment. Not only will the general public be asked to accept an almost certain health risk, but we are also being asked to bear the financial risk as well, by way of grants, assumed liability, and guaranteed loans. If coal conversion technologies were safe and economically feasible they would have already been developed in this country by private enterprise. If we are really interested in saving liquid fuel so as to reduce imported oil and, thus, reduce foreign dependence - then let's put a more energy-efficient automobile on the road. This will save more fuel than the 88 billion dollar synfuel industry will ever produce.

Let me now turn to the problem of siting. Let's assume that all of the synfuels plants planned for Western Kentucky will be built. Within just a few miles of Henderson, Kentucky, and across the Ohio River from the large metropolitan area of Evansville, Indiana, there are going to be three major coal conversion synfuel plants. A 6000-ton-of-coal-per-day demonstration plant, which is to be scaled up later to a 30,000-ton-of-coal-per-day plant, is planned for Newman, Kentucky. An approximately 30,000-ton-of-coal-per-day plant is planned for Baskett, Kentucky, and one of the same size is planned for Geneva, Kentucky.

The mortality statistics for the counties in the general area already show that there is a problem. The death of residents in Daviess County exceeds the U.S. rate for death in early infancy, heart disease, cerebrovascular disease, emphysema, and malignant neoplasms. The deaths of residents in Henderson County exceed the U.S. rate for death in early infancy, pneumonia and influenza, heart disease, arteriosclerosis, emphysema and malignant neoplasms. In Vanderburgh County, Indiana, the death rate due to air pollution-correlated diseases is also relatively high. Why are three large

coal conversion plants even being considered for this area? There are over 200,000 people in this area that are being asked to accept a considerable health risk. The South Africans used much better judgment when they located the SASOL synfuel plant a good 60 miles from the heavily populated area of Johannesburg, South Africa. Here we are planning three large plants within a small area containing over 200,000 people. One of the plants essentially borders the city of Henderson, Kentucky.

Professor Orcutt at Yale University and Professor Mendelsohn of the University of Washington published a paper just two years ago which shows that if you want to live in an area where the probability of death associated with air pollution is the highest in the United States, you should move to the Ohio River Valley. Northwestern Kentucky, where these three plants are to be located, is in the high risk area even before the plants are constructed.

One only has to glance at the data to see that cities in this area have already had problems meeting the primary ambient air standards, which are set at levels designed to protect public health. If the decision makers were concerned about people's health, they would not locate synfuel plants in the Ohio River Valley and, particularly, not near large population centers. In the eyes of the planners, it appears dollars mean more than lives.

Synfuels Symposium Response #2

Richard A. Wham, M.D.[1]

With regard to the paper "King Coal: The Environmental, Economic, and Health Implications of the Synfuel Industry", I would like to make the following remarks. The conclusion that "small is beautiful", when applied to the synfuel industry, seems appropriate. Small is certainly not the direction we are currently taking in the planning of the first several plants in Western Kentucky. Several of the projects planned for this area have been described in terms such as "the world's largest industrial complex"- certainly not compatible with thinking such as "small is beautiful."

The position paper accurately concludes that private industry in this country has already decided that coal conversion on a large scale is not economically sound. Otherwise we would not be in a position of having to infuse billions of dollars from the public treasury into unproven and potentially dangerous technology. The near-term future of coal conversion synfuel industry is being decided right now in Washington. If the government funding is not forthcoming, I think we will see private industry desert a sinking ship very rapidly.

The final statement in the position paper speaks to a 40-50% cut in energy consumption in the United States. In the past three years, seven major studies by the California Energy Commission, the Ford Foundation, the Harvard Business School, the Mellon Institute, the National Academy of Sciences, the Princeton Center for Energy and Environmental Studies, and Resources For the Future have all concluded that the United States can significantly reduce energy consumption while maintaining economic growth and improving productivity.

Knowing that such information exists, we can logically proceed to the very basic question regarding coal-conversion synfuels- "Who needs it?"

The first paragraph contains the statements--refering to synthetic fuels--"They are not man-made from chemical derivatives. Rather they are self-contained in coal, oil shale, tar sands, animal residues, plant materials and solid wastes." I'm more than a little uncomfortable with these statements. To me they convey the impression that synfuels are really "natural and organic"- terms which when applied to breakfast cereals and shampoos convey the feeling of health and safety.

In reality the coal conversion process streams contain literally hundreds of organic compounds, most of which do not normally occur in nature. A host of trace elements are concentrated in the process, many of which are

---

[1]Route 6, Box 344, Henderson, KY 42420.

extremely toxic. Among the compounds are some of the most toxic and dangerous chemicals known to science. Many of these substances are known to be related to increased rates of cancer, birth defects, and mutations. Workers in the industry will be endangered by occupational exposure, while the general population will be exposed by means of air and water contamination. Recently, EPA and industry studies have shown that even the end products, "clean-burning synfuels," contain toxic materials not ordinarily found in fuels obtained from conventional sources. Thus, the synfuel industry is capable of not only contaminating vast areas near the plant sites and downwind and downstream, but in addition the end products, when placed into the usual commercial distribution channels, will expose millions of additional people.

The economic cost of the proposed synfuel industry should be mentioned briefly. Commenting on the staggering price tag of 88 billion dollars, President Jimmy Carter proudly called it "greater than the sum total of the interstate highway system, the Marshall Plan and the space program combined." Most responsible economists agree that given the government's track record, the actual cost will be several times higher.

The position paper contains the following sentence: "One commercial, subsidized, well-monitored plant should be able to generate once and for all the environmental, economic, and health research data necessary to decide upon large-scale production." Since the technologies of various coal conversion processes differ markedly, one plant will not supply all the answers.

But a phrase in that sentence is far more profound in its implications than possibly the entire statement: "...data necessary to decide..." That four-word phrase when applied to the subject being discussed here tonight is earth shaking. Who accummulates the data? Who decides what data are valid? Who decides what the general public should be told? (We assume the public should be given the data and have some input to the decision-making process.)

Conditioned by years of over-sell and downright fradulent advertising, we are naturally suspect when an industry with a vested interest promotes its product. We are also conditioned to look to our government to supply us with unbiased information or legally require the selling party to inform us, whether it be truth-in-lending statements or nutritional data on a food package.

Here in Kentucky, however, we have trouble getting accurate and full disclosure of data, particularly synfuel data. At times, it seems that the state government and the general public have developed an adversary relationship.

A few days ago I received a good-looking document from the Kentucky Department of Energy entitled "The Kentucky Synfuel Industry--A Basis for Assessment and Planning." March, 1981. The Kentucky Department of Energy has taken the key role of promoting synfuels to the people of the state. The introduction states: "The primary objective (of the report) is to develop a detailed description of the synfuel industry and identify impacts in order to stimulate and focus federal, state, and local planning. The

information should also be useful in informing affected businesses and industries, the general public, and public interest groups about the synfuels industry."

Certainly no one can fault the objectives. Unfortunately, whether through intentional bias or merely through lack of adequate research, the document fails to achieve its purpose of transmitting meaningful, reliable information. Indeed, much of the material is misleading, incomplete, erroneous, and in some cases exactly opposite from the truth!

Let me cite a few examples to demonstrate why I choose to use such strong language.

p. 33 KDOE: "A very well defined set of rules and standards, permits, and compliance procedures have been established to ensure that the air quality will continue to improve in areas with existing problems..."

In contrast let me quote from Dr. Grady Stumbo, Secretary, Department of Human Resources, State of Kentucky, dated February 25, 1981: "It is disquieting to note that environmental quality standards and emission limitations do not yet exist for most of the classes of compounds that are of concern."

A recent document prepared by the U.S. Department of Energy states: "...standards and limitations do not yet exist for most of the classes of compounds that are of concern...Thus, compliance with existing environmental requirements alone will not ensure complete protection of the workers, the public, or the environment."

Another misleading statement from the KY DOE paper: p. 57: "Since the project is scheduled to begin in about 1983, highway improvements could feasibly be completed in time. Such improvements include the possibility of upgrading U.S. 60 west of Henderson."

The KY Department of Transportation, February 20, 1981: "Even if four-laning of U.S. 60 were given high priority by KYDOT, it could not be completed in time to accommodate the scheduled peak construction worker traffic."

KY DOE p.v.: "Synfuel plants which are being designed for zero discharge, should have minor effects on water quality."

Comments from the KY Department of Natural Resources: "It is unclear whether a zero discharge concept can be economically or technologically implemented."

"...during a failure of any system in the waste water treatment unit, the untreated or partially treated wastewater will be discharged directly into the Green River. This is totally unacceptable." "Accidental Spills--a greater concern than the operation of the plants themselves is the accidental spillage of liquid products during transportation. The liquid synthetic fuels have been shown to contain highly water soluble compounds such as benzenes or phenols which are extremely toxic...Due to the toxicity of the liquid products it may be advisable to treat their transport in a manner similar to hazardous wastes."

U.S. DOE document: "Because of their potential toxicity to humans and aquatic organisms, the SRC-I discharge of cyanide, chlorine, phenol, and cadmium during low-flow conditions is considered a significant degradation of water quality."

The KY DOE is well aware of this information but chooses to tell us "should have minor effects on water quality."

KY DOE p. 9: "The Midwest has been identified as the most favorable location for synfuel plants." Since this is a report about Kentucky, we would assume that Midwest refers to Western Kentucky.

In June, 1980, the U.S. DOE published a document called Synthetic Fuels and the Environment-An Environmental and Regulatory Impacts Analysis. In this document the DOE determined what locations would be best and worst for locating a coal conversion plant. Several categories were considered. In the categories of Environmental Health, Ecological Sensivity, and Air Quality, the areas where KY DOE proposes to locate the plants are in the worst or next-to-worst classifications. All of these factors would indicate to reasonable people that Western Kentucky is not a rational site for a huge synfuel industry. Politics and dollars are very important in the site selection process.

KY DOE p. 15: regarding SRC-I, a plant proposed for Western Kentucky--"An extensive data base for SRC process exists and is largely available from U.S. DOE reports."

The truth is that very little data, especially regarding health and environmental effects, are known. This was noted in a recent Government Accounting Office report: "The report questioned the wisdom of building the Newman (SRC-I) plant to handle 6,000 tons of coal a day when the largest pilot plant now operating only handles 50 tons a day. The great jump in size poses serious risks that the known technology can not be adapted successfully to the Newman plant. The report questioned whether there had been adequate testing of smaller pilot plants to justify the construction of large demonstration plants. The great jump in size poses serious risks that the known technology can not be adapted successfully to the Newman plant."

Time does not permit me to cite numerous other examples of misleading information. Why have I spent so much time apparently attacking a state agency? Only to try to make the point that citizens must have access to reliable data if we are to make rational choices. The fact that the Kentucky Department of Energy has been placed in a position of being the chief promoter is an unfortunate situation. The conflict of interest between being a promoter and a non-biased regulator and data gatherer is apparent. Those of you from other states must guard against this situation developing in your areas.

Much about synfuels is not known. Difficult decisions are going to be made in the near future which will affect the health and environment for many years to come. Let us hope that through meetings such as you are attending here today, our leaders, through you, will become informed with reliable information and logical decisions will follow. Hopefully these decisions will be based on long range goals rather than on short range political motivations.

Former Congressman William S. Moorhead, chairman of the House-Senate conference committee that wrote the Energy Security Act, stated: "The synfuel industry was born of the political process. It may die because of the political process."

May it rest in peace.

Acid Rain Symposium: Introduction

Richard L. Perrine[1]

Acid rain - the deposition from atmospheric sources of wet (and sometimes dry) acidic materials - is drawing increasing attention as evidence mounts that it can have damaging, long-term consequences (Ember, 1981). In northern European countries such as Norway and Sweden several thousand lakes have been acidified, and entire fish populations have been lost as a result of sulfur and nitrogen-based acidic inputs, primarily resulting from combustion of fossil fuels (Barnes, 1979; Overrein, 1981).

There are indications that a similar process is underway in portions of the northeastern U.S. and Canada (Likens and Bormann, 1974; Likens, et al., 1979). Precipitation with a pH of 4 or less is not uncommon. The economic and ecologic consequences remain undetermined. However, we appear to have reached a point where we must put at risk either the economies of source regions or the economies and environment of receptor regions of North America. For instance, policies that reduce costs to utilities and industries in the Ohio River Valley may incur significant costs to industries and ecosystems in the Northeast. A share of the blame lies with an earlier "technological fix" decision to use tall stacks to dilute and disperse sulfur and nitrogen oxides. Although not presently at risk to the same degree, the western U.S. is not immune. Recent data indicate that high levels of acidity in precipitation in the West is causing reason for concern (Morgan and Liljestrand, 1979; McColl, 1980). The problem is also characterized by a conflict between needs for good science and for quick action. The "commons" of the air environment cannot be over-grazed, yet where do we draw a "safe" boundary based on today's limited and uncertain scientific knowledge?

The purpose of these papers is to provide an overview of the problem tailored specifically to the needs of environmental educators. As shown by European experience, acid rain problems develop slowly and may result in irreversible degradation. For this reason, public education on the origins, movement, and impacts of acid rain is particularly important. Continuing efforts at a high level of sophistication are needed to identify the "best" methods of problem resolution and generate public support for management programs. Generations of decision-makers need to be educated.

These papers address five aspects of the problem of acid rain: 1) its origin; 2) important conversion processes (atmospheric chemistry); 3) the long-distance transport of intermediates and degrading acid products; 4) deposition processes; and 5) environmental effects.

---

[1]Professor and Chairman, Environmental Science and Engineering, University of California, Los Angeles 90024.

REFERENCES

Barnes, R. A. 1979. "The Long Range Transport of Air Pollution: A Review of European Experience." Journal of the Air Pollution Control Association, Vol. 29:12:1219-1235.

Ember, Lois R. September 14, 1981. "Acid Pollutants: Hitchhikers Ride the Wind." Chemical and Engineering News, Vol. 59:37:20-31.

Likens, G. E., and F. H. Bormann. 1974. "Acid Rain. A Serious Regional Environmental Problem." Science, Vol. 184:1176-1179.

Likens, G. E., et al. 1979. "Acid Rain." Scientific American, Vol. 241:4:43-51.

McColl, John J. February 19, 1980. "A Survey of Acid Precipitation in Northern California." Report on Research for the California Air Resources Board, University of California, Berkeley.

Morgan, J. J., and H. M. Liljestrand. October 15, 1979. "Measurement and Interpretation of Acid Rainfall in the Los Angeles Basin." Report on Research for the California Air Resources Board, California Institute of Technology, Pasadena, California.

Overrein, Lars N. January 14-15, 1981. "Acid Precipitation as an Environmental Problem in Europe." Paper presented at California Symposium on Acid Precipitation, California Air Resources Board, San Francisco, California.

Acid Rain Symposium:

The Origin, Evolution, Transportation, and Deposition of Acid Precipitation

Richard L. Perrine[1]

The Origin of Acid Rain

The U.S. relies very heavily on fossil fuels for energy production (Gibson, 1981; GCA Corporation, 1980). All fossil fuels contain some sulfur and nitrogen. When coal is burned, particularly coal with a high sulfur content, one of the byproduct reactions is:

$$S + O_2 \longrightarrow SO_2$$

Then, the addition of water will yield sulfurous acid:

$$SO_2 + H_2O \longrightarrow H_2SO_3$$

In many instances an oxidation step will intervene;

$$SO_2 + 1/2\ O_2 \longrightarrow SO_3$$

leading to the formation of sulfuric acid.

$$SO_3 + H_2O \rightleftharpoons H_2SO_4$$

The mechanisms of molecular interaction are more complex than presented, but the end results are as indicated (Wark and Warner, 1981).

Unless the sulfur-containing combustion byproducts are removed from fossil fuels or stack gases (through the use of scrubbers), the downwind spread of acidifying effluents from coal combustion is certain. Though perhaps with a lesser sulfur content, oil burns in like fashion to form similar combustion byproducts.

Many fuels also contain nitrogen byproducts and combustion generates nitrogen oxides. However, there is an even more important source of acidic nitrogen (Wark and Warner, 1981). In any heated mixture of oxygen and nitrogen, such as combustion air, there is at least a trace level of free oxygen atoms. This facilitates the initiation of the very fast, two-step, cyclic chain reaction:

$$O + N_2 \longrightarrow NO + N$$

$$N + O_2 \longrightarrow NO + O$$

---

[1]Professor and Chairman, Environmental Science and Engineering, University of California, Los Angeles 90024.

And as a consequence, nitric oxide (NO) is formed. Further oxidation is spontaneous (though slow in "clean" air):

$$2NO + O_2 \rightleftharpoons 2NO_2$$

As with sulfur oxides, these molecules act as the anhydrides of nitrous and nitric acids. The multistep process may be summarized in the following reactions:

$$H_2O + NO + NO_2 \rightleftharpoons 2HNO_2$$

$$H_2O + 3NO_2 \rightleftharpoons 2HNO_3 + NO$$

As a consequence of such processes all fossil fuel combustion shares the potential for the eventual creation of acid precipitation.

The fact that such a reaction can take place, however, is not sufficient to create a pollution problem. Equilibrium must favor pollutant production, and the reaction must be fast enough to manufacture sufficiently large quantities. For example, sulfur goes completely to the dioxide under combustion conditions. The oxygen-nitrogen-nitric oxide equilibrium is highly temperature dependent, as is its rate of formation. At relatively high combustion temperatures, such as 4000°F, equilibrium results in nitric oxide quantities of more than 10,000 parts per million, and these levels may be approached within very small fractions of a second.

Emissions Sources

Table 1 lists U.S. source categories for man-made sulfur oxides (SO_x) and nitrogen oxides (NO_x), for the year 1977, in millions of tons (and by percentages) (EPA, 1980). The table indicates that stationary fuel combustion is of overwhelming importance to SO_x, while fuel combustion and transportation dominate the NO_x portion of the problem. Emissions totals are huge; 31.5 (for SO_x) and 21.7 (for NO_x) millions of tons per year.

Table 2 illustrates the uneven distribution of SO_x and NO_x emissions by EPA regions (EPA, 1980). (States included are listed for each region). A huge imbalance is apparent when population within each region is contrasted with SO_x or NO_x emissions. For example, the receptor Region I (including Maine, Vermont, New Hampshire) has about 6 percent of the population and 2 to 3 percent of the source quantity. The Ohio River Valley area of Region V has 21 percent of the population and 23 to 29 percent of the source quantity. Perhaps even more important, the Ohio River Valley lies directly upwind of Region I, and therefore, feeds its wastes into sensitive northeastern areas. A further breakdown of the data by state indicates, for example, that just three Ohio River Valley states - Ohio, Pennsylvania, and Indiana - make up 25 percent of the SO_x source. Texas and California are unusually high in NO_x emissions (contributing about 15 percent). But Ohio, Pennsylvania, and Indiana follow just behind. In general, SO_x emissions in the East are more important than NO_x

Table 1

Categorical Distribution of Manmade U.S. SO_x and NO_x Emissions for 1977, in Millions of Tons (EPA, 1980).

Major Source Category	SO_x emissions (percent of U.S.)	NO_x emissions (percent of U.S.)
Stationary fuel combustion	24.9 (79.0)	11.0 (50.7)
- Coal	19.5 (61.9)	5.8 (26.7)
- Oil	4.8 (15.2)	2.2 (10.1)
- Gas	- -	2.7 (12.4)
Industrial processes	5.6 (17.8)	1.0 (4.6)
- Primary metals	2.8 (8.9)	0.06 (0.3)
- Petroleum	0.98 (3.1)	0.44 (2.0)
- Chemical manufacturing	0.87 (2.8)	0.19 (0.9)
- Mineral products	0.70 (2.2)	0.23 (1.1)
Transportation	0.86 (2.7)	9.4 (43.3)
- Gasoline	0.23 (0.7)	6.0 (27.6)
- Diesel fuel	0.39 (1.2)	3.1 (14.3)
TOTAL U.S.	31.5	21.7

Table 2

Regional Emissions of SO_x and NO_x Compared to Populations (Percent of U.S. Totals) (EPA, 1980).

EPA Region	States	Percent of U.S. Population	Percent of U.S. SO_x Total	Percent of U.S. NO_x Total
I	CT, ME, MA, NH, RI, VT	5.6	2.1	3.4
II	NJ, NY, PR, VI	12.9	5.3	7.0
III	DE, DC, MD, PA, VA, WV	11.1	15.0	10.7
IV	AL, FL, GA, KY, MS, NC, SC, TN	16.3	21.5	17.5
V	IL, IN, MN, MI, OH, WI	20.6	29.0	23.0
VI	AR, LA, NM, OK, TX	10.3	9.0	17.0
VII	IA, KS, MO, NE	5.3	6.6	6.5
VIII	CO, MT, ND, SD, UT, WY	2.9	2.9	3.7
IX	AZ, CA, HI, NV, GU, AS	11.7	7.3	8.1
X	AK, ID, OR, WA	3.3	1.3	3.1

emissions, with the reverse situation in the West. In addition, there has been a general shift toward greater importance of NO_x emissions over time.

Those who are less aware of environmental concerns may question the significance of the contribution of natural sources of sulfur and nitrogen compounds to the overall problem of acid precipitation. Indeed, natural sources for sulfur and nitrogen compounds are well recognized. For example, ammonia from biological decay generates about a billion metric tons annually, with added amounts volatilized from land and sea. Further, while ammonia is naturally basic, and first might be expected to partially neutralize acids, it can also act as a promoter of the precursor components of nitric acid. That is, NH_3 may react with hydroxyl radicals (OH) or may be catalytically oxidized to form nitrites and nitrates. However, these processes are infrequent and so may be of minor consequence. Aside from rare and extreme processes (such as Mt. St. Helens), natural sources either have no impact or tend to mitigate the formation and consequences of acid rain.

Acid rain source materials need not be wet. Aerosols are readily formed from SO_x and NO_x (or their acid products) in the absence of moisture, and can transport and deposit the same acid mass as actual rain. Sulfates are a common example. Modeling efforts have provided some estimates of the relative share of wet and dry deposition. On the average, U.S. sources are thought to provide a 1.3 wet to 1.0 dry share of eastern U.S. deposits, and a 3.0 wet to 1.0 dry share of Canadian deposits. Of course, results vary with the season and conditions, such as rainfall or snowfall, and are limited by our current ability to model. However, in areas such as the western U.S., where rainfall is sparse, an understanding of dry deposition is critical.

Atmospheric Transformation Processes

The pollutants which most commonly result in acid rain are gaseous SO_2 and NO. As previously indicated, gaseous SO_2 and NO are susceptible to oxidation and subsequent hydration which may result in the formation of sulfuric and nitric acids. It now appears that the entire complex of urban and industrial air pollutants and their chemistry may have some influence on acid rain (Wark and Warner, 1981).

For example, it is known that nitrogen oxides are deeply involved in the formation of both acid rain and photochemical smog. Nitrogen dioxide absorbs sunlight, harnessing solar energy to drive the pollutant-forming processes. These reactions may be summarized by the following equations:

$$NO_2 + h\nu \longrightarrow NO + O$$

$$O + O_2 + M \longrightarrow O_3 + M$$

$$O + H_2O + M \longrightarrow H_2O_2 + M$$

(where M represents any other molecule which may assist by removing excess energy from the collision process). Either the oxygen atom itself, or ozone or hydrogen peroxide, is capable of oxidizing sulfur dioxide. For example:

$$SO_2 + O_3 \longrightarrow SO_3 + O_2$$

The result is strengthened acidity.

The chemistry of atmospheric reactions, particularly those involving atmospheric aerosols (in this case liquid droplets), is very complex and not yet well understood. Several experiments suggest that the formation of aerosol and disappearance of SO_2 speed up with photoxidation in the presence of urban smog constituents. An increase in relative humidity appears to slow aerosol formation somewhat. The actual chemical identity of the aerosol constituents has received relatively little attention. The simple SO_2 - O_2 system leads to H_2SO_4. Sulfate is a likely constituent of other aerosols as well. When formed initially in an urban environment containing hydrocarbons, organic acids may form a portion of a carbonaceous aerosol. Additional knowledge of systems such as this is presently needed.

The impact of climate on both a very large and small scale is important. Belief is growing that the simple acid precursor materials, such as SO_2, largely undergo transformations to higher oxidation states within clouds. This is where chemical compounds such as peroxides could prove particularly important.

The limited state of our understanding is accentuated if we ask the basic question: "What is the acidity of 'pure' rain?" Acidity is measured by a pH scale which ranges from 0 (acidic) to 14 (alkaline) with 7.0 neutral. A change of 1.0 on the pH scale reflects a ten-fold change in acidity or alkalinity. Pure rainfall was once thought to be slightly acidic, with a pH of 5.6 (Gibson, 1981). However, based on various suppositions, some authorities now suggest lower values. Thus, although we know the processes influencing the constituents and fate of acid rain and we recognize general impacts, considerable research is still needed.

Deposition

One would expect the rate at which acidic compounds are deposited to be dependent on both air concentration and some measure of velocity at which they fall toward the ground. The "deposition velocity" is a measure of pollutant concentration reaching the ground per unit area and time (GCA, 1980). Deposition velocities have been estimated for certain conditions, but depend on many poorly understood factors. Dry deposition rates are particularly susceptible to atmospheric conditions such as stability, turbulence, and windspeed. Roughness and vegetative cover of the ground are also important. Thus, to a very large degree, such parameters must be estimated from the observed behavior of acid-laden storms.

Observations of acid rain events over a reasonable time period in the Adirondacks of New York State (Johannes, et al., 1981), Florida (Brezonik, 1980) and in Arizona and California (Morgan and Liljestrand, 1979; McColl, 1980) have several common elements and can provide insights into the phenomenon of acid rain.

The rate of deposition of acid precipitation varies with the amount, duration, and intermittant nature of rainfall. In addition, the amount of sulfate deposited tends to decrease with the length of the rainfall event. Looking at the variation in pH during storms, values at the start of the event commonly are quite a bit higher than at a later time (after 3 or 4 hours). This has been demonstrated by observations of storms at sites throughout the country. Measurements at the end of storms commonly exhibit a lower, more constant level of pH. A plausible reason is that dust particles in the atmosphere which are usually basic, tend to neutralize rainfall at early stages. Later on, most of this material has been swept from the sky and its acidic contents can dominate. While individual data points show tremendous scatter, amounts of nitrate and sulfate tend to correlate with the change in pH.

Another general characteristic of acid rain deposition is that the pH tends to increase, and the concentration of acidic ions decrease, with downwind distance from major source locations. For example, in California, pH values change from a two-season mean pH of 4.5 near the coast at Los Angeles to a value near 5.4 in the mountain ranges 100 miles inland (Morgan and Liljestrand, 1979). Corresponding changes in non-sea salt sulfate are from a coastal 46 μ eq/l to an inland 6.0 μ eq/l; a drastic reduction in acidifying potential. Northern California observations of near 4.5 in the San Francisco Bay area shift to approximately 5.2 at Lake Tahoe on the California-Nevada border. Measured acidity along the same trajectory drops from near 40 μ eq/l to about 7 μ eq/l. In summary, acid deposition can be characterized as a "wash-out fan" which gradually spreads out and moves away from emissions sources, diminishing in concentration with time.

Why then doesn't the acid rain in the eastern U.S. gradually fade away and become of no consequence? The most likely answer is that patterns of emissions are continuous from heavily industrialized areas, such as the Ohio River Valley. In actuality, multiple "wash-out fans" blend and superimpose to create a continuous flow of airborne acidic materials. These, then, may be deposited in the heterogeneous pattern which generally is expected for these somewhat random processes.

REFERENCES

Brezonik, P. L., E. S. Edgerton, and C. D. Hendry. 1980. "Acid Precipitation and Sulfate Deposition in Florida." Science, Vol. 208:4447: 1027-1029.

Environmental Protection Agency. 1980. "1977 National Emissions Report." In: National Emissions Data System of the Aerometric and Emissions Reporting System. Report EPA-450/4-80-005.

GCA Corporation. December, 1980. Acid Rain Information Book. Draft Final Report DOE/EV/10273-1, Prepared for the U.S. Department of Energy.

Gibson; James H. January 14-15, 1981. "Atmospheric Deposition (Acid Rain) - Its Origin and Effects," Paper presented at California Symposium on Acid Precipitation, California Air Resources Board. San Francisco, California.

Johannes, A. H., E. R. Altwicker and N. L. Clesceri. May, 1981. Characterization of Acidic Precipitation in the Adirondack Region. Report EA-1826, for the Electric Power Research Institute.

McColl, John J. February 19, 1980. "A Survey of Acid Precipitation in Northern California." Report on Research for the California Air Resources Board, University of California, Berkeley.

Morgan, J. J. and H. M. Liljestrand. October 15, 1979. "Measurement and Interpretation of Acid Rainfall in the Los Angeles Basin." Report on Research for the California Air Resources Board, California Institute of Technology, Pasadena, California..

Wark, Kenneth and Cecil F. Warner. 1981. Air Pollution, Its Origin and Control. Harper and Rowe, Inc., New York, Second Edition.

Acid Rain Symposium: Acid Precipitation in the Northeast

Alan Schwartz[1]

Although emissions of SO_x and NO_x increased substantially between 1940 and 1970, SO_x emissions actually decreased nearly 10 percent in the decade of the seventies. This was probably due to the use of lower sulfur fuels for home heating and industry and reduced emissions from non-ferrous metal smelters. However, the total emissions of NO_x increased over 17 percent during this same period, primarily because the number of miles driven in the U.S. increased by 30 percent and the rise in industrial output (CEQ, 1980). Future trends, however, for both of these precursors of acid rain look bleak. Even though all new plants will be far more stringently controlled than older plants, there will still be an increase in the total amount of coal burning, with a concurrent increase in SO_x emissions. The observation that coal burning contributes to acid precipitation was first made in 1911, twenty-two years before the pH scale was developed (Crowther and Ruston, 1911). The outlook for NO_x emissions appears to be even worse, with EPA predicting a 50 percent increase between 1970 and 2000 (GCA Corporation, 1980).

Between 1950 and 1973, measurements of precipitation in the Northeast indicated increasing acidity over an expanding geographic area (Cogbill and Likens, 1974). This worsening situation in New York and Eastern Canada is attributed to the combined effects of taller stacks and the prevailing winds. During the 1970's, approximately 300 stacks over 300 feet tall were constructed with 260 of these 300 stacks built by the electric utility industry. Over 28 percent of the 186 stacks over 500 feet tall were built in EPA Region V (Illinois, Indiana, Minnesota, Michigan, Ohio, and Wisconsin) the area that also has the highest SO_x and NO_x emissions in the nation (GCA Corporation, 1980). This increase in stack height has been shown to improve local ambient air quality substantially, but at the same time increase both the residence time and distance travelled for acid rain precursors (NAS, 1975; Braekke, 1976).

The transport of materials emitted from tall stacks in EPA Region V follows the path of the prevailing winds north and eastward. For example, prevailing surface winds for July carry materials from these states directly to the Adirondacks of New York State, Eastern Ontario, and Quebec. In January, the prevailing surface winds in these areas are from the northwest, carrying acid rains from the largest single source of SO_x emissions in the world, the INCo Smelter in Sudbury, Ontario. Analysis of air mass movements and chemical transformations in the atmosphere have shown that emissions in one state result in acid precipitation in other states hundreds of miles from the source (Oden, 1968; OECD, 1977; Galloway and

---

[1]Associate Professor and Chairman of Environmental Studies, St Lawrence University, Canton, NY 13617.

Whelpdale, 1979). Although the exact mechanisms for the conversion of acid rain precursors to acid rain are poorly understood, research such as the Acid Precipitation Experiment (APEX) indicate that complex chemical transformation does occur in the clouds (Ember, 1981).

As the air mass with its burden of acids flows eastward, the sulfuric, nitric, and a small amount of hydrochloric acids are deposited when it rains or snows. Although the Adirondack region of New York has relatively high annual precipitation (40-49 inches per year) it is even more important to note that the Eastern Adirondack region has over 150 days per year with some (0.1 inch or more) precipitation (ESSA, 1968). As a result, the high elevations on the windward side of the Adirondacks receive a great deal of the acid precipitation falling in the northeastern U.S. This is compounded by the fact that the Adirondack and much of Ontario and Quebec are part of the Pre-Cambrian Shield and thus contain well weathered metamorphic and igneous rocks. This geologic condition results in low productivity and poorly buffered waters.

Because the temperature in the Adirondacks is at freezing or below for much of the year, precipitation often falls as snow. This results in acid storage in the snow pack from November to April and release in a pulse with the first thaws of spring. Acid pulses were first identified in Sweden over a decade ago and evidence from the Adirondacks indicates similar problems (Schofield, 1977).

A five-year study of 849 Adirondack lakes from 1975 to 1979 indicated that 212 or 25 percent of the lakes had become acidified to a critical level (a pH in the summer below 5). Another 256 or 30 percent had a pH of between 5.0 and 6.0 and were thus considered endangered (Pfeiffer and Festa, 1980). In general, the most seriously acidified lakes were smaller lakes. It is ironic that these small isolated cold water trout ponds were once viewed as the least likely to be impacted by human activities. Although the remaining 2,028 Adirondack lakes have not been tested since 1974, there is no reason to believe they have not followed a similar trend. These pH measurements, many of which were taken by helicopter sampling methods in mid-summer, do not give any indication of the lowest pH levels of the lakes that would be expected just after the spring thaw.

In addition to small size, lakes at higher elevations of the Adirondacks appear to be more acidified. Approximately 85 percent of the acreage of water sampled above 2500 feet had pH reading below five, while less than 10 percent of the acreage below 2,000 feet had such low readings.

Approximately one-third of lakes less than 50 acres in size had reached this critical level, while less than 2 percent of lakes over 1,000 acres had similar low readings. Thus, the problem of acidification is not spread uniformly over the entire six-million acre Adirondack Park, but is concentrated in small lakes at high elevation on the western side of the mountains. These results are strongly correlated with differences in mean precipitation (Pfeiffer and Festa, 1980).

The evidence presented by the Pfeiffer and Festa (1980) study is not only striking in documenting the deterioration of Adirondack lakes, but also

concludes that much of this deterioration is recent. Comparisons of historic colorometric data with recent colorometric pH data from lakes for which historic data are available, clearly indicates an increase in the number of lakes with a pH below six, and a decrease in overall pH. The mean pH of this subsample of 138 lakes was 6.75 between 1930 and 1934, and 6.51 in 1979. Approximately 60 percent of these lakes have had a reduction in pH level, while another 16 percent have remained unchanged. The number of lakes below pH of 6.0 tripled over this time period from 9 in 1930 to 27 in 1979 (Pfeiffer and Festa, 1980).

REFERENCES

Braekke, F. H. (ed.). 1976. Impact of Acid Precipitation on Forest and Freshwater Ecosystems in Norway. SNSF Project, Research Report FR 6/76, Oslo, Norway.

Cogbill, C. V., and D. E. Likens. 1974. "Acid Precipitation in the Northeastern United States." Water Resources Research, Vol 10:1133-1137.

Council on Environmental Quality (CEQ). 1980. Environmental Quality. U.S. Government Printing Office, Washington, D.C.

Crowther and Ruston. 1911. "The Nature, Distribution and Effects Upon Vegetation of Atmospheric Impurities In and Near an Industrial Town." Journal of Agricultural Science, Vol. 4:25-55.

Ember, L. September 14, 1981. "Acid Pollutants: Hitchhikers Ride the Wind." Chemical and Engineering News, pp. 21-30.

Environmental Science Services Administration (ESSA). 1968. Climatic Atlas of the United States, U.S. Department of Commerce, Environmental Data Service.

Galloway, I. N. and D. N. Whelpdale. 1979. "An Atmospheric Sulfur Budget for Eastern North America." Atmospheric Environment, Vol. 14:409-417.

GCA Corporation. December, 1980. Acid Rain Information Book. Report No. DOE/EV/10273-1, Prepared for the U.S. Department of Energy, Washington, D.C.

National Academy of Sciences (NAS). 1975. Atmospheric Chemistry: Problems and Scopes. Committee on Atmospheric Science, Natural Resource Council, Washington, D.C., 130 pp.

Oden, S. 1968. The Acidification of Air and Precipitation and its Consequences in the Natural Environment. Ecology Committee Bulletin No. 1. Swedish National Science Research Council, Stockholm, Sweden. 117 pp.

Organization for Economic Cooperation and Development (OECD). 1977. OECD Programme on Long Range Transport on Air Pollutants. Published by OECD, Paris, France.

Pfeiffer, M. and P. Festa. 1980. Acidity Status of Lakes in the Adirondack Region of New York in Relation to Fish Resources. New York State Department of Environmental Conservation, Albany, N.Y. 36 pp.

Schofield, C. L. 1977. "Acid Precipitation's Destructive Effects on Fish in the Adirondacks." New York Food and Life Science Quarterly, Vol. 10:3:12-15.

Acid Rain Symposium: Environmental Effects of Acid Precipitation

John H. Baldwin[1]

Introduction

A growing body of scientific evidence suggests that acid rains may be responsible for widespread ecological destruction as well as damage to human health and property. In general, the degree of damage to human and natural systems is a function of the amount, acidity, longevity of exposure and sensitivity of an organism or material to acid precipitation. Figure 1 indicates the complex pathways of the origin, transportation, and deposition of acid precipitation. The toxicity of acid precipitation can be altered significantly through interaction with vegetation, soils, bedrock, and surface and ground-waters (Braekke, 1976; Oden, 1976).

The most influential factor in determining the environmental damage from acid precipation is the capacity of the watershed to neutralize the acid influent. In general, drainage basins with thin soils and granitic (crystalline) or other non-calcarious bedrock have "soft" waters that are unable to neutralize or buffer acid influents. Basins with calcarious deposits or bedrock tend to have "hard" water with higher concentrations of alkaline earths (or greater "alkalinity") that have a greater capacity to buffer acid influents. Thus, the capability of an ecosystem to resist damage from acid rains is largely a function of the bedrock composition of the area (Galloway and Cowling, 1978).

Figure 2 delineates the regions of North America with the greatest sensitivity to acid precipitation. The shaded areas are regions of igneous or metamorphic bedrock with a relatively low buffering capacity. The actual buffering capacity of each area may vary because of natural deposits or artificial sources (such as agricultural runoff) or calcareous materials that could improve the buffering capacity of the ecosystem (GCA Corporation, 1980).

As the amount of acid precipitation increases in a sensitive environment, the natural buffering capacity of an ecosystem (provided primarily by bicarbonate ions) diminishes, until the system capacity is exceeded and the acidity of the water dramatically increases. This situation is most common in the spring when rains are heavy and bound acids are released from melting snow and ice. The resulting abrupt change in pH often results in substantial damage to aquatic flora and fauna (GCA Corporation, 1980).

Acid precipitation can also indirectly damage natural and human systems by increasing the solubility and mobility of toxic metal and nutrient cations

[1]Assistant Professor, Department of Urban and Regional Planning, University of Oregon, Eugene, OR 97403.

Figure 1

Environmental Pathways of Acidic Precipitation
(Rosencranz and Wetstone, 1980).

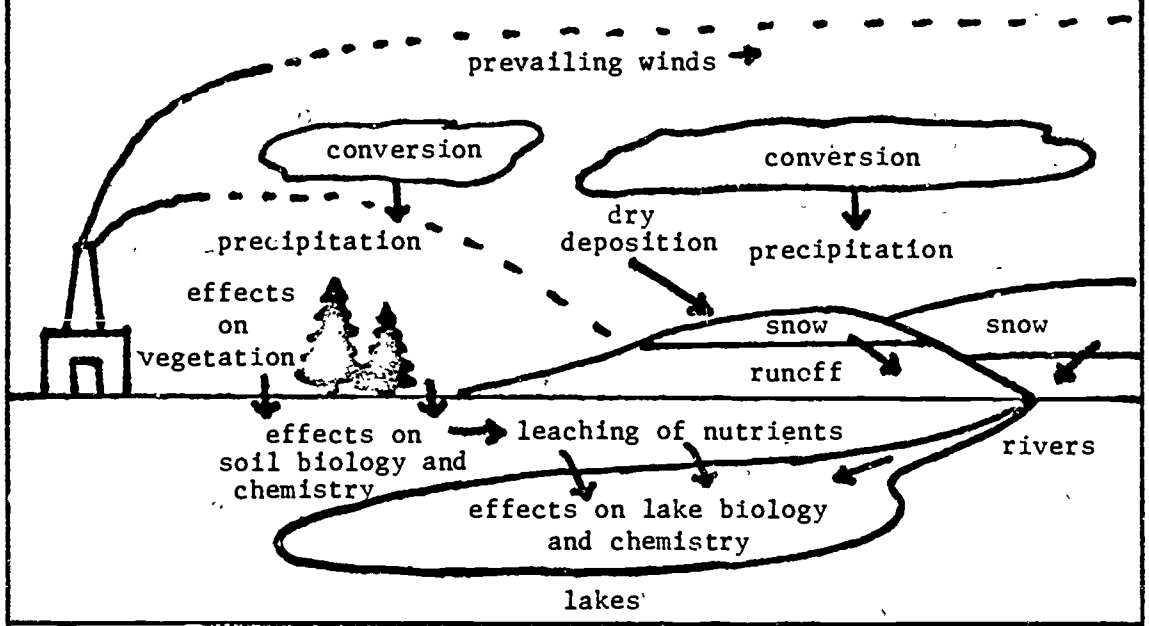


Figure 2

Areas of North America Sensitive to Acid Rains
(dark areas) (Galloway and Cowling, 1978).

in soils and sediments (Braekke, 1976; Oden, 1976). It is extremely important to emphasize that this discussion of the impacts of acid rains is generally based on studies of unbuffered environments. Great care should be exercised in extrapolating the impacts to more highly buffered systems.

Effects on Aquatic Ecosystems

A. Impacts on Aquatic Flora

A number of studies have shown that acid precipitation can reduce the number, variety, and productive capacity of primary producers and decomposers in aquatic communities. This in turn disrupts energy, nutrient, and mineral cycles and flows of entire ecosystems. Studies in Scandinavia and northern Ontario, Canada have indicated a substantial reduction in the number and diversity of aquatic plant species when the pH of a waterway drops below 5.0 (Hendrey, et al., 1976). Kwiathowki and Roff's study (1976) of lakes in Ontario found that increasing acidity resulted in the reduction of species of Chlorophyta (green algae) from 26 to 5; reduction in the species of Chrysophyta (golden brown algae) from 22 to 5; and reduction in the species of Cyanophyta (blue-green algae) from 22 to 10.

In addition, acid influents also promote the growth of mats of Sphagnum moss, filamentous algae, and fungus. These mats tend to seal nutrients in sediment, choke out other aquatic plants, and tie up cacions (such as Ca^{+2}) necessary for biological production. In many studies the decline of other macrophytic (e.g., Lobelia and Isoetes) and decomposer (e.g., certain forms of bacteria) species was attributed to acidification (Barnes, 1979; Hendrey, et al., 1976; Grahn, 1976). The decline in the overall rate of microbial decomposition results in the accumulation of organic matter, and disruption of nutrient cycling, energy flows, and overall trophic relationships (Grahn, et al., 1974).

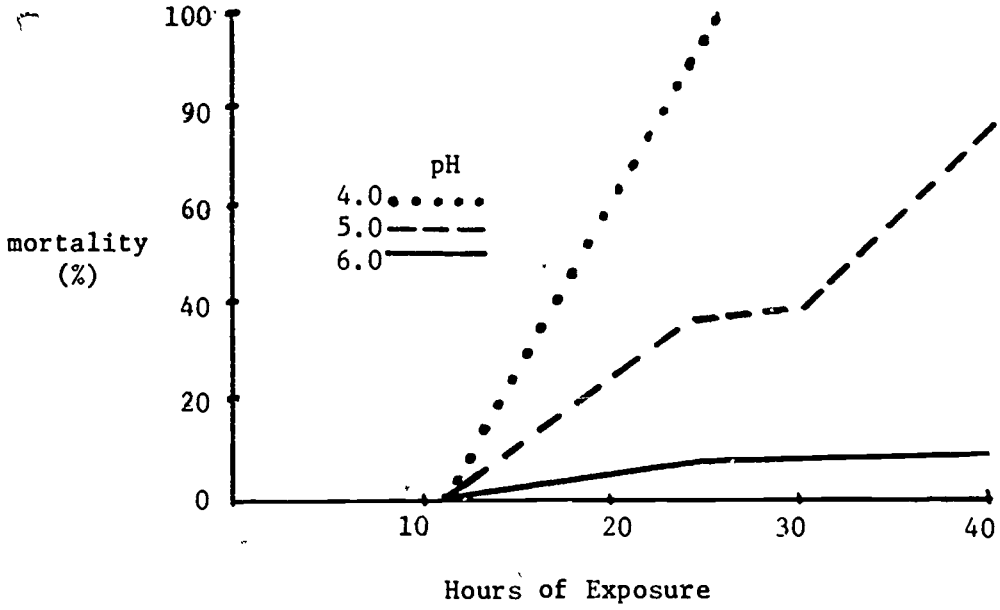
B. Impacts on Aquatic Invertebrates

Acidification of lakes and streams can also result in serious disruption of the aquatic invertebrate community. Studies of North American and Scandinavian lakes have indicated a decline in the number and diversity of mollusks, crustaceans, and insects (i.e., mayflies and stone flies). Figure 3 indicates the effects of exposure of Gammarus adults (a valuable source of food for fish) to acidic conditions. Short term episodes of acidification such as a spring surge, could entirely eliminate these amphipod crustaceans from lakes and streams (GCA Corporation, 1980; Hendrey and Wright, 1976; Sprules, 1975).

At a pH below 5.0, only a few pH-tolerant invertebrates persist. These include air-breathing insects or insects with tough cuticles that resist ion losses such as the Gyrinidea (whirligig beetles), Notonectidae (backswimmers), and Corixidae (water boatman) and some organisms that live within, and are protected by sediments (i.e., Oligochaeta, Tubificidae, and Chironomidae) (Hendrey, 1978). Finally, acid sensitivity of invertebrates varies considerably at various periods in their life cycle. Invertebrates that are in a sensitive stage during the spring surge in acidity, such as aquatic insects that are preparing to emerge, are particularly vulnerable (Bell, 1971).

Figure 3

Mortality Rates of Gammarus Adults Exposed to Various Levels of Acidity (Borgstrom and Hendry, 1976).



C. Effects on Aquatic Vertebrates

Aquatic vertebrates such as fish and amphibians (i.e., frogs and salamanders) play important predator/prey roles in the aquatic food chain. Changes in populations and species of aquatic vertebrates can significantly alter community structure and function. Aquatic vertebrates are most sensitive to acidity during the reproductive stage. In many cases the reproductive cycle coincides with spring episodes of acidification (Borgstrom and Hendrey, 1976; Leivestad, et al., 1976).

The tolerance of fish to acid waters varies according to a number of factors including (GCA Corporation, 1980):

- species - among the salmonids, rainbow trout are the most sensitive followed by salmon, brown trout, and brook trout respectively. Sensitivity of fish eggs also varies by species.

- strain - because of genetic variation or acclimation, certain strains are more tolerant to acidic conditions.

- age and size - larger, older fish are more tolerant to acidity than smaller, younger fish.

temperature - higher water temperature will increase sensitivity to pH.

season - acidic episodes at different times of the year may differ in toxic effects.

chemical constituents of water - synergism and antagonism with chemical constituents of the water can alter sensitivity.

When the pH of a waterway drops to between 5.0 and 6.0, declines in certain salmonid species (i.e., brook and rainbow trout) occur. A pH level between 4.0 and 5.0 is harmful to most salmonids (including common carp). A pH level below 3.5 is lethal to most fish (EIFAC, 1976). The disappearance of fish populations was first reported in Scandinavia over 50 years ago. However, in the last 15 years, the rate of such disappearances has increased considerably (Leivestad, et al., 1976). Similar losses have been reported in Ontario, Pennsylvania, and New York (Arnold, et al., 1980; Beamish, 1976; Pfeiffer, 1979; Schofield, 1976).

Laboratory studies have indicated that the reproductive failure of fish under acidic conditions is caused by an inhibition of gonadal maturation and increased sensitivity and mortality of eggs and fry to the acid conditions (Beamish, et al., 1975; Beamish, 1976; Menendex, 1976; Trojnar, 1977a, 1977b).

Long term exposures to acid conditions can result in osmoregulatory disfunction (e.g., impaired sodium uptake) and accumulations of toxic metals in fish that can damage gills and make the fish inedible (EIFAC, 1969; Schofield, 1979; Tomlinson, 1979).

Amphibians, such as frogs, toads, and salamanders are especially susceptable to pH changes because they breed and lay their eggs in ponds and streams. At a pH level below 6.0 increased egg mortality of some amphibians has been detected and a pH of 4.0 or lower is usually lethal to most frog embryos (Gosner and Black, 1975; Pough, 1976).

A summary of the effects of increasing acidity on aquatic communities is presented in Table 1.

Effects on Terrestrial Ecosystems

Assessing the impacts of acid precipitation on terrestrial ecosystems is considerably more difficult than for aquatic ecosystems. Terrestrial ecosystems are more highly buffered, making it more difficult to measure pH changes and to detect and correlate changes in ecosystems structure and function. To date, studies have been unable to attribute measured changes in natural terrestrial ecosystems directly with changes in acidity. However, controlled laboratory and field studies have provided insights into possible changes.

A. Effects on Soils

Assessing the impacts of acid precipitation on soils is extremely difficult because agricultural and airborne sources of acids are hard to

Table 1

Summary of Effects of Aquatic Organisms With Decreasing pH (GCA Corporation, 1980; Hendrey, 1978)

8.0 - 6.0	A decrease of 0.5 to 1.0 pH units in the range 8.0 to 6.0 may cause detectable alterations in community composition. Productivity of competing organisms will vary. Some species will be eliminated.
6.0 - 5.5	Decreasing pH from 6.0 to 5.5 will cause a reduction in species numbers and, among remaining species, significant alterations in ability to withstand stress. Reproduction of some amphibians is impaired.
5.5 - 5.0	Below pH 5.5, numbers and diversity of species will be reduced. Many species will be eliminated. Crustaceans, phytoplankton, mollusks, and many insect species will begin to drop out. Overall, invertebrate biomass will be greatly reduced.
5.0 - 4.5	Below pH 5.0, organic decomposition will be severely impaired. Organic debris will accumulate rapidly. Most fish species will have vanished.
4.5 and below	Below pH 4.5 all of the above changes will be greatly exacerbated. Many algae species will disappear.

differentiate. In addition, soils vary considerably in their buffering capacity, physical-chemical properties and soil biota. In general, acid precipitation can damage soils in a number of ways including: 1) modified cation exchange; 2) mobilization and soil contamination of heavy metals; and, 3) modification of microbiological communities.

As acidic water passes through soils, the free hydrogen ions replace bound nutrient cations such as Ca^{+2}, Mg^{+2}, K^{+}, and Na^{+} and other minerals which are released into groundwater (Oden, 1976). The few studies conducted of the impacts of accelerated cation exchange and leaching of nutrients generally agree that acid precipitation can result in the loss of soil cation exchange capacity and accelerated rates of loss of Ca^{+2}, Mg^{+2}, and K^{+} nutrients (Malmer, 1976; Overrein, 1972; Wiklander, 1979). However, natural forces such as weathering or accelerated nutrient recycling by vegetation may compensate for these losses (McFee, et al., 1976). For instance, roots may absorb, and plants hold, excess nutrients and later deposit them on the soil surface as litter or vegetative leachate (Abrahmsen and Dollard, 1979).

In general, as soil acidity increases, the mobility and availability of toxic metals increases. The accumulation of aluminum compounds to the point of phytotoxicity is of particular concern (Tomlinson, 1981). However, more research is needed on the effects of toxic metal mobility

on biological processes such as plant growth, microbial decomposition, nitrogen fixation and biomagnification (Abrahmsen and Dollard, 1979).

Acidification decreases the rate of many soil microbiological processes. Nitrogen fixation by Rhizobrium bacteria (on leguminous plants), actinomycetes, Cyanophyta and certain bacteria is inhibited by lowering soil pH. In addition, nutrient cycles are disrupted (e.g., the rate of mineralization of nitrogen in forest litter and nitrification of ammonium compounds). Finally, the overall rate of decomposition is slowed by the acidification and accelerated mobilization of heavy metals (Braekke, 1976; Reuss, 1975; Tyler, 1976).

B. Effects on Vegetation

A number of laboratory and field studies in which acid precipitation was simulated (in composition and rate of deposition) reported vegetative damage. At a pH of 3.0 or less, acid precipitation causes spotting of leaf surfaces and areas of plant growth (such as terminal buds). These spotted or necrotic areas reduce the size of the functional leaf surface, disrupt photosynthetic and physiological processes and reduce overall leaf productivity. This can result in damage to agricultural and forest species. Although several studies have reported damage to eastern white pine, yellow birch, and oak trees from acidic conditions (Wood and Bormann, 1974; Lang, et al., 1978), other studies have failed to verify these results or have reported increases in the rates of growth in seedlings or saplings (Wood and Bormann, 1977; Abrahmsen and Dollard, 1979). Additional research is needed to resolve these questions.

To date, there have been no reports of agricultural damage in the U.S. from acid precipitation. This may be due, to a large extent, to the inability to factor out the wide variety of environmental variables (e.g., duration, frequency, and acidity of precipitation; plant nutrition; plant diseases; other pollutants) that influence the nature and extent of damages (Jacobson and van Leuken, 1977). Controlled laboratory and field studies, however, have reported foliar lesions in sunflowers, beans, and spinach and a reduction in the dry weight of beans, mustard greens, broccoli, radishes, and spinach(Jacobson, 1978; Lee, et al., 1980; Shriner, 1979). To date, reliable estimates of the potential economic damage to forest and agricultural systems have not been made.

Acid rain can induce a number of other vegetative effects including:

Loss of K^{+}, Mg^{+2}, and Ca^{+2} nutrients from folar leaching. Partial compensation may be made by fertilization effects of nitrate and ammonia compounds in acid precipitation. The overall effects on plant uptake and cycling of nutrients remains unresolved (Glass, et al., 1979).

Accelerated deterioration of waxy leaf surfaces (Shriner, 1976).

Increased susceptibility to bacterial and fungal infections (Shriner, 1978).

Changes in symbiotic and parasitic relationships (Shriner, 1976).

Reduced rates of decomposition and nitrogen fixation (discussed previously).

Decrease in edible fruit production (Glass, et al., 1979).

Death of feeder roots and decline in overall rates of growth in spruce, fir, and beech forests in Europe from increases in soluble aluminum in forest soils (Tomlinson, 1981).

Heavy metal accumulation and toxicity in forest vegetation such as mushrooms, lichens, and mosses that could create hazards to wildlife and humans if consumed (Tyler, 1980).

Effects on Human Artifacts and Health

A. Effects on Human Artifacts

Acid precipitation can damage human artifacts through accelerated corrosion of metals and erosion and leaching of stone and building materials. The detrimental effects of acid rains vary considerably and are determined, in part, by the type, acidity, frequency, and duration of precipitation; the rate of evaporation; and the sensitivity of the host material. For instance, in areas where dry deposition exceeds wet deposition, periodic rainfall may actually prevent corrosion of metals by washing sulfate particles from surfaces (Kucera, 1976). It is also extremely difficult to distinguish the effects of acid precipitation from direct damage induced by various forms of air pollution.

The metals most vulnerable to acid precipitation are those whose corrosion resistance depends on a protective layer of carbonates, sulfates, or oxides (such as copper or zinc) that dissolve at a pH of of 4.0 or less (Kucera, 1976). The most vulnerable stone and construction materials are limestones, dolomites, calcareous sandstones, and morters that blister, scale, or lose surface integrity when in contact with acid rains. Acid precipitation may also create staining problems in stonework from leaching of chemical constituents (Cowling and Dochinger, 1978; Sereda, 1977).

Acid precipitation and related forms of air pollution have recently damaged some of the oldest and most valuable structures in the world including the Parthenon, the Colosseum, and the Taj Mahal (Moffit, 1980). In 1980, the Greek government announced a ten-year, $18.5 million program to save the Acropolis from further deterioration. In the past thirty years, scientists estimate that the Parthenon has suffered more damage from air pollution than in the previous thirty-five centuries since its construction (Associated Press, 1980).

B. Effects on Human Health

Mobility of metallic compounds in soil is increased as acidity increases, creating a potential human health hazard through contamination of food and water. Heavy metal concentrations have been reported in higher levels than normal in the waters and biota of acidified regions (Prouzes, et al., 1977). Abnormal concentrations of aluminum, cadmium, copper, lead, nickel,

manganese, mercury, and zinc have been reported (Beamish, 1976; Glass and Loucks, 1979; Roberts, 1980; Wright and Gjessing, 1976). In western Sweden, acidified well water caused by acid precipitation was found to contain abnormally high concentrations of aluminum, copper, lead, manganese, and zinc. In addition, the copper plumbing in some homes was so badly corroded, it required replacement (Hultberg and Wenblad, 1980).

Little is known of the long-term health impacts of these problems. In a few cases, contamination exceeds public health standards, but the actual health impacts have never been assessed. In Clarion County, Pennsylvania a lead contamination problem resulted from accelerated leaching of lead from household plumbing caused by acidified waters (Roberts, 1980). Tomlinson (1979) reported mercury levels in acidified Canadian lakes in concentrations an order of magnitude higher than U.S. drinking water standards. It should be emphasized that these studies are preliminary and that the cause/effect relationship has not been firmly established. Because of the severity of potential environmental and economic impacts, a great deal of additional research is needed on the long-term ecologic, economic, and health impacts of acid rains.

REFERENCES

Abrahmsen, G. and G. J. Dollard. 1979. "Effects of Acid Deposition on Forest Vegetation." In: Ecological Effects of Acid Precipitation. M. J. Wood (ed.), Electric Power Research Institute, Report #EPRI SOA77-403, Palo Alto, California.

Arnold, D. E., R. W. Light, and V. J. Dymond. 1980. Probable Effects of Acid Precipitation on Pennsylvania Waters. Environmental Protection Agency, Report No. EPA-600/3-80-012. Corvallis, Oregon.

Associated Press. May 4, 1980. "Greece Announces $18.5 Million Plan to Save Acropolis Structures." Los Angeles Times.

Barnes, R. A. December, 1979. "The Long Range Transport of Air Pollution: A Review of European Experience." Journal of the Air Pollution Control Association, Vol. 29:12:1219-1235.

Beamish, R. J. 1976. "Acidification of Lakes in Canada by Acid Precipitation and the Resulting Effects on Fish." Water, Air, and Soil Pollution, Vol. 6:501-514.

Beamish, R. J., W. L. Lockhart, J. C. Van Loon, and H. H. Harvey. 1975. "Long Term Acidification of a Lake and Resulting Effects on Fishes." Ambio, Vol. 4:98-102.

Bell, H. L. 1971. "Effects of Low pH in the Survival and Emergence of Aquatic Insects." Water Research. Vol. 5:313-319.

Borgstrøm, R. and G. R. Hendrey. 1976. "pH Tolerance of the First Larval Stages of Lepidurus arcticus (Pallas) and adult Gammarus lacustris." International Report 22/76, SNSF Project, Ås, Norway.

Braekke, F. H. (ed.). 1976. Impact of Acid Precipitation and Forests and Freshwater Ecosystems in Norway. Research Report 6/76, SNSF Project, Ås, Norway, 111 pp.

Cowling, E. B. and L. S. Dochinger. 1978. "The Changing Chemistry of Precipitation and its Effects on Vegetation and Materials." In: Control and Dispersion of Air Pollutants: Emphasis on NO_x and Particulate Emissions, AICHE Symposium, Vol. 7:134-142.

Environmental Protection Agency (EPA). 1980. Research Highlights 1979. Office of Research and Development, Report No. EPA-600/9-80-005, Washington, D.C.

European Inland Fisheries Advisory Committee (EIFAC). 1979. "Water Quality Criteria for European Freshwater Fish." Water Research, Vol. 3:596-611.

Galloway, J. N. and E. B. Cowling. 1978. "The Effects of Precipitation on Aquatic and Terrestrial Ecosystems; A Proposed Precipitation Network." Journal of the Air Pollution Control Association. Vol. 28:229-235.

GCA Corporation. December, 1980. Acid Rain Information Book. Draft Final Report DOE/EV10273-1, Prepared for the U.S. Department of Energy.

Glass, G. E. and O. L. Loucks (eds.). 1979. Impacts of Air Pollutants in Wilderness Areas in Northern Minnesota. Environmental Research Laboratory, EPA, Duluth, Minnesota.

Glass, N. R., G. E. Glass, and P. J. Rennie. November, 1979. "The Effects of Acid Precipitation." Environmental Science and Technology. Vol. 13:11:1350-1355.

Gosner, K. L. and I. H. Black. 1975. "The Effects of Acidity on the Development and Hatching of New Jersey Frogs." Ecology. Vol. 38: 256-262.

Grahn, O. 1976. "Macrophyte Succession in Swedish Lakes Caused by Deposition of Airborne Acid Substances." In: Proceedings of the First International Symposium on Acid Precipitation and the Forest Ecosystem. L. S. Cochinger and T. A. Seliga (eds.). U.S. Forest Service General Technical Report NE-23, Upper Darby, Pennsylvania.

Grahn, O., H. Hultberg, and L. Landner. 1974. "Oligotrophication - A Self-accelerating Process in Lakes Subjected to Excessive Supply of Acid Substances." Ambio, Vol. 3:93-94.

Hendrey, G. 1978. Aquatics Task Force on Environmental Assessment of the Atikokan Power Plant: Effects on Aquatic Organisms. Department of Energy and Environment, Brookhaven National Laboratory Associated Universities, Inc., Upton, New York.

Hendrey, G. R. and R. F. Wright. 1976. "Acid Precipitation in Norway: Effects on Aquatic Fauna." Journal of Great Lakes Research. Vol. 2: (Supplement 1): 192-207.

Hendrey, G. R., K. Baalstrud, T. S. Traaen, M. Laake, and G. Raddum. 1976. "Acid Precipitation: Some Hydrobiological Changes." Ambio, Vol. 5:224-227.

Hultberg, H. and A. Wenblad. 1980. "Acid Ground-Water in Southwestern Sweden." In: Ecological Impact of Acid Precipitation, D. Drabløs and A. Tollan (eds.), SNSF Project, Ås, Norway.

Jacobson, J. S. 1978. "Experimental Studies on the Phytotoxicity of Acidic Precipitation: The U.S. Experience." Conference on the Effects of Acid Precipitation on Terrestrial Ecosystems, NATO Advanced Research Institute.

Jacobson, J. S. and P. van Leuken. 1977. "Effects of Acidic Rain on Vegetation." Proceedings of the Fourth International Clean Air Congress. pp. 124-127.

Kucera, V. 1976. "Effects of Sulfur Dioxide and Acid Precipitation on Metals and Anti-Rust Painted Steel." Ambio, Vol. 5:243-248.

Kwiathowski, R. E. and J. C. Roff. 1976. "Effects of Acidity on the Phytoplankton and Primary Productivity of Selected Northern Ontario Lakes." Canadian Journal of Botany. Vol. 54:2546-2561.

Lang, D. S., D. S. Shriner, and S. V. Krupa. 1978. "Injury to Vegetation Incited by Sulfuric Acid Aerosols and Acidic Rain." 71st Annual Meeting of the Air Pollution Control Association, Houston, Texas, Paper No. 78-7.3.

Lee, J. J., G. E. Neely, and S. C. Perregan. 1980. Sulfur Acid Rain Effects on Crop Yield and Foliar Injury. Environmental Protection Agency Report No. EPA-600/3-80-016.

Leivestad, H., G. Hendrey, I. Muniz, and E. Snekvik. 1976. "Effects of Acid Precipitation on Freshwater Organisms in Norway." In: Impact of Acid Precipitation on Forest and Freshwater Ecosystems in Norway. F. H. Braekke (ed.), Research Report, 6/76 SNSF Project, Ås, Norway.

Malmer, N. 1976. "Acid Precipitation: Chemical Changes in the Soil." Ambio, Vol. 5:231-234.

McFee, W. W., J. M. Kelly, and R. H. Beck. 1976. "Acid Precipitation: Effects on Soil Base pH and Base Saturation of Exchange Sites." In: Proceedings of the First International Symposium on Acid Precipitation and the Forest Ecosystem. L. S. Dochinger and T. A. Seliga (eds.), U. S. Forest Service General Technical Report NW-23, Upper Darby, Pennsylvania.

Menendex, R. 1976. "Chronic Effects of Reduced pH on Brook Trout (Salvelinus fontinalis)." Journal of the Fisheries Research Board of Canada. Vol. 23:118-123.

Moffet, B. May 15, 1980. "Acid Rain Poses Potential Danger." Los Angeles Times, Part IX, p. 6.

Oden, S. 1976. "The Acidity Problem - An Outline of Concepts." Water, Air and Soil Pollution. Vol. 6:137-166.

Overrein, L. N. 1972. "Sulfur Pollution Patterns Observed: Leaching of Calcium in Forest Soil Determined." Ambio, Vol. 1:145-147.

Pfeiffer, M. 1979. List and Summary of Acidified Adirondack Waters Based on Data Available as of April 1979. New York State Department of Environmental Conservation, Albany, New York.

Pough, F. H. 1976. "Acid Precipitation and Embryonic Mortality of Spotted Salamanders (Ambystoma maculatum)." Science, Vol. 192:68-70.

Prouzes, R. J., R. McLean and G. H. Tomlinson. 1977. "Mercury: The Link Between pH of Natural Waters and the Mercury Content of Fish." Coordinating Committee for Scientific and Technical Assessments of Environmental Pollutants, National Academy of Sciences, National Research Council, Washington, D.C.

Reuss, J. O. 1975. Chemical/Biological Relationships Relevant to Ecological Effects of Acid Rainfall. EPA Report 600/3-75-032. Washington, D.C.

Roberts, C. March 2, 1980. "Acid Rain, Snow Present Danger Across Much of U.S." Los Angeles Times. Part VIII, pp. 6-7.

Rosencranz, A. and G. Wetstone. June, 1980. "Acid Precipitation: National and International Responses." Environment. Vol. 22:5:6-8.

Schofield, C. L. 1976. "Acid Precipitation: Effects on Fish." Ambio, Vol. 5:228-230.

Schofield, C. L. 1979. "The Acid Precipitation Phenomenon and Its Impact in the Adirondack Mountains of New York State." Scientific Paper for the Science and Technology Staff, New York State Assembly, Albany, New York.

Sereda, P. J. 1977. "Effects of Sulphur on Building Materials." In: Sulfur and its Organic Derivatives in the Canadian Environment. Natural Resource Council of Canada, Ottawa, Canada, pp. 359-426.

Shriner, D. S. 1976. "Effects of Simulated Rain Acidified with Sulfur Acid on Host-Parasite Interactions." In: Proceedings of the First International Symposium on Acid Precipation and the Forest Ecosystem. L. S. Dochinger and T. A. Seliga (eds.), U.S. Forest Service General Technical Report NW-23 Upper Darby, Pennsylvania, pp. 919-925.

Shriner, D. S. 1978. "Effects of Simulated Acidic Rain on Host-Parasite Interactions in Plant Diseases." Phytopathology, Vol. 68:213-218.

Shriner, D. S. 1979. "Atmospheric Deposition; Monitoring the Phenomenon; Studying the Effects." In: Handbook of Methodology for the Assessment on Vegetation. W. W. Beck, S. V. Krupar and S. N. Lanzon (eds.), Air Pollution Control Association, Pittsburgh, Pennsylvania.

Sprules, G. W. 1975. "Midsummer Crustacean Zooplankton Communities in Acid Stressed Lakes." Journal of the Fisheries Research Board of Canada, Vol. 32:389-395.

Tomlinson, G. H. 1979. "Acidic Precipitation and Mercury in Canadian Lakes and Fish." Scientific Paper for the Science and Technology Staff, New York State Assembly, Albany, New York, pp. 104-118.

Tomlinson, G. H. 1981. Acid Rain and the Forest: The Effects of Aluminum: The German Experience. DOMTAR Research Center, Sennerville, Quebec, Canada, 22 pp.

Trojnar, J. R. 1977a. "Egg and Larval Survival of White Suckers (Catostomus commersoni) at Low pH." Journal of the Fisheries Research Board of Canada, Vol. 34:262-266.

Trojnar, J. R. 1977b. "Egg Hatchability and Tolerance of Brook Trout (Salvelinus fontinalis) Fry at Low pH." Journal of the Fisheries Research Board of Canada, Vol. 34:574-579.

Tyler, G. 1976. "Heavy Metal Pollution, Phosphatase Activity, and Mineralization of Organic Phosphorus in Forest Soils." Soil Biology and Biochemistry, Vol. 8:327-332.

Tyler, G. 1980. "Metals in Sporophores of Basidiomycetes." Transactions of the British Mycological Society, Vol. 24:41-49.

Wiklander, L. 1979. "Leaching and Acidification of Soils." In: Ecological Effects of Acid Precipitation. M. J. Wood (ed.), Electric Power Research Institute, Report #EPRI SOA77-403, Palo Alto, California.

Wood, T. and F. H. Bormann. 1974. "The Effects of an Artificial Acid Mist Upon the Growth of Betula alleghaniensis (Britt)." Environmental Pollution, Vol. 7:259-268.

Wood, T. and F. H. Bormann. 1977. "Short-term Effects of a Simulated Acid Rain Upon the Growth and Nutrient Relations of Pinus strobus (L)." Water, Air and Soil Pollution, Vol. 7:479-488.

Wright, R. F. and E. T. Gjessing. 1976. "Changes in the Chemical Composition of Lakes." Ambio, Vol. 5:219-223.

ENVIRONMENTAL EDUCATION APPLICATIONS—THE PRACTITIONER'S PERSPECTIVE

Concept Mapping:
A Theory-Based Strategy for Environmental Education

Woodward S. Bousquet[1]

Introduction

Virtually everyone who has described environmental education agrees that one principal goal is to help citizens become knowledgeable about the earth's biophysical and sociocultural environments (Stapp, et al., 1969; Roth, 1969; Lucas, 1972). In order to promote understanding of the concept[2] underlying this goal it follows that environmental educators must have some insight into how people learn.

With a few notable exceptions (e.g., Burrus-Bammel and Bammel, 1977; Van Matre, 1979; and Lawson, 1980), efforts in environmental education that have made explicit use of learning theory in guiding program development or research are relatively scarce. Recent advances in cognitive theories of learning, however, have provided a foundation of educational principles that are directly applicable to the development of strategies for teaching and learning environmental concepts.

In this paper Ausubel's theory of meaningful learning will be presented as one framework with direct application to many tasks which environmental educators face. The concept mapping strategy, which is based upon meaningful learning theory, will then be described. Finally, how concept mapping can help guide curriculum, instruction, and evaluation will be explained.

Ausubel's Theory of Meaningful Learning

The theory of meaningful learning (Ausubel, 1963; Ausubel, Novak and Hanesian, 1978) emphasizes the central role of concepts in the learning process. As Ausubel states in the epigraph to his text (1978: iv):

> If I had to reduce all of educational psychology to just one principle, I would say this: The most important single factor influencing learning is what the learner already knows. Ascertain this and teach him accordingly.

The most important aspects of "what the learner already knows" are the particular concepts that the learner possesses in his or her cognitive structure. A person learns unfamiliar concepts by identifying a substantive, meaningful relationship between the new concept and one or more concepts that he or she already understands.

---

[1]Science and Mathematics Education, 283 Arps Hall, The Ohio State University, Columbus, OH 43210.

This process Ausubel calls meaningful learning. The opposite of meaningful learning is rote learning, in which a learner makes arbitrary associations between the learning material and his or her existing store of concepts (Ausubel, Novak and Hanesian, 1978: 27).

Meaningful learning has several advantages. First, concepts that are learned meaningfully can expand a person's knowledge of related concepts; e.g., learning about herons can add to students' knowledge of the concepts bird, pond, and predator. Since meaningful learning involves the construction of logical links between new concepts and pre-existing knowledge, information learned meaningfully will be retained longer (Ausubel, 1960). In addition, these concepts can later serve as subsumers -- mental anchors -- for learning additional related concepts.

Ausubel (1979: 181-182) argues that instruction should emphasize the area of study's most general and inclusive concepts. The nine unifying themes of biology formulated by the Biological Sciences Curriculum Study, and the five conceptual strands used by the National Park Service in its National Environmental Education Development (NEED) project provide good examples of inclusive concepts. Such broad concepts are powerful because they can have direct relevance to subsequent learning experiences, they provide the broadest subsumers for new but related subject matter, and they assist learners "in integrating the component elements of new knowledge both with each other and with existing knowledge."

In addition, Ausubel points out that each student's store of concepts is unique. Therefore, each person will construct different concept links while involved in the same learning task. In order to enable each person to accomplish this, instruction must provide activities which allow learners to reformulate the material in ways that are meaningful to them.

Concept Mapping

From the preceeding discussion, it follows that concept learning activities based upon Ausubel's theory of meaningful learning should involve learners in 1) identifying concepts in the material to be learned; 2) determining which of these concepts are the more general and inclusive; 3) meaningfully linking these concepts to each other; and 4) meaningfully relating these concepts to concepts they already know.

One learning device that is designed according to these theory-based criteria is the concept map. The strategy was developed and is being assessed by Joseph Novak and his research group at Cornell University (Stewart, Van Kirk and Rowell, 1979; Novak, 1981). Essentially, a concept map is a diagram that indicates relationships among concepts in a discipline, a part of a discipline, or an interdisciplinary area of study. Depicted on the concept map are not only concepts themselves but also principles, which describe meaningful relationships between pairs of concepts.

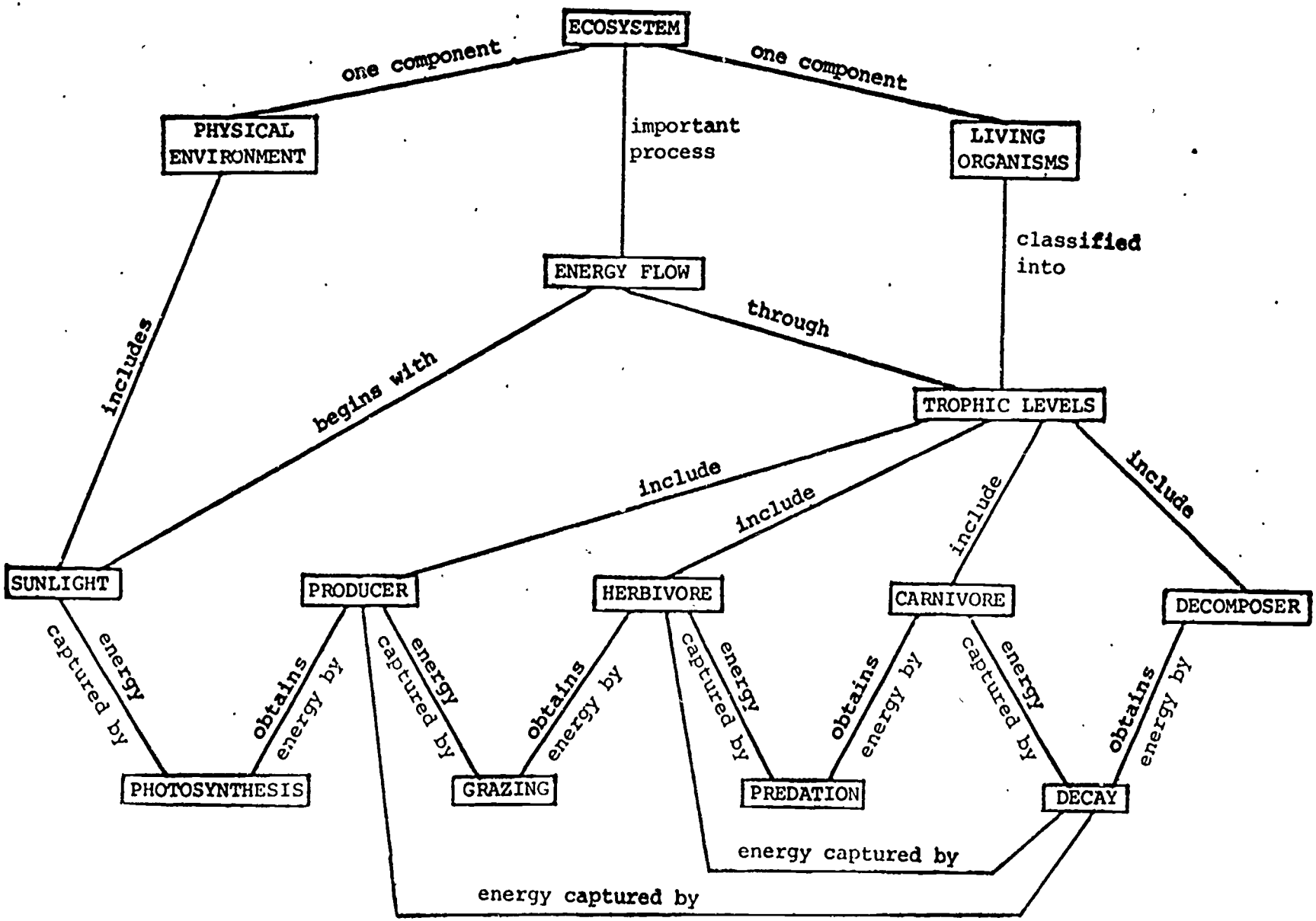


Figure 1: CONCEPT MAP OF ENERGY FLOW IN AN ECOSYSTEM

Figure 1 shows a concept map of energy flow in an ecosystem. Notice that the most inclusive concept, "ecosystem," appears at the top of the map. As one progresses down the map, the concepts become less inclusive and more specific. Note, too, that unlike an outline a concept map is two-dimensional. This characteristic allows for the illustration of the complex connections that exist among concepts. For example, in Figure 1 the concept "physical environment" is linked vertically to the more general concept "ecosystem" above it and to the more specific concept "sunlight" below it. Furthermore, the map includes the concepts "producer," "herbivore," "carnivore" and "decomposer" which lie at the same hierarchical level.

One of the best ways[3] to introduce concept mapping to people unfamiliar with the technique is to choose a short reading and have participants in small groups jointly construct maps of the information presented. The selection should contain a majority of concepts that are already familiar to the learners to make the task easier. Consider the following paragraph, adapted from Natural Resource Conservation (Owen, 1980, 21-22):

> Photosynthesis may be defined as the process by which solar energy is utilized in the conversion of carbon dioxide and water into sugar. With a few minor exceptions this process can occur only in the presence of chlorophyll, a green pigment found in plants, which serves as a catalyst for the reaction. In a sense, solar energy is "trapped" by chlorophyll and channeled into sugar molecules in the form of chemical energy. The world's green plants fix 550 billion tons of carbon dioxide daily.

The first step is to identify the concepts -- the regularities in objects and/or events -- described in the paragraph. These include process, plants, green pigment, sugar molecules, catalyst, solar energy, chemical energy, carbon dioxide, water, photosynthesis, and chlorophyll. Students are often surprised at how many concepts appear in a single paragraph! By writing each of these concepts on a gummed label or small slip of paper, they can be easily organized.

Next, the concept labels should be arranged from the most general (most inclusive) to the most specific (least inclusive). The most general concepts go at the top of the map being generated, the most specific examples at the bottom, and the concepts of intermediate importance somewhere in between. In the example, the entire selection deals with a process that plants conduct called photosynthesis, so the concepts plants, process and photosynthesis can be considered the most general and belong at the top of the map. "Green pigment" and "550 billion tons daily" are specific concepts that have probably the least relevance to the process being described. Therefore, gummed labels bearing these concepts should be placed at the bottom of the map.

At this point, concepts that are related to each other should be grouped. For instance, both catalyst and green pigment describe the concept chlorophyll so the three concepts belong together. The next step in concept mapping is to identify principles -- linking words -- that verbally tie concepts to one another; e.g., photosynthesis <u>is</u> <u>a</u> process that <u>utilizes</u> solar energy.

Finally, it is necessary to devise an organizational scheme of concepts and principles that preserves the hierarchy while depicting the vertical and horizontal relationships among the concepts. Here is where providing an example of a completed concept map can help beginners. Several patterns of concepts and concept links usually need to be tested before finding a satisfactory arrangement.

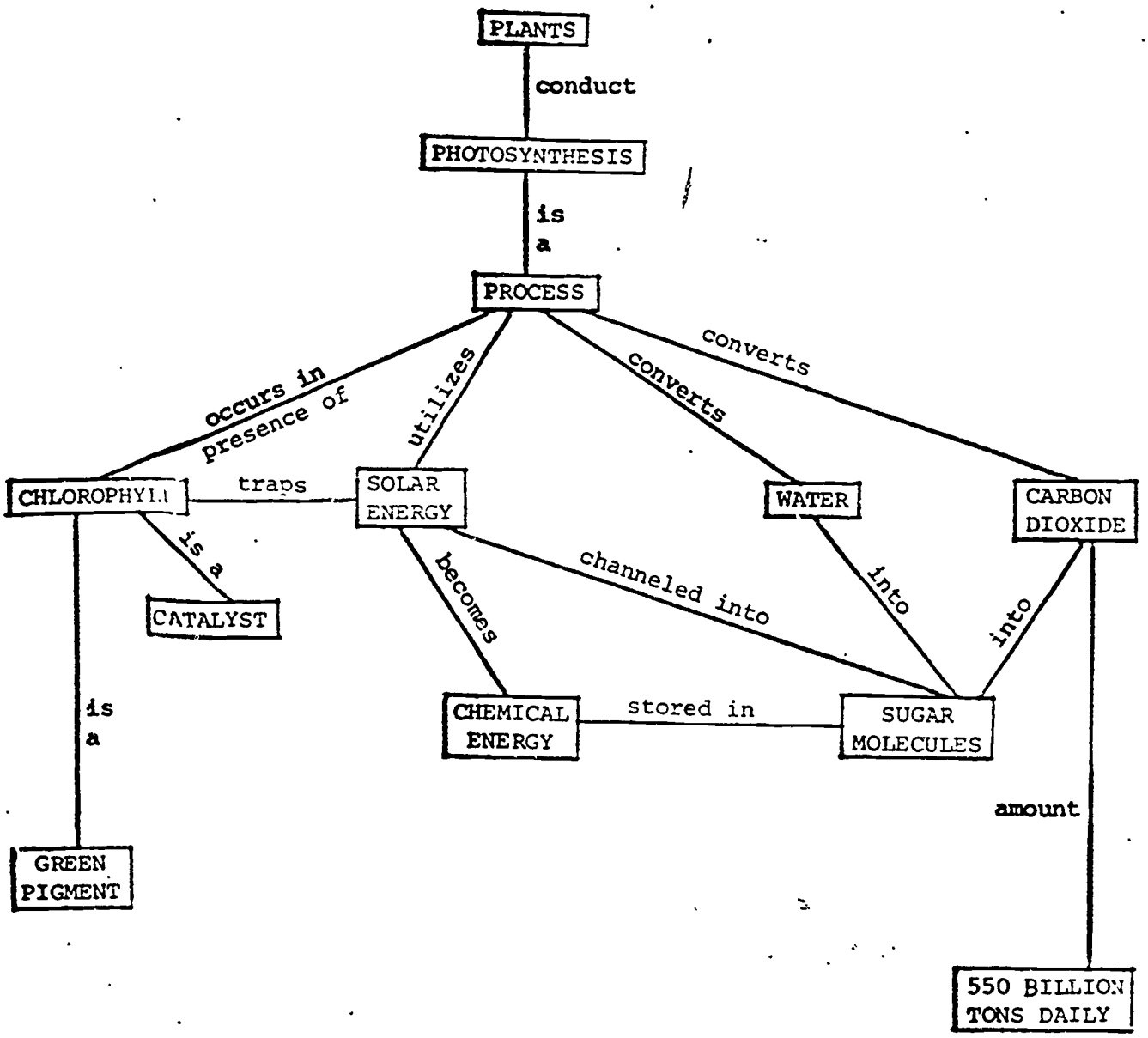


Figure 2: CONCEPT MAP FOR PHOTOSYNTHESIS PARAGRAPH

Figure 2 is one of many possible concept maps that can be constructed from the sample reading. Since each person possesses a unique organization of concepts and principles in his or her cognitive structure, a concept map that is meaningful to its maker may not be the most meaningful arrangement to another person. There is thus no single "correct" concept map; the best maps are those that are most meaningful to persons who construct or read them. However, each concept map should also meet the following criteria:

1. Concepts are arranged in a hierarchy; i.e., the map starts with the most general concepts at the top and proceeds downward to the most specific concepts or examples;

2. Related concepts are linked by lines (principles) that show these relationships;

3. Each principle has a label that describes how the linked concepts are related.

Compare the concept mapping strategy to the implications for concept learning activities that were derived from meaningful learning theory and presented at the beginning of this section of the paper. Concept mapping asks learners to identify concepts, decide which are more general and inclusive, and meaningfully relate these concepts to each other. Furthermore, since some concepts in any learning task should be concepts with which learners are already familiar, concept maps show learners how concepts they already know relate to the new concepts they are in the process of learning.

Uses of Concept Mapping

Since concept maps illustrate the structure of a discipline or other area of study, concept mapping can have many uses in education. Among the possibilities are applications to curriculum, instruction, and evaluation.

Curriculum: Johnson (1967: 130) defines curriculum as "a structured series of intended learning outcomes." Curriculum is therefore a description of the planned results of a group of learning experiences. Instruction, then, is the arrangement of teaching methods and learning materials that will be employed to help students achieve these intended outcomes. If Johnson's perspective on curriculum is accepted, the task of curriculum development is to identify learning outcomes that are appropriate for a given unit and group of learners. These intended results must then be organized in a manner that reflects the structure of the subject matter.

A concept map is an ideal tool for curriculum development. Construction of a concept map requires the teacher to break an area of study into its concepts; these constitute the unit's intended learning outcomes in the cognitive domain. By organizing the concepts in a hierarchy and then identifying principles which meaningfully link concepts to one another, the educator has portrayed both the individual cognitive learning outcomes and their structural relationships. This concept map more completely depicts the structure of the cognitive components of a curriculum than can a list of behavioral objectives.

Instruction: In a college physics course, Moriera (1977) ended each unit with a map of the important concepts covered. Bogden (1977) constructed a concept map for each of a series of genetics lectures and used them as the focus of student discussion sections. In both courses, the concept maps were used to summarize the important ideas in each course segment. The maps served as supplements to readings, lectures, and laboratories for some students, while others used the concept maps as aids in reviewing course material.

Another way concept maps can be used in instruction is to have students make their own maps. This involves the learners themselves in analyzing study material for concepts and principles and then constructing maps that reflect how they perceive the structure of that information. It is often said that teaching something is an excellent way to learn it. Since concept mapping requires people to construct their own meaning out of subject matter, concept mapping should be another effective approach to learning.

The third instructional purpose that concept maps can serve is particularly relevant to an interdisciplinary field such as environmental education. With separate learning modules and distinct mini-courses popular in many schools, students are often presented with a fragmented view of knowledge. Mapping some of the major concepts needed to addressed an environmental problem such as air pollution can help students see how the pieces of information they are acquiring relate to each other in practical situations. As Bainbridge (1977) suggests, concept mapping offers a vehicle for crossing disciplinary boundaries to many students who are unable to accomplish this synthesis on their own.

Evaluation: Too often students are tested on how well they remember examples used to teach important concepts instead of being asked to explain the meaning and significance of those concepts. Be referring to a concept map when preparing a test, teachers can remind themselves to focus test questions upon the course's most general and inclusive concepts. After all, it is knowledge of these broad concepts -- not knowledge of specific examples -- that will become the conceptual anchors for future learning. Concept maps also help a teacher identify important principles (concept links) with which students should be familiar.

Students can be tested by asking them to make maps from a list of important concepts. Novak (1981: V-8 to V-9) produced two forms for assessing concept maps. The shorter version is intended for classroom use to give teachers an overall, qualitative picture of students' conceptual knowledge and ability to m maps. The longer comprehensive form provides numerical data on more spe ic aspects of maps such as number of correct principles and degree of b hing. Not only do these data allow for quantitative evaluations and co arisons, they also help identify weaknesses that should be corrected by further instruction on concepts and/or the mapping technique. No significant variation in the scores given by five raters on 18 different concept maps was found, so the scoring procedures can be used consistently by different evaluators.

Of course, rigorous scoring of students' concept maps should not be performed until the students become competent at the strategy. Once students become good mappers, the maps they make can become valuable tools for diagnosing individual learning difficulties.

Assessment of concept maps can go beyond evaluation of individual learners to the level of program evaluation. If, for example, an entire group of students fails to indicate or inaccurately describes an important conceptual link on their maps, this may mean that the program as a whole is not promoting that desired learning outcome. Concept maps can thus become part of the feedback loop for program development and evaluation.

Conclusion

This paper has argued that Ausubel's theory of meaningful learning is a useful paradigm for environmental education. Concept mapping, a technique derived from meaningful learning theory, was described, and several applications of the strategy to curriculum, instruction and evaluation were suggested.

Analysis of the potential, effectiveness and limitations of concept mapping has recently begun. Among the questions that need to be addressed are these: Is having students make their own maps more effective in facilitating concept learning than providing instructor-constructed maps as study aids? What factors influence the degree to which learners benefit from experience with concept maps? Since concept mapping is based upon learning theory, do students who are good concept mappers have a better understanding of human learning processes? Do concept maps influence students' attitudes towards learning or towards the concepts presented? How can concept mapping best be integrated into existing educational practice?

Numerous additional possibilities for research projects involving concept maps exist, and the strategy awaits expanded application to environmental education.

NOTES

2 Definitions of the term "concept" vary. For purposes of this paper, a concept will be treated as a regularity in objects and/or events designated by a label or symbol (after Gowin, in press). Thus, the concept label "mammal" identifies regularities such as warm-bloodedness, possession of fur or hair, and nursing of the young by the mother.

3 These directions are adapted from Stewart, Van Kirk and Rowell (1979: 173-174) and Novak (1981: V-3 to V-9).

REFERENCES

Ausubel, David P. 1960. The Use of Advance Organizers in the Learning and Retention of Meaningful Verbal Material. Journal of Educational Psychology, 51: 267-272.

Ausubel, David P. 1963. The Psychology of Meaningful Verbal Learning. New York: Grune and Stratton.

Ausubel, David P. 1979. "Education for Rational Thinking: A Critique," in Anton E. Lawson (ed.) The Psychology of Teaching for Thinking and Creativity, 1980 AETS Yearbook. Columbus, OH: ERIC Clearinghouse for Science, Mathematics and Environmental Education.

Ausubel, David P., Joseph D. Novak and Helen Hanesian. 1978. Educational Psychology: A Cognitive View, 2nd edition. New York: Holt, Rinehart and Winston.

Bainbridge, Brian W. 1977. How to Teach Procedures, Problem Solving, and Concepts in Microbial Genetics. Journal of Biological Education, 11, 4: 285-295.

Bogden, C. A. 1977. The Use of Concept Mapping as a Possible Strategy for Instructional Design and Evaluation in College Genetics. Unpublished master's thesis. Ithaca, NY: Cornell University.

Burrus-Bammel, Lei Lane, and Eugene Bammel. 1977. "The Relationship Between Experiential Learning, Perception, and Information Processing," in Robert McCabe (ed.) Current Issues in Environmental Education -- III. Columbus, OH: ERIC Clearinghouse for Science, Mathematics and Environmental Education.

Gowin, D. Bob. In press. Educating. Ithaca, NY: Cornell University Press. Cited in Novak.

Johnson, Mauritz, Jr. 1967. Definitions and Models in Curriculum Theory. Educational Theory, 17, 2: 127-140.

Lawson, Anton E. 1980. "Making Value Judgments: A Question of Cognitive Development?" In Arthur B. Sacks, Lei Lane Burrus-Bammel, Craig B. Davis, and Louis A. Iozzi (eds.) Current Issues VI: The Yearbook of Environmental Education and Environmental Studies. Columbus, OH: ERIC Clearinghouse for Science, Mathematics and Environmental Education.

Lucas, Arthur M. 1972. Environment and Environmental Education: Conceptual Issues and Curriculum Implications. Unpublished PhD dissertation. Columbus, OH: The Ohio State University.

Moriera, Marco A. 1977. An Ausubelian Approach to Physics Instruction: An Experiment in an Introductory College Course in Electromagnetism. Unpublished PhD dissertation. Ithaca, NY: Cornell University.

Novak, Joseph D. 1981. The Use of Concept Mapping and Gowin's "V" Mapping Instructional Strategies in Junior High School Science; the Cornell University "Learning How to Learn" Project. Final report to the National Science Foundation. Ithaca, NY: Cornell University, Department of Education.

Owen, Oliver S. 1980. Natural Resource Conservation. 3rd edition. New York: Macmillan Publishing Co., Inc.

Roth, Robert E. 1969. Fundamental Concepts for Environmental Management Education (K-16). Unpublished PhD dissertation. Madison: University of Wisconsin.

Stapp, William B., et al. 1969. The Concept of Environmental Education. Journal of Environmental Education, 1, 1: 30-31.

Stewart, James, Judith Van Kirk and Richard Rowell. 1979. Concept Maps: A Tool for Use in Biology Teaching. American Biology Teacher, 41,3: 171-175.

Van Matre, Steve. Sunship Earth; An Acclimatization Program for Outdoor Learning. Martinsville, IN: American Camping Association.

Mountain PLAY: An Off-Site Environmental Education Program for Mount Rainier National Park

Theresa M. Carroll[1]

Introduction

In the past, field trips were fairly easy to arrange and conduct. Today, however, fuel and budget shortages are making it more and more difficult for teachers in Washington to take their pupils to visit sites such as Mount Rainier National Park, and others which are beyond walking distance from the school. Increasingly, outdoor activities and learning opportunities will have to utilize the local school environment.

"Mountain PLAY:" Design

Until now the only teaching materials concerning Mount Rainier were written for use on-site at Mount Rainier National Park. Learning opportunities were unavailable for the majority of classes which were unable to visit the park. "Mountain PLAY" (Packet for Learning About Your Mountain) is an Environmental Education learning activity package about Mount Rainier National Park. The program is designed to be used primarily on or around the local school site. The logic behind "Mountain PLAY" is simply this: "If the students cannot come to The Mountain, we will take The Mountain to them!" "Mountain PLAY" is the first Environmental Education program for a national park designed especially for use off-site in the schools.

Developed for children in grades 4-6 in the Western Washington State schools, the package can be adapted for use in any grade from pre-school to junior high. "Mountain PLAY" consists of a 156-page activity book and six board games with accompanying game cards. It is divided into fifteen units, each of which contains activities, background information, and suggested books and films on one of the following fifteen concepts related to the Mount Rainier National Park environment:

A. The relationship between The Mountain and the lower forests and meadows-- "an arctic island in a temperate zone."

   1. There are countless species of plants found in Mount Rainier National Park, and all are adapted to living in their environment.

   2. There are countless species of wildlife found there as well, and all are adapted to living in their environment.

---

[1]National Park Service, Mount Rainier National Park, Longmire, WA 98397.

3. The plants and wildlife of Mount Rainier inhabit four different environments or life zones, which change as one ascends The Mountain.

4. The energy on which all life in the Mount Rainier environment depends comes from the sun and is passed through the food web.

5. The forest environment of Mount Rainier is continually changing through the process of forest succession.

6. In order to live in such a harsh environment, the plant life of the alpine and subalpine meadows of Mount Rainier must be very hardy. At the same time they are fragile in that they cannot withstand human footsteps.

B. The ongoing physical dynamics of The Mountain

7. Water in the rivers and glaciers of Mount Rainier plays an important role in the shaping of the local environment.

8. Mount Rainier is a dormant volcano which, like Mount St. Helens, has the potential of erupting again.

9. The environment of Mount Rainier changes with the seasons.

C. The relationship between The Mountain and people-- both those who have lived in the area over the centuries and those who continue to be affected by the presence of The Mountain.

10. Hikers to the Mount Rainier backcountry must try to leave as little human impact on the natural environment as possible.

11. There were many events in history which led to the establishment of Mount Rainier National Park.

12. Native American traditions and beliefs influenced their usage of Mount Rainier and its surrounding area.

13. National Parks are established to preserve areas for the enjoyment of people in such a way as to leave those areas unimpaired for future generations.

14. There are many things to do and see at Mount Rainier National Park, and visitors must try to do and see them safely.

15. The different things people value in Mount Rainier and the natural world generate inspiration and respect, which lead to the ultimate protection of the environment.

"Mountain PLAY:" Use

The activities in each unit of "Mountain PLAY" are based on the Environmental Education philosophy of not only lecturing, but doing. They range

from board games and self-directing task cards designed for classroom learning centers, independent enrichment seatwork, or extra credit, to class simulations, role-playing, student projects, and school ground field trips designed for small groups or the whole class. All of the activities are interdisciplinary and use Mount Rainier as a theme to teach all subjects, from math and science, to language arts, social studies, and the arts. Today, with the shift towards "back to basics" in education, the fact that "Mountain PLAY" can be integrated into the everyday classroom curriculum is a very important aspect of the program.

Teachers are using a variety of ways to incorporate "Mountain PLAY" into their everyday classroom curriculum. The package provides numerous opportunities for meeting school district prescribed student learning objectives in such areas as creative writing, grammar, math problem solving, and graphing skills.

Elementary school teachers are using "Mountain PLAY" in the following ways: preparation for outdoor school and field trips, classroom learning center activities, and instructional units on Mount St. Helens and forest regions. Kindergarten teachers are using Mt. Rainier as a topic for daily "sharing" sessions and are designing curriculum centers in the classroom which use "Mountain PLAY" activities to teach art, reading readiness, language arts, math, science, social studies, music, and coordination skills. Clover Park School District has prepared learning packages for K-6 gifted education. The curriculum writing team was pleased with the immediately usable classroom materials in "Mountain PLAY."

At the junior high level "Mountain PLAY" is being used in P.E. classes and science clubs to teach backcountry ethics and hiking skills. In a foreign language class "Mountain PLAY" games were played in French and a class book on Mt. Rainier was written in French. In science classes one teacher is placing students on independent study contracts to complete at least one activity from each "Mountain PLAY" unit at the rate of two per month.

Substitute teachers are also finding "Mountain PLAY" useful. When faced with a situation where the regular teacher has left few lesson plans the substitute is able to incorporate many "Mountain PLAY" activities on short notice.

Outside of school, "Mountain PLAY" activities are being used on family outings and in Scouts, where they lead to achievement awards.

Teachers using "Mountain PLAY" in their classes report that the activities are readily usable and are easily adapted to any subject or grade level. Students appear to enjoy the hands-on learning in "Mountain PLAY," while at the same time their awareness and understanding of Mount Rainier and the immediate school environment is increasing.

The success of "Mountain PLAY" has been shown by the growing popularity of the package among teachers in Western Washington. The increasing numbers of requests for copies of the package indicate the increasing importance of

off-site Environmental Education programs for National Parks and similar areas, in lieu of field trip packets, as school budgets grow tighter and energy grows scarcer.

For information on obtaining copies of "Mountain PLAY" write to the author at Mount Rainier.

Creative Problem Solving Practices for Environmental Education: A Workshop

Michael R. Cohen[1]

Creativity and problem solving are critical components of environmental education. They are included as major goals in many good environmental education programs. Fortunately, extensive development in creativity and problem solving are currently available to provide a wide range of ideas and practices for instruction, curriculum development, program planning, and research in environmental education.

The activities described in this workshop provide a one hour introduction to creativity and problem solving. They help participants: review their perceptions of creativity and problem solving; experience a variety of conceptual blocks which prohibit creative problem solving; and integrate creative problem solving into their environmental education responsibilities. Each activity should include open interaction between presenter and participants.

ACTIVITY 1: MEMORY AND PATTERNS.

In this activity the participants are asked to memorize a set of numbers in 15 seconds. The three sets to be memorized are shown in Figure 1. Participants usually have little trouble with the top set. It is interesting that almost all participants will group the numbers into sets of twos, threes, or fours. The middle set is usually accompanied by complaints of, "It's too long." But this set should not be any problem since it is made up of odd numbers 1 through 23. The bottom set usually takes a few minutes to complete. Normally, this is allowed to remain until a few participants have seen a pattern.

ACTIVITY 1: DISCUSSION

The first set of numbers shows the speed of our thinking ability. How can your brain work so quickly that in less than a second you are organizing nonsense numbers?

The second set shows our ability to see patterns. But many participants want to give up when they see such a long number. It is useful to ask for their feelings at seeing a longer number. It is also an opportunity to show that problems can be solved if they are broken down into smaller parts. If they cannot see the pattern just cover numbers 13 through 23. The pattern of odd numbers is then clear.

---

[1]Department of Science and Environmental Education, School of Education, Indiana University, Indianapolis, IN 46204.

The third set, like so many problems, has at least two solutions. It is a set of the squares of whole numbers starting with 1. And the sequence can be obtained by adding consecutive odd numbers to beginning with 3. This is, 1 + 3 = 4, 4 + 5 = 9, 9 + 7 = 16, etc.

This entire set of number problems should lead to interesting interactions between participants. Useful general questions include: How good are you at simple memory tasks? What are your strengths and what are your weaknesses in observing patterns?

ACTIVITY 2: PATTERNS AS CONCEPTUAL BLOCKS

In this activity the participants are asked to divide Figure 2 into its two component parts. Then they are asked if they can divide it any other ways. There are many solutions to this problem. Two circles, one clear and one containing lines. One clear circle and one half moon lines figure. And the two circles with the lines removed from one.

ACTIVITY 2: DISCUSSION

This activity leads into the next perception activity. Discussion should concentrate on how each participant felt after separating the figure. When did they realize there was more than one answer?

ACTIVITY 3: PERCEPTION AS A CONCEPTUAL BLOCK

The participants are asked to read the statement in Figure 3 and then count the number of "f's" in the statement. Ask the participants not to discuss this with each other. Some participants will see 3 f's. Others will see 4, 5, or 6. (It is worthwhile trying this on colleagues to see how it works.)

ACTIVITY 3: DISCUSSION

In this activity each person really tries to accurately count the f's. But for some reason many cannot see more than 3. And each person who sees 3 is sure that they are correct. This is an excellent place to discuss perception as a conceptual block. In many of the environmental problems we face we have people who see different points of view. This activity shows how deeply ingrained our perceptual cues are.

ACTIVITY 4: SETTING UP FALSE BOUNDARIES TO PROBLEMS

Figure 4 shows one of the most traditional problems. It is usually found in every book on creativity or problem-solving. The problem is usually stated with the following instructions: "Using only four straight lines and not retracing the lines or lifting the pencil from the paper, connect all nine dots." These instructions set up the participants' inability to solve the problem. A better way to state the problem is to ask the

participants for the least number of straight lines that can connect the nine dots. But you cannot retrace your lines or lift your pencil from the paper. This way most participants will solve the problem with five lines. Once they have solved the problem they are asked if they can solve the problem with less than five lines. Then less than, 4, 3, or 2. (Actually the problem can be solved with 1 line; Adams, 1976, page 18.)

ACTIVITY 4: DISCUSSION

This problem includes a number of typical problems faced in all problem solving. You do not know what the answer should be. Once you have an answer you are satisfied and do not look for simpler or better answers. In solving the problem you have to extend the boundaries of the problem. Many people stay with in the limits of the nine dots. That way you can only solve the problem with 5 lines.

DISCUSSION AND ANALYSIS

Before people begin to study creativity and problem solving they look for information and systems to solve their problems. What is really needed is practice and the ability to see that we are our worst enemies. We have strengths and weaknesses of which we have to be aware. These activities are only a small start at looking at creativity and problem solving.

Most traditional schooling establishes habits in students that make it difficult for them to be creative problem solvers. One needs to be able to spend the time thinking about problems. Speed kills creativity and problem solving ability. Yet schools are built on speed. One needs to be able to think about problems not just memorize answers. Yet school spend much time reinforcing memory skills. Problems need to be seen as opportunities not as limits. In schools we do not look with favor at our ability to find problems. And finally, problems have only one known solution in most school settings.

Environmental education cannot afford a view of problem solving and creativity that maintains old styles. The activities outlined here are a beginning. The books and articles listed provide additional leads to use to increase creative problem solving practices for environmental education.

1 3 4 2 7 8 5 8 6

1 3 5 7 9 1 1 1 3 1 5 1 7 1 9 2 1 2 3

1 4 9 1 6 2 5 3 6 4 9 6 4 8 1

FIGURE 1. Sets of numbers to be memorized as part of Activity 1. (Adapted from Rubinstein, 1975, page 8.)

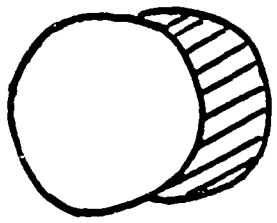


FIGURE 2. Figure to be divided into two component parts as part of Activity 2. (After McKim, 1972, page 69.)

FINISHED FILES ARE THE RESULT OF YEARS OF SCIENTIFIC STUDY COMBINED WITH THE EXPERIENCE OF YEARS

FIGURE 3. Sentence to be read as part of Activity 3. Participants are then to count the number of "f's" in the sentence.

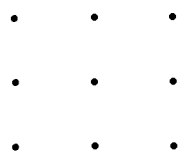


FIGURE 4. Nine dot problem to be solved as part of Activity 4. (After Cohen, in press.)

REFERENCES

Adams, James L. 1976. Conceptual Blockbusting. New York: W. W. Norton.

Cohen, Michael R. In press. "Problem Solving as a Goal of Energy and Environmental Education," Journal of Environmental Education.

Cohen, Michael R. and Larry Flick. 1981. Expanding Children's Thinking Through Science, CESI Sourcebook II. Columbus, Ohio: ERIC/SMEAC.

McKim, Robert. 1972. Experiences in Visual Thinking. Monterey, CA: Brooks/Cole.

Prince, George. 1970. The Practice of Creativity. N. Y.: Collier/Macmillian.

Rubinstein, Moshe. 1975. Patterns of Problem Solving. Englewood Cliffs, NJ: Prentice Hall.

Environment, Education, Technology: An Oceanic Perspective

Rosanne W. Fortner[1]

One of the most important results from our country's space program has been the unique perspective gained by looking back at our planet from space. All at once we were able to see a "whole earth catalog" which showed that ours was a water plant with an indisputably finite array of resources.

A closer look at that planet reveals that as stewards of its resources we have not done a commendable job. Our extravagant use of fossil fuels not only threatens the independence we fought for two centuries ago, it also threatens our very lives through the contaminants it adds to our air and water. The technology that produces important household chemicals, plastics, and "the good things in life" also produces hazardous wastes requiring new technologies for safe disposal. Our intensive agricultural practices place increasing demands on the soil and the watershed.

The list of ecological disasters and near-disasters, highlighted by the media, has stirred our national consciousness over the past decade. Environmental educators, propelled by forward-looking legislation and a committed cadre of citizens, accepted the challenge of producing an electorate informed on environmental matters and able to make wise decisions for our planetary future. And with so much of that planet being water, it was nearly inevitable that marine and aquatic education should become a major tributary of environmental education. The idea was conceived as a response to a perception that the water environment needed special attention in proportion to its importance in the ecosphere.

Long considered only for its marine science aspects and characterized by the diver exploring a colorful coral reef, the image of marine and aquatic education is due for a change. Like environmental education, marine and aquatic education crosses all disciplines, from science to music, from art to history, from literature to vocational technology. It views the environment as a continuum, with what happens in the air affecting the water, what happens in the mountains affecting the coastline, and what happens in social institutions affecting scientific progress. And like other environmental education efforts, it does not rely only on classroom instruction, but involves experiences in nonformal settings, whether planned or coincidental. Scouting, 4-H, museums, zoos, television programs, magazines, beach walks and boat trips can play a part in the building of an aquatic awareness. In summarizing the feelings of hundreds of marine and aquatic educators, Goodwin and Schaadt (1978:6) defined the movement as "that part of the total educational process which enables people to develop a sensitivity to and a general understanding of the role of the seas and freshwater in human affairs and the impact of society on the marine and aquatic environments."

---

[1]Environmental Communications, School of Natural Resources, ANRPP, The Ohio State University, 2021 Coffey Road, Columbus, OH 43210.

Though its "marine science" and "oceanography" ancestors often styled themselves as distinct formal subject areas in the schools, modern marine and aquatic education frequently takes a very different form which practitioners call infusion. Basically, infusion is a process of integrating water-related materials or examples into the existing curriculum. The model does not produce new courses to be taught, or even new units to be squeezed into the teacher's work load. Instead, small-scale but significant alterations of subject matter begin to restore to the water world its rightful position of importance in all subjects.

Curriculum development efforts of the Ohio Sea Grant Education Program have produced numerous examples of infusion ideas. For example, since the walleye is a popular food and game fish in Lake Erie, food chains and energy pyramids using the "Big Mac" -producing organisms are exchanged for the trophic relationships needed to produce a harvestable-size walleye (Leach, Reil and Fortner, 1980). The lake food chain is compared to others in the ocean and on land, and basic ecological principles are illustrated.

In another investigation, traditional earth science lessons in weather maps and contour mapping become keys to the possible solution of an aquatic mystery--the cause for the sinking of the Edmund Fitzgerald (Fortner and Jax, 1980). This investigation epitomizes the interdisciplinary nature of marine and aquatic education in that its title, The Great Lakes Triangle, is from a popular nonfiction book (Gourley, 1977) whose content is discussed; the science investigations are related to the economics of carrying freight by water; and a final consideration of feelings imparted by Gordon Lightfoot's song, "The Wreck of the Edmund Fitzgerald," leads to a creative writing exercise. A teacher may choose to utilize the entire curriculum package, or only those parts that fit with his or her traditional subject area. Ideally, such interdisciplinary infusion materials could lead to closer working relationships among teachers in several departments of the school.

The same is true of some issue-oriented materials for marine and aquatic education. If one of our goals is "to evolve a new 'water ethic' embracing the proper uses, protection and conservation" of water resources (Goodwin and Schaadt, 1978:6), we must provide information upon which rational decisions may be based. Curricula developed by Michigan's Sea Grant Program ("The Sea Lamprey Story," 1981) consider the impact of the sea lamprey upon the Great Lakes fishery and how the problems may be solved. Historical, political, economic, social, and scientific aspects of the issue are considered. PCBs in fish are the subject of an Ohio Sea Grant investigation (Mayer, White-Predieri and Ihle, 1981) and overfishing is considered in Project COAST's "Where Have All the Menhaden Gone?" (1974).

Simulations involving land uses in the coastal zone are the subject of materials from the Hawaii Marine Social Studies project ("Ostrich Bay," 1979) and Project Coast ("Superport," 1974), while managing the resources of the global sea is considered in Ohio's "It's Everyone's Sea, Or Is It?" (Mayer and Ihle, 1981). Such activities place students in the decision-making roles they will eventually assume as adults, and like environmental education simulations in general, they provide a glimpse of the social, political, and economic aspects of science-based problems that have no clearcut correct answers.

The scope of marine and aquatic education therefore is shown to be appropriately global. No area of the curriculum has been left unaddressed, and no teacher needs to feel, as many once did, that materials for special needs are unavailable. Funding from governmental agencies, private organizations and industries has propelled the development of many exemplary curriculum projects all over North America. In addition to the thousands of articles, activities, and reference works cataloged by the ERIC system, an information retrieval system specifically for water-related materials has been established--the Marine Education Materials System (MEMS) at the Virginia Institute of Marine Science. The system includes materials for the handicapped, ideas for use with potential dropouts or with the gifted and talented, career information, tested classroom activities, field trip guides, etc. Descriptions of formal and nonformal programs, reports of research findings, tidbits of oceanic subject matter, and updates on national happenings are found in quarterly issues of Current, The Journal of Marine Education.

Victor Hugo once wrote that nothing in this world is as powerful as an idea whose time has come. Considering the enthusiasm with which marine and aquatic education has been received and the rapidity with which support for programs has grown, it appears that this may be one of those timely ideas. Not only is the subject matter exciting and immediately vital to our personal and political survival, the methods too have a contribution to make to education in general. To infuse rather than to add on--a lesson we could make use of when energy education, sex education, citizenship education, population education and all the rest threaten to inundate the conscientious educator. Another lesson is to integrate subject areas rather than segregate them--to show by our example that we truly believe everything is connected to everything else. These changes could provide more positive approaches to all types of subject matter, thus facilitating the entire educational process.

According to Goodwin and Schaadt (1978:9) the concept of education about the world of water is new only in degree. There have always been elements of marine and aquatic education in our classrooms, but only recently have we become aware of the urgency of informing people that oceanic vastness does not imply invulnerability to damage. It is time to get on with the business of marine and aquatic education while the chance to increase understanding is at an optimum and the means of avoiding environmental crisis are still available. We must let education be the bridge that effectively and protectively provides for our planetary future.

REFERENCES

Fortner, Rosanne W. and Daniel Jax. 1980. "The Great Lakes Triangle." Columbus, OH: Ohio Sea Grant Education Program.

Goodwin, Harold L. and James G. Schaadt. 1978. The Need for Marine and Aquatic Education. Newark, DE: Delaware Sea Grant College Program.

Gourley, Jay. 1977. The Great Lakes Triangle. New York: Aaron M. Priest, Inc.

Leach, Susan, Gabriele Reil and Rosanne Fortner. 1980. "To Harvest a Walleye." Columbus, OH: Ohio Sea Grant.

Mayer, Victor J., Amy J. White-Predieri, and Stephanie Ihle. 1981. "PCBs in Fish: A Problem?" Columbus, OH: Ohio Sea Grant, 1981.

Mayer, Victor J. and Stephanie Ihle. 1981. "It's Everyone's Sea: Or Is It?" Columbus, OH: Ohio Sea Grant.

"Ostrich Bay," Coastal Resources Development Game. 1979. Manoa, HI: Curriculum Research and Development Group.

"Simulation Game: Superport." 1974. Newark, DE: Project COAST.

"The Sea Lamprey Story," Unit I of Investigating the Great Lakes Environment. 1981. Ann Arbor, MI: Michigan Sea Grant.

"Where Have All the Menhaden Gone?" 1974. Newark, DE: Project COAST.

SET Literacy: A Goal for the Perplexed

James D. Lubbers[1]

A Need For A New Approach

The term "science" should arouse a host of feelings within anyone who has an interest in the environment and the human situation. Likewise, "environment" is a key component of many scientific explanations and definitions or is an over-all framework within which all of the physical and biological sciences are placed. Either term introduces a myriad of infrastructures and concepts that may provide insight into the relationship between humans and nature. Science, if defined as a process, allows us to examine our situation from the "inside out;" whereas "environment" inherently and necessarily provides us with an holistic "outside" view of our relationship to nature. In essence, both of these viewpoints are critically essential for making realistic, rational decisions on matters involving any interaction with natural processes. Furthermore, the need for both perspectives is strengthened by the dependency each has upon the other. Any analysis of our situation from an environmental viewpoint is valid only if the information is "scientifically" accurate and if the investigation is "scientifically" logical. Comparatively, a "scientific" analysis of our situation cannot avoid operating within environmental parameters and has little meaning if not related to some greater holistic schema or perspective depicting our dependency on the natural environment.

Our technological predicament being the object of such scrutiny is largely a product of science in that we have developed many tools, techniques and methodologies for modifying our environment in our "best interest." A wide array of technologies has helped us with many problems, given us longer life, personal wealth, and the ability to annihilate ourselves instantly with nuclear weaponry or slowly through environmental problems and the scarcity of resources as projected in studies such as Limits to Growth. Technological growth is the single biggest threat to our survival. Regardless of what symptoms we choose to examine, our ability to forsee the impacts and consequences of technological change cannot keep pace with the rate of change itself. Even though largely a product of science, our technology has a momentum of its own that defies analysis, even by its creators.

Implications For Education

The two viewpoints described above inevitably have become incorporated into educational aims, goals, and objectives. Science education has enjoyed a long history of development in attempting to meet the needs of both the general public and the scientific community. Environmental education, on

---

[1]Lecturer of Interdisciplinary Sciences, State University College at Buffalo, 1300 Elmwood Avenue, Buffalo, NY 14222.

the other hand, has grown out of the relatively recent environmental movement which has been attempting to give people an opportunity to gain an understanding of our predicament and remedy the source of their frustrations. Both types of education are essential. Both seem to be failing miserably. Science education is falling further and further behind in maintaining the scientific literacy level necessary to understand technological change, and environmental education does not yet have the momentum and experience necessary to realize its goals. On top of this, neither one has had the luxury of real cooperation from the other and cooperation is necessary to allow some balance of perspectives about the role of technology in society. Since technology is the issue, the object being scrutinized, it is necessary that we as educators begin to examine this zone of confrontation itself. Rather than "science" or "environmental" education as a focus, "technology" should be the central theme, with the role of technology in society being examined from both a scientific and an environmental perspective. It is essential for us to sort out the irrelevant or outdated information and focus on the present situation and our very survival. In other words, a new format is needed to synthesize and essentially reorganize the traditional concept of science education and the relatively unfounded efforts indiscriminantly known as environmental education. Since both perspectives pertain to the role of technology in society, why not directly examine technological issues? The longer each faction pursues its goals separately, even if attempting an objective look at the role of technology, the more time will be wasted through duplication and fragmentation of efforts and/or disagreement over which is the best method.

Bridging The Gap

Our survival depends on a clean, healthy natural environment and a complex, viable technological support system. Proponents of one cause or the other must realize that we need both, that either by itself will not work effectively, and that promotion and development of one is diametrically opposed to the quality and integrity of the other. Only by simultaneously considering both concerns in decision-making situations can the promotion and development of both "systems" remain in balance.

To prepare people for this kind of thinking, educators must present both (or all) perspectives on particular issues and do so within a decision-making context. Learners must be exposed to different values and attitudes in order to help them understand, analyze, evaluate, and apply the information received as well as to help them formulate or modify their own values and attitudes. When examining the role of technology in society as a central theme for science and environmental education many of these conditions are met. In other words, the nature of the content itself provides the approach and methodology for educators to simulate in the classroom. Such techniques may include technology assessment, impact analysis, cost/benefit analysis, scenario generation, and many others.

Admittedly, in the real world the cutting edge of technological change usually involves decisions based on a great deal of information derived from both science and environmental perspectives. In the classroom, students cannot be expected to have the background for appreciating the complexity of real world issues. But if educators can illustrate the

setting, the need, and the role of such knowledge and skills by providing classroom-scaled scenarios, then the framework for continued education and rational decision-making may be established.

Also in the real world, scientific literacy represents the more traditional goal of science education; environmental literacy symbolizes the goal of environmental education; and now we are recognizing the need for technological literacy. Taking this one step further, we can approach this new concept by falling back on the interdependency of science and environment as a source of input for gaining technological literacy. This interdependency enables educators to identify the scientific potentials of and the environmental constraints on any technological activity or any aspect of technological growth or change. In this sense, technological literacy is really a synthesis of both scientific literacy and environmental literacy. At the same time, analogous to the role of technology in society, this new-found concept of "technological literacy" takes on a new meaning, a special momentum of its own. To avoid alienation from science or environment, technology must be viewed in terms of resources demanded and products (positive or negative) resulting from such activity. Likewise, in education, technological literacy cannot overlook its dependency on both scientific and environmental literacy. In this respect, scientific literacy is especially important because of its long tradition and close tie with technology.

In an effort to keep all of this from getting out of hand, the "literacy" needed ideally would be a combination of all major aspects of science, environment, and technology (represented as a synthesis of the goals of both scientific and environmental concerns). Such a combination can be referred to as Scientific-Environmental-Technological literacy, or SET literacy for short (see Figure 1).

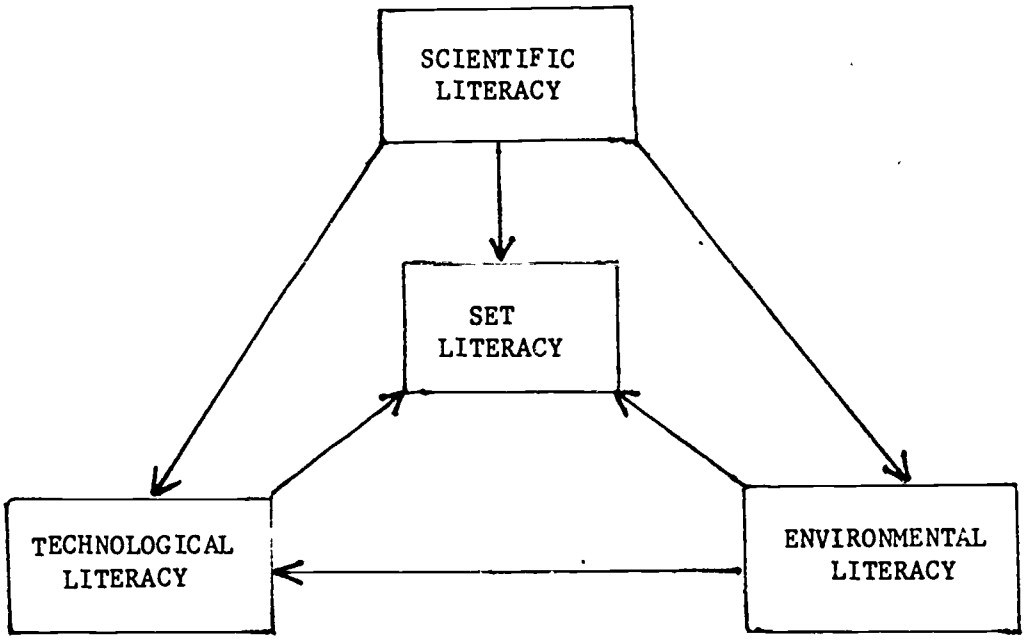


FIGURE 1. SET Literacy Model (Arrows Read: "Contributes to")

Scientific literacy is at the top and has no incoming arrows because it represents science as a relatively pure and well-founded source of knowledge. Also, scientific literacy remains as an essential requisite for environmental and technological literacy. This should be the major concern among elementary and junior high school teachers. They should emphasize those scientific concepts and explanations that are particularly relevant to environmental and technological issues, keeping in mind the ultimate objective of SET literacy.

Environmental literacy, albeit somewhat dependent on scientific literacy, has some "pure" origins in the environmental movement. As a result, many environmentally-oriented curriculum materials have appeared, signalling an important additional dimension to our "situation." These concerns should be presented to students as soon as they are able to appreciate the scope and power of science. Again, these concerns must be related to the larger picture of human activity and balanced by acknowledging the necessity of and our dependence on science as a source of new knowledge. Junior high and high school teachers in particular can play an important role in the development of the values and attitudes related to these perspectives.

Technological literacy, per se, does not have much of a basis in education, except as it may be gained indirectly by synthesizing objectives from other sources. As has been suggested, SET literacy may represent a more realistic approach. Technological literacy cannot really stand on its own (indicated by two incoming arrows in Figure 1), and because of its dependency on scientific and environmental perspectives does not represent a realistic goal in itself. SET literacy can provide a framework for organizing and accommodating the tremendous quantities of information available today. An ideal setting for promoting SET literacy would be the last semester of high school where all students are required to take a course, team taught by science and social studies teachers, on the role of technology in society.

Attitudes toward technology are in transition at the present time. The role of technology in society is destined to remain one of the most critical and important issues related to our survival. Indeed, the decisions we make regarding the use of technology will determine our survival. If educators start now to help people understand the role of technology, promote awareness of our dependency on both the natural system and the man-made system, and increase our ability to process and organize information, then perhaps educational obsolescence will become obsolete.

REFERENCES

Bella, D. A. 1979. Technological Constraints on Technological Optimism. Technological Forecasting and Social Change, 14, 15-26.

Caldwell, L. K. 1980. Environmental Activism, Phase III: The Burdens of Responsibility. In Current Issues VI: The Yearbook of Environmental Education and Environmental Studies. Selected Papers from the Ninth Annual Conference of the National Association for Environmental Education (Albuquerque). Arthur B. Sacks, Lei Lane Burrus-Bammel, Craig B. Davis, and Louis A. Iozzi, editors.

Caldwell, L. K. 1975. Managing the Transition to Post-Modern Society. Public Administration Review, 35:6, 567-572.

Drengson, A. R. 1980. Shifting Paradigms: From the Technocratic to the Person Planetary. Environmental Ethics, (John Muir Institute), 2:3, 221-240.

Etzioni, A. and C. Nunn. 1974. The Public Appreciation of Science in Contemporary America. Daedalus, 103, 191-205.

Glass, B. 1970. The Timely and the Timeless. The Interrelationship of Science, Education, and Society. New York, Basic Books.

Goldman, R. D., B. B. Platt, and R. B. Kaplan. 1972. Dimensions of Attitudes Toward Technology. Journal of Applied Psychology, 57:2, 184-187.

Harms, N. C., and R. E. Yager (eds.). 1981. What Research Says to the Science Teacher, Vol. 3. Washington: National Science Teachers Association.

Hirschhorn, J. S. 1974. Engineering and Nonengineering Student Attitudes Toward Technology. Science Education, 58:1, 29-33.

Rowe, M. B. 1980. The Role of Undergraduate Colleges in Developing Attentiveness to Science and Technology. Journal of College Science Teaching, 10:1, 53-54.

Sizer, I. W. 1980. Science, Technology, and the Quality of Life: A Challenge to Education. BSCS Journal, 3:2, 21-24.

Taviss, I. 1972. A Survey of Popular Attitudes Toward Technology. Technology and Culture, 13:4, 606-621.

Toffler, A. 1980. The Third Wave. New York, William Morrow and Company, Inc.

Zollar, U. and F. G. Watson. 1974. Technology Education for Nonscience Students in the Secondary School. Science Education, 58:1, 105-116.

A Survey and Analysis of Successful Community Solar Programs

John McKirchy[1] and John H. Baldwin[2]

Introduction

Throughout the United States, communities are initiating energy conservation and renewable energy programs because of high energy prices, threatened curtailments of supplies, and increasing socioeconomic and environmental impacts from the production and consumption of energy. Local governments are becoming actively involved in energy management because many of the tools for the regulation and management of energy, such as land use and transportation controls, building codes, and facility siting regulations, are under the jurisdiction of local governments. Further, local governments and citizen groups are best able to identify and define local problems, evaluate the availability of indigenous resources, and estimate the capabilities of a community to formulate and initiate a successful solar energy program.

This study provides a survey and analysis of five successful community solar programs: Davis, California; San Bernardino, California; San Luis Valley, Colorado; Schuchuli, Arizona; and Soldiers Grove, Wisconsin. The case studies indicate the practicability of solar energy programs in a variety of social and physical environments. The analysis summarizes program elements that have helped to make them successful.

Case Studies

A. San Bernardino, California

The San Bernardino Westside Community Development Corporation (CDC) was formed in 1972 to rehabilitate and revitalize a deteriorating intercity minority neighborhood. In 1976, under the leadership of its director, Valarie Pope Ludlam, the CDC began using solar energy programs to provide low cost energy for the poor, housing rehabilitation and weatherization for the elderly, and occupational training for low income and minority teenagers. In its first solar project, the CDC built a centralized solar heating system that provides all the hot water and 80 percent of the space heating for ten homes. Funding for the project was provided by the Veterans Administration (U.S. Department of Energy, 1980). Funding for additional programs was obtained from the State of California and the Department of Health, Education, and Welfare.

To assist in the manufacture of solar collectors, the CDC developed its own sheet metal and machine shops (San Bernardino Westside CDC, 1978). The

[1]Law Department, City of Buffalo, NY 14202.
[2]Department of Urban and Regional Planning, University of Oregon, Eugene, OR 97403.

CDC now has the capability to build or manufacture solar greenhouses, passive systems, and a variety of active systems.

The CDC is currently developing a 13 acre, three building Energy Technology Center. The 18,000-square-foot center will include a light manufacturing facility, powered in part by a solar photovoltaic system, which will be used for the manufacture of solar hardware and energy-related products. A second facility will use solar generated steam for curing concrete blocks and space heating. The Center will also have an administration building to house the CDC staff and to serve as a center for product assembly, research, and training programs (San Bernardino Westside CDC, 1979). Program trainees have been very successful in obtaining employment both in the technical trades and in the solar energy industry (U.S. Department of Energy, 1980).

The San Bernardino Westside CDC has been highly successful in attacking many of the problems of an intercity neighborhood through the development of solar energy systems. The CDC is providing vocational training for inner city minority teenagers and energy, rehabilitation and weatherization of the homes of poor and elderly residents. The San Bernadino Westside CDC hopes to capture even greater benefits as the solar energy industry comes of age.

B. San Luis Valley, Colorado

In 1977, the Rocky Mountain Center on Environment (ROMCOE) received a grant for the design and direction of a project to enable a community to create its own renewable energy program (ROMCOE, 1978). San Luis, a rural, low income, predominantly Hispanic community in South Central Colorado was selected for this program.

Maria and Arnie Valdez developed and coordinated the "Future Power" Program to provide educational and technical assistance to the community. Three workshops on solar energy and energy conservation were presented, resulting in the construction of a variety of active solar systems for use in the community (Senauke and Oler, 1980).

The Future Power program spawned a host of community organizations active in local solar energy development, including the San Luis Valley Solar Energy Association and the People's Alternative Energy Services. These organizations sponsor regular meetings, organize community support for solar energy development, publish brochures and guides to solar energy utilization, and host public educational programs on solar energy and energy conservation. These groups also provide technical assistance to individuals seeking to use solar energy in residential, commercial, and agricultural applications. Because of these activities, the use of solar energy is now commonplace in the San Luis Valley, and is likely to become a major part of this region's energy future (ROMCOE, 1978).

C. Davis, California

In an effort to encourage the substitution of solar energy for conventional fuels, the City of Davis adopted an innovative building code which serves

as a cornerstone of the Davis Solar Program. The Davis building code was designed to promote the use of passive solar building designs in an effort to reduce space heating requirements and overall energy use. The code limits the amount of glass area in new buildings, and allows additional windows only if they are south-facing and designed to capture solar heat during the winter months. It also requires attic, wall, and floor insulation and light exterior colors to reflect heat in the summer months (City of Davis, 1974). The code was developed through the joint efforts of leaders in the city government and students and staff of the University of California-Davis.

The City of Davis also passed an energy-conserving subdivision ordinance and a solar access ordinance (Bainbridge, 1976; 1978). To improve energy efficiency in new development, the City of Davis increased the allowable housing density from three to seven and one-half homes per acre. Local neighborhood shopping centers were encouraged to reduce the distance between residences and commercial services. Narrower highways, smaller parking lots, and shading by deciduous trees were all encouraged to reduce summer heating from hot pavement. To reduce transportation energy consumption, bicycle transportation was promoted through the development of an extensive system of bicycle paths. Today, the ratio of bicycles to cars in Davis is over 3 to 1. (See Figure 1 for the layout of a Davis solar subdivision).

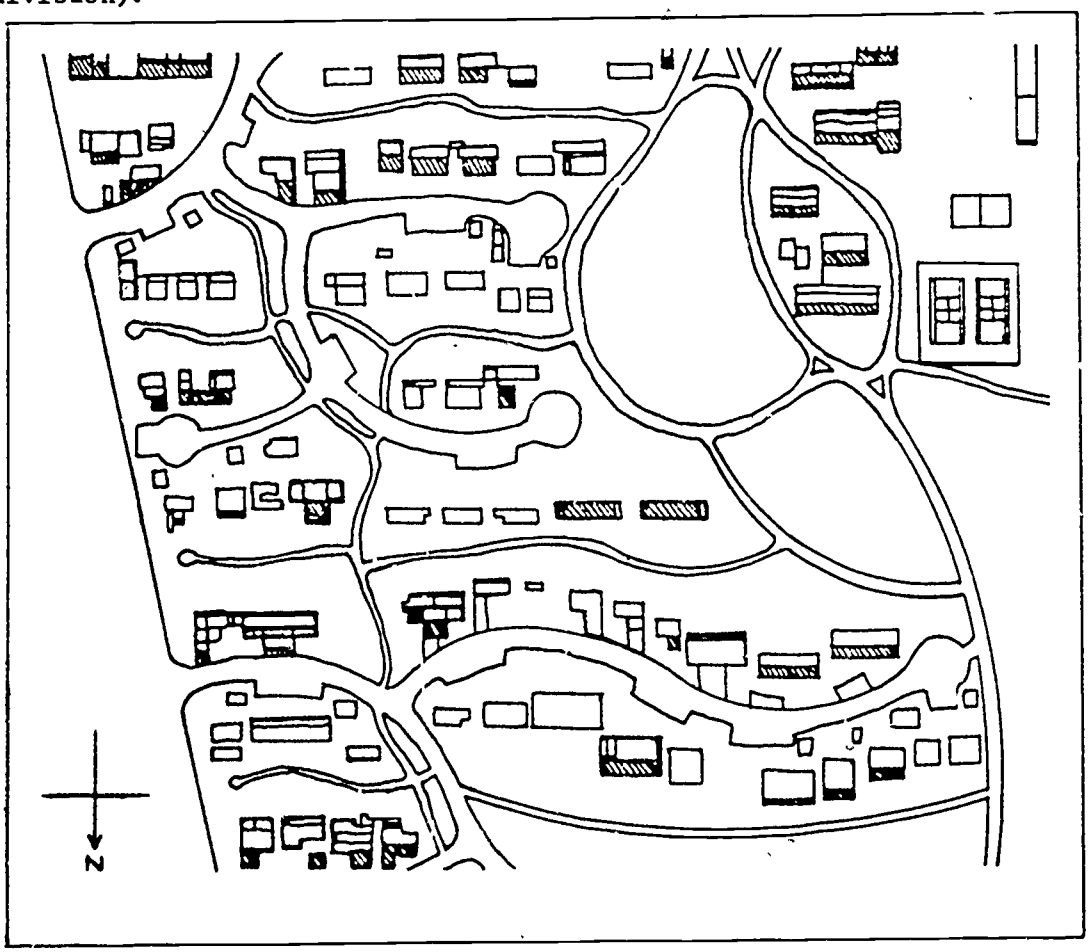


FIGURE 1. Layout of a solar subdivision in Davis, California. Note the E/W street orientation, narrow streets, parking bays, bike paths and relatively high density of homes (Brewer and Mackie, 1980).

The City of Davis has also initiated housing priority and low income solar housing programs. Under the housing priority program, the City of Davis reviews new housing proposals according to local housing goals and energy design criteria (which include solar energy utilization). The low income solar housing program, supported by a grant from the U.S. Department of Housing and Urban Development, provides housing to the poor with substantially reduced heating and cooling requirements (The Elements, 1977).

The technical breakthroughs and regulatory aspects of the Davis program have great significance for all community solar programs. The Davis program, however, also demonstrates the importance of strong community support and educational efforts for solar energy development. A comparative study of the Village House Subdivision in Davis with another solar subdivision in Helmet, California found that the Davis approach of community organizing, motivating, and educating was more successful in reducing energy consumption and providing solar energy than the more "technical-fix" approach of Helmet (Hamrin, 1979).

D. Soldiers Grove, Wisconsin

Soldiers Grove is a small village in southwest Wisconsin that is building the first solar-heated central business district in the United States. The old central business district of the community is in the floodplain of the Kickapoo River. Flooding caused extensive damage to the commercial district several times in the last century. To remedy the problem, the Army Corps of Engineers proposed a $3.5 million levee system to protect the district (worth approximately $1 million). Rather than build the levee system, the Village Board decided to relocate the business district to a site approximately one-half mile from the old district. Financial and technical assistance for the relocation were provided by the University of Wisconsin, the University of Wisconsin Extension, the Argonne National Laboratory and the U.S. Department of Energy and Housing and Urban Development (Becker, N.D.).

The high cost of energy was also creating difficulty to local merchants and homeowners. In March 1979, a task force from the Wisconsin Division of State Energy and the Argonne National Laboratories recommended that the new central district be developed with maximum thermal efficiency, passive solar heating and the construction of a central wood waste fired heating plant. With the help of a $900,000 HUD grant, construction began in May, 1979. Eventually, over thirty commercial structures and twelve homes will be relocated and built so that at least 75 percent of the space and water heating energy will be supplied by the sun (Becker, 1979; N.D.).

In order to fully utilize solar and wood energy, the entire downtown site was declared a "planned development district." The master development plan specified building location, height and thermal performance, as well as the location of plantings, landscaping, and other details. The buildings will be concentrated on the northern end of the relocation site to avoid shadows cast by nearby hills. Areas shaded during the critical winter months will be used for parking spaces. Buildings will be constructed in two east-west rows, with the shorter building located in the southern row to minimize the shadowing of the northern row (Becker, 1979).

Soldiers Grove has a bright energy future because of its innovative renewable energy program. The program is even more remarkable in the light that over 70 percent of the population of the community are low income or elderly persons. If a conservative, low-income village in Wisconsin can develop a sound innovative solar energy program, it can be done anywhere.

E. Schuchuli, Arizona

Schuchuli is a small, remote village in the Papago Indian Reservation in southwestern Arizona. Schuchuli was without electricity until the U.S. Department of Energy and NASA designed and installed the first community photovoltaic system in the United States. The 3.5 KW photovoltaic system was designed to provide electricity to replace a failing diesel water pump. The system includes sufficient battery storage to allow it to run for ten days without recharging. Electricity, in excess of pumping requirements, from the system powers fifteen 4.7 cubic foot refrigerator/freezers, a wringer washing machine, and a sewing machine, all located in a central general services building. In addition, the system provides electricity for two 20 watt fluorescent lights in each of the twenty-two village homes (Senauke and Oler, 1980).

The system was designed so that its cost (in 1978 dollars) was competitive with the costs of building a 17-mile electric line to the village (Bahr, 1979). However, the system has the economic advantage of fixed electrical generating costs. As the cost of conventionally generated electricity escalates, the relative economics of the photovoltaic system will continually improve.

The technical feasibility and economic viability of the project have been proven. However, some of the villagers are disenchanted with the system. The villagers were/are not actively involved in the overall planning, design, construction, maintenance, and repair of the system. In the planning process, they were only involved in prioritizing the community uses of electricity above and beyond the requirements for pumping water. Many view the low level of service provided by the system as a sacrifice (relative to the 17-mile electric line) and the system as a "foreign technology." In future projects, greater community participation in design and implementation could substantially reduce these problems (Senauke and Oler, 1980).

Analysis

Because of variation in community energy goals and requirements and local renewable energy resources, attempts to identify a single "model" strategy for developing a community solar program would be fruitless. However, there are several important characteristics shared by these programs that provide some insights into the development and implementation of a successful community solar program.

The most apparent and perhaps important attribute of these programs is that they were designed, implemented, and controlled from within the community. With the exception of Schuchuli, Arizona, all of the programs were

community-initiated and controlled. This decentralized, localized decision-making is critical for renewable energy programs, where the emphasis is on solving local problems with local energy resources. The solutions often require sacrifices or lifestyle changes. The motivation to overcome these barriers is strongest when generated from within.

The importance of local control and participation is illustrated in two of the case studies. The Schuchuli villagers were only peripherally involved in the photovoltaic system design and siting and are incapable of maintaining and repairing the system themselves. Thus, many of the villagers perceive the technology as experimental, foreign, and inadequate in providing for their energy needs. In contrast, the West San Bernardino program was initiated and controlled by a local community development corporation. Because the program was generated from within the community, public trust and acceptance of the use of an innovative new program for community development was more easily established.

The role of government in most of these programs was to provide funding and technical assistance to the communities to facilitate their programs. All of the successful programs studied placed strong emphasis on community educational programs. Educational programs provided the technical skills necessary to build solar passive and active systems as well as to provide citizens with the confidence and motivation necessary for a successful program. In the majority of the programs leadership was inspired, competent, and experienced in community organizing.

The solar programs varied considerably according to the needs and problems of each community. In developing or redeveloping communities such as Davis, California, or Soldiers Grove, Wisconsin, programs tend to employ both passive and active systems with emphasis on municipal regulation of new development. Low income programs such as San Luis Valley or San Bernardino place a greater emphasis on marshalling limited financial and human resources for solar development. These programs tend to emphasize retrofitting of existing structures and the use of solar flat plate collector systems. Government involvement in these programs was most often in a public-private sector partnership to use solar programs to generate energy, employment, and assist in community development.

It is important to note that these successful programs occurred in small communities or isolated neighborhoods within larger metropolitan areas. Smaller communities or isolated neighborhoods tend to consist of a more homogeneous group of people that more easily perceive and are motivated to collectively attain a common goal. Smaller communities also have the advantages of personal relationship between citizens and city officials for a more effective translation of goals and aspirations. Finally, many of the barriers to solar energy development are more quickly and easily overcome in small communities because of their relatively simple, comprehensible legal and administrative procedures.

Summary

Several important lessons can be learned from this study about the design and implementation of community solar energy programs. Community energy

programs should be designed and implemented from within the community with the people most likely affected involved in the decision-making. State and federal assistance should be sought for technical and financial support. The responsibility for planning, coordinating, and implementing the program should be given to a dedicated individual or group of individuals with experience in community organizing. The needs of the community as well as the capabilities of various solar systems to meet those needs should be fully explored. These studies should encompass community energy, environmental, employment and economic development goals.

Technical applicability and community acceptance are both important for the utilization of a new energy system. The Schuchuli program was successful in its intent to demonstrate the technical and economic feasibility of the photovoltaic system. It failed, however, to win widespread community support. By paying closer attention to community needs and processes, the multiple goals of technical and economic feasibility and community acceptance can be accomplished, accelerating the rate of system utilization.

Finally, it is important to note that these case studies represent successful programs in hot and cold, poor and wealthy, minority and "majority," and in urban and rural environments. Solar energy programs are providing energy, vocational training, employment, neighborhood rehabilitation and community development. We need no longer speculate and theorize about the benefits of solar energy. These benefits are real and tangible and are being realized all over the country today.

REFERENCES

Bahr, Donald M. 1979. Second and Third (Combined) Quarterly Report on the Social and Economic Impact of the Schuchuli Photovoltaic Project. Unpublished Preliminary Report for the U.S. Department of Energy.

Bainbridge, David. 1976. Designing Energy Efficient Neighborhoods. University of California Extension, Davis, California.

Bainbridge, David. 1978. Planning for Solar Access, A Primer. Solar Office, California Energy Commission, Sacramento, California.

Becker, William S. 1979. Renewable Energy Systems Planning in Soldiers Grove. Solar Energy Research Institute, Golden, Colorado.

Becker, William S. No date. The Making of a Solar Village. Wisconsin Energy Extension Service, Madison, Wisconsin.

Brewer, Deborrah and Marsha Mackie. 1980. Implementing Energy Efficient Land Use. Oregon Department of Energy.

City of Davis. 1974. A Strategy for Energy Conservation, Proposed Energy Conservation and Solar Utilization Ordinance for the City of Davis. Davis, California.

Hamrin, Jan. April, 1979. "Energy Saving Homes: Don't Bet on Technology Alone." Psychology Today.

Rocky Mountain Center on Environment (ROMCOE). 1978. San Luis Future Power. A Program to Enable a Community to Create Its Own Energy Future. Rocky Mountain Center On Environment, Denver, Colorado.

San Bernardino Westside Community Development Corporation. 1978. Program Description.

San Bernardino Westside Community Development Corporation. 1979. Program Description.

Senauke, Scott, and John Oler. 1980. Community Solar Applications: Issues and Implications for Planners. Comprehensive Masters of Arts Thesis, School of Architecture and Urban Planning, University of California, Los Angeles.

The Elements. 1977. The Davis Experiment. Public Resource Center, Washington, D.C.

U.S. Department of Energy. February/March 1980. "Communities and Energy." The Energy Consumer.

The Secret Sea Turtles of Lara Bay: An EE Dilemma

Theresa McNaney and Craig B. Davis[1]

In 1979, the Iowa State University environmental studies program initiated a foreign internship program on the island of Cyprus in the northeastern corner of the Mediterranean Sea. The purpose of this program was to provide students with professional experience in various aspects of environmental problem solving and with experience working in a culture very different from their own. Cyprus was selected as a site for this program because it is a developing country, because it is an island and is therefore easy to study from an ecological systems perspective, and because it is a beautiful place to spend the summer.

Since 1979, 25 students have served internships in the program. Internships last for eight weeks, are not salaried, and carry eight semester-hour credits. Interns have been placed with eight Ministries and one private company. Four of these interns have worked with the Department of Fisheries and have been assigned to Lara Bay on the west coast of Cyprus where they studied the egg-laying habits and incubation ecology of green and loggerhead sea turtles.

The purpose of the Sea Turtle Project is to find a way to preserve these large turtles which return to the sandy beaches along the west coast of Cyprus each summer. Female turtles come ashore to lay their eggs several times during the summer, always at night. Once a female turtle finds a suitable spot, she excavates a large hole in the sand with her front flippers, tossing sand several feet with each swipe, and gradually sinking into the beach. When she gets the hole deep enough, she digs an egg chamber with her hind flippers, lays 40 to 120 eggs, recovers the nest, and returns to the sea. Young turtles hatch in about 50 to 60 days, climb from their sandy nest, and make their way across the beach to the sea.

The trip across the beach seems to imprint the site on the turtles' navigational apparatus, allowing them to return to the same beach years later to repeat the egg-laying process. But this short trip from nest to sea is a dangerous one. Young turtles are tasty morsels for various predators, i.e. foxes, sea gulls, and ghost crabs. Few make it to the sea. Foxes may even excavate nests to feed on turtle eggs.

Much of the routine work at the Lara Bay hatchery involves protecting the turtle eggs and young turtles from predators and studying the ecology of turtle incubation. The evening is the busiest time of day. At about 10 p.m., the hatchery staff begins walking the beaches looking for turtle tracks, which resemble large tire tracks. When laying turtles are found, they are measured and tagged and the nest site is flagged. The next

---

[1]Environmental Studies, Iowa State University, 141 Bessey Hall, Ames, IA 50011.

morning the nest is excavated and the eggs are carefully moved to the hatchery and reburied in nursery nests. These nests are surrounded by chicken wire to keep foxes out and are fitted with thermocouple probes for measuring nest temperature. Eggs are counted and measured before they are reburied. When the turtles hatch, they are protected during their trip across the beach to the sea.

The Lara Bay sea turtle project has been successful so far. Eggs can be protected and young turtles can be escorted to the sea. These ecological problems are the easy ones. A more difficult problem is the "human problem." Sea turtle populations all over the world are being destroyed for the few pounds of yellow, gelatinous calipee that each turtle contains. Calipee is used to make turtle soup, a delicacy for the affluent. Thus far, Cypriots have not become involved in this exploitation of the sea turtle.

One reason for this lack of exploitation may be that few Cypriots know about the turtles. The beaches of western Cyprus are isolated and are visited infrequently. Most Cypriots have never heard of Lara Bay. The Department of Fisheries would like to introduce the turtles and the turtle project to the Cypriot people and steps in that direction have been taken; in 1980 a TV documentary was filmed at Lara Bay. Officials in the Department of Fisheries hope that an environmental education effort focused on this unique resource could increase national pride and stimulate Cypriots to protect the turtles. On the other hand, such education would increase the visibility of the resource and could tempt potential exploiters. Cypriots are not known for having protectionist attitudes toward wildlife. Human pressure on wildlife resources is great on the island. Cypriot laws protect many species, but few of these laws are adhered to or enforced. Letting the secret of the sea turtles of Lara Bay out of the bag could lead to the demise of Cypriot sea turtle populations. It is a classic Catch-22 situation.

Developmental Variables Affecting Environmental Sensitivity in Professional Environmental Educators: A Research Abstract

Nancy J. Peterson[1] and Harold R. Hungerford[2]

The major purpose of this study was to investigate and attempt to isolate those variables which are perceived by professional environmental educators as being of prime importance in developing their own environmental sensitivity (ES). The study was initiated in 1979 and subsequently involved interviewing twenty-two (22) North American environmental educators. The personal interview format was chosen after two pilot studies utilizing a questionnaire format failed to provide sufficient informtion to complete the study. Each interview lasted approximately one hour.

Both primary and ancillary sensitivity data were obtained during the interview session. These data were used along with demographic information in order to construct a generalizable sensitivity profile for environmental educators. It was hoped that this sensitivity profile, in turn, could be used to identify discrete predictor variables for the early development of environmental sensitivity.

A number of predictor variables were identified for environmental sensitivity development in environmental educators. Whether these predictors are generalizable beyond this population is questionable. However, the investigators believe that they would be similar for any group including members with equally empathetic perspectives. The variables identified are synthesized and diagrammed in Figure I and are as follows:

(1) Major factors and/or experiences leading to ES were of a continuous nature or long-term and are neither episodic nor sporadic.

(2) Activities such as exploring/playing in the out-of-doors as a child, hunting and fishing, and involvement in youth organizations or group camping were important for ES development.

(3) Although participants were not raised in any one particular environment (i.e., rural, surburban, or urban), frequent visits to nearby natural areas or open spaces were critical for ES development.

(4) Role models, both non-familial (which comprise 64 percent of all role models given) and familial (comprising the remaining 34 percent) were instrumental in developing ES.

(5) Familial sensitivity was viewed as an important contributing ES variable in six (6) out of every ten (10) participants.

---

[1]Graduate student.
[2]Professor, Science/Environmental Education, Department of Curriculum, Instruction and Media, Southern Illinois University, Carbondale, IL 62901.

MAJOR SENSITIVITY VARIABLES

(FOR PROFESSIONAL ENVIRONMENTAL EDUCATORS)

A Synthesis

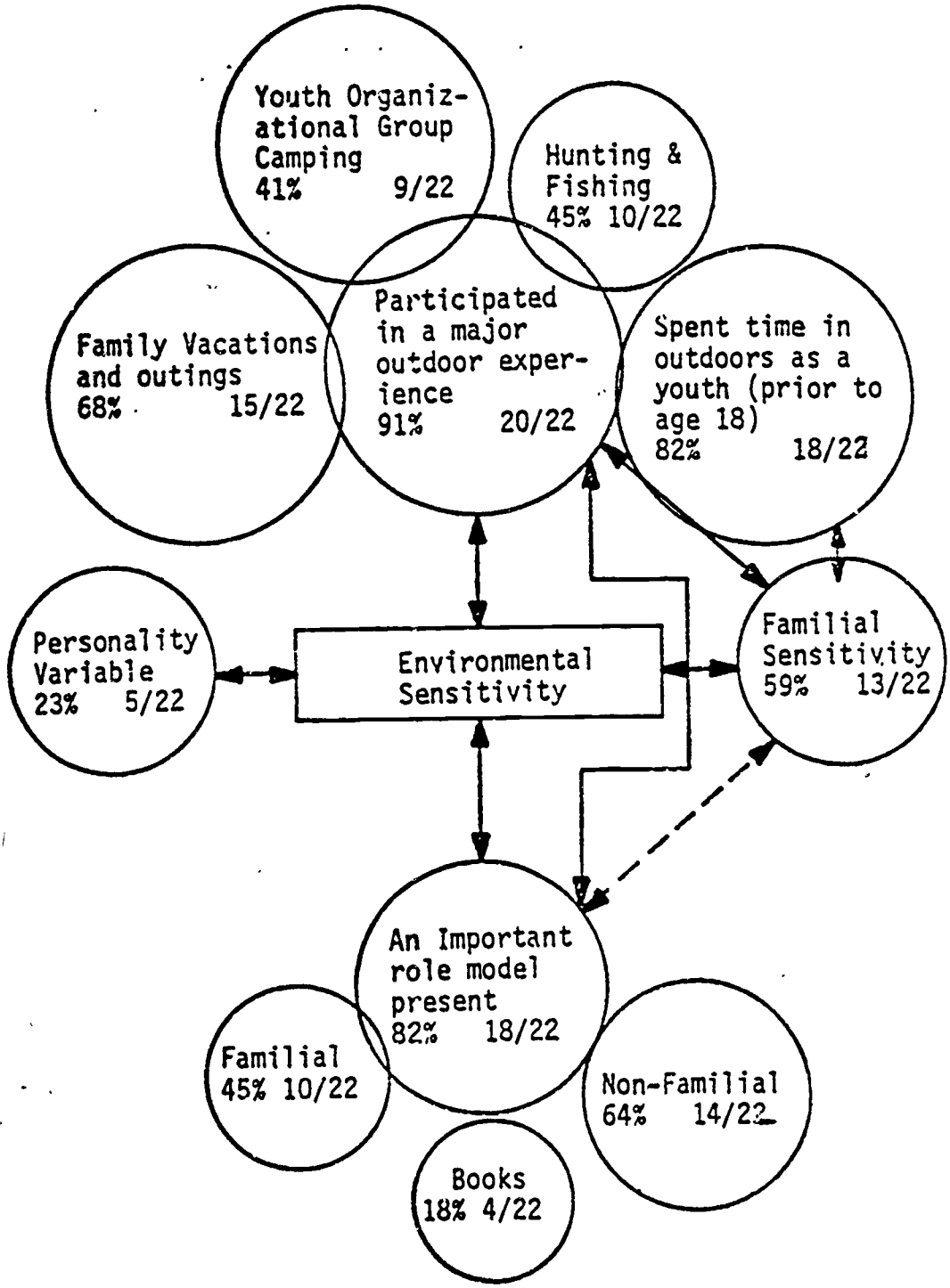


Figure I

(6) In almost all instances, contributing ES variables were positive ones and occurred during the first eighteen (18) years of life. The mean (average) age at which participants felt they had acquired ES was 12.25 years.[3]

Typically, environmental educators make certain assumptions concerning experiences which are useful in developing long-lasting and significant environmental sensitivity. This study seems to hold promise for clarifying the veracity of some of these assumptions. Therefore, the writers offer a number of inferences based on the data collected in this study which appear to have educational significance.

(1) Environmental education (EE) programs may be more effective if they are conducted on a continuous basis. Involvement in short-term EE programs or field experiences appears to have limited impact on ES development. Other types of follow-up activities, either recreational or educational, seem to be important for ES development.

(2) To gain the greatest degree of sensitivity, the EE program should start teaching participants at a young age. The pre-school and elementary years appear to be important stages in which environmental attitudes are formed. Programming should continue through the adult years.

(3) Frequent contact with natural areas of open spaces seem to be necessary for ES development. Interaction with natural areas often results in greater understanding of nature and an emotional bond with those specific areas.

(4) Role models appear to be equally important as outdoor experiences in developing ES. Therefore, the EE program should not only concentrate on outdoor experiences but should also provide exposure to environmentally concerned and active individuals. Teachers constituted the greatest percentage of role models named, stimulating interest in environmental systems and providing educational and professional guidance. Oftentimes, the teacher(s) developed a close friendship with the participant. The frequent citation of teachers by respondents seems encouraging. Hopefully, as more teachers become involved in EE and act as role models one will see an increase in individuals sensitive to the environment.

(5) The loss of a natural area, experienced in personal terms, usually through residential or commercial development, had a profound affect on one-fourth of the individuals interviewed. Degradation of areas which participants frequently visited produced a feeling of great loss. This may have some importance to the EE practitioner. Focusing the EE program on local issues or problems rather than focusing on issues outside the community may exert a more powerful influence on ES development.

---

[3]These findings are similar to those reported by R. Thomas Tanner in his study, "Significant Life Experiences: A New Research Area in EE", The Journal of Environmental Education. Vol. 11, No. 4, 1980.

Navajos and Energy

Thomas Tanner[1]

Recently, a certain amount of attention has been attracted to the problems of energy development on Navajo lands. This article briefly outlines those issues and presents a selection of materials which provides background for developing a case study of them. It is hoped that the materials noted here will be used in just this way. The materials are not only non-technical in nature, but examination of them quickly reveals that the problems are as profoundly political, ethical, cultural, and historical as they are simply technical; it is these dimensions which are emphasized in the recommended materials.

Among the problems are the following: Navajos who worked in the uranium mines in the 1950's and 1960's allegedly display(ed) an alarmingly high incidence of terminal lung cancer, and the tailings from the mines are purportedly still very dangerous to the communities near them. Coal deposits on tribal lands were leased years ago at a fixed price when the Navajo had little political power, so today they are still being paid only pennies per ton for their coal. The surface mining disturbs significant areas of land, although the coal companies seem to be making an effort at restoration. The large new coal-burning power plants in the area provide electricity for other regions but air pollution for the immediate vicinity (although the newer plants are cleaner than those built several years ago). They require significant amounts of water in a region where the supply of water can truly be described as precarious.

All of this is just part of the culture crisis which the Navajo experience in the clash between traditional values and modern realities. They are the largest and perhaps the most independent and traditional Native American group. Their tribal land totals 25,000 square miles, the same size as the state of West Virginia. According to various sources, the indigenous population there has increased from 9,500 in 1865 to about 150,000 today, a 25- to 30-year doubling period typical of traditional peoples with modern medicine the world over. The venerable sheep-herding economy has reportely diminished the quality of land to a serious degree, given this population growth. (The reclaimed coal land which this writer has seen certainly looked better than much of the grazed range, although only time will tell the completeness and success of the reclamation effort.)

Following is a short list of selected resources which deal with these related problems. The Reader's Guide to Periodical Literature could be used to update and expand the list.

---

[1]Associate Professor, Environmental Studies and Secondary Education, Iowa State University, 141 Bessey Hall, Ames, IA 50011.

PRINT

"Battle for Big Mountain," GEO, March, 1980, pp. 8-30. GEO is published at 450 Park Avenue, New York, NY 10022. $4/copy, $36/year.

Special section on Native Americans and energy, SURVIVAL RIGHTS, #7, 29-35. For back issues, write to ECOLOGY DIGEST (the name has changed), Box 60961, Sacramento, CA 95860. $1.25/copy for back issues, $5.25/year current subscription.

"Progress Comes to Black Mesa," NATIONAL PARKS & CONSERVATION MAGAZINE, September 1971, 4-9. 1701 18th Street, Washington, DC 20009. $15/year.

Desert Solitaire, by Edward Abbey. I promote this wonderful book whenever/wherever it is relevant, which is often. The chapter "Cowboys and Indians, Part II" is the one especially applicable here. But don't miss the rest of the book, either. Paperback, $2.50, Ballantine Books, a division of Random House, 201 East 50th Street, New York, NY 10022. Copyright 1968, but still going strong -- sixth printing in 1978.

NON-PRINT

People and Energy in the Southwest. The people in the title are the Navajo and Chicano. 27 minutes; 130 color slides and cassette; produced 1979. $125 to individuals and citizen groups, $200 to institutions; rental, $30 postpaid. New Mexico People and Energy, 810 Vassar NE, Albuquerque, NM 87106. Also ask for price list of their printed reports, including profiles of energy corporations dealing with the Navajo nation (a study commissioned by the nation).

Navajo: The Last Red Indians. An excellent British background film on Navajo culture and modern threats to it. Not seriously dated despite 1972 release. 35 minutes, color. 16 mm, $500; video, $215. Time-Life Films, Time & Life Building, New York, NY 10020.

The Uranium Factor. Health hazards of uranium in Navajoland. Investigative report, expose' style, produced 1980. Transcript free of charge from ABC News, Close-Ups, 7 West 66th Street, New York, NY 10023. 60 minutes, color; video, $550 from ABC Wide World of Learning, 1330 Avenue of the Americas, New York, NY 10019, attention Celeste Chin. May be available in 16 mm at a later date.

GROUPS

National Indian Youth Council, Inc., 201 Hermosa NE, Albuquerque, NM 87108. Since this is a contribution-supported group, students should probably tender a contribution if making extensive requests for literature or information.

AND FINALLY

Some fine periodicals to keep ahead of developing environmental issues. Good for student research. Should be in every high school materials center; a bargain.

ENVIRONMENTAL ACTION, 11 issues/year, $15. 1346 Connecticut Avenue NW, Suite 731, Washington, DC 20036.

NOT MAN APART, 12/year, $15. Friends of the Earth, 124 Spear Street, San Francisco, CA 94105.

SUN TIMES, 12/year, $15. Solar Lobby, 1001 Connecticut Avenue NW, Suite 510, Washington, DC 20035.

The Energy Impact of Food Choices

Jane L. Taylor, Margaret E. Cowan, Dave M. Deutsch, Barbara Gugerli-Dolder, Christian L. Hanna, Lori D. Mann, Karen A. Rutledge, Deborah S. Yandala, Paul T. Zeph, Karen S. Zimbelman[1]

Introduction

In the coming decade it will become increasingly clear that we live and operate in a global system. Geographically, modern communications and transportation have brought about a greater closeness and interchange among nations. Economically, it is evident that we share a global economy. Political and social issues have worldwide effects that transcend national and cultural boundaries. Ecologically, we are becoming more aware that problems such as species extinction, pollution, resource depletion, and the threat of nuclear war are everyone's problems. Now, more than ever, people need to have a comprehensive understanding of the world and realize that personal decisions that we make on a local, national, and international level have the potential to affect the future of everyone on the earth. A major role of environmental education should be to help people develop a global perspective on the environment.

In developing global environmental education programs, it is important for environmental educators to become aware of existing constraints. Traditionally, our society has tended to focus on its own nation and culture. Our foreign policy, based on our own national interests, give us a limited perspective on other countries. After an intensive review of current literature and speaking with other educators, we found that there is very little interest and knowledge about other peoples and countries. Language is a major barrier to communication. As a society, we lack the appropriate materials for global environmental education; further, teachers do not have adequate training in world environmental issues. Nations have different ideologies and values, and the emphasis on nationalism makes it difficult for us to eliminate communication barriers, and to share experiences. There is a prevalent attitude of individualism that leads to a lack of efficacy, or a feeling that individual actions cannot affect the global environment. As environmental educators, we need to build in ourselves and others the knowledge, awareness, skills, concern, and motivation to act with the understanding that our everyday personal actions do affect the entire world.

Environmental education, due to its interdisciplinary approach and emphasis on the cognitive, affective, and skill domains, has the potential to foster a global perspective through the use of reinforcing learning environments. Acting locally and thinking internationally is an effective strategy for developing a global consciousness that can be utilized in the learner's own community. For example, a community's use of lawn fertilizers has an

[1]The University of Michigan, School of Natural Resources, Ann Arbor, MI 48109.

effect on the availability of fertilizers for world food production. The release of acid effluents in one country may have a serious impact in the form of acid rain in another country. Working on real community problems and facing the resulting issues that are raised is particularly effective with young learners or those whose experiences are confined to limited areas. Dealing with local issues allows learners to become involved with tangible community concerns and this can help them broaden their perspective while retaining a sense of efficacy.

The following activity is designed to focus on a local issue which frequently has international implications. It is hoped that activities such as this can bring about global perspectives and help overcome some of the barriers to achieving a world view. Although there are many topics that can be explored, this activity centers around food and the environment, and can provide a focal point from which to begin examining a complex problem. Food is a universal concern. The food choices that we make (individually) have many far-reaching implications. In this activity, we deal with the issue of energy as it is involved in our food decisions and more specifically, as it relates to transportation, processing and packaging, and the food chain. These aspects are analyzed in terms of the amount and the efficiency of energy used.

An important part of the activity is the way it is structured. The learners are immediately involved in a simulated shopping experience that lets them make a decision on foods for a meal. From here, in small groups, the data are collected, integrated, and examined in a broader context. This effectively involves the learners and their decisions in a non-threatening manner. Ideas are then generated by the group on some of the global implications of the food choices, and information dealing with the specific energy concerns is elicited and discussed.

There is a stress on the progression from individual personal decisions to the direct and indirect consequences of the decisions on local, national, and global levels. By focusing on one aspect (energy) of the issue (food), the participants can begin to link local actions to international concerns. The ability to establish these linkages is an integral part of the activity, as it is a transferable method that learners can use to examine other local issues from a global perspective. This activity can be used as it is presented or modified to reach learners in formal and non-formal settings. The activity is designed for youth and adults.

ACTIVITY: <u>THE ENERGY IMPACT OF FOOD CHOICES</u>

A. Concept to be developed: Local decisions frequently have international implications.

B. Understanding to be developed: Choices made in a local grocery store usually have an energy impact.

C. Time: 45-75 minutes.

D. Materials: Magazines, glue, scissors, cardboard.

E. Procedure:

1. Preparation for activity.

a. Gather magazines containing pictures of common food items. Cut out pictures of each of the 38 food items listed in "Grocery Store Items" below. Cut out 38 pieces of cardboard (5" X 8") and write the name of one of the food items on each of the 38 pieces of cardboard. Then glue one or more pictures of the same food item on each of the cards (i.e., on the card labelled "chicken" there would be one or more pictures of chickens).

b. Above each of five tables placed along the walls of the room, place one of five labels (Meat, Beans/Grains, Dairy, Produce, and Beverage) and with all of the pieces of cardboard (with the food item labelled and pictures of the food item) that apply to the food category; (i.e., Category: Dairy with the pieces of cardboard labelled -- eggs, Velveeta cheese, cheddar cheese, Dannon Yogurt, ice cream, and cottage cheese). In front of each piece of cardboard, place a stack of 3" X 5" cards with the name of the product and on the back of each card place the appropriate transportation (T), food chain (FC) and processing packaging (PP) number. (See master chart for appropriate data).

c. Make a master chart and keys for the room identical to the one outlined below. (Keep this sheet covered until debriefing period is to begin):

d. A handout listing all the items available in the grocery store excluding the information on their location, transportation, food chain and processing can be given to the participants beforehand to help them plan their meal in advance.

Master Chart: Grocery Store Items

Group Total	Meat	Location	Transportation	Food Chain	Processing Packaging
_____	1) Tuna Fish	Pacific	4	3	3
_____	2) Local Fish	Local	1	3	2
_____	3) Chicken	California	3	3	3
_____	4) Assorted Cold Cuts	Various	3	4	4
_____	5) Ground Beef	Australia	4	4	3
_____	6) Steak	Texas	3	4	3
_____	7) Chicken Soup	Various	3	3	4

Group Total	Beans/Grains	Location	Transportation	Food Chain	Processing Packaging
_____	1) Peanut Butter	Various	2	1	2
_____	2) Lentils	Midwest	2	1	2
_____	3) Brown Rice	Arkansas	2	1	2
_____	4) Minute Rice	Various	3	1	4
_____	5) White Wheat	Various	2	1	3
_____	6) Pop-n-Fresh Rolls	Various	2	1	4
_____	7) Cake Mix	Various	3	1	4

Group Total	Dairy	Location	Transportation	Food Chain	Processing Packaging
_____	1) Eggs	Local	1	2	2
_____	2) Processed Cheese	Various	3	2	4
_____	3) Non-processed Cheese	Midwest	2	2	3
_____	4) Dannon Yogurt	Ohio	3	2	3

Group Total	Dairy	Location	Transportation	Food Chain	Processing Packaging
_____	5) Ice Cream	Various	3	2	3
_____	6) Cottage Cheese	Local	1	2	2

Group Total	Produce	Location	Transportation	Food Chain	Processing Packaging
_____	1) Tomatoes	Mexico	4	1	2
_____	2) Bananas	Lat. Amer.	4	1	2
_____	3) Spinach	Local	1	1	1
_____	4) Asparagus	Local	1	1	1
_____	5) Citrus	California	3	1	2
_____	6) Frozen Broccoli	California	3	1	3
_____	7) Frozen-French Fried Potatoes	Various	3	1	4
_____	8) Pringle's Potato Chips	Various	3	1	4
_____	9) Canned Pineapple	Hawaii	4	1	3
_____	10) Frozen Strawberries	Michigan	2	1	4

Group Total	Beverage	Location	Transportation	Food Chain	Processing Packaging
_____	1) Water	Local	1	0	0
_____	2) Soft Drinks	Various	3	1	4
_____	3) Orange Juice	Florida	3	1	3
_____	4) Milk	Local	1	2	2
_____	5) Tea	Sri Lanka	4	1	3
_____	6) Coffee	Brazil	4	1	3
_____	7) Sanka	Brazil	4	1	4

Key to Transportation (Energy) Figures -- Energy Scale:

1. Local (products obtained locally or within state).
2. Regional (products obtained in neighboring states).
3. National (products obtained beyond neighboring states).
4. International (products obtained outside United States).

Key to Food Chain (Energy Efficiency) Figures -- Energy Scale:

1. Plants -- vegetables, rice, bread.
2. Dairy Products -- eggs, cheese, milk.
3. Fish/Poultry -- tuna, chicken.
4. Red Meat -- beef, steak.

Key to Processing & Packaging (Energy) Figures -- Energy Scale:

1. Little to None -- (e.g., fresh foods)
2. Low Energy -- (e.g., canned foods)
3. Moderate Energy -- (e.g., frozen foods)
4. High Energy -- (e.g., dehydrated foods)

2. Instructions for the activity.

a. The instructor asks all of the participants to select 3-5 items for an evening meal from the simulated grocery store in the room (take one 3" X 5" card from the stack in front of the cardboard with pictures of the food item). They are given a specific amount of time to complete the task (10-15 minutes should be an adequate amount of time). If they prefer to plan their meal prior to visiting the simulated grocery store, refer each participant to the handout reproduced for each participant. Inform the participants that if they have any questions regarding any item in the grocery store to see the grocery store clerk (instructor).

b. After selecting their 3-5 items (3" X 5" cards) from the simulated grocery store, the participants should return to the chairs to commence the debriefing.

3. Instructions for debriefing the activity.

a. The instructor should inform the group that this activity is designed to focus on the concept that "local decisions frequently have international implications."

b. The instructor should then ask the group to identify ways that they think their food choices might have some international impact (they might suggest ways, such as: an impact on some land usage decision in a third world country; high amounts of energy used for producing fertilizers/pesticides to grow crops and to transport them from another country; exploitation of cheap labor in a developing country; etc.). Their ideas should be listed on a blackboard or on newsprint.

c. The instructor should then inform the group that this activity is designed to focus on one aspect of the international environment and that is on "energy." More specifically, the focus will be on energy involving: a) transportation; b) food chain (energy efficiency); and c) processing and packaging.

d. The instructor should then ask the group to make known their 3-5 choices by putting up the master chart on Grocery Store Items prepared before the activity and quickly go down the list by calling out the name of each of the 38 items and tabulating the total group numbers on the column on the left hand side.

e. The instructor should then refer to the keys for the chart [(a) Key to the Transportation Figure, (b) Key to the Food Chain -- Energy Efficiency -- Figures]. It should be made clear that these figures are not absolutes, but provide a general estimate of the energy involved within each of the categories (transportation, food chain, and processing and packaging). The number on the energy scale within a category is not meant to equate the energy used in one of the other categories (for example, a number 2 on the energy scale in transportation is not equal to the number 2 on the energy scale in processing and packaging).

f. The instructor could then ask the participants one or more of the following questions:

1) Did you (or do you think people in general) ask the grocery store clerk (instructor) any questions that related to the food items (such as where a product was grown or shipped from; how the product was processed; any locally grown products; were fertilizers or pesticides used in the production of a food item, etc.)? Using organic fertilizers and biological versus chemical pesticides provide more energy savings.

2) Did you (or do you think people in general) give any consideration when you went grocery shopping to the buying of locally or regionally grown foods over a same product grown more distantly to conserve energy used in transporting food items? (Growing fresh produce locally reduces energy used in commerce and freight).

3) When you went to the grocery store did you (or do you think people in general) give much or any consideration to the concept that eating lower on the food chain (plants or dairy products) is more energy-efficient than eating higher on the food chain (meats)? In other words, there is a lot more energy involved in producing a pound of meat protein than a pound of plant protein (a pound of meat protein requires at least 4 times as much energy as a pound of plant protein). A great variety of plant proteins such as whole wheat bread, whole wheat macaroni, or legumes could be used in cooking in place of meat dishes. The beef that is consumed should be forage-fed, not grain-fed, varieties. Supplemental material can be used in handouts to facilitate the activity. A good source for information regarding energy efficiency can be found in Lappe (1975).

4) Did you (or do you think people in general) give any consideration to how the product you purchased was processed (fresh, canned, frozen or dehydrated) or packaged? (Generally, processed vegetables and fruits use far more energy than non-processed ones. Canning generally uses more energy than fresh produce, but less than frozen and far less than dehydrated. It should also be kept in mind that smaller containers require more packaging material than larger ones. Stores that encourage shoppers to bring their own containers are needed.

5) Did you learn anything new from this activity? Did anything surprise you? Will this activity have any impact on you when you go to a grocery store next time? If so, specifically what impact?

CONCLUSIONS

Activities similar to this one can be extremely beneficial to the participants of any type of educational program either in a formal setting (school) or non-formal situation (youth groups, church groups, adult education, citizen groups). The theme, acting locally and thinking internationally, can help people to develop valuable skills and competencies and an awareness of global concerns. Looking at problems with a global perspective prepares the individual to explore solutions with an understanding of the benefits, costs, and responsibilities inherent in such participation.

The ability to make knowledgeable decisions on local issues based on a global perspective provides a framework for the development of personal values and behaviors that add consistency to our lives. Environmental education stresses the importance of the interactions and interrelations of humans with their environment in the broadest sense. This element of interdependence is a major step toward establishing a humane, global - centric population.

REFERENCES

Anderson, Lee. 1979. Schooling and Citizenship in a Global Age. Bloomington, Indiana: Mid-America Program for Global Perspective in Education.

Becker, James M. 1979. Schooling for a Global Age. New York: McGraw-Hill, 1979.

Boyer, William. April, 1975. "World Order Education: What is It?" Phi Delta Kappan. Vol. 56, No. 8, pp. 524-27.

Brown, Lester R. 1978. The Twenty-Ninth Day. New York: W. W. Norton, 1978.

Fritsch, Albert J., Linda W. Dujack and Douglas A. Jimerson. 1975. Energy and Food. Center for Science in the Public Interest.

Goldbeck, Nikki and David. 1977. The Supermarket Handbook, Access to Whole Foods.

Hanvey, Robert G. 1979. An Attainable Global Perspective. New York: Center for Global Perspectives, pp. 1-28.

Hightower, Jim. 1975. Eat Your Heart Out. New York: Quadrangle Books.

Hunter, Beatrice Trum. 1970. Consumer Beware. New York: Simon and Schuster.

King, David C. October, 1980. "Global Education." Association for Supervision and Curriculum Development Update. Alexandria, Virginia.

Lappe, Frances Moore. 1975. Diet for a Small Planet. New York: Ballantine Books.

Lappe, Frances Moore. 1977. Food First. New York: Ballantine Books.

Lerza, Catherine and Michael Jacobson. 1975. Food For People Not For Profit. New York: Ballantine Books.

Meadows, Dennis L., et al. 1972. The Limits to Growth, New York: Universe Books.

Robbins, William. The American Food Scandal. New York: William Morrow and Company.

World Future Society. 1980. Through the 80's: Thinking Globally, Acting Locally. Washington, D.C.

Microcomputers and Environmental Training

Robert D. Townsend[1]

The Ohio State University's EPA Information Dissemination Project in Columbus, Ohio, and the U.S. Environmental Protection Agency's National Training and Operational Technology Center in Cincinnati, Ohio, have developed an information-instructional network. Utilizing the Compuserve Information Service (formerly Micronet), a time sharing system piggy-backed onto business computers that are not used much in off-hours, the OSU-EPA Project is exploring the capabilities and potential of microcomputer systems in training programs across the country.

The computer system (hardware) used in the development of the program consists of the following components: a 48K RAM Apple II+ computer, disk drive and controller, a standard home color TV unit or monitor, a micro-modem, and a printer. The Apple II+ system has 48 thousand (48K) bytes of random access memory (RAM), a communication interface to send and receive data from other computers, and an interface that permits the use of a home color TV to display information. Three languages are available to the user: Applesoft, Basic, and Integer.

Apple Discs are used in the storage and retrieval of data. Blank discs are approximately five inches (12.7 cm) in diameter and cost approximately $3.00.

Three objectives are associated with the initial phase of this project:

- to develop the electronic message board
- to investigate the capabilities of the systems in disseminating information from the Instructional Resources Information System (IRIS)
- to locate and develop "software" programs for use in training.

Electronic Message Boards

Sending messages on a computer network is a convenient method of communicating with other people. An individual on the network can receive messages when he/she is ready, and leave messages knowing that the recipient will ultimately get them. One can send messages to as many people as desired with only one command. By keeping a list of people on file under a group name it is possible to send a group message at any time.

The message board currently under development by OSU-EPA will also announce meetings and conferences and provide a means for pollution control contractors, consulting firms and equipment manufacturers to announce their goods and services. The message board will provide a vital communications

---

[1]Instructional Resources Coordinator, EPA Instructional Resources Center, 1200 Chambers Road, Columbus, OH 43212.

link among pollution control training organizations, the states, EPA Regional offices, universities, and the U.S. EPA.

Information Dissemination

Bibliographic citations developed by the OSU-EPA Project are available in either printed form or microfiche. The IRIS data base has been mounted with two commercial "vendors," Lockheed-Dialog and Bibliographic Retrieval Service (BRS).

Currently, OSU-EPA is investigating the quantity of information that can be stored on an Apple disc. Recent studies indicate that 45-50 document abstracts can be mounted per disc. In the near future, a trainer will be able to purchase discs containing citations on such specific topics as Activated Sludge, Safety, Chlorination, Anaerobic Digestion, Management/ Supervision, and Public Participation.

Microcomputers As Instructional Tools

Several wastewater facilities in Maryland and the New England states are currently monitoring processes and producing process control data using microcomputer systems. A troubleshooting program has been developed by Rutgers University in New Jersey but cannot be adapted to the Apple system. Therefore, efforts are underway to develop a troubleshooting package compatible with the Apple System. Programs have been developed to record an entire facility's operating data and to support maintenance programs.

The Future

The advancement of microcomputer technology and the gradual decreases in the costs of the equipment have enabled personnel in pollution control, education, and information dissemination to take advantage of the inherent advantages in such systems. In addition, more than 200 data bases are available to the public, covering such diverse topics as energy, pollution, biology, medicine, Chem Abstracts and the Dow Jones News, and Quotes Reporter.

The enormous quantity of information generated every day around the world has led to the development of systems to organize, manage, and provide accessibility to data. Lockheed-Dialog is adding data bases to its data management system at a rate of two per week.

Because networks are a relatively new idea, users have the opportunity to influence significantly how they develop. Use patterns, subscription choices and suggestions to network managers will make significant contributions to development and change. The potential for educational use of networks as actual training tools in addition to their use as information exchangers is particularly innovative, and this area has many avenues yet to explore.

NOTE

U.S. EPA's National Training and Operational Technology Center was closed as of September 30, 1981. Continued development of these programs is under an EPA grant to Ohio State's EPA Instructional Resources Center.

NTOTC's Environmental Training Materials

Thea Teich Townsend[1]

Introduction

The National Training and Operational Technology Center (NTOTC) has developed and presented short courses and other programs in water pollution control for the last 14 years. Recently, training in hazardous wastes and drinking water has been added to the curriculum. Employees from federal, state, and local agencies as well as from a variety of industries have attended courses at NTOTC, a unit of U.S. EPA's Office of Water Programs.

Government policy in recent years has dictated a gradual reduction in the direct training activities of the EPA. One reason is the determination that training would be more logically and effectively handled on the state level, another is the increasing costs in terms of real dollars and temporary loss of manpower of sending employees to a central location for training. Thus, NTOTC has shifted much of its attention away from direct training and moved into managing grants to fund: (1) dispersed offerings or development of courses; (2) the packaging of courses concerning standardized procedures; (3) the organization of courses in instructional technology to increase the teaching skills of trainers; and (4) the development of resources and programs increasing the availability of those resources to training personnel in the private sector.

This paper describes some of the training materials and resources that have been developed in-house or through NTOTC grants. This report is designed to increase public knowledge that these activities and materials exist and that they have been field-tested and are available.

Furthermore, since governmental budget-cutting has resulted in the elimination of NTOTC wholly by October 1, 1981, it is even more important that this knowledge be disseminated.[2]

It is essential that information about these training materials become known. Without a national environmental training center these materials could soon become lost unless a concerted effort is made to insure their availability and exposure.

The following materials were developed for use in water pollution control training courses. However, some of the materials in their entirety and others in part could be used in other educational programs.

---

[1]Presently, Ohio River Valley Water Sanitation Commission, 414 Walnut Street, Cincinnati, OH 45202.

[2]After October 1, 1981, many NTOTC materials and other instructional programs will be available from: EPA Instructional Resources Center
The Ohio State University
1200 Chambers Road
Columbus, OH 43212

- Instructional Technology: Basic and Advanced

Included: Staff Guide with transparency masters
Participant Reference Manual

Programs aimed at developing instructional skills in "on-the-job" trainers and others whose abilities and background are primarily in technical operations have been organized at EPA since the early seventies. These were finally compiled and reorganized into this two-course set.

The Basic Course consists of 14 units of instruction and materials for use in the organization of the workshop. Included are alternative schedules, sample letters to participants, a pre-workshop survey, equipment lists, and other information. The instructional units in the Basic Course are entitled: Introduction; Problem Analysis, Task Analysis, Objectives Specification, Evaluation Techniques; Instructional Methods and Media; Lesson Planning; Developing Oral Communication Skills; Development of First Presentations; Instructional Media and Related Resources; Classroom Management; Development of Second Presentation; Workshop Summary; and Evaluation and Conclusion.

An example of a lesson provided by this program is Basic Instructional Technology Unit Five: Evaluating Techniques, Lesson 2: Constructing Written Tests. A Staff Guide provides an outline for the workshop leader's discussion. It reviews general considerations in test design such as definition of Intended Role and Function of Test; definition of the Type of Behavior to be Evaluated; and planning the Content of the Test.

Then the workshop leader discusses types of test items and rules for writing objective test items.

The participant reference manual reviews the entire unit as a whole, summarizing content, providing copies of overhead transparencies and giving examples. Assignments give students practice in developing their own test items. Remember, the "students" in this workshop will eventually be training others in content of operations courses.

- Troubleshooting Operations and Maintenance Problems in Wastewater Treatment Facilities

Included: Instructor's Manual, Trainee Notebook Materials,
35-mm slides

This extensive course, consisting of 15 units of instruction, pre-and post-course assessment, directions for administration, course summaries, slides and masters for overhead transparency production, was produced under a grant from NTOTC by the Environmental Resources Training Center of Southern Illinois University at Edwardsville. The Center modified and expanded materials originally developed by the American Public Works Association, again under EPA grants, to assist state and federal water pollution control personnel with wastewater treatment plant inspections.

The process of troubleshooting is defined as the procedure for identifying and isolating a problem, formulating alternative actions and solutions, and combining corrective action with short and long range follow-up.

Course objectives include not only the development of technical knowledge in trainees, but also the expansion of interpersonal skills that are an integral part of any project.

A variety of educational techniques are used in this course, including case studies, discussions, record analysis, role playing, simulations, and small group interaction as well as the more usual lectures. The entire course requires approximately 45 hours of instruction, although opportunities exist for modifying the course to 35 instructional hours or a five-day workshop. This reduction is possible because many of the instructional units relate to one particular wastewater treatment process. Thus, determining the specific needs of workshop participants can be crucial in the organization of the workshop.

An introductory instructional unit summary sheet provides the instructor with an overview of the content and activities involved in each unit, if taught exactly as described. This is by no means required and instructors are encouraged to individualize the course. Some instructional units in the Troubleshooting Course are entitled: Elements of Troubleshooting; Sewer Use Control: Pre/Primary Treatment; Fixed Media Biological Systems; Oxidation Lagoons and Laboratory Practices.

- Operational Considerations in Wastewater Treatment Plant Design

This course, slated for complete revision and field testing during 1981 and the spring of 1982, addresses the difficult problem of designing a wastewater-treatment facility in terms of ease of operations. Rarely do wastewater treatment plant operators participate in the planning and construction phases of a facility. However, operators must manage the facility and perform the laboratory, maintenance, and other tasks required in the treatment of wastewater. Many wastewater treatment facilities are not designed for ease of operations, and difficulty in performing these tasks can lead to a plant being in violation of water pollution permits.

Thus, the rationale for this course is the prevention of design problems that can lead to operations difficulties. The course assumes an engineering background and familiarity with wastewater treatment plants on the part of its participants. The student manual is organized in an outline format which reviews the various equipment, tanks, and other structures found in a treatment plant, and then provides parameters which should lead course participants to pay closer attention to flexibility and operations in the design and planning of plants.

Large numbers of exemplary plans and charts are provided as well as graphs and equations indicating mathematical methods of minimizing certain problems.

- Sludge Treatment and Disposal

Included: Student Manual
Instructor Manual
35-mm slides, audio tapes

Produced by Linn-Benton Community College in Albany, Oregon through a grant from NTOTC, "Sludge Treatment and Disposal" is a set of 26 modules, some currently available, others to be completed before the end of 1981.

The course modules provide a water pollution control trainer with all the materials needed to present the course, including lecture outlines, 50-80 35-mm slides per module, audio tapes, written scripts, student materials, course objective, and worksheets. Indeed, the course can be utilized by individual students in a self-paced instructional program as well as a conventional classroom.

"Sludge Treatment and Disposal" modules currently available are entitled: Planning Considerations, Sludge Characteristics, Sludge Conditioning, Gravity Thickening, Flotation Thickening, Aerobic Digestion, Anaerobic Digestion I and II, Drying Beds, Incineration - Multiple Hearth Furnace, and Sanitary Landfill.

The Planning Considerations module can also be used as a public information program to describe sludge disposal techniques and problems to municipal officials and community groups as well as introduce wastewater treatment operators to various sludges and their disposal. Essentially, this module forms an outline which is amplified in succeeding sections.

The second module entitled "Sludge Characteristics" describes sludges and measurement techniques used to ascertain these characteristics. Despite the fact that only about 1/10 of 1% of a wastewater flow consists of solids, a city of 10,000 produces about 5000 lbs of wastewater solids each day. This material must be removed, treated, and disposed of at the sewage treatment plant.

The module reviews the differences among primary, secondary and chemical sludges and volatile, fixed, dissolved, and suspended solids. Measureable sludge characteristics are defined and mathematical equations to determine such statistics as sludge volume index, specific gravity, and concentration are explained.

The third module on Sludge Conditioning describes the steps that must be taken to prepare sludge for water removal. Thoroughly illustrated with clear diagrams, the module explains chemical, heat treatment and elutriation (washing) methods of sludge conditioning. The effects of inorganic metal ions in coagulating and removing water from sludge are described. Sludge conditioning equipment is also reviewed.

Process operations for the preparation of sludge for stabilization are then described in several modules. "Gravity Thickening" begins by providing plant flow diagrams and then proceeds to describe the purpose, characteristics and potential problems of sludge undergoing gravity thickening. The following module, "Flotation Thickening" describes another process for preparing sludge for stabilization.

Later modules in the Sludge Disposal course describe step-by-step various stabilization methods such as aerobic and anaerobic digestion, procedures for dewatering and finally, disposal alternatives.

Additional modules currently are in draft stages and expected to be finalized late in 1981.

- Land Application of Wastes

Included: 21 modules
Audio-tutorial units (slide/tape)
Instructor's Program

Developed in 1978 by the New York State College of Agriculture and Life Science at Cornell University, this course is intended for engineers, scientists, planners, waste management specialists and others involved in environmental protection. The application of municipal waste to land, as opposed to more conventional treatment methods, has been designated a preferable practice by EPA. But because land application of wastes is a controversial issue, with legal, economic and societal ramifications, engineers and planners must be knowledgeable of all these concerns and not just the technical and scientific considerations required in selecting a land application site.

The course attempts to clarify this controversial issue by utilizing a combination of self-paced study, workshops and team problem-solving in its format. The 21 modules are divided into two sections; the first group of seven emphasizes broad topics and inter-relationships among fundamental concepts. The second group of 14 modules provides more detailed information for compilation of design problems and includes material entitled Climate and Wastewater Storage; Pathogen; Costing Land Application System; Potentially Toxic Elements; Waste Application Systems; Non-Crop and Forest Systems; and Legal Aspects.

Besides these modules - which are intended to be used to meet specific individual needs and not as a sequenced "textbook" - a 4-1/2 day workshop involving class instruction, discussion, guest speakers, optional field trips and team project work is a major part of the course. The instructor's program is primarily a guide to organizing this workshop and goes into minute detail as to the preparation required. The Instructor's Program also reviews various instructional methods, the course's learning objectives, the rationale for them, and how they can be met.

This course also uses case studies and role playing to enable participants to learn about the success or failure of actual attempts at land application of wastes. Participants also divide into teams to look at particular issues and report to the group their findings and recommendations.

The modules in this course are available as a hard-bound book as well as a package of individual, 3-hole punched, 8-1/2 X 11 modules.

- Activated Sludge Process Control Course

Developed by GMP Associates, Inc. under contract to U.S. EPA's NTOTC, this course provides advanced training in methods used to control the activated sludge process. Activated sludge is the process most used in secondary treatment (organics removal) in wastewater treatment plants. Through aeration, microscopic organisms are brought into maximum contact with the organic solids remaining in the wastewater flow after primary treatment (settling). This leads to the biological breakdown of the organic solids fraction.

However, the process is far from simple and subject to upset for a variety of reasons, including temperature, components in wastewater flow, toxics, level of aeration, etc. To train wastewater treatment operators in the sometimes complicated methods of determining causes of problems in the activated sludge process, Alfred W. West of the EPA developed in the early 1970's a series of pamphlets on process control for the activated sludge process. The course developed by GMP expanded upon these pamphlets to produce "Activated Sludge Process Control".

The course's 28 sections primarily contain the chemical, microbiological, and mathematical tests that should be performed to maintain control over the activated sludge process and prevent violation of water pollution control permits.

Worksheets to be completed in class or as homework are also included in this 5-day workshop course.

- Working for Clean Water,
  An Information Program for Citizen Advisory Groups[3]

Included: 18 units, each with a Citizen's Handbook
Instructor's Manual
An audio-visual presentation (16-mm film or slide/tape unit)

Pennsylvania State University's Institute of State and Regional Affairs has developed a program to help advisory groups improve decision-making in water quality planning. Titled "Working for Clean Water, An Information Program for Citizen Advisory Groups," the program consists of 18 units based on key issues related to water quality and wastewater treatment planning.

The program is designed for citizens and local officials involved in environmental planning activities. Each unit contains an audiovisual presentation (either slide/tape or a 16-mm film), a Citizen Handbook for each advisory group member, and an Instructor's Manual to assist organizers in preparing for and conducting the training program. The audio-visual

[3]Summary of these materials written by Bernard J. Lukco of NTOTC and appeared in the EPA IRC Bulletin, February, 1981, reprinted with permission.

presentations highlight major issues and important aspects of each pollution control topic. The Handbook elaborates on these points and provides additional, more detailed information. Training sessions include guided discussions of local topics and some problem-solving exercises.

If citizens are to be involved with community decisions pertaining to technical subjects such as those represented by water quality, they must be aware of the basic concepts, current technologies, alternative considerations, and management techniques involved. As advisory group members, they have a unique opportunity to see to it that wastewater planning meets community goals, and that water quality objectives are met in an effective, affordable manner.

Units include: Role of Advisory Groups; Public Participation; Facility Planning in the Construction Grants Program; Municipal Wastewater Processes; Overview; Small Systems; Innovative and Alternative Technologies; Water Conservation and Reuse; Land Treatment; Multiple Use; Industrial Pretreatment; Groundwater Contamination, among others.

-.Operation of Wastewater Treatment Plants

Included: A 3-volume home study course of approximately 2000 pages

This self-paced instructional program, originally developed under grants from the Federal Water Pollution Control Administration by Kenneth D. Kerri and Bill Dendy of California State University at Sacramento in 1971, was revised by the same authors under EPA grants in 1980.

The course includes materials to prepare new wastewater treatment plant operators as well as to expand the skills of experienced operators and prepare them for certification examinations.

The first volume is largely an introduction to wastewater treatment and the equipment and procedures used to provide secondary (biological) treatment. The second volume expands upon the first by detailing further the activated sludge process and sludge digestion and solids handling. These chapters (Chapters 11-19) also review laboratory procedures for control tests, analysis of data, report writing and plant safety. Thus, this volume is intended for the treatment plant operator who has or desires greater responsibility for the operations of the plant. The third volume concerns more complicated wastewater treatment procedures and the problems associated with industrial wastes.

The course is illustrated with drawings, diagrams and photographs. Detailed pictures of equipment are provided. Besides a final exam, each volume also includes a glossary and index. Short quizzes and answers are also found throughout the course materials.

RESEARCH AND EVALUATION
REFEREED PAPERS

Environmental Education in the K-12 Schools: A National Survey

John F. Disinger[1]

Abstract

State education agency specialists in environmental education recommended exemplary efforts directed at elementary and secondary schools within their states. A questionnaire survey produced 284 project/program descriptions from 49 states. Responses were categorized and tabulated; results are summarized and discussed in this paper.

In cooperation with the State Environmental Education Coordinators Association (SEECA), the ERIC Clearinghouse for Science, Mathematics, and Environmental Education (SMEAC) at The Ohio State University in 1979 conducted a survey of exemplary and secondary schools of the United States (Disinger, 1979). Its primary purpose was to gather descriptive information. The environmental education specialist identified by each state education agency was requested to provide recommendations of "outstanding school-related environmental education projects/programs." The director of each recommended project or program was asked to complete and return a questionnaire detailing overall description, purposes, goals and objectives, history, funding sources, materials produced, evaluation, staffing, services provided for participating teachers, status of implementation, and plans for the future.

This survey was the fifth such effort conducted by ERIC/SMEAC (Disinger, 1972; Disinger and Lee, 1973, Disinger, 1975; Disinger, 1976). Only one of the earlier efforts (1972) was tied to recommendations from state education agencies. The 1973, 1975, and 1976 surveys also were broader in scope, in that they were not specifically limited to elementary and secondary schools, but instead included a broader range of target audiences.

Recommendation from state education agencies produced 409 names and addresses of project/program directors. Only one state made no recommendations; the maximum number of recommendations from any one state was 25.

Requests for completion of questionnaires were sent to each project/program director in August 1979. A follow-up request to non-respondents was sent in October 1979. The two waves produced 284 usable responses (69.4 percent). Table 1 lists numbers of recommendations, and responses, by state.

The stated intent of the 1979 survey, as of its predecessors, was to develop a printed directory describing ongoing efforts in environmental education. The report was to serve as a "state-of-the-art" document for

[1]Professor, Environmental Education, School of Natural Resources, The Ohio State University, 2021 Coffey Road, Columbus 43210.

Table 1

Numbers of Projects/Programs Surveyed, by State

State	Rec.	Resp.	%	State	Rec.	Resp.	%
Alabama	7	5	71.4	Montana	1	1	100.0
Alaska	6	1	16.7	Nebraska	2	2	100.0
Arizona	11	2	18.2	Nevada	4	2	50.0
Arkansas	12	11	91.7	New Hampshire	13	10	76.9
California	10	6	60.0	New Jersey	7	4	57.1
Colorado	18	11	61.1	New Mexico	5	3	60.0
Connecticut	10	7	70.0	New York	6	5	83.3
Delaware	5	3	60.0	North Carolina	7	4	57.1
Florida	11	11	100.0	North Dakota	1	1	100.0
Georgia	7	6	85.7	Ohio	11	10	90.9
Hawaii	4	3	75.0	Oklahoma	4	4	100.0
Idaho	12	10	83.3	Oregon	10	7	70.0
Illinois	11	10	90.9	Pennsylvania	25	10	40.0
Indiana	10	6	60.0	Rhode Island	9	7	77.8
Iowa	10	5	50.0	South Carolina	3	1	33.3
Kansas	4	4	100.0	South Dakota	0	--	--
Kentucky	7	6	85.7	Tennessee	8	4	50.0
Louisiana	1	1	100.0	Texas	8	7	87.5
Maine	11	10	90.9	Utah	10	4	40.0
Maryland	3	3	100.0	Vermont	11	7	63.6
Massachusetts	10	7	70.0	Virginia	9	8	88.9
Michigan	10	8	80.0	Washington	10	9	90.0
Minnesota	14	9	64.3	West Virginia	8	5	62.5
Mississippi	8	4	50.0	Wisconsin	10	9	90.0
Missouri	10	7	70.0	Wyoming	7	4	57.1
					409	284	69.4

practitioners, students, and others involved in environmental education, primarily for sharing information as to current practice. Sufficient information was provided by questionnaire responses to suggest possibilites of some generalizations, as well as to indicate a number of potential areas for more detailed, rigorous study. The data available did not allow analyses beyond simple "Frequencies" and "Crosstabs" calculated by the standard computer programs of the Statistical Package for the Social Science (SPSS), available through the Instruction and Research Computer Center, The Ohio State University.

Self-Descriptions

Questionnaire respondents were asked to check as many terms as they felt appropriate to their projects/programs, from a list of eight possible descriptors. Because no limitation was placed on the number which might be checked, directors responded by indicating between one and eight terms. Several added additional terms, but no apparent pattern emerged from them, so they are not reported here. The average number of descriptors checked was 4.2, based on 1208 check marks for 284 respondents (Table 2). This may indicate programs of broad scope, in terms of the possible descriptors available (conservation education, energy education, environmental education, marine education, natural resources, outdoor education, population education, urban environmental education). These eight descriptors were selected for the questionnaire on the basis of their frequent use by practitioners in the environmental education field, as evidenced by the types of materials related to environmental education processed into the ERIC system. They were not defined in materials sent to respondents.

Table 2

Descriptors Checked by Project/Program Directors

Descriptor	Time Checked	Percent
Environmental Education	251	88.3
Conservation Education	209	73.6
Outdoor Education	196	69.0
Natural Resources	187	65.8
Energy Education	166	58.5
Urban Environmental Education	78	27.5
Population Education	65	22.9
Marine Education	56	19.7

Several observations may be made at this point. First, 33 directors did not check environmental education as an appropriate descriptor for their projects/programs. Second, the "traditional" areas of conservation education, outdoor education, and natural resources received relatively greater attention than did the "newer" concerns of marine education, population education, and urban environmental education. Energy education, perhaps because it is currently a "hot topic," was indicated as a descriptor in nearly 60 percent of the cases. Another consideration here, as at many other points in this paper, is that the sources of the original recommendations - the environmental education specialists in the state education agencies - may have biased their own samples under the terms of their job descriptions, whether stated by their employing agencies or self-dictated.

Using cross-tabulation, an attempt was made to locate political (viz., Department of Education regions and/or states) and/or geographical (by physiographic regions and provinces) patterns of emphasis, but no apparent groupings emerged. In four states, much higher proportions of outdoor education emphases were noted than in the total sample, perhaps indicating a bias on the part of the state education agency or its environmental education specialist. In one state, energy education was disproportionately represented on the high side, which likely reflects the primary funding support of that state education agency's specialist with "energy money." Most of the projects/programs reporting marine education involvement were located in physiographic provinces bordering the oceans, with few near the Great Lakes or other water bodies and essentially none away from surface water. Forty-one of the 56 occurrences of the use of the marine education descriptor (73.2 percent) were along the Atlantic and Gulf of Mexico coasts.

Primary Foci

Making use of statements of purpose and objectives as reported by project/program directors, an attempt was made by this investigator to determine the primary focus of each of the 284 cases. The same eight descriptors were considered as labels, but the term natural resources was found to be used consistently with the term conservation education, so natural resources was dropped from this list to reduce redundancy.

Some difficulty was encountered in selecting the appropriate term for the primary focus. Resolution of this difficulty was achieved by labelling efforts clearly focused on one of the discrete areas (conservation education, energy education, marine education, population education, urban environmental education) with that label. Remaining projects/programs were labelled "environmental education" if they reported clear consideration of at least two of the areas, or of environmental considerations (i.e., pollution, etc.) Four projects/programs were unclassifiable using this scheme, and were labelled "not clear" (Table 3).

Less than half the cases (131, or 46.1 percent) met either of these tests for identification as having environmental education as the primary focus. Again, the "traditional" areas (conservation education and outdoor education) were well-represented, but in this case two of the "newer concerns" (population education and urban environmental education) did not

Table 3

Primary Foci of Reporting Projects and Programs

Primary Focus	Total	Percent
Environmental Education	131	46.1
Outdoor Education	63	22.2
Conservation Education	36	12.7
Energy Education	33	11.6
Marine Education	17	6.0
Population Education	0	-
Urban Environmental Education	0	-
Not Clear	4	1.4
	284	100.0

appear at all; none of the reporting projects/programs were identified with either of these as the primary focus. Energy education and marine education were judged to be the primary foci of nearly 12 percent and 6 percent, respectively, of the entries; these projects and programs were generally associated with support from agencies and/or organizations outside formal educational structures having professional concerns in them.

"Housing" of Projects/Programs

State education agency specialists, in their nominations of projects and programs for consideration, were asked to consider only efforts "in and for" elementary and secondary schools. Table 4 indicates that only 56.7 percent of the respondents were actually housed in such schools, with an additional 3.5 percent housed in the state education agencies themselves and 3.2 percent in regional education agencies - Boards of Cooperative Educational Services (BOCES), Cooperative Educational Services Agencies (CESAs), and the like. Thus, 63.4 percent of the reporting projects/programs were directly associated with "formal" elementary and secondary educational institutions, and 36.6 percent were not. Post-secondary educational institutions account for 12.7 percent of those responding, generally with their teacher in-service programs, but the remaining 23.9 percent (68 cases) represented entities outside the "formal" educational structure. These included governmental agencies at all levels having management rather than educational missions, non-profit public organizations such as garden clubs and public parks, and business and industry. It is clear that many "outside" interests have sufficient stake in environmental education to become involved in its presentation "in and for" elementary and secondary schools.

Table 4

"Housing" of Projects/Programs

Base of Operation	Number	Percent
K-12 School or School District	161	56.7
Public or Quasi-public Agency or Organization	40	14.1
Post-secondary Educational Institution	36	12.7
Business/Industry	11	3.9
State Education Agency	10	3.5
Regional Education Agency (BOCES, CESA, etc.)	9	3.2
Public Park	9	3.2
Other State or Federal Agency (Not Educational Agency)	8	2.8
	284	100.1

Multi-Disciplinary vs. Mono-disciplinary

Because environmental education as generally defined calls for multi-disciplinary approaches in its presentation, each project/program description was analyzed by this writer to determine whether or not such a mode was apparently pursued. Of the 284 responses, 169 (59.4 percent) appeared to do so, while 109 (38.4 percent) appeared to be associated with essentially mono-disciplinary approaches (Table 5). Multi-disciplinary efforts were noted most strongly in the science-social studies combination (36.6 percent of all cases), and many of the rest (62 cases, or 21.8 percent) at least attempted to deal conjointly with science, social studies, and arts/humanities. Most of those appearing to be mono-disciplinary (32.4 percent of all cases) focused on science, while 3.9 percent dealt with the social studies and 2.1 percent primarily with arts/humanities.

Target Audiences

A plurality of the projects/programs reporting were directly specifically toward the total elementary and secondary school audience, suggesting school-wide and/or school-system-wide integration of environmental education (Table 6). Most of the remainder targeted on segments of that audience, heavily at the elementary school level, but with some attention

Table 5

Content Area Foci of Projects/Programs

Content Area(s)	Number	Percent
Science and Social Studies (M)	104	36.6
Science (S)	92	32.4
Science, Social Studies, and Arts/Humanities (M)	62	21.8
Social Studies (S)	11	3.9
Arts/Humanities (S)	6	2.1
Science and Arts/Humanities (M)	3	1.1
Unstated or Unclear	6	2.1
	284	100.0
M = multidisciplinary	169	59.4
S = single discipline	109	38.5

Table 6

Target Audiences of Projects/Programs

Target Audience	Number	Percent
Elementary-secondary (broad range)	107	37.7
Elementary Grades	58	20.4
Formal and Non-formal Audiences (broad range)	41	14.4
Secondary Grades	40	14.1
Middle Grades	11	3.9
Teacher In-service	11	3.9
Broad Formal Audiences (K-16, etc.)	10	3.5
Post-secondary Formal (Not Teacher Education)	2	0.7
Non-formal Audiences Only	1	0.4
Not Stated or Not Clear	3	1.1
	284	100.1

to the secondary and middle grades. Of the remaining cases, 14.4 percent were targeted on both "formal" and "non-formal" (i.e., "school" and "non-school") audiences, 3.9 percent dealt specifically with teacher in-service efforts, and 3.5 percent targeted on "formal" audiences ranging through and beyond the K-12 grades.

Size of Target Audiences

Of some interest is a consideration of what is considered "exemplary" in terms of size, or scope, of target audiences (Table 7). Most of the respondents (70.5 percent) indicated operation at the school district or regional levels; "regional level" is here defined to include both multi-district efforts such as those of BOCES and CESAs, as well as projects/programs operated by public and quasi-public agencies and organizations such as nature centers, resident centers, parks, and the like, which also service multiple school districts and/or relatively large geographic areas. State-wide target audiences were identified by 13.7 percent of the sample, while 9.2 percent operated within one school building or a single classroom. Sixteen efforts (5.6 percent), most of them supported by business/industry or Federal grants, were directed at multi-state or national audiences.

Table 7

Target Area of Audience

Target Area	Number	Percent
One School District	103	36.3
Regional (Within One State)	97	34.2
Statewide	39	13.7
One School Building	19	6.7
Multi-state (Not National)	10	3.5
Single Classroom	7	2.5
National	6	2.1
Not Clear	3	1.1
	284	100.1

Sources of Funding

In addition to local school budgets, most respondents indicated availability and use of funds from "outside" sources. The continuing impact of

the Elementary and Secondary Education Act of 1965 (ESEA), primarily through Title III in earlier years and now generally through Title IV-C, is apparent from the indication that 37.7 percent of all respondents either currently receive or have in the past received support from that source (Table 8). More than one-fifth (21.5 percent) specifically indicated financial support from public and quasi-public agencies and organizations, while 64 instances of Federal funding from agencies outside the U.S. Department of Education were reported. In some cases (not shown by Table 8), a single project or program received funds from more than one Federal agency; some appear quite adept at synergistic funding. Business/industry support was noted by 35 respondents, 28 indicated funding from state agencies other than the state education agency, and 47 received support from their state education agencies.

Table 8

Funding Sources Tapped

Funding Source	Number	Percent
ESEA Titles III, IV-C	107	37.7
Public and Quasi-public Agencies and Organizations	61	21.5
State Education Agencies	47	16.5
Business/Industry	35	12.3
Other State Agencies (Not Education)	28	9.9
Office of Environmental Education, U.S. Department of Education	23	8.1
College/University	19	6.7
U.S. Department of Energy	9	3.2
National Science Foundation	8	2.8
Sea Grant	8	2.8
Other Federal Agency Sources	39	16.5

Instructional Materials

The development of instructional materials, and the subsequent availability of those materials to others, was reported by many projects/programs; 86.6 percent indicated that they had developed materials, and 39.2 percent noted that their materials were purchasable by interested parties (Table 9).

Generally, purchasable materials were made available at the cost of reproduction and handling; no profit motive was detected. Seventy-one of the cases (25.0 percent) have had materials accepted for announcement and availability through the ERIC system. A small percentage (3.2 percent) indicated commercial affiliations for distribution of materials.

Table 9

Instructional Materials Developed and Available

Primary Focus	N	Materials Developed	Materials Purchasable	Commercial Affiliation
Environmental Education	131	116 (88.5%)	55 (42.0%)	3 (2.3%)
Outdoor Education	63	55 (87.3%)	22 (34.9%)	0
Conservation Education	36	28 (77.8%)	12 (33.3%)	3 (8.3%)
Energy Education	33	29 (87.9%)	13 (39.4%)	2 (6.1%)
Marine Education	17	14 (82.4%)	9 (52.9%)	1 (5.9%)
Other	3	3 (100.0%)	0	0
	284	245 (86.6%)	111 (39.2%)	9 (3.2%)

As implied above, instructional materials developed and used by these projects/programs are generally localized in nature; they are targeted specifically on their own audiences, and in many cases are of limited use "outside." However, many provide models of apparently viable approaches which may well be generalizable.

Evaluation

Table 10 indicates the extent of evaluation of materials and/or programs, as related to primary focus, and suggests that little priority has been associated with such evaluation. This "analysis" is of the sketchiest nature, and is based on recording "no evaluation" for either no response or direct negative response to a question directly soliciting information concerning evaluation, "some" for indications that homemade, "informal," and/or "internal" evaluation was conducted, and "formal" for direct specification of research methodologies and results. Perhaps the most

obvious observation is that the "traditional" areas - conservation education and outdoor education - demonstrate the least attention to evaluation, formal and non-formal.

Table 10

Level of Evaluation
as Related to Primary Focus

Primary Focus	N	None	Some	Formal
Environmental Education	131	52 (39.7%)	68 (51.9%)	11 (8.4%)
Outdoor Education	63	44 (69.8%)	17 (27.0%)	2 (3.2%)
Conservation Education	36	23 (63.9%)	13 (36.1%)	0
Energy Education	33	13 (39.4%)	12 (36.4%)	8 (24.2%)
Marine Education	17	7 (41.2%)	10 (58.8%)	0
Other	4	3 (75.0%)	1 (25.0%)	0
	284	142 (50.0%)	121 (42.6%)	21 (7.4%)

An examination of evaluation data in terms of the housing of projects/programs (Table 11) suggests that elementary and secondary schools are more involved in evaluation of environmental education "in and for" elementary and secondary schools than are colleges and universities, even though those post-secondary institutions provide bases of operation. This may relate to a necessity for evaluation by K-12 schools to justify support from outside funding sources, and/or indicate a response to continuing pressures for accountability.

Consultant Services, In-Service Opportunities

In any "new" field, in-service teachers have a need for "on-the-job" assistance in implementing unfamiliar instructional activities. Table 12 indicates that the two most common forms of assistance - consultant services and in-service training activites - are frequently available in environmental education, in all its facets. This survey did not attempt to evaluate the extent or effectiveness of such efforts, but merely their existence. It must be noted that examples reported here are tied to the

Table 11

Level of Evaluation
as Related to "Housing" of Project/Program

Base of Operation	N	None	Some	Formal
K-12 School or School District	161	72 (44.7%)	76 (47.2%)	13 (8.1%)
Public or Quasi-public Agency or Organization	40	30 (75.0%)	9 (22.5%)	1 (2.5%)
College/University	36	22 (61.1%)	14 (38,9%)	0
Business/Industry	11	3 (27.3%)	4 (36.4%)	4 (36.4%)
State Education Agency	10	3 (30.0%)	4 (40.0%)	3 (30.0%)
Regional Education Agency (BOCES, CESA, etc.)	9	3 (33.3%)	6 (66.7%)	0
Public Park	9	5 (55.6%)	4 (44.4%)	0
Other State or Federal Agency (Not Education)	8	3 (37.5%)	5 (62.5%)	0
	284	141 (49.6%)	122 (43.0%)	21 (7.4%)

specific projects and programs reported, and do not include more general consultant services and in-service opportunities. Projects/programs labelled energy education, marine education, and environmental education provide relatively more assistance to teachers than do conservation education and outdoor education efforts.

Table 13 indicates relationships between provision of consultant services and in-service opportunities and bases of operation, or housing, of projects/programs, and provides little indication of differences among them. It is noted that public or quasi-public agencies and organizations seem to be relatively less active in each area, though no apparent reason is clear. Also, K-12 schools and school districts were relatively more involved in in-service activities than in provision of consultant services.

Cautions

What all of this means is, of course, difficult to say. The survey was designed to elicit descriptive information, not to serve as a scientific

Table 12

Services Provided for Teachers
as Related to Primary Focus

Primary Focus	N	Consultant Service	In-service
Environmental Education	131	86 (65.6%)	97 (74.0%)
Outdoor Education	63	34 (54.0%)	40 (63.5%)
Conservation Education	36	21 (58.3%)	22 (61.1%)
Energy Education	33	28 (84.8%)	25 (75.6%)
Marine Education	17	13 (76.5%)	12 (70.6%)
Other	4	4 (100.0%)	1 (25.0%)
	284	186 (65.5%)	197 (69.4%)

Table 13

Services Provided for Teachers
as Related to "Housing" of Project/Program

Base of Operation	N	Consultant Service	In-service
K-12 School or School District	161	98 (60.9%)	113 (70.2%)
Public or Quasi-public Agency or Organization	40	22 (55.0%)	20 (50.0%)
College/University	36	27 (75.0%)	28 (77.8%)
Business/Industry	11	9 (81.8%)	9 (81.8%)
State Education Agency	10	8 (80.0%)	9 (90.0%)
Regional Education Agency (BOCES, CESA, etc.)	9	8 (88.9%)	9 (100.0%)
Public Park	9	7 (77.8%)	7 (77.8%)
Other State or Federal Agency (Not Education)	8	7 (87.5%)	5 (62.5%)
	284	186 (65.5%)	197 (69.4%)

sample. It was to some degree successful in its attempt to develop a representative national sample of high-quality efforts, in and for K-12. Since this approach by definition excluded weaker efforts, it is a biased sample.

The questionnaire from which data were extracted was very much open-ended; its purpose was to solicit descriptive information, rather than more readily categorizable numerical responses. Thus, bias in interpretation of responses on the part of this writer is a very real possibility, one of which he is uncomfortably aware. Future surveys of this nature would be better conducted on a more local level (i.e., with single-state initiation and control), with instrumentation designed specifically for more rigorous analysis. Ideally, conducting separate surveys in each state, with cooperative effort between state education agencies and university schools or departments of education should produce a clearer picture. Agreement on common instrumentation, perhaps using the questionnaire used in this survey as a starting point, should provide data more readily interpretable, more worthy of generalization.

The sources of recommendations - in effect, 49 environmental education specialists in state education agencies - may not have been the best points of contact in some states, because many of them have additional and conflicting duties which effectively limit the time and effort available for environmental education. Too, a wide range of definitions of what constitutes environmental education is exhibited by both these specialists and their employing agencies, as demonstrated by the variations in types of activities recommended. However, this writer's experience with these specialists over a ten-year period indicates that they are the most knowledgeable individuals concerning in-state K-12 activity, on a national basis.

Summary

Nonetheless, a somewhat hazy picture of the status of environmental education "in and for" elementary and secondary schools does emerge:

1) There is clearly "a lot of it," though "it" is ill-defined - conservation education, energy education, marine education, outdoor education, population education, urban environmental education, in various mixes; fragmentation, and continuing fuzziness of definition, are apparent.

2) Many activities labelled environmental education focus on specific subsets; there is relatively greater emphasis, based on this writer's analysis of questionnaire responses, on "traditional" areas such as conservation education and outdoor education than on areas of more recent general concern such as energy education and marine education. Neither population education nor urban environmental education appear to be of central concern to those surveyed, though both receive some attention in relation to other areas.

3) Environmental education is frequently dealt with in a multi-disciplinary fashion. Recent and current environmental concerns are often related to the constants of the curriculum, particularly science and social studies.

4) A number of organizations and agencies outside formal educational structures and hierarchies demonstrate interest in and support of K-12 environmental education.

5) "Homemade" materials are common in environmental education. Most are not commercially viable, partly because they are homemade, nor are they "slick," perhaps because they are often localized. A cursory examination of such materials as accepted for inclusion in the ERIC data base indicates frequent "borrowing," often with modification, of activities between and among projects and programs, though this area was not addressed in this survey.

6) Support services - consultant services and/or in-service opportunities - are often provided for teachers involved in environmental education in its various aspects, though extent and quality were not addressed.

7) Evaluation of program and/or materials effectiveness has not been a priority consideration of environmental educators; this survey indicates that they are more concerned about practice than about evaluation. This may reflect the general impatience of educational practitioners with evaluation and/or their prioritization of how they allocate their resources - expertise, time, money. There appears to be an open, potentially fruitful, field for those interested in evaluation, along with increased demand for it as an adjunct of accountability. It would seem that evaluation of programs and materials deserves increased attention, not only for justification of current efforts but also for improved effectiveness in terms of increases in environmental knowledge, more viable environmental attitudes, and more responsible environmental behavior.

NOTES

1. This survey was supported by SMEAC Information Reference Center, The Ohio State University.

2. Computer work for this report was completed by Woodward S. Bousquet, Research Associate, ERIC/SMEAC.

REFERENCES

Disinger, John F. 1972. A Directory of Projects and Programs in Environmental Education for Elementary and Secondary Schools. Columbus, OH: ERIC/SMEAC. ED 071 881.

Disinger, John F., and Beverly M. Lee. 1973. A Directory of Projects and Programs in Environmental Education for Elementary and Secondary Schools, 2nd edition. Columbus, OH: ERIC/SMEAC. ED 086 558.

Disinger, John F. 1975. A Directory of Projects and Programs in Environmental Education, 3rd edition. Columbus, OH: ERIC/SMEAC. ED 114 259.

Disinger, John F. 1976. A Directory of Projects and Programs in Environmental Education, 4th edition. Columbus, OH: ERIC/SMEAC. ED 135 669.

Disinger, John F. 1979. A Directory of Projects and Programs in Environmental Education for Elementary and Secondary Schools, 5th edition. Columbus, OH: ERIC/SMEAC. ED 187 515.

Energy Conservation as a Means of Avoiding the Construction of New Power Generation Facilities

Kevin C. Gottlieb[1]

Abstract

Energy conservation can increase fuel availability significantly while reducing the need for capital, imported oil, and new power plants. Utilities, through corporate diversification, can manage energy demand and contribute simultaneously to economic and natural resource stability. Achieving this objective will require stronger commitment from the utilities and clear policy directives from the federal government.

The major industrialized nations of the world are engaged in a debate which will determine much about the future of civilization. One side in this debate argues for increasing development of energy supply while the other side advocates more efficient use of existing energy supply and, where possible, curtailing use.

While this debate has been simplified to a "growth versus no growth" argument, that label is far too simple. Indeed anyone who would vote for one side against the other in this debate would be deceiving themselves with simplicity. Clearly, there is some relationship between energy supply and economic activity. But there is also a relationship between energy supply and more efficient use of energy. In short, if energy is used more efficiently or consumption is reduced in one enterprise, then the energy "saved" is available for other enterprises. In fact, societies must search not only for more energy but for ways to use more effectively the energy they already have. The debate then, with which this paper begins, is artificial and counterproductive. It does, however, serve the purpose of directing the discussion to the essential issue.

Energy growth in the United States could range between zero and three percent between 1980 and the year 2000. Many external variables will dictate how fast our energy supply will grow. Not all of these variables can be controlled by choice. Indeed, many are controlled by chance. However, when one analyzes programs for the efficient use of conservation of energy, the number of variables which can be controlled by choice increases dramatically. How well America grows economically will be determined in large measure by the nation's commitment to what the Edison Electric Institute refers to as "productive conservation".

Other countries have been noticably successful at energy conservation. Fully 95 percent of the Common Market's increased electrical energy supply since 1976 came from increased efficiency while only 5 percent came from

[1]Associate Professor, Department of Social Science, Michigan State Universiy, East Lansing, MI 48823; 5209 Waterview Drive, Rockville, MD 20853.

new power plants. Sweden has a modern history of exceeding America's per capita Net National Product while using 40 percent less energy per person. And oil consumption in Japan and Germany dropped at the rate of 15 percent last year alone.

Clearly, if the United States is to maintain economic growth or stability in a resource-finite world, a more vigorous analysis of appropriate energy usage must be fostered. The "soft-path" versus "hard-path" ideological split must be avoided. The temptation to politicize energy policy must give way to one over-arching consideration: that is, matching the appropriate energy supply to the task for which the energy is required.

What does this mean? It means that future energy policy must have the flexibility of a variety of sources: conservation; domestic oil and gas development; increased use of coal, solar, wind, and geothermal energy; continued use of nuclear power; more stable energy relationships with Mexico and Canada; and a reevaluation of our energy arrangements with Saudi Arabia, Nigeria, and other large exporters to the American market ("Carving Up Energy," March 29, 1981:B-6). In short, the U.S. must seek a balanced approach to energy supply in order that the nation might have the necessary options for appropriate use and conservation.

How can this balanced approach be achieved? This paper is limited to discussing the contribution to be made by energy conservation, and, specifically, the means by which conservation can lead to a reduction in the need for new power generation facilities.

Conservation is working in America. Oil imports in May of 1980 were 1.5 million barrels a day less than May of 1979. The annual growth rate in energy demand has declined from 5.4 percent per year in 1976 to half of one percent in 1979. Gasoline consumption declined by 8.5 percent from 1979 to mid-1980. And American oil imports which declined by 8 percent last year are now near the rate of the 1975 recession when there were 20 million fewer cars and trucks on the highways and industrial production was 25 percent lower than in 1980 ("The Drop in Oil Imports," 1981:A-14). But conservation in the U.S. is not working as fast or as well as it is in other countries. The National Academy of Sciences estimates that 25 percent of our present energy consumption could be saved (Sawhill, June 9, 1980:6; "Report on Building a Sustainable Energy Future," 1981:46). By 1990, new retrofits of homes and apartments alone could save as much as eight quadrillion BTU's annually--this would equal a discovery of two oil fields as big as Alaska's North Slope. Some analysts, Amory Lovins for one, have suggested that future energy use could be cut by as much as 40 percent (Perry and Streiter, 1977:13). However, insofar as there is any demand elasticity, the reduction in energy use through increased efficiency will result in lower total user costs and, therefore, divert the use of the "saved" energy to perform other tasks (Ibid).

Why is the national conservation effort lagging behind? Conservation is a function of many factors: price, availability, cultural habits, public transportation capacity, and education, to cite just a few of the factors. Many known methods of conservation are under-utilized because of public attitudes rather than technological deficiencies. It is a "people problem", not a technical one. To begin to deal with this problem, the

Department of Energy financed the "1980 Summer Study on Building Energy Efficiency." Social scientists from throughout the country worked on the study and concluded that energy conservation may be falling short of its potential because "the consumer's sense of self-esteem leads to decisions that do not conform to the government's model of rational economic behavior." (Foote, 1980:C-3). The effort, if it is to succeed, must be to shift conceptions of self-esteem to produce a new attitude toward energy conservation. The consumer's notions of health, convenience, and comfort direct their attitudes about energy consumption. Therefore, reducing consumption must be tied in a positive way to these notions. If consumers can be involved actively in the conception, design, and implementation of a conservation strategy, the commitment will be both more intense and more persuasive as an example to others. For example, oil consumption could be cut by more than 50 percent by raising the average fuel economy of the nation's automobiles from the current 15 miles per gallon to 40 miles per gallon ("40 MPG-At Least," August 22, 1980: A-10). But how many consumers feel even remotely involved in the auto industry's efforts at fuel economy? If there is any consumer feeling on this issue, it may well be that the massive auto firms manipulate consumers according to the demands of the industry rather than the needs of the society. (The automobile industry vigorously opposed the 1980 Jackson-Magnuson Senate bill which would have required auto fleet averages to reach 40 miles per gallon by 1995. The domestic auto industry's opposition was unanimous even though several foreign automakers already had models getting more than 40 MPG). Little wonder then, that the average driver feels only a concern for gasoline price and not for consumption.

How serious is it that the energy conservation effort is moving too slowly? Reliance on imported petroleum increased from 38 percent of our total energy supply in 1975 to 45 percent in 1979 while prices more than doubled. "More ominous, oil lifted from insecure sources in Africa and the Middle East has grown from 60 percent to 80 percent of the total U.S. imports over the same period..." (Thompson, Karaganis, and Wilson, 1979:1). In 1979, 10 percent of all petroleum consumed in the U.S. was used by electric utilities. Using a liquid fuel (often obtained from an unstable foreign nation) to produce electricity is, on balance, not the best use of limited liquid fuels. Inasmuch as liquid fuels are in short supply and solid fuels (coal and uranium) are in more abundant supply, it is sensible for energy policy planners, where possible, to move electric power generation from a liquid fuel base to a solid one. The urgency of such a move is demonstrated by America's $90 billion annual foreign oil bill. That amount is equal each year to the net assets of General Motors, Ford, IBM, and General Electric combined (Sawhill, John C., April 14, 1980:1). How can this reliance on foreign oil be reduced? There are two potential answers. The first is to increase domestic energy production. The second is to decrease or redirect energy consumption by increasing energy efficiency. How can these objectives be accomplished? The limited length permitted for this paper prevents a discussion here of the many methods for increasing domestic energy production. Moreover, the focus of this paper is on the process for increasing energy efficiency in order to perform more tasks while using proportionately less energy. The current term used most often to describe this process is "energy management." Quite simply, "energy management" is a series of policies and specific corporate actions to increase conservation by creating public and/or private entities to

conserve energy. These might vary from a utility creating a wholly owned subsidiary for energy audits and for installing insulation, to a private corporation which arranges for cogeneration with a private utility.

In the utility industry, this trend toward establishing subsidiaries is called "diversification." The logic behind this trend is as follows: as the cost of capital for new plant construction increases, utilities must seek means of avoiding new construction and the high interest payments which go with it. To do this and still meet their responsibility for providing service, they must ease demand on their system, i.e. reduce consumption. To reduce consumption, the utility must manage consumer energy usage in such a way that it will not inhibit economic growth but will decrease the rate of energy consumption growth, and where possible, actual energy use. Therefore, more utilities are diversifying their corporate effort by adding energy management firms. These firms develop, market, and implement energy-use products and programs with the dual objectives of reducing consumer costs and utility demand.

Theoretically, everyone wins with this diversification. The consumer pays less for the energy consumed without sacrificing comfort or productivity. The utility saves the high interest costs of capital for new generation facilities and avoids the risk of being saddled with excess generating capacity should conservation increasingly succeed. In reality, however, many utilities are too financially strapped to permit their entry into any new business ventures. These firms must cut plant construction first to improve their balance sheets before moving into capital-intensive energy conservation programs.

The realities facing the utility industry are undeniable. Sales growth of kilowatt output is slowing. Shareholders' equity as a percent of net income is declining precipitously. And the combination of utility income and construction credits as a function of interest charges has fallen by almost two thirds over the last twenty years. (A High Risk... February 23, 1981:76) Cutting utility plant construction, unilaterally, will not adequately solve either the companies' financial problems or the nation's need for ready access to reliable sources of power. This is especially true if the economy rebounds in the 1980's and 90's. According to the National Electric Reliability Council, 18.5 percent of the new generating capacity due to be available between 1976 and 1985 will be delayed until 1989. And 18.7 percent additional capacity will experience further delay or total cancellation (Tenth Annual Review..., 1980:9). This trend is, clearly, a source of mixed emotions for utilities and consumers alike.

Energy management provides an alternative to simple cancellation of plant construction. A brief example illustrates what one utility system has done in the name of energy management.

The New England Electric System decided to control the spiral of new plants and higher prices through an approach that combines the best efforts of consumer and producer alike to limit the growth in energy demand to a level that best meets the needs of consumers and investors.

NEESPLAN, New England Electric's program for planning for the 1980's and 1990's, maps out a new approach over a fifteen-year period. That plan is a

flexible conservation and load management program which can adapt to rapidly changing events in the world energy market.

NEESPLAN includes the use of new rate forms (with regulatory approval) designed to induce additional customer conservation and load adjustment actions. New England Electric is also expanding its residential, commercial, and industrial energy audit programs and an attic insulation incentive program.

The company is moving ahead as well with development of a patented load control system and will continue efforts to shave the winter and summer peaks through heat storage and air conditioning cycling.

New England Electric will also assist customers interested in using cogeneration, coal, and other renewable resources.

The first edition of NEESPLAN, covering the period 1980 to 1995, was designed to minimize customers' energy costs consistent with reliable electric service and to reduce the company's dependence on foreign oil from 73 percent to just 10 percent of the total energy requirements. The intention is to hold peak demand and energy growth to an average of no greater than 1.8 percent and 2.1 percent per year respectively.

To meet these objectives, the first issue of NEESPLAN laid out five basic programs - each with specific goals and objectives.

1. An intensive conservation and load management program aimed at reducing new generating capacity requirements by 1000 MW.

2. A program to convert half of the company's oil-fired generating capacity to coal.

3. A major expansion of the domestic fuel exploration and production program.

4. A new generating capacity program, limited to 200 MW to be split equally between conventional and alternate sources and...

5. A new business venture program designed to promote achievement of NEESPLAN objectives, i.e., diversification.

The following conservation and load management programs were either instituted or continued during the first year of the NEESPLAN:

1. An energy-efficient appliance program was launched with the distribution to all one million customers of instructions on how to use the energy guide labelling on new home appliances.

2. Some 8800 home energy audits were performed in Rhode Island and Massachusetts through company co-sponsored programs.

3. An insulation incentive program was instituted for heating customers consisting of grants which underwrite the homeowner's cost of financing additional attic insulation.

4. A pilot energy audit program for commercial and industrial customers was completed.

5. Two solar research programs were advanced. The first, aimed at determining the load profile of electric water heaters which were used to back up solar systems, was completed. The second consists of a 100 KW solar photovoltaic demonstration and is under way now.

6. A voluntary customer peak-load reduction experiment involving some 65,000 customers and resulting in a marked reduction in peak demand on two heavy-use days during the winter was carried out.

7. A series of four energy management seminars for 250 large industrial customers was conducted.

8. A demonstration of the company's patented load control system (TWACS), involving 150 customers, was successfully launched.

9. Two area colleges agreed to move forward with individual cogeneration projects while the cogeneration arrangement between New England Electric and United Shoe Machinery completed its second successful year in operation.

10. An electric vehicle test program aimed at determining the impact of electric cars on company load profiles also got under way during 1980.

11. The approval by the Rhode Island and Massachusetts utility commissions was sought to institute flat rates for residential customers and to restrict the electric heating rate to present heating customers. Approval for a time-of-use storage heating rate has also been requested.

Successful implementation of this NEESPLAN will result in a savings to customers of some $1.35 billion over the 15-year planning period as well as a reduction in new capital requirements of $2.6 billion (Material for this system was provided by Lynda Clare, New England Electric System). More importantly, the flexibility which a varied energy management program provides is invaluable as a tool for adjusting to possible reductions in energy supply.

According to a recent Booz, Allen, Hamilton study on utilities, the major motivation for these energy conservation management ventures is not profit but rather the desire to hold down growth (Booz, Allen, and Hamilton, 1980:16). Reduction of demand is far less costly than expanding generating capacity. Each kilowatt saved costs $100-$200, while the cost of each kilowatt in a new base load plant ranges from $1000-$1500. Depending on the region of the country, the cost of conservation can be less than a third of marginal generation costs. Following a conservation approach, therefore, reduces peak load growth, holds down capital requirements, and avoids the weakening of company stock. Clearly a firm which succeeds in doing this will be more attractive to investors and will obtain more advantageous capitalization terms when new funds are needed.

Why then are all utilities not rushing to develop new energy management ventures? Some utilities fear that state Public Utility Commissions will

not permit them to separate their energy management business ventures from their conventional regulated utility enterprise (Alm, 1981:A-23). This means that the revenues would be assimilated thereby reducing the economic value to the stockholders who must bear the risk of a new venture and absorb the losses if it fails.

Other utilities worry about charges of anti-trust. Even if these charges eventually are proven to be without foundation, the legal costs and negative impact of the bad publicity will linger. Additional utility fears have been expressed about the reliability of regular power services when the utility diversifies into businesses which could become more profitable or more time-consuming.

In the Booz, Allen study, the results are conclusive that more utilities will choose to enter the energy management market during the next decade (Booz..., 1980:30). However, given the importance of energy conservation as a matter of public policy, society's policy-makers must be concerned about the form of these new utility ventures and the speed, or lack of speed, with which they become operational.

Unfortunately, government signals to utilities about energy conservation have been slow, confusing, and somewhat contradictory. Beyond the rhetoric of the stated interest in energy conservation one finds a disappointing reality. The Carter administration proposed a modest experimental utility energy management program for ten states to demonstrate the concept. A second Carter program, to train 8000 technicians to perform energy audits, was also proposed. Both programs were eliminated from President Reagan's 1982 budget as he cut 78 percent of all funds for energy conservation. (This figure was provided by the Energy Conservation Division of the Department of Energy. The original Reagan budget-cut proposal for conservation was 80 percent. The figure of a 75 percent cut appears in Omang, 1981:B-1).

Throughout the entire federal government, there is no systematic program to encourage or assist utilities in the move to energy management. While that effort was included in the Public Utilities Regulatory Policies Act of 1978 (PURPA) under DOE's Economic Regulatory Administration, the Reagan budget cut will cause that agency to lose the bulk of its personnel assigned to utility energy management programs. Similarly, efforts to achieve "cost of service" and "time of day" rates will not be pursued because of reduced personnel. Instead, utilities will be required merely "to consider" ten new rate designs proposed by ERA but without any specific timetable, follow-up, or commitment.

One must ask what kind of signal the government is sending to the nation about energy conservation.

Insofar as the economic and regulatory sectors are revised to be more encouraging, integration of energy management ventures into the mainstream of utility considerations will be more likely. Failure to achieve this integration will affect not only the utilities but also the delicate balance between energy growth and economic stability. By conserving energy, we can have both growth and stability. Given the finite nature of

our energy sources, the failure to save enough energy accelerates the society's movement toward the decline of our economic system as well as the depletion of our energy supply. That is an outcome which is as unacceptable as it is frightening.

REFERENCES

Alm, Alvin. April 22, 1981. "Deregulate Electricity," Washington Post.

"Carving Up Energy," March 29, 1981. Washington Post.

"The Drop in Oil Imports," February 6, 1981. Washington Post.

Foote, Carol. August 21, 1980. "Motivating People to Save Energy," New York Times.

"A High Risk Era for the Utilities," February 23, 1981. Business Week.

Investor-Owned Utility Business Prospects and Problems in Energy Management. November 5, 1980. Booz, Allen, and Hamilton, Inc., Chicago.

"40 MPG-At Least," August 22, 1980. Washington Post.

Omang, Joann. February 26, 1981. "DOE Trims Energy Conservation Regulations," Washington Post.

Perry, H. and S. H. Streiter. 1977. Multiple Paths for Energy Policy: A Critique of Lovins' Energy Strategy, National Economic Research Associates, Inc., New York.

Report on Building a Sustainable Energy Future. 1981. Solar Energy Research Institute, Government Printing Office for the U.S. House of Representatives, Washington.

Sawhill, John C. April 14, 1980. The Dynamo of Energy Independence, U.S. Department of Energy, address, Johnstown, PA.

Sawhill, John C., unpublished and untitled address, reprinted by the U.S. Department of Energy, June 9, 1980. (Delivered to the New England Conference of Public Utility Commissioners, Boston, MA)

Tenth Annual Review of Overall Reliability and Adequacy of the North American Bulk Power Systems. 1980. Reliability Council, Princeton, N.J.

Thompson, W. F., J. J. Karaganis and K. D. Wilson. 1980. Economic Growth in the Future II, Praeger Publishers, New York.

A Comparison of Four Groups on Perceptions of Environmental Issue Importance

Harold R. Hungerford[1] and Peter A. Rubba[2]

Abstract

The purpose of the study is to assess and compare four groups' perceptions of the top environmental issues facing mankind. Included among these are samples of 103 secondary school students, 193 K-12 science teachers, 90 readers of an EE newsletter, and 73 EE trainees. Each sample is surveyed with a questionnaire on which respondents designate and rank their perceptions of the top three environmental issues. While the four samples are found to share the perception that energy consumption is a top environmental issue, there are significant differences in perceptions among the four groups. The most notable of these is that the secondary students and science teachers perceived the importance of over-population to a far less degree than did the newletter readers and EE trainees.

Introduction

An environmental issue may be defined as a culturally-imposed, ecologically-related problem in the biosphere (Hungerford & Peyton, 1976). Environmental issues have their roots in differing human values relating to perceptions of use and abuse of the earth's resources. It is the polar nature of these values which surround environmental issues that sets group against group, and results in continual debate concerning what constitutes quality of life and quality of the environment.

How do different populations of humans react to questions of importance regarding the environmental issues facing mankind? Surprisingly, little information exists in this area although a number of studies have examined perceptions of discrete environmental issues or sets of issues. The National Wildlife Federation, for example, reports annually on a survey of its readership with respect to "conservation issues." In actuality, these "conservation issues" turn out to be readers' rankings of national environmental priorities. For 1979 these priorities ranged from "Fight Pollution" to "Revamp New Water Projects" and included "Teach More Conservation."

In 1980, 1,576 adults were interviewed in a study conducted by Resources for the Future (REF). The REF Survey sought to sample the civilian U.S.

---

[1]Professor in the Science and Environmental Education Center, Department of Curriculum, Instruction and Media at Southern Illinois University-Carbondale 62901.
[2]Assistant Professor in the Science and Environmental Education Center, Department of Curriculum, Instruction and Media at Southern Illinois University-Carbondale 62901.

population 18 years of age and older. The Survey reported adults' perceptions of energy priorities, the degree of concern about domestic problems (including inflation, poverty, fuel shortages, and six environmental issues), knowledge about the environment and energy, and views on regulation of cancer-causing chemicals.

A number of other studies have focused on environmental issues from an assortment of perspectives. These studies involved discrete issues (Arbuthnot, 1977; Young, 1980) or multiple issues (Weigel & Weigel, 1978). In none of these instances, however, were different populations compared according to their perception of environmental issue importance to mankind. It is important to determine whether different populations perceive environmental issues similarly or differently, especially in light of the educational implications the findings could yield.

Rubba and Hungerford (1980, 1981) published partial results from a series of surveys designed to examine questions of environmental issue perception differences across populations. This research report presents the complete findings from the study.

The Problem

The purpose of the study was to assess and compare among four groups' perceptions of the top environmental issues facing man worldwide. Those groups were (1) Illinois junior high school and senior high school students; (2) elementary and secondary level science teachers from Illinois; (3) readers of the Illinois Environmental Education Update; and (4) environmental education trainees from Wisconsin. To this end, the following research questions were stated to guide the study:

1. What environmental issues are perceived by the four groups under study as the top three facing man worldwide?

2. What similarities/differences exist among the four groups under study in perceptions of the top three environmental issues facing man worldwide?

Subjects

The 459 subjects surveyed in the study were drawn from four sample groups. One sample consisted of 103 seventh through twelfth graders who displayed science projects at the Illinois Junior Academy of Science (IJAS) Region 8 Science Fair held at Southern Illinois University at Carbondale in March, 1980. These students represented public and parochial school units within a 21-county region of southern Illinois. The sample was composed of 45 females and 58 males, among which 38 were in grade 7, 38 in grade 8, 5 in grade 9, 11 in grade 10, 5 in grade 11 and 6 in grade 12.

A second sample was composed of 193 of the individuals who attended the Illinois Science Teachers Association (ISTA) Convention held at Knox College in Galesburg, Illinois during November, 1980. These science teachers represented public and parochial school units from across the

state. The sample included 98 females and 95 males, of which 58 were elementary school teachers, 61 junior high school teachers, and 74 senior high school teachers.

Ninety readers of the Illinois Environmental Education UPDATE composed the third sample. The UPDATE is a publication of The Environmental Education Association of Illinois. Its readership consists of individuals with professional environmental education interests, e.g., environmental educators, conservation agents, and science teachers. Among the 90 individuals in the sample were 16 environmental coordinators, 5 school administrators, 3 secondary science department heads, 12 elementary school teachers, 25 secondary school teachers, and 29 individuals of other professions. Twenty-nine of the sample members specified they functioned mainly as science educators, 19 mainly as environmental educators, 15 mainly as administrators, 9 mainly as elementary generalists, and 5 mainly as social studies educators.

The fourth sample included 73 individuals attending the University of Wisconsin at Stevens Point (UWSP) during January, 1980. Twenty-six of the respondents were graduate students in environmental education and 47 were inservice teachers attending an NSF sponsored ecology/environmental education institute.

Instrumentation

Four versions of the same questionnaire were used to collect data in the study. Each version was developed by the researchers and contained two sections. The first section collected demographic data from respondents. The particular items which composed this section differed between questionnaire versions in accordance with the respective sample.

The second section of the questionnaire was congruent across versions. This section collected respondents' perceptions of the top environmental issues facing man worldwide. It contained a list of 18 environmental issues and three items which asked respondents to note the environmental issues they perceived to be the first, second, and third most important environmental issues facing man worldwide. Respondents were informed that they were free to note any environmental issue, whether or not it appeared among the 18 issues listed. The 18 environmental issues listed in the second section of the questionnaire are presented in Tables 1 through 4, below.

The validity of the questionnaire was accepted at face value by the researchers prior to the study. However, over the course of surveying the four groups only five of the 459 respondents specified an environmental issue not on the original list, and only two new issues were stated (see Table 3).

Data Collection

Questionnaires were distributed to the sample of junior high school and high school students as they displayed their science projects at the 1980

IJAS Region 8 Fair. Questionnaires were distributed to the 1980 ISTA conventioneers and collected through a booth in the convention display area. The 193 science teachers who responded represented 43 percent of the 550 individuals attending the convention.

In mid-March 1981, the questionnaire was mailed, along with a cover letter, to each of the 247 readers of the UPDATE who resided within Illinois. By early April, 90 individuals (36 percent) had completed and returned questionnaires. At UWSP, the questionnaires were administered to the environmental education trainees during January, 1981 while they were attending environmental education classes.

Data Analysis

In analyzing questionnaire response, data distributors were compiled which showed the percentage of each sample which listed the respective environmental issues as the first, second, or third most important facing man worldwide, and the total of these. The results of those analyses were used to construct ranked order distributions of the first, and of the total first, second, and third percentage designations given each issue. These distributions were used to facilitate visual review and analysis of the data.

The degree of associations between the samples' data were determined using Pearson product-moment correlation coefficients. Each coefficient was tested for a significant difference from zero at the 0.05 level. These computations were carried out on the PLATO (Programmed Logic for Automated Teaching Operations) system using a statistical computations program developed by Avner (1980).

Findings

Tables 1 through 4 present summaries of the data collected from the respective samples--Table 1 for the junior high school and senior high school student sample; Table 2 for the elementary school, junior high school, and senior high school science teacher sample; Table 3 for the UPDATE readership sample; and Table 4 for the environmental education (EE) trainee sample. Those tables list the percentages of individuals in the respective samples who designated each of the 18 environmental issues as the most important (1°), the second most important (2°), and the third most important (3°) facing man worldwide, and the total of those designations (Σ). The tables also present the rankings of the most important and total percentage designations.

As Table 1 shows, energy consumption, air pollution, and nuclear waste disposal were designated by the secondary student sample as the three most important environmental issues facing man worldwide, respectively, based upon the percentage of first designations. When the total number of first, second, and third designations are used as the criterion, the ranking was very similar--air pollution, energy consumption, and nuclear waste disposal, respectively.

Table 1

Secondary Students' Ratings of the Top Environmental Issues, n=103

Issue	% Designating				Rank	
	1°	2°	3°		1°	Σ
Air Pollution	23	13	17	53	2	1
Distribution of Food	6	6	8	20	5	6
Endangered Animals	6	7	5	18	5	7
Endangered Plants	0	1	0	1	16	17
Energy Consumption	29	15	8	52	1	2
Forest Management	0	0	0	0	16	18
Human Sewage Disposal	3	1	2	6	9	13.5
Land Use Management	0	1	4	5	16	15
Noise Pollution	0	3	0	3	16	16
Nuclear Waste Disposal	14	11	8	33	3	3
Over-Population (Human)	3	4	5	12	9	10
Overuse of Mineral Resources	4	7	6	17	7	8
Production of Food	6	9	6	21	5	5
Soil Conservation	1	2	3	6	12	13.5
Solid Waste Management	1	3	3	7	12	12
Water Pollution	1	12	10	23	12	4
Wilderness Preservation	3	4	7	14	9	9
Wildlife Management	1	4	3	8	12	11

Table 2

Science Teachers' Ratings of the Top Environmental Issues, n=193

Issue	% Designating				Rank	
	1°	2°	3°	Σ	1°	Σ
Air Pollution	6	5	9	20	6	6
Distribution of Food	3	4	5	12	9.5	9
Endangered Animals	2	3	1	6	12	14
Endangered Plants	1	1	2	4	15	15
Energy Consumption	25	20	13	58	1	1
Forest Management	1	0	1	2	15	16.5
Human Sewage Disposal	0	0	2	2	17.5	16.5
Land Use Management	7	7	12	26	5	5
Noise Pollution	0	0	1	1	17.5	18
Nuclear Waste Disposal	13	16	10	39	3	2
Over-Population (Human)	18	9	7	34	2	3
Overuse of Mineral Resources	4	3	3	10	7.5	11
Production of Food	4	8	5	17	7.5	7
Soil Conservation	2	6	3	11	12	10
Solid Waste Management	1	2	4	7	15	13
Water Pollution	8	8	11	27	4	4
Wilderness Preservation	3	4	9	16	9.5	8
Wildlife Management	2	4	2	8	12	12

Table 3

UPDATE Readers' Ratings of the Top Environmental Issues, n=90

Issue	% Designating				Rank	
	1°	2°	3°		1°	Σ
Air Pollution	3	6	6	15	8.5	6
Distribution of Food	3	0	1	4	8.5	12
Endangered Animals	0	1	1	2	16.5	15
Endangered Plants	0	1	1	2	16.5	15
Energy Consumption	12	19	22	53	2	1
Forest Management	0	1	0	1	16.5	18
Human Sewage Disposal	0	0	0	0	16.5	20
Land Use Management	10	16	12	38	3	3
Noise Pollution	0	1	0	1	16.5	18
Nuclear Waste Disposal	9	8	5	22	4	4
Over-Population (Human)	36	10	2	48	1	2
Overuse of Mineral Resources	1	6	2	9	11.5	11
Production of Food	5	5	2	12	5	8
Soil Conservation	4	2	7	13	6.5	7
Solid Waste Management	0	2	9	11	16.5	9.5
Water Pollution	4	6	8	18	6.5	5
Wilderness Preservation	1	5	5	11	11.5	9.5
Wildlife Management	0	0	1	1	16.5	18
Other:[a]						
Chemical Waste Disposal	2	0	1	3	10	13
Wetlands Management	0	1	1	2	16.5	15

[a]Environmental issues added by respondents

Table 4

Environmental Education Trainees' Ratings of the Top Environmental Issues, n=73

Issue	% Designating				Rank	
	1°	2°	3°		1°	Σ
Air Pollution	0	1	0	1	13	12.5
Distribution of Food	0	11	10	21	13	5.5
Endangered Animals	0	0	0	0	13	16
Endangered Plants	0	0	0	0	13	16
Energy Consumption	33	28	12	73	2	2
Forest Management	0	0	0	0	13	16
Human Sewage Disposal	0	0	1	1	13	12.5
Land Use Management	4	13	10	27	3.5	3
Noise Pollution	0	0	0	0	13	16
Nuclear Waste Disposal	3	4	14	21	5.5	5.5
Over-Population (Human)	49	21	7	77	1	1
Overuse of Mineral Resources	1	1	5	7	7.5	10
Production of Food	1	8	11	20	7.5	7
Soil Conservation	0	3	3	6	13	11
Solid Waste Management	3	4	4	11	5.5	9
Water Pollution	4	4	14	22	3.5	4
Wilderness Preservation	0	3	10	13	13	8
Wildlife Management	0	0	0	0	13	16

Among the science teacher sample (Table 2) energy consumption, over-population and nuclear waste disposal, respectively, were designated as the three most important environmental issues facing man worldwide based upon the percentage of first designations. A slightly different ranking was found when the total number of first, second, and third designations were considered; the respective environmental issues were energy consumption, nuclear waste disposal, and over-population.

A review of the UPDATE readers' data in Table 3 points out that over-population, energy consumption and land use management, respectively, were designated as the three most important environmental issues facing man worldwide based upon the percentage of first designations. The total number of first, second, and third designations yield energy consumption, over-population and land use management, respectively, as the three top environmental issues.

Table 4 shows that over-population and energy consumption, with a tie between land use management and water pollution, were designated by the EE trainees as the three most important environmental issues facing man worldwide based upon the percentage of first designations. The total number of first, second, and third designation yield the same ranking, except that water pollution moved from a tie for third, to the fourth position.

The Pearson product-moment correlation coefficients calculated between samples based upon the percentage of most important designations given each environmental issue are presented in Table 5. Table 6 presents the correlation coefficients calculated between the samples based upon the total percentage of first, second, and third most important designations assigned each environmental issue.

Table 5

Correlations Between Samples: Percentages Designating Environmental Issues Most Important (1°)

Samples:	Secondary Students	Science Teachers	UPDATE Readers	EE Trainees
Secondary Students	_____	0.67 (0.003)[a]	0.18 (0.470)	0.33 (0.183)
Science Teachers		_____	0.75 (0.001)	0.83 (0.001)
UPDATE Readers			_____	0.91 (0.001)
EE Trainees				_____

[a]two-tailed probability

Table 6

Correlations Between Samples: Percentages Designating Environmental Issues First, Second and Third Most Important (Σ)

Samples:	Secondary Students	Science Teachers	UPDATE Readers	EE Trainees
Secondary Students	_____	0.70 (0.001)[a]	0.45 (0.058)	0.39 (0.114)
Science Teachers		_____	0.90 (0.001)	0.84 (0.001)
UPDATE Readers			_____	0.91 (0.001)
EE Trainees				_____

[a]two-tailed probability

As indicated in Table 5, statistically significant (0.05 level or below) correlations were found to exist between the secondary student and science teacher samples, the science teacher and UPDATE reader samples, the science teacher and EE trainee samples, and the UPDATE reader and EE trainee samples on the percentage of most important designations given each environmental issue. Statistically significant correlations between the same pairs of samples were found among the total designation data on the environmental issues. Those correlations are presented in Table 6.

Comparisons made of the data presented in Table 1 through 6 yielded a number of interesting observations:

1. There was concurrence among the four samples on the significance of only one issue--energy consumption. Energy consumption was the only issue listed among the top three environmental issues facing man worldwide by all four samples.

2. The secondary students selected air pollution as the most important environmental issue overall. That environmental issue was not ranked among the top three by any of the other samples. In fact, the next highest ranking for air pollution was sixth by both the science teachers and the UPDATE readers.

3. Land use management was among the top three issues designated overall by only two of the samples--the EE trainees and the UPDATE readers.

4. Over-population was among the top three issues designated overall by the science teacher, the UPDATE reader, and the EE trainee samples. When the percentage of most important ratings was examined, however, only the UPDATE reader and EE trainee samples listed over-population among the top three environmental issues facing man worldwide, and it stood out in each sample by a large degree over any other issue. Thirty-six percent of the UPDATE readers listed over-population as the most important environmental issue, and 49 percent of the environmental education trainees listed it. No other issues were within 16 or more percentage points.

5. Regardless of the specific environmental issue selected as the most important by any of the groups, there was a greater agreement as to what that issue was in both the UPDATE reader and EE trainee samples, than in the other two samples. As Table 7 illustrates, that consistency also ran across samples. The EE trainees and UPDATE readers both designated over-population as the number one environmental issue, while the students and science teachers chose energy consumption, though by far lesser percentages.

Table 7

Comparison of Groups with respect to the Number One Environmental Issue Each Specified

Group	Issue	%
Secondary Students n=193	Energy Consumption	28
Science Teachers n=103	Energy Consumption	25
UPDATE Readers n=90	Over-Population	36
EE Trainees n=73	Over-Population	49

To test the sample congruency inference, chi-square procedures were applied to the frequency data collected from each sample on the issue of over-population as the most important. The chi-square results showed that there

was not a statistically significant difference between the secondary students and science teachers ($X^2_1 = 1.03$, $p > 0.05$), or between the UPDATE readers and the EE trainees ($X^2_1 = 0.38$, $p > 0.05$). However, a statistically significant difference was found between these two clusters of samples ($X^2_1 = 18.98$, $p < 0.001$).

The correlation coefficients presented in Tables 5 and 6 also tend to reinforce these observations on consistency among the groups. Yet, those correlation coefficients also show a relationship among the responses of the science teacher and UPDATE reader samples, and among the science teacher and EE trainee samples. These latter relationships were anticipated, however, given that a large proportion of the individuals in the UPDATE reader and EE trainee samples were science teachers.

Discussion

Throughout the course of this study, the researchers held the assumption that the EE trainee sample and the UPDATE reader sample represented populations more knowledgeable about the environment and its issues than did the science teacher or secondary student samples. Thus, it was not surprising to observe that the formerly noted two samples did, indeed, perceive the importance of environmental issues differently from the latter two samples. The nature of these varying perceptions lead to the generation of some interesting, and possible educationally significant, hypotheses for further testing:

1. Professional and pre-professional groups closely allied with the environment will rank environmental issues differently than will students and professional groups not closely allied with the environment.

2. Groups knowledgeable about the environment will tend to cluster on one particular environmental issue as the most important one to a far greater extent than will less environmentally-knowledgeable groups.

3. Educated social groups will perceive energy consumption as one of the most important environmental issues.

4. Groups knowledgeable about the environment will perceive over-population and land use management to be more important than less environmentally-knowledgeable groups.

5. Secondary school students will perceive air pollution to be a more critical environmental issue than will either science teachers or

groups more knowledgeable about the environment, e.g., educated adult social groups.*

6. Environmentally-knowledgeable groups will, by and large, choose fewer issues for ranking than less environmentally-knowledgeable groups.

7. The environmental issue perceptions of less environmentally-knowledgeable groups will fluctuate to a larger extent over time, in correspondence with exposure to popular media reports on environmental issues, than will those of more environmentally-knowledgeable groups.

If these inferences can be shown to be truly generalizable to a variety of school and professional settings, and if the rankings of environmental issues by environmentally-knowledgeable groups are valid, some interesting educational implications emerge:

1. Pre-service and in-service teachers who are not highly knowledgeable about the environment should somehow be made aware of the perceptions of environmentally-knowledgeable groups and the reasons for these perceptions.

2. Greater emphasis should be placed on the investigation of overpopulation and land use management as environmental issues in formal school settings.

3. Due to the influence of popular media on less environmentally-knowledgeable groups, the school may desire to counter media's impact on perceptions concerning environmentally issues of greatest importance to human beings worldwide.**

---

*Note: This particular hypothesis was reinforced by data collected from 59 high school chemistry students in Iowa. Twenty-five of the 59 chemistry students ranked air pollution No. 1, 2, or 3. The only issues ranked higher by this group were nuclear waste disposal and energy consumption.

**The researchers acknowledge and thank Ms. Kamariah Bakar, Ms. Joyce Smith, Ms. Jody Hines, Dr. Malcolm Swan, Dr. Audrey Tomera, and Dr. Richard Wilke for their assistance in collecting data for this study.

REFERENCES

Arbuthnot, J. 1977. The Role of Attitudinal and Personality Variables in the Perception of Environmental Behavior and Knowledge. Environment and Behavior, 9(2).

Avner, R. A. 1980. STAT: A Basic Statistical Service Package (11th ed.). Control Data Corporation, Minneapolis, MN.

Hungerford, H. R. and R. B. Peyton. 1976. Teaching Environmental Education. Portland, ME, J. Weston Walch.

National Wildlife Readers Speak Out. 1979. National Wildlife, 17(4), 16.

Public Opinion on Environmental Issues. 1980. Washington: U.S. Government Printing Office.

Rubba, P. A. and H. R. Hungerford. 1980. Secondary Students Perceptions of Top Environmental Issues. Illinois Environmental Education Update, 1980, 10(110), 8-9.

Rubba, P. A. and H. R. Hungerford. 1981. Science Teachers' Perceptions of the Top Environment Issues. Illinois Environmental Education Update, 11(7), 8-9.

Weigel, R. and J. Weigel. 1978. Environmental Concern: The Development of a Measure. Environment and Behavior, 10(1), 3-15.

Young, R. A. 1980. The Relationship between Information Levels and Environmental Approval: The Wilderness Issue. The Journal of Environmental Education, 11(3), 25-30.

Environmental Decision-Making: The Public Challenge

Louis A. Iozzi[1] and Janey M. Y. Cheu[2]

Abstract

The problems of deteriorating environmental quality, diminishing non-renewable resources, increased energy demands, adverse effects of technology, and population pressures present a challenge for citizens to think logically and creatively in dealing with such issues. However, research shows that only a small segment of today's adult population has adequate ability to do so. Development in cognitive thinking and moral/ethical reasoning is imperative. This paper will analyze the levels of cognitive and moral/ethical reasoning development required for effective environmental decision-making.

Introduction and the Nature of Environmental Issues

The call for societal participation in the environmental decision-making process has been sounded by many over the past decade. One of the more vocal proponents for this need has been Barry Commoner (1972), who elucidated the nature of environmental problems, and argued:

> "We come then to a crucial question: who is to be the Solomon of modern technology and weigh in the balance all the good that comes from it against the ecological and social costs?...
>
> "Confronted by decisions on nuclear power, radiation, nitrate levels, photo-chemical smog, bacterial warfare, and all the other technicalities of environmental problems, it is tempting to call in the scientific expert. Scientists can, of course, evaluate the relevant benefits: how many kilowatt hours of electricity a nuclear power plant can deliver and at what price; or the yield of corn to be expected from nitrogen fertilizer. They can also evaluate the related risks; the radiation dose to people on the vicinity of the power plant and the hazards to infants from nitrate levels exacerbated by fertilizers. These evaluations can be derived from appropriate theories, principles, and data.
>
> "However, no scientific principle can guide the choice between some number of kilowatt hours of electric power and some number of cases

[1]Department of Education, Cook College, Rutgers - The State University of New Jersey, New Brunswick, NJ 08903; Director, Institute for Science, Technology and Social Science Education, Rutgers - The State University of New Jersey, New Brunswick, NJ 08903.
[2]Associate Director, Institute for Science, Technology and Social Science Education, Rutgers - The State University of New Jersey, New Brunswick, NJ 08903.

of thyroid cancer, or between some number of bushels of corn and some number of cases of infant methemoglobinemia. These are values judgments; they are determined not by scientific principle, but by the value we place on economic advantages and on human life or by our belief in the wisdom of committing the nation to mass transportation or to biological warfare. These are matters of morality, of social and political judgment. In a democracy they belong not in the hands of 'experts,' but in the hands of the people and their elected representatives." (Commoner, 1972, pp. 197-198)

Indeed, the public has begun to respond. Lynton Caldwell, et al., (1976), have identified numerous case histories across the country to illustrate how citizens have attempted to impact policy decisions on environmental issues and concerns. In most of the cases cited, however, the citizen's role was an adversary one, challenging policy or protesting environmental degradation. Broad-base dialogue, or representation from society at large in the planning and decision-making process, was limited.

He noted that citizen activists for environmental quality were not drawn from the total public at large. Rather, such movements enlisted their support primarily from one segment of society:

"The environmental (and consumer) protection movements have drawn heavily upon the middle class for leadership and membership... These middle class activists command informational and organizational skills that can be employed to challenge official explanations and alibis. Among the citizens groups are accountants, lawyers, teachers, business executives, farmers, scientists and engineers." (Caldwell, et al., 1976, p. xix)

However, there are many problems associated with the participating decision-making process. As Harvey Brooks has pointed out (Brooks, 1976), a major difficulty in the participating decision-making process is that there is no way of assuring that all relevant interests and perspectives will be adequately represented. Brooks elaborates:

"Many affected groups may not even perceive that their interests are involved. Others may be young children, or unborn future generations. As many have stressed, people's needs and wants are not givens, but depend (among other things) on their knowledge of what is possible or available." (Brooks, 1976, p. 133)

While we strongly support these positions, we are also deeply concerned about the feasibility of the last point--specifically that dealing with public participation in the decision-making process. We agree that society should be involved in this process, but our concern centers on the question of can society deal effectively and equitably in resolving environmental conflicts and problems.

Caldwell, et al., underscored the crux of the problem regarding participatory decision-making on environmental matters:

"Technical and scientific expertise, requiring years of extensive preparation and experience, are required for the performance of a large number of problem tasks. Regardless of their intelligence,

persons cannot readily prepare themselves for the more demanding public functions like, for example, food and drug administration, aviation, nuclear reactor safety, or the analysis of flood control alternatives. The citizen can seldom offer expertise equal to that of the professional public executive or technician. How, then, can the concerned amature assist, correct, or control the behavior of the expert?" (Caldwell, et al., 1976, p. xxvii)

Environmental Decision-Making

What, then, is required of the citizen if he/she is to participate effectively and responsibly in the decision-making process? Clearly, knowledge of the issue(s) is important. But, an attempt to keep well-informed on most contemporary issues is, for most, an impossible task. The magnitude of the difficulty can be attributed to the "knowledge explosion" which is dramatically illustrated by Dr. Robert Helliard of the Federal Communications Commission:

> "At the rate at which knowledge is growing, by the time a child born today graduates from college, the amount of knowledge in the world will be four times as great. By the time that child is fifty years old, it will be 32 times as great and 97 percent of everything known in the world will have been learned since the time he was born." (Abbott, p. 26)

In addition to understanding basic knowledge about the particular environmental issue of concern, one must also be equipped to deal with the complexities of that issue. Thus, the citizen/participant in the environmental decision-making process will need, besides other specialized skills, to examine rationally the various possible alternatives to the problem at hand, to predict--with some degree of confidence--the probable consequences of an action, and moreover, to evaluate accurately the desirability of the consequences of the action. As cognitive developmental theorists have indicated, those involved in the decision/policy-making process will need: (1) an ability to analyze carefully a variety of complex problems; (2) to recognize and create perceptual and conceptual patterns; and (3) to link those patterns to expectations and compare the expectations to the actual outcomes of the decision rendered. Such complexity requires that those included in the environmental decision-making process function at the highest levels of cognitive development. Moreover, because the moral dimension is such a significant aspect of environmental problem solving, decision-makers must additionally be able to resolve conflicts at the most mature stages of moral reasoning.

Cognitive Development in Adolescence and Adulthood

The noted Swiss psychologist Jean Piaget has made major contributions toward analyzing and describing how children learn and how they develop logical reasoning abilities. According to Piaget, logical reasoning develops in a series of step-wise stages. Although Piaget typically avoided the association of age ranges with cognitive stages, his research indicates that between 2 years and 7 years of age children progress through

what he has called the sensory-motor stage. During the years 7 through 11, children progress intellectually through the stages of concrete thinking and between the ages of 11 and 15+ they reach the highest level of intellectual development, that of formal thought (operations). All children progress through the same sequences of stages, although at different rates. No stages are skipped, and so long as one is developing progress continues upwards.

Of particular importance to our theses are the stage of concrete operations and the stage of formal operations.

Concrete Operations

Individuals functioning primarily at the concrete level of reasoning utilize essentially an empirical-deductive process. Descriptive reasoning strategies such as

seriation or ordering and prioritizing
classifying or categorizing
measuring or quantifying

are the dominant strategies employed. More specifically, the concrete operational thinker is:

- capable of thinking logically in relation to physical (concrete) objects
- shifting from physical reversibility only to reversing mentally an action
- capable of mentally holding two or more variables at a time while studying objects
- able to reconcile apparently contradicting data
- becoming increasingly sociocentric and aware of the views of others
- able to think of physically absent things that are based on vivid images of past experience
- restricted, essentially, to dealing with objects rather than ideas.

In essence, the primary aim of the concrete thinker is to describe adequately his/her experiences, focusing on the here and now.

Formal Operations

The formal thinker, on the other hand, is capable of doing all that the concrete thinker can do, but he/she can, in addition, conceptually isolate and control variables. Formal thought is a hypothetico-deductive process

where one constructs hypotheses and mechanisms to test those hypotheses. It emphasizes such strategies as:

- proportional reasoning
- correlational reasoning
- probabilistic reasoning

With these reasoning strategies the formal thinker can:

- reason hypothetically-deductively
- generate multiple alternatives to problems
- distinguish between probable and possible events when dealing with reality and abstractions
- evaluate and compare possible consequences of alternatives
- isolate variables to test the validity of propositions; mentally control variables
- relate ideas - one to another
- reflect on own thinking

The primary aim of the formal thinker is the linking of events in terms of cause and effect relationships.

Information Processing - Concrete vs. Formal Thought

If, as we and many others contend, information or knowledge is an important --indeed necessary--component for effective decision-making, how does the concrete operational thinker deal with information? How does the formal operational thinker use information as compared to the concrete thinker?

In processing information, the concrete thinker deals with information essentially as a "given." He/she does not recognize inconsistencies and/or contradictions in various components of information. The concrete thinker, moreover, focuses essentially on singular variables--often reducing arguments and data to simplistic distortions. Complex information is not processed very effectively by the concrete operational thinker.

The formal thinker, however, handles information in a probabilistic manner--always questioning the adequacy and assumptions of the information. He/she correlates and compares the knowledge already acquired with new and emerging information. He/she constantly asks: how can the new information address the question at hand? The formal thinker, moreover, looks for discrepancies in information, organizes the information in new and unique ways, thinking creatively, and functions in a futuristic mode--continually seeking additional pertinent information. Moreover, the formal problem solver questions the benefits and hazards of particular decisions. Essentially, he/she asks: "Where will my decision lead?"

Clearly, the complexities and interdisciplinary nature of contemporary environmental issues and the far-reaching impact that decisions on those issues can have on the nation and, indeed, the world, demand reasoning at the level of formal operations. It should be evident that decisions and solutions rendered at the concrete level are sufficient for only a very limited number of the critical challenges confronting us.

Moral Judgment and Reasoning

Is formal reasoning in the cognitive domain alone sufficient for making equitable as well as effective environmental policy decisions?

As stressed earlier, an important--indeed critical--aspect of environmental problem-solving is the moral-ethical dimension (Commoner, 1972; Tribe, et al., 1976; Caldwell, et al., 1976). Scientific and technological feasibility alone cannot answer those questions that involve human values and aspirations. While there are many approaches used to describe this value domain, we find Kohlberg's cognitive developmental approach more encompassing and pertinent.

Refining and extending Piaget's early research in moral reasoning (Piaget, 1932), Kohlberg has determined that children progress in the moral realm through a series of stages. These stages are, in highly simplified form:

Stage 5: Social Contract

- Emphasis on democratic ethic and reaching social consciousness
- Respect for self and others

Stage 4: Law and Order

- Do your duty, set a good example
- Respect authority and follow the rules

Stage 3: Conformity

- What is right is what others expect of me
- Be kind and considerate of others - good intentions

Stage 2: "Back Scratching"

- What's right is what's good for me
- Eye-for-an-eye, tooth-for-a-tooth concept of justice

Stage 1: Obedience and Punishment

- Right is what authority commands
- Be good to avoid punishment

Each stage is characterized by a different way of perceiving and interpreting one's experience. At stage 2, for example, "right" and "wrong" are judged in terms of satisfying one's own needs and sometimes the needs of others if it is convenient to do so. Stage 3 reasoning centers around maintaining approval in one's own social group. The focus is on conformity to group expectations. At the higher principled (stages 5 and 6) stage, reasoning takes into account the welfare of others in a broader context, and includes concerns for human dignity, liberty, justice, equality--those very same principles upon which our Constitution is based.

In the Piagetian mode, Kohlberg views development, not as mere accumulation of information, but changes in thinking capabilities--the structure of thought processes. In the course of development, more complex thought structures are attained and result in the extension of an individual's social perspective and moral reasoning capabilities. Applying higher levels of thinking to problems results in problem solutions that are more consistent and more generalizable.

All children progress through the same sequence of stages in a stepwise fashion. No stages are skipped, but some people progress faster and farther than others through the stages. Stages 1 and 2 comprise the pre-conventional level, stages 3 and 4, the conventional level, and stages 5 and 6 collectively are referred to as the post-conventional level.

It is our contention that for the most part environmental decisions have been made at Kohlberg's stage 2--"What's right is what's good for me." The "here and now" mentality has dominated environmental decisions while a stage 5 reasoning maturity is what has been--and still is--needed. Simply, the state of the environment today can be traced to decisions based on stage 2 reasoning.

The Relationship Between Cognitive Development and Moral Reasoning

Moral reasoning and cognitive development are inextricably intertwined. One must be able to comprehend the complexity of the problem in order to deal with the sophisticated nature of the moral issues. Level of cognitive development, on the other hand, influences, and, in fact, limits the degree to which our moral reasoning capacity develops. As stated by Kohlberg and Gilligan (1971):

> "In Piaget's and our view, both types of thought (moral state development and cognitive stage development), and types of valuing...are schemata which develop a set of general structural characteristics representing successive forms of psychological equilibrium. The equilibrium of affective and interpersonal schemata, justice or fairness, involves many of the same basic structural features as the equilibrium of cognitive schemata logicality..."
>
> "What is being asserted, then, is...that the existence of moral stages implies that moral development has a basic cognitive-structural component."
>
> "The Piagetian rationale just advanced suggests that cognitive maturity is a necessary, but not sufficient condition for moral judgment maturity." (pp. 1069-1071)

In essence, then, the acquisition of late formal cognitive stage development is a necessary but not sufficient condition for post-conventional (stages 5 and 6) moral judgment; acquisition of early formal cognitive development is necessary but not sufficient for conventional (stages 3 and 4) moral maturity; concrete operations in the cognitive area is necessary but not sufficient for pre-conventional (stages 1 and 2) moral judgment maturity. Table 1 summarizes this view:

Table 1

Logical Stage	Moral Stage	
Concrete Operations (classifying and categorizing)	Stage 1	Obedience and Punishment
Concrete Operations (reversibility)	Stage 2	"Back Scratching"
Formal - Substage 1 (inverse of the reciprocal)	Stage 3	Conformity
Formal - Substage 2	Stage 4	Law and Order
Formal - Substage 3	Stage 5	Social Contract
	Stage 6	Universal Ethical Principle

The "necessary but not sufficient" implies that while formal operations may be necessary for principled moral reasoning, one may be a theoretical physicist (clearly capable of formal thought) and yet may not reason about moral issues in a principled manner.

Formal Thought and Moral Reasoning Development in Adolescence and Adults: Research Findings

Although the research reported by Piaget might lead many to believe that the level of formal thought is achieved by most people by the age of 15 or 16 years, more recent studies have not confirmed this. Lovell (1961) found that relatively few of his subjects, ranging from childhood to adulthood, operated at the formal level. He suspected that, by and large, the subjects with whom Piaget worked in Geneva were exceptionally able students.

Kohlberg, et al., studied 265 persons between the ages of 10 and 50. The subjects were lower-middle and upper-middle class California parents (age 45 to 50) and their children (age 10 to 30) (Kuhn, Langer, and Kohlberg, 1971). The percentage of 265 persons showing clear formal operational reasoning was:

Age	Percent Formal
10-15	45%
16-20	53%
21-30	65%
45-50	57%

Kohlberg, et al., concluded that "it is not until age 21 to 30 that a clear majority (65 percent) attain formal reasoning by the criteria utilized." They suggest that there is no further development for formal resoning after age 30. This means that almost 50 percent of American adults never reach the cognitive realm during adolescence (Kohlberg & Gilligan, 1971, p. 1065).

Chiappetta (1976) summarized 10 major studies dealing with formal operational thought. Each of the studies reviewed "(a) employed at least three (and usually more) Piagetian type tasks and, (b) where the researchers presented the tasks in a personal interview format to the subjects (Chiappetta, 1976, p. 25+). The results of Chiappetta's analysis follows (Table 2). Chiappetta concluded that over 85 percent of the adolescents and young adults did not achieve the level of formal operational intellectual development!

Labinowicz seems to most accurately summarize the situation insofar as cognitive development is concerned:

> "It is estimated that only one-half of the American adult population has reached the level of formal operational thought. Most adults reach the level of thought only in their area of expertise. The level of formal operations may be reached without advance schooling, as in auto mechanics. At the same time, a surprising percentage of college students do not function at this level." (Labinowicz, 1980, p. 87).

In the area of moral reasoning, Kuhn, Langer, and Kohlberg (1971) measured the moral reasoning maturity of the same sample of California parents and their children. They found that only 10 percent of that sample showed principled or stage 5 and/or 6 moral reasoning! Other follow-up studies conducted by the Center for Moral Education at Harvard produced results consistent with these findings.

Public Involvement in Environmental Decision-Making - the Needs

If we are, indeed, serious, and sincere about involving society as full partners in environmental decision-making, it is clear that we must proceed without delay to develop a citizenry that will in fact be capable of dealing with the complex and urgent tasks that lie ahead. While a sound knowledge and/or information base is a necessary prerequisite for intelligent decision-making and problem-solving on all issues, as discussed earlier, information alone is insufficient. Additionally:

- We must develop and implement programs of instruction that emphasize the cultivation and development of problem-solving, decision-making, and critical analysis skills--logical thought--in our youth. Such programs can and indeed should begin at the upper elementary grades and continue through secondary schools and into college and professional technical schools.

- We must develop and implement programs of instruction that directly address the moral/ethical aspects of environmental problems. Such programs must also foster growth towards more mature moral reasoning and behavior. This program also should begin at the upper elementary grades and systematically and sequentially continue through college.

Table 2
Studies of the Percentage of Subjects at Various Developmental Levels

Study			Developmental Level		
Researcher	Sample	Number of Tasks used	Concrete %	Transitional %	Formal %
Nordland, et al. (1974)	96 students age range 11.7-12.6 yrs.	10	83.4	---	15.6
Renner and Stafford (1972)	298 students grades 7,8,9	6	77	13	6
Renner and Stafford (1972)	290 students grades 10,11,12	6	66	17	14
Lawson and Blake (1974)	68 high school biology students	3	47	---	53
Lawson (1974)	high school students	5			
	51 biology		64.8	---	35.2
	50 chemistry		22	---	78
	33 physics		36.3	---	63.7
Nordland, et al. (1974)	506 high school students	10	85.8	---	13.2
Chiappetta and Whitfield (1974)	high school seniors	3			
	26 vocational		61.5	---	38.5
	26 general		53.8	---	46.2
	26 college prep.		27	---	73
McKinnon and Renner (1971)	131 college freshmen	5	50	25	25
Lawson and Renner (1974)	143 college freshmen	5	51	27	22
Juraschek (1974)	college students	3			
	141 prospective elem. teachers		52	---	48
	19 math student teachers		1	---	99
	11 honors calculus students		0	---	100

- We must ensure that curricula designed to accomplish the above are futures focused--concentrating on issues projected (with some degree of confidence) to be of importance one or even two decades hence. Moreover, such efforts should include critical analyses of contemporary environmental concerns as well as past issues to gain insights on the long-range benefits and consequences of our decisions.

A few such programs do, in fact, already exist. For example, Tanner's Of Democracy, Truth and Courage: Case Studies in Environmental Education has for some time provided a means for helping students to develop an awareness of the complexity of environmental issues and their inherent value components. The various critical analyses activities and experiences included in Tanner's six case studies are useful beginnings to develop the needed skills for complex environmental decision-making.

The Institute for Science, Technology and Social Science Education at Rutgers has produced Preparing for Tomorrow's World--a twelve-module curriculum designed primarily to provide a means for developing the types of skills described earlier in students in grades 7 through 12. This program which has proven to be highly effective has been extensively field tested, and has the endorsement of the New Jersey Department of Education. The program has also received national endorsement from the U.S. Department of Education and is currently under consideration by the Joint Dissemination Review Panel for inclusion in the National Dissemination Network.* Currently, the Institute is in the process of developing an additional set of six similar units for use in grades 4, 5, and 6.

In the Meantime...

The development of a society capable of dealing effectively and equitably with environmental decision-making/problem-solving cannot be accomplished within the time span of one year or even perhaps five or ten years. Unfortunately, though, our decisions and problems cannot be set aside while society attempts to develop the necessary capabilities. What can be done in the meantime?

From a developmental standpoint, the fact that many people do not develop to their fullest potential suggests that opportunities are not presented that challenge existing modes of thought. Development is in essence a process of active involvement on the part of the individual. Hence, responding to the call for citizen participation and providing opportunities for involvement at various levels may be the critical mechanism for increasing the capabilities of our citizenry. Where education can be structured to allow students to interact in more dynamic ways that promote growth, so too can this be offered at the community level. The context of environmental issues discussion has for all too long been that of adversary opponent confrontations, often becoming emotional matches. What is now needed are forums which allow greater dialogue

*Review Panel to meet on June 2, 1981.

between specialists, policy-makers, and citizens. Rather than isolating the issues to singular perspectives, the full range of views--scientific, technical, social, and ethical--must be explored and integrated. Our citizens must be exposed to situations that challenge them to look at complex situations from a broader, more integrative perspective. They must begin to wrestle with perplexing problems through mutual dialogues. Only through more open exchanges and mutual learning can more mature understandings be achieved.

For example, the "two cultures" gap elucidated by C. P. Snow is omnipresent in environmental matters. Each area of specialty has its own esoteric language and jargon. These communication differences need to be reduced to terms that can be more readily understood by all so that specialists can begin to share ideas and perspectives with each other. By examining common issues on a more common ground, each begins to learn from the other. Environmental decision-making can move owards greater and more effective citizen participation if the dialogue encourages explorations of various ideas to stimulate thinking in the various realms. This type of dialogue is, in essence, different from situations where one interest group vies with another to promote and forward its position. Such situations result in battles won or lost, with the environment the ultimate loser. Decisions made on this basis have not benefited from critical examination and input from varying sources.

As our environmental challenges increase, so too does the need for citizens capable of responding to those challenges. Therefore, it is important to insure that a larger majority of our society possess those more sophisticated abilities by providing opportunities for intellectual growth. Clearly, one's potential for development in both the cognitive and moral areas is dependent upon many other factors--not just educational experiences. It is our contention, moreover, that large segments of society have not developed to their fullest capabilities in the areas described because they were not, to date, challenged to do so.

We maintain further that through the dual approach discussed in this paper and using materials such as those developed by Tanner and ourselves, and engaging citizens in interactive dialogue, our goal of more meaningful and effective participatory decision-making will, in fact, be achieved.

REFERENCES

Abbott, William. February, 1977. Work in the Year 2001. The Futurist, XI, 1, 26.

Brooks, Harvey. 1976. Environmental Decision Making: Analysis and Values. Tribe, Lawrence, et al. When Values Conflict. Cambridge, Mass.: Ballinger.

Caldwell, Lynton, Lynton R. Hayes, and Isabel M. MacWhirter. 1976. Citizens and the Environment. Case Studies in Popular Action. Bloomington, Indiana University Press.

Chiappetta, Eugene L. 1976. A Review of Piagetian Studies Relevant to Science Instruction at the Secondary and College Level. Science Education. John Wiley and Sons, 60 (2): 253-261.

Commoner, Barry. 1972. The Closing Circle. New York: Alfred Knopf.

Gruber, Howard and J. Jacques Voneche. 1972. The Essential Piaget. New York: Basic Books, Inc.

Kohlberg, Lawrence. 1976. Moral Stages and Moralization: The Cognitive Developmental Approach. In Thomas Lickona (Ed.), Moral Development and Behavior. Theory, Research, and Social Issues. New York: Holt, Rinehart and Winston, 31-53.

Kohlberg, Lawrence and Carol Gilligan. Fall, 1971. The Adolescent as a Philosopher: The Discovery of Self in a Post-Conventional World. Daedalus, 1051-1086.

Kuhn, D., J. Langer, and L. Kohlberg. 1971. The Development of Formal Operational Thought: Its Relation to Moral Judgment. Center for Moral Education, Harvard University. Unpublished Paper.

Labinowicz, Ed. 1980. The Piaget Primer. Thinking, Learning, Teaching. Menlo Park, Cal.: Addison-Wesley Publishing Company.

Lawson, Anton. November, 1971. The Development Learning Paradigm. Journal of Research in Science Teaching, Vol. 16, Issue 6. John Wiley and Sons.

Piaget, Jean. 1965. The Moral Judgment of the Child. New York: Free Press.

Tribe, Lawrence. 1976. When Values Conflict. Cambridge, Mass.: Ballinger.

Integrating Environmentalism into the System: The Successes, the Tribulations, and the Implications

David I. Johnson[1] and James G. Truchan[2]

Abstract

Michigan Environmental Commission collected $200,000 in fines and penalities for pollution law violations from 1836 to 1974. Since obtaining concurrent jurisdiction, the Michigan Department of Natural Resources has collected over $6 million in fines and penalities from polluters for the state in criminal, civil, and adminstrative proceedings.

This paper briefly summarizes the development of the environmental law enforcement system, illustrates the enormity of current environmental enforcement problems, and discusses the implications for environmental education.

Appointing citizen commissions to manage natural resources and environmental concerns in Michigan began in 1873. That year the Board of Fish Commissioners was established by law, with an appropriation of $7,700. In 1887, the Forest Commission was established as an entity separate from the Board of Agriculture. The State Game, Fish, and Forest Fire Commission was formed in 1907. Other commissions such as the Public Domain Commission, the Board of Geological Survey, and the State Parks Commission were formed in the early 1900's (DNR, 1978).

In 1921, Public Act 17 combined all functions of the previously mentioned commissions into the Conservation Commission. The Act also created the Department of Conservation with a staff and Director. A Water Pollution Control Division was added to the new Department in 1925. This Water Pollution Control Division was abolished in 1929 and the pollution control function was taken over by the new statutarily created Stream Control Commission, separate from the Department of Conservation. Renamed the Water Resources Commission, the agency was included into the Department in 1966. In 1972 the Air Quality Commission and the Resources Recovery Division were transferred from the Department of Public Health to the Department of Natural Resources. In that same year, the Governor transferred his Land Use and Environmental Quality Committees to the Department of Natural Resources. With this centralization of environmental functions came an effort to improve environmental law enforcement effectiveness by the Department of Natural Resources (Anderson and Kammer, 1978).

---

[1]Department of Fisheries and Wildlife, 13 Natural Resources, Michigan State University, East Lansing, MI 48824.

[2]Department of Natural Resources, Environmental Enforcement Division, Mason Building, Box 30028, Lansing, MI 48909.

The citizen regulatory commission approach was successful because the laws were relatively simple, the violations were obvious, and because offenders willingly complied to commission orders. This same system when expanded to a comprehensive environmental protection program became a hindrance to enforcement of environmental laws. "Compliance without confrontation" had become the guiding philosophy to the staff which made enforcement recommendations to a commission whose representatives were drawn from the regulated groups. As a result, the permit system overseen by the commission system was "viewed by industry as a license to pollute rather than as a system instituted to prevent pollution." (Anderson and Kammer, 1978).

Individuals employed as staff to the commissions tended to be either engineers or scientists (usually aquatic biologists). Engineers were trained to design and evaluate the effectiveness of various pollution control systems, but generally not trained to evaluate the effects of pollutants on biological systems. Alternatively, the biologists understood the biological effects of the pollutants, but not the technology needed to minimize damage. Neither group was effective when administrative procedures did not bring polluters into compliance. Even with effective statutes, staff was ineffective in dealing with polluters because they lacked knowledge of the usual law enforcement processes and methods of collecting evidence suitable for court use in either criminal or civil proceedings. As a result, the commissions could only deal effectively with individuals and industries that were willing to comply. Unfortunately, many major water pollution problems in Michigan were not caused by polluters willing to comply with environmental statutes. Concurrently environmental problems have changed from simple Biochemical Oxygen Demand (BOD) problems to complex issues involving toxic substances, hazardous wastes, and illegal dumping by organized crime. Therefore, the inability of state institutions to handle these problems was partially a result of administrative structure, enforcement philosophy, and training of responsible personnel.

Recognizing in the early 70's the enormity of the environmental problems it faced, the Department of Natural Resources pressed for a consolidation of the environmental enforcement function. Beginning in 1973 (under the State of Michigan Executive Reorganization Order 1973-2) and completed in 1976 with the State of Michigan Executive Order 1976-8, the air and water commissions were transferred into the Department of Natural Resources and the Department was given concurrent enforcement authority. Since the change of enforcement power in 1976, the collection of fines and damages by the state has amounted to over $6 million. In contrast, the total fines collected from 1836 to 1974 was about $200,000. Only $4,000 was collected between 1970 and 1976. Therefore, if the dollar amount of fines collected is used as a measure of enforcement effectiveness, the recent changes in administrative structure, enforcement philosophy, and training of personnel has been an effective addition to the commission system.

Two cases which illustrate the legacy of the commission system and its inadequate enforcement will be discussed. The first of these is the Hooker Chemical site at Montague, Michigan. The second is the Story Chemical Company, located just to the south of the Hooker site near Muskegon, Michigan. These two cases are examples of corporate philosophy which completely frustrated the nonconfrontation enforcement policy.

The Hooker plant started production in the early 1950's producing chlorine, caustic soda, and C-56. The plant left approximately 1.2 million cubic yards of solid waste, drums, and heavily contaminated soils and including over 100 separate chemical compounds including Mirex, Kepone, Dioxin, hexachlorocyclopentadiene (C-56), carbon tetrachloride, and trichloroethylene. These toxic chemical wastes also contaminated nearly 20 billion gallons of groundwater which flowed from the company property, contaminating private drinking water wells and nearby White Lake.

A lawsuit was filed by the State in early 1979 to correct this problem. In October 1979, an out of court settlement was obtained that requires all the surface wastes, including 20,000 drums, be removed along with the underlying soils. The depth of soil removal will vary from a few inches to thirty feet. In addition, the former C-56 production facility will be demolished and the soil beneath excavated down to the water table (Kelley vs. Hooker Chemical and Plastics Corp., 1979).

The wastes and soils will be excavated and the C-56 production facility will be sealed in a specially-designed clay vault chamber on Hooker's property. The top, bottom, and sides of this vault will be constructed of compacted clay 10 feet thick with 10^{-7} cm/sec permeability requirements; to be large enough to contain the wastes the vault will be 800 feet on a side and extend about 50 feet above the ground.

The estimated 20 billion gallons of contaminated groundwater will be collected by a groundwater capture well system. The captured water will be treated by activated carbon filtration to remove chlorinated hydrocarbon contaminants. The treated water may be used in the plant or released into White Lake. The judgment requires that the capture well system be evaluated and upgraded if the flow of contaminants into White Lake is not halted. The Occidental Petroleum Company, parent corporation of Hooker Chemical, has agreed to pay up to $2 million over the next 50 years to operate and maintain these systems in case of bankruptcy or improper maintenance by Hooker (Kelley vs. Hooker Chemical, 1979).

But why was such a massive clean-up necessary? The answer is not simple. The company policy was hardline antagonism toward Department of Natural Resources staff. State employees were not allowed to enter the Hooker Chemical property without prior approval. Pictures taken of their property and its operations were confiscated. This company's antagonism and the lack of follow-up by the Department of Natural Resources allowed Hooker to contaminate the ground and groundwater with toxic chemicals for over twenty years. Only the actual filing of a lawsuit by the State changed the company's posture.

Antagonism was certainly not the problem at Story Chemical. Beginning in 1956 and continuing until the company went bankrupt in 1976, there was a constant stream of orders from the Water Resources Commission and its staff allowing discharges, reporting violations, and requiring upgrading. The company would promise everything, do a little, but never do it all or do it right.

> "State officials also stood by for years while the Company unleashed extreme toxic materials into the ground water in Muskegon County and

created the disaster which will be with those county residents for scores of years to come.

"For two years, during 1975 and 1976, residents in the vicinity of Story Chemical Company drank poisoned water coming out of their taps, even though the stench was nauseating.

"Repeated complaints from the residents drew local health department investigators attention and resulted in the discovery that poisoned water, cutting a half mile long swatch, was contaminating drinking water supplies.

"Fish died in local ponds, residents began drinking bottled water and property values declined.

"By the time state officials took decisive action, the Story Chemical Company had declared bankruptcy." (Anderson and Kammer, 1978).

After the company went bankrupt in 1976, the site was abandoned, leaving a site which contained 10,000 drums of various chemicals, 90,000 pounds of phosgene gas, and 6,000 pounds of chemical sludge of unknown chemical composition. The surrounding groundwater was also contaminated with known carcinogens up to 1-1/2 miles away from the property. The value of the homes with contamined groundwater surrounding the site have plummeted and many residents drink only bottled water.

The State received $600,000 from a property purchaser for clean-up of the site. In addition, the State legislature appropriated $670,000 to provide an interim water supply to the affected residents. In 1977 the on-site surface wastes were removed. Subsequently, new waste disposal sites from another chemical company were discovered which stopped the water supply project. The cost for a water supply system has now risen to more than three million dollars. It now appears the federal government through EPA's Superfund will be able to fund cleanup of this site. It must be reiterated that Story Chemical seemed willing to cooperate, but failed to do so despite numerous requests by the Commission and its staff.

Examination of these case histories reveals that once outside the realm of the law-obedient majority, the prosecution of environmental polluters closely resembles other criminal prosecutions. These "environmental criminals" have made millions of dollars, used up or destroyed public resources, and then have left the results of their profiteering for tax dollars to reclaim. They perpretate their crimes by preventing investigation or failing to obey commission or court ordered clean-up. They are willing to use the same methods that other criminals use to avoid obedience to the law. Because of this attitude, the State's only recourse was to approach the problem using traditional criminal and civil law processes.

It was this milieu in 1976 that initiated the Governor's Executive Order (ERO 1976-8), which transferred concurrent enforcement power from the Water Resources Commission to the Natural Resources Commission which then delegated that responsibility to the Director of the Department of Natural Resources. New enforcement procedures were then developed which were

independent from the commission system. The current Water Resources and Air Pollution Commissions and Resource Recovery Division still issue permits, enter into agreements, and issue orders, but they have limited enforcement discretion and act primarily in an advisory capacity.

This system is not perfect. Commissions staff still often fail to utilize the enforcement potential available to them because their supervisors operate under a non-enforcement philosophy. As a result, it is not uncommon for permit violators to receive 6-10 letters warning them to stop their discharge. When data are collected to be used in court actions, they will likely be collected improperly, and if a sample is collected it may not be kept with the proper "chain of custody". Both failures negate the use of such material as evidence in court.

The Michigan Department of Natural Resources has attempted to address the enforcement problems by the establishment of a special structure and a staff trained to enforce environmental laws through voluntary or court-ordered compliance. Their authority permits them to investigate, arrest, develop cases, negotiate, and obtain compliance with the environmental laws of the state. Since this staff is not comprised of lawyers, all of these activities are done with the knowledge and direct assistance of the State Attorney General's Office and local county prosecutors.

In 1978, the enforcement group became institutionalized within the DNR as the Environmental Enforcement Division with four branches. The three branches directly involved in enforcement activities are:

Civil Litigation - develops and prepares cases involving hazardous wastes and unpermitted water discharges.

Permit Enforcement - develops and prepares cases involving statute violations of air quality, solid wastes, and permitted water violations.

Investigation and Training - conducts investigation of possible criminal, civil and administrative enforcement actions and also provides investigative training department-wide.

The fourth branch, Environmental Review, deals with preventive enforcement. That group reviews and presents environmental impacts of department activities as well as coordinates impact studies with other agencies, municipalities, and industries needing permits for various projects.

From the description of the Environmental Enforcement Division, the relationship of the three enforcement branches may not be apparent. The investigation and training branch contains the true police officers of the group. The individuals in this branch are trained in traditional criminal police work, but also have technical backgrounds in water quality, resource recovery, or wildlife biology, etc. These officers do field investigations, serve warrants, make arrests, coordinate with the other law enforcement agencies, and oversee the evidence collection (chain of custody) from field to lab to court. Their diversity of responsibility requires technical competence in the major environmental areas (air, water, toxic materials, and hazardous waste) and particularly in field observation

skills. However, the major proportion of their training must be law-oriented.

An example of the criminal section's effect is a case involving the Michigan Department of Transportation (MDOT). MDOT was caught dumping brine from a salt storage area into the Huron River. Environmental enforcement officers served warrants on the Director MDOT and other knowledgeable people in his Department at the direction of the local prosecutor. The political fallout was extensive. One interesting detail is that the Director of the MDOT was a past member of the Water Resource Commission, the Commission whose statutes he and his department were violating.

The permit and civil litigation branches have very different enforcement responsibilities. The permit group generally works within the commission system. Most enforcement actions involving permit violations are handled by administrative law processes. This process uses a hearing system in which the permit violator presents his/her case, with or without counsel, to a hearings officer. The hearings officer then makes a decision regarding the merits of the case. The permit violator may be exonerated or may be required to stop the violation as ordered by the hearings officer or the case may be escalated to civil litigation if violation continues to occur despite an administrative order requiring abatement.

Suing a company is always a long process since civil lawsuits are generally heard last on the State court dockets. Often there is a two, or more, year lag before a case comes to trial. Such lag times create a real problem in hazardous waste and toxic contamination problems. Once a suit is filed, the company must file a disclaimer on the annual report to the Security Exchange Commission if it engages in the sale of securities. When this disclaimer is posted, the company finds it difficult if not impossible to borrow money so the threat of civil suit is an important deterrent. It may in fact urge larger corporations to settle out-of-court to solve the problem rather than defend itself in a lawsuit. Filing a lawsuit is no frivolous decision. The evidence must be prepared, the witness list must be developed, and in general the case must be completely prepared before referral to the State Attorney General or to a county prosecutor for prosecution.

Unfortunately, very few people are trained to do environmental enforcement work and time required for on-the-job training is no longer appropriate. Therefore, on-the-job training must be provided for those already working for environmental enforcement agencies, as well as preparing traditional students to assume this role.

It should be understood that all the knowledge, attitudes, and skills needed may not be achievable in the traditional educational formats, but they can be achieved through utilization of other disciplines and experiential programs. The foundation for environmental enforcement must be technical competence in ecology and in the broad field of environmental science. Specialized expertise is a must so that an individual can participate effectively as an expert witness. Which also provides professional self-satisfaction. Breadth of knowledge is also required so

the enforcement specialist can examine a situation, locate pertinent data, organize required expert witnesses, examine briefs and depositions, and assist attorneys in developing the right line of questioning for the case. Problem-solving skills, and the ability to understand the data generated and its limits based on statistical analyses, are fundamental.

Engineering expertise among enforcement officers must be sufficiently adequate so that they will be able to communicate with engineering experts. Environmental engineers must be more than engineering experts; they must be able to understand the ecological consequences of their engineering decisions. They both must be conversant enough to present alternative engineering solutions and their consequences to solve the pollution problem appropriately for society and the ecosystem.

An understanding of business fundamentals is also imperative. Just as the FBI employs accounting techniques to discover fraud, so must environmental investigators. They must understand business finance, accounting, and general business organization so that they can effectively investigate and develop cases against companies that violate business laws as well as environmental laws. Enforcement personnel must work with the business world on a day-to-day basis; therefore, they must have an understanding of white collar crime and its implications.

Potential enforcement personnel must become familiar with the legal system, a system much different from academia. It is an antagonistic system where the differing paradigms and statistical inference of academia are inconsequential. The opposition tries to discredit your testimony by attacking your background, knowledge, or self-control. Your knowledge of ecosystem effects, public health effects, and the economic and social consequences of those effects must be confidently and effectively communicated to laymen and judges with no technical background to convince them of the veracity of your position.

The environmental scene has moved from the streets in the late sixties and early seventies to the courtrooms and boardrooms in the late seventies and early eighties. For the most part, the laws are in the place, but we as environmental educators need to provide the skilled personnel to enforce those laws.

REFERENCES

Anderson, Thomas and Kerry Kammer. 1978. Preliminary report of the Special Joint Committee to study State Procedures dealing with pollutants and contaminants. The Michigan Legislature.

Department of Natural Resources. Environmental Enforcement Division. Story Chemical File. Box 30028, Mason Building, Lansing, Michigan 48909.

_____. A Partial List of Chronological Events Important in Michigan Conservation. Box 30028, Mason Building, Lansing, Michigan 48909.

Kelley vs. Hooker Chemicals and Plastics Corp., Ingham County Court #79-22878-CE.

The State of Michigan. January 15, 1973. Executive Order 1973-2. Transfer and Consolidation of Environmental Functions within the Department of Natural Resources Executive Office.

_____. Executive Order 1976-8. June, 1976. Reorganization of the Department of Natural Resources, Executive Office.

Environment, Technology, and the American Dream

John Opie[1]

Abstract

Technology has historically been seen as a liberating force in modern society; in the United States technology is even associated with the fulfillment of democratic ideals. An environmental or holistic approach demands reappraisal of technology, but not in terms which entirely repudiate its value.

The greatest revolution in human history has been largely neglected by scholars. Gradually, over perhaps 500 years between 1300 and 1800, a shift in human perception took place which completely reversed the poles of culture. Since the beginnings of self-consciousness three million years ago, humans believed the entire outside world was filled with sentient life. Animals, trees, soil, rocks, and the sky had life, thought, emotions, will, and actions. The wind literally caressed. The sea was savage. Trees did whisper. Rocks hurtled themselves down cliffs on unsuspecting travellers or were agents of unseen willful forces. This panvitalism (animism) is not surprising, since ordinary wisdom would lead humans to conclude that the outside world had the same characteristics as what they were most familiar with, themselves. The greatest riddle of this earlier world was not life, but death.

Western civilization, through Western science, discovered lifeless materiality. Gradually, by means of the decline of Christian spirituality in the late middle ages, the isolation of the individual in the Renaissance, the rise of modern skepticism, and the extraordinary power of science to explain the cosmos, the earlier panvitalism was traded for an inanimate world. The irreducible essence of existence in a Newtonian world was not consciousness but minute particles in a vacuum, stationary or in motion. By the 20th century even the human brain was comprehended in light of chemical exchanges and electrical charges. Not only the outside world but humanity itself was best examined when broken into component inanimate parts. The greatest riddle of the modern world is not death, but life. Even religious questions center on the Silence of God and the Death of God, or at least His absence as a life-giving force.

Since the Renaissance, at least, human self-consciousness, in all its complexity, has been set over against the vast grinding world of materiality. There is a deep-seated polarization in the modern Western mind which is all the more profound because it seems beyond explanation. Consciousness and materiality are so different it is difficult to discover points of contact. On the one hand is man, more supremely aware in the

[1]Fellow, National Humanities Center; Editor, Environmental Review; Professor of History, Duquesne University , Pittsburgh, PA 15282.

modern world than any other era of his unique capacities of mind and spirit. On the other hand is this compelling commitment to inanimate materially as the foundation for all existence. And the equally compelling drive to reduce even humanity to this lifeless conglomerate. Materiality is both the method and the subject. But is not the process the denial of humanity?

Look at the explanation of the French Annales historian, Fernand Braudel, in his monumental studies of the Mediterranean world in the 16th century, and of early modern capitalism. For Braudel, the truth, reality, and essence of history are in elemental geographic "structures." Humanity's physical surroundings overwhelm mere "events" of human history; Braudel's search is for "a history in slow motion from which permanent values can be detected." What stands out in the New World, for example, are the vast spaces. Human influences seem paltry, like islands set up in the middle of incomprehensibly large oceans, buffeted by superhuman forces. Braudel plays down the ordinary sequence of political, military, community, family, individual, and cultural events almost into insignificance. Life is like an efflorescence, a penumbra around the sun, compared to the cycles of slow, repetitious, ever-recurrent, geographical movement, crossing uncounted generations. Braudel's structures are omnipresent limits for human possibility: food supplies, populations, and the struggle to tame nature are all involved in this "ground floor of history." Technology appears on the scene as Braudel's "conjuncture," the process or mechanism by which humanity seeks to cope with the vast materality of the world.

One historic response has been to take advantage of the material world's mindlessness. In the year Thomas Jefferson became President--1800--virtually all of mankind lived in material want. This scarcity of humanity's physical needs was its historic condition. Most of the people who have ever lived have been poor and hungry. But by 1800 the new United States was entering an era, in the words of the modern philosopher, Alfred North Whitehead, "when even wise men hoped." A major component of Jefferson's phrase in the Declaration of Independence, "life, liberty, and the pursuit of happiness," applied to the material improvement of a better standard of living. Jefferson insisted that a large part of human misery was the oppression induced not only by tyranny but by poverty. In a new age of humanitarian awareness, thoughtful Americans could not be indifferent to human want.

Jefferson, Franklin, and other leaders were intensely aware that the new society they proposed must be grounded in material improvement as well as political liberty. Congress was given express authority "to lay and collect taxes, duties, imposts, and excises, to pay the debts, and provide for the common defense and general welfare." The government was to encourage "internal improvements." There was no doubt that the Declaration of Independence, the Revolution itself, and the transformation of the Articles of Confederation into the Constitution were in large part responses to economic grievances. By 1800 the test was to see to it that these vague promises of a better material life be put into practice.

A pragmatic "American Enlightenment" provided the dominant climate of opinion during the formative years of the new nation. This was an intellectual consensus which affirmed the powers of human progress. Less

often noted, the Enlightenment stressed that human pain, suffering, poverty, and deprivation were not accepted as man's eternal lot, but wrongs which required immediate attention. The imperative of the new age was to make ordinary daily life good, rational, and orderly. The American Enlightenment can be identified as the beginning of attention to material improvement in a "standard of living."

During this formative era in American history, a debate appeared over the proper interaction between man and the surrounding material world. Could agriculture or manufacturing provide more adequately for the physical and moral well-being of Americans? Which would fulfill the new ideals of humanitarian benevolence, human progress, and cultural growth? Jefferson concluded that the genius of America was agriculture; the American yeoman farmer, laboring independently on his family plot, was the essence of virtue. America's strength rested in the independent, privately-owned, small family farm. Alexander Hamilton's 1791 Report on Manufactures argued, in sharp contrast, for industrialization as the ultimate weapon in mankind's struggle with nature. Technology was "an artifical force brought in aid of the natural force of man . . . . an accession of strength." Human labor devoted to manufacturing was superior to agricultural work: "constant" not "seasonal," "uniform" not "careless," and noticeably "more ingenious" and hence "more productive."

But technological innovation took place under specific circumstances. Unlike the political fireworks of Declaration of Independence, Constitution, Bill of Rights, and the two-party system, the new United States had not exploded upon the industrial scene. National leadership was intensely aware of the severe material limitations of the new nation. Henry Adams wrote in terms which combined Braudel and F. J. Turner's "frontier thesis." "Even after two centuries of struggle the land was still untamed: forest covered every portion, except here and there a strip of cultivated soil; the minerals lay undisturbed in their rocky beds, and more than two thirds of the people clung to the seaboard within fifty miles of tide-water, where alone the wants of civilized life could be supplied. . . . Except in political arrangement, the interior was little more civilized than in 1750." Elsewhere Adams noted, "No civilized country had yet been required to deal with physical difficulties so serious, nor did experience warrant conviction that such difficulties could be overcome."

But reeling from the War of 1812, and especially the effects of the embargo and high tariffs, it became clear that the United States could not survive as a pastoral and agrarian nation alone, no matter how prosperous.

Eventually, as tens of millions of European immigrants poured into the new United States in the 19th century, they would be attracted not only by liberty and democracy, but also by the opportunity to achieve a high standard of living and quality of life not attainable to elsewhere. American institutions encouraged technological development which made life easier. After millenia of scarcity, poverty, and human degradation, the promise of America became a reality through technological improvement and implementation.

But this abundance was not always the case. The United States was once an undeveloped country. In 1800 90 percent of the people lived on subsistence

farms in "undertooled" circumstances. Their technology had not changed substantially since Roman times. By necessity the typical American was a self-sufficient farmer and lived under high risk conditions. He lived in a world of wood and stone, hand tools and animal power, of hard physical labor, and little protection from the hardships of climate, disease, and deprivation. Power-driven machinery was limited to water wheels and windmills to grind grain, saw wood, and power furnace bellows.

The spread of agricultural prosperity was a major achievement in itself; to establish manufacturing on any large scale would be extraordinary. But contrary to expectations, by 1850 American society became vastly different from the largely agrarian paradise of 1800. Americans experienced a major expansion of new material goods undreamed of in 1800. Through prodigious use of water power, wood, and coal to run the new machines in the new factories, large-scale production did more to transform American life than would have been possible through traditional farming, no matter how prosperous. Hamilton's belief in the superior results of mechanization seemed vindicated. American measures of standard of living and quality of life were not merely improved but changed as well. Through the labor-saving powered machines in the factories. Americans believed they had created entirely new opportunities in a society already rich in resources. Even Jefferson acknowledged the utility of applied science. Technology became not the opposite pole from humanity, but a middle ground mediating between the human spirit and worldly nothingness.

Robert Heilbroner called the transformation produced by the American System the beginning of a "democracy of things." The measure for a superior standard of living included not only basic necessities, but increasingly items that made life convenient, comfortable, and "progressive." Items unimagined in 1800, or extremely expensive in 1815, were soon taken for granted as the rightful possessions of a large middle class. Bent pieces of iron were replaced by safety pins, wax paper was superseded by large cheap panes of window glass. The traditional flint and steel was replaced by the newfangled safety match. Machinery now turned out cotton textiles, carpeting, shoes, "patent" furniture, tableware, and wall paper became the style instead of paint or leather wall covering. To the list must be added cast-iron stoves, spring mattresses, flush toilets, gaslights, and even rollershades for windows.

The American dream which lured immigrants for generations, can be seen as having two levels. One can be described in the phrase, "food, clothing, and shelter for all,: or the realization of the promise of a better material life. Mankind has lived in scarcity most of its history; American society was the first to effectively break out of the pattern and build a civilization based on abundance. The second level is summed up in the three words--liberty, equality, opportunity. A democratic society, whatever its limitations and faults, claims to be superior in its creation of the free individual.

My specific interest in this framework is to analyze the contribution, if any, of technology to the American dream. Is the American dream an abstraction outside of ordinary life? Does America as an industrial society have relevance to America as a democratic open society? The conclusions are obvious: basic American democratic goals are a mockery unless

there are means to reach them. The higher level of life created through science and technology provides some of these means. Conversely, science and technology are worthless unless there exists a social climate willing to try and test their effectiveness in improving life. But we need clearly articulated definitions of the American dream, to explore science and technology as societal tools, and to ask what clear and direct links exist between features of the American dream, the features of a technological world, and the features of American geography.

By 1900 Americans seemed to have acquired a permanent wealth-making mechanism made up of coal to burn, steel to process, machines to fabricate. In 1900 the annual value of manufacturing was more than twice that of agricultural products, a pace of growth and change that many countries today would find hard to match. Already in 1895 the United States had become the leading industrial power in the world and by 1910 its output was twice its nearest rival. By 1913 the United States accounted for more than a third of the world's industrial output. Between 1865 and 1915 steel production rose from a typical (for the era) 16,000 tons to an unbelievable 56 million tons. Even Andrew Carnegie was incredulous:

> To make a ton of steel one and a half tons of iron stone has to be mined, transported by rail a hundred miles to the Lakes, carrried by boat hundreds of miles, transferred to cars, transported by rail one hundred and fifty miles to Pittsburgh; one and a half tons of coal must be mined and manufactured into coke and carried fifty-odd miles by rail; and one ton of limestone mined and carried on hundred and fifty miles to Pittsburgh. How then could steel be manufactured and sold without loss at three pounds for two cents? This, I confess, seemed to me incredible.

The combination of cheap energy resources, new processes, industrial centralization, and intensive capitalization made steel extremely cheap. In 1873 it had been $100 a ton, too expensive for steel rails. Carnegie's 1875 Edgar Thompson Works in Pittsburgh in one step halved the price to $50 a ton. Ten years later it was $20 a ton and by the turn of the century less than $12 a ton, almost one-tenth the price a quarter-century earlier. Steel replaced iron as a universal metal in railroad bridges, girders for buildings, nails and wire, and transformed American material life.

The nature of human endeavor itself changed. Moderization did not come easily. Regimented, identity-less working conditions led to dehumanization and the potential for conflict. The Strike and Panic of 1873, the Railroad Strike of 1885, the Haymarket Affair of 1886, the Homestead Steel Strike of 1892, and the Pullman Strike of 1894, brought on widespread fears of economic collapse, threats of socialist and anarchist conspiracies, and ultimately revolution. But workers and farmers did not rise in proletariat rebellion. The property and lives of the middle class were not taken away. The apparent death throes of American civilization were really its growing pains. The same fragmentation of labor that caused strife also enormously increased productivity. Between 1865 and 1929 productively increased fourfold. The standard of living during the same period rose at a spectacular rate, a fundamental explanation why American experienced labor strife but no labor revolution. New patterns of consumption created new demands for income, including the accelerating move from the historic small

farm to the new industrialized city. Many Americans experienced a transition from working class subsistence goals to middle class aspirations, often regardless of individual income or status.

By any external measure, the standard of material life that Americans claimed around 1900 was remarkably high. Even by European standards it was very prosperous. Americans began to demand a cornucopia of goods at moderate prices, with superior durability, convenient to use, and which would create new, interesting, and useful activities. Desireable household furnishings included wood stoves, sewing machines, "cabinet" furniture, carpets and fabrics, clocks, china, glassware, the horsedrawn buggy. In a great degree, individual rural households set the pattern for American consumer expectations well into the twentieth century. (In 1900, 60 percent of all Americans still lived on the farm.) Goods became standardized and mass-produced, not individually custom-made according to taste. These material aspirations which spread across American now took for granted high energy availability to power industrial production.

The blandishments of technology were irresistible. But was not the mediating power of technology so great that nature was dangerously exploited on the one hand and on the other hand humanity subverted? These were the questions raised in the era of progressive reform.

Immigrants admired Americans because they appeared to be a bold, energetic, inventive, and enterprising people who took high risks for large results. Historically, Americans stuck with a technology until it worked properly. In the 1880s, steamboats did blow up too often, but they were needed to make the Mississippi region thrive. Trains repeatedly derailed but they were needed to span the continent. Early in this century, everyone who travelled in an automobile carried a tire repair kit and expected to use it often; the cars and tires and roads only gradually improved. With patience, and with a large amount of time, money, and engineering skill to set things right, innovations like the airplane were made more risk free. The rewards were the greatest material abundance in human history.

People believe in a technology, or repudiate a technology, not intrinsically or in itself, but because of the service or function which a technology offers, and in relation to perceived or real technological hazards. In an undeveloped American society, as early in the 19th century, with an economy of scarcity, the original function of technology was to offer a substitute for hard physical labor, and to produce goods more rapidly, at lower prices, with higher quality.

Economic growth emerged as the most prominent objective in the United States. This was material growth, the result of technology and industry, measured by GNP. Growth was the foundation for (1) the promise of a democratic society, (2) the promise of the middle class, and (3) belief in quantitative progress. Industrial growth was the framework for scientific discovery, technological innovation, business enterprise, capitalistic economics, and the management of large, complex, systems. The traditional American conviction was that more is better, and Americans acquired a reputation for their preoccupation with material wealth. Especially they argued that it overcame poverty, created jobs, and incomes, and encouraged freedom, equality, and opportunity. The policy of growth was to make

abundant supplies of energy available at the cheapest prices in order to expand the productivity of labor.

But the ideal of economic growth has recently come under severe attack. It is described as cancerous, actively dangerous, creating dehumanized situations, and leading to the degradation of life, including pollution and ugliness. This argument stresses a negative balance from economic growth. Growth based on industrial technology has been a failure. It does not eliminate hard-core poverty, suffering, and inhuman conditions. All of these may actually be on the increase. Analysts report on contemporary problems of growth. Its benefits are unfairly distributed, despite surpluses. Growth can damage the environment and waste resources. Unproductive or dysfunctional growth has not been distinguished from productive and socially useful growth. Dysfunctional growth includes military development and porkbarrel works.

Nevertheless we have enjoyed over two hundred years of a strongly supportive material resources and technological base for our abstract ideals. I want to call these the four pillars of American abundance--cheap food, cheap land, cheap water, and cheap energy, of high quality and readily available. No other people in human history have been so fortunate. These pillars gave us not only our high standard of living but also a superior quality of life. And simultaneously they gave us the opportunity over time to prove our institutions: free, open, pluralistic, democratic.

But recently these pillars have been shaken in very direct ways. Food prices go up and yet are still unreasonably low as far as farmers are concerned. We are running out of good farmland while real estate prices skyrocket. Large parts of the nation are perpetually short of water, threatening a nation-wide crisis. Agitation over the "energy crisis" has become tiresome, but the crisis is as real as its high prices. It is as if the supports of American society have been unexpectedly pulled out. The fear is whether our technological agility can resolve the problems, but even more it is fear over the loss of the American dream. Our perception of the American dream helps determine how we view our standard of living and our quality of life, which in turn explains how and what we value in our lives. We might divide these values into three categories. The first we can call the fulfillment of basic human needs: food, clothing, housing, medical care. In the United States we tend to take these as a birthright. They are still hopeful goals in much of the world. The second category I call entitlements: good health, family cohesiveness, a useful and liberating education, personal safety, and personal integrity (continuity and dependability in daily life). These we believe we deserve--are entitled to--because we live in an industrial and democratic society. The third category can be labelled higher aspirations, or factors which make life satisfying: human dignity, self-esteem, freedom to choose one's individual destiny, economic equity, political justice, social and physical mobility, and freedom of knowledge. The purpose of a civilization is to move beyond material survival alone. A sufficient standard of living is the foundation of civilization, and civilization also encourages aspirations to a superior quality of life.

A parallel set of widely-held contemporary beliefs about a democratic society constitutes the following:

Since the founding of the nation, Americans have a common allegiance to ABSOLUTE IDEALS, which are akin to "inalienable rights," notably liberty, equality, individualism, property, progress, and public order.

These absolute ideals are guiding principles for PRAGMATIC IDEALS (the means to achieve national goals), including the work ethic, productivity, entrepeneurialism, and education, in turn stressing qualities of initiative, adaptability, experimentation, versatility, and ingenuity.

Pragmatic ideals produce results--CONSEQUENT IDEALS. Most evident are material abundance, economic growth, social stability, freedom (liberty, equality, opportunity), and "quality of life."

While these democratic ideals usually belong to the domain of politics, few of them can be realized except through the conditions which encourage technological innovation and industrial development. We cannot avoid a circular argument here, like a positive feedback loop. Technological innovation, properly applied, creates and guarantees normative values. And basic beliefs about the needs and aspirations of society are embodied in the development of technology. But the question raised in the last two decades is whether the negative aspects of the feedback loop have come to dominate the relationship, thus bringing on the classic polarization.

We need to go back not one decade but four, and we find that a look at three books, in 1940, in 1950, and in 1960, clarifies the situation.

1940 was a grim year, set between two decades of strife and uncertainty about the future of American democracy. Basic American values were shaken by internal collapse, notably the Depression, and by the external challenge of totalitarianism. In 1940 the historian Ralph H. Gabriel examined the fortunes of an American Democratic Faith--the clusters of belief which historically had sustained American society. He concluded that these beliefs had endured through major changes and crises in our history, and were still useful under modern conditions.

In other words, Gabriel asked by what permanent values do Americans measure themselves. And what do they consider a successful realization of their goals? Or conversely, what do Americans consider signs of decline or failure? We are asking the same questions in the 1980s in a different milieu of national and individual priorities. What are the relationships between the energy, technological, economic, environmental, and human aspects of society? How are democracy and technological development related? What are the links between national goals, quality of life, and economic prosperity?

In 1950 David Potter wrote his historical classic, People of Plenty, which emphasized that the promise of a democratic society lies in the productivity of modern technology and industrial development. He reflected the temper of his own time when he concluded that the feedback between human values and technology was not only positive but essential.

The public climate began to change in 1960. Especially influential was a new environmental awareness. In 1960 Rachel Carson's Silent Spring, and the attempts by major chemical companies to prevent its publication, raised the public's consciousness about environmental degradation. It seemed that high-technology industry was the major culprit, and in the case of the chemical industry, the very success of powerful insecticides devised by high technology became the focus of controversy. For the first time high technology itself came under attack (as would nuclear technologies later).

Closely associated with an environmental critique was the Club of Rome 1972 report, The Limits to Growth. This international analysis influenced the United Nations and drew attention from national governments. Its computer-based position argued that the world's population, economic production, food requirements, and pollution levels will "overshoot" available resources by 2000; the biosphere will not have the capacity to sustain the man-made world. This stance was criticized as too pessimistic, and the Club of Rome has since modified its views, but the magnitude of the issues raised has reinforced public concern about the negative relationship between technology and society.

The last two decades have led Americans to cast a critical look at their historic "production ethic" measured by economic growth and GNP. We can no longer rely on cheap energy and cheap food to perpetuate the "Christmas syndrome" of the "people of plenty." But any threat to the abundance of consumer goods, steady and satisfying economic growth, and a generous standard of living, is deeply disturbing and enervating. As noted above, the new environmental awareness of the 1960s has created doubts about major side effects of high technology industrial output. In the 1970's, growing energy scarcity raised questions about how well American economic habits could continue into the future. In both decades the persistence of poverty and human suffering disturbingly contradicted the abundance promised by technology. In sum, the American way of life seemed flawed, perhaps fatally. And the shape of modern society seemed to be changing, due also to endemic inflation, the decline of international superiority, and the unexpected pressure on most Americans to live with less on lowered expectations. Fresh interest in alternative "voluntary simplicity" life styles based on "appropriate technology" has encouraged active criticism of existing American living standards.

Another form of criticism, largely from the business community, emphasizes concern over the troubled state of American's technological capability, especially when innovation and productivity are compared to foreign advances. According to this viewpoint, America's major problem is that the pace of progress is slowing. If American society is characterized by growth and change, any slowdown forces a broad-based examination of causes and consequences. This includes the unrest about a "production ethic." Are people unwilling to make the necessary social adjustments to allow for further technological innovation? Blame is laid upon hesitation due to environmental awareness, fears over public safety, and government regulations. What are fundamental American values conducive to productivity and control of inflation?

Today's tension between positive and negative views of technology and its fruits has led to America's own extended version of "two cultures."

Advocates argue that technology maximizes output of labor, reduces hazardous or degrading work, maximizes use of resources, and develops new materials (plastics). From this stance, more technology, not less, is the only ethical course. Advocates argue that technology humanizes American values, such as freedom and justice, by making them attainable. Critics believe that technology produces undesireable products, has harmful side effects, such as pollution, uses up irreplaceable resources, creates inhuman social conditions, with unforeseen future impact, and its long-range consequences are dangerously unknown. Critics stress a new morality, emphasizing environmental protection and public safety for a better human weal. The risk factors and cost factors are too high. In sum, advocates picture technology as the source of a protective "armor" for humanity while critics stress human vulnerability--a "eggshell" view--to the hazards of a technological society.

But this confrontation also contains a high degree of ambiguity which raises doubts about differences in substance. Advocates of industry admit that the days of the Christmas syndrome are over, while critics of industrial technology admit that material growth is a primary means to overcome scarcity, poverty, and limitations to quality of life. High technology and quality of life, once again, may not stand in opposition to each other.

Underrated "externalities," so often ignored in the development and use of technologies, make up the clusters of belief in the American Democratic Faith. These include notions of standard of living and quality of life which form public opinion and dominate public policy. Exploration of the past, present, and potential future of these clusters of belief, too often judged irrelevant, immeasureable, and largely imponderable, is a task for the properly trained humanist (who is also often judged irrelevant, immeasureable, and largely imponderable). This exploration, when made in pragmatic terms, puts the humanist into the mainstream of American life today; his (or her) training and analysis is particularly relevant as social change and technologies change appear so interlocked. Much can be said for the notion, "High technology is packaged thought."

REFERENCES

Ayres, C. E. 1961. Toward a Reasonable Society: The Values of Industrial Civilization. Austin, TX: The University of Texas Press.

Braudel, Fernand. 1967, 1973. Capitalism and Material Life, 1400-1800. New York: Harper and Row.

Cole, H. S. D., et al. 1973. Models of Doom: A Critique of the Limits to Growth. New York: Universe Books.

Ellul, Jacques. 1964. The Technological Society. New York: Alfred A. Knopf.

Energy in Transition, 1985-2010; Final Report of the Committee on Nuclear and Alternative Energy Systems, National Academy of Sciences. 1980. San Francisco: W. H. Freeman and Company.

Energy, Natural Resources, and the Environment in the Eighties. President's Commission for a National Agenda for the Eighties. 1980. Washington, DC: U.S. Government Printing Office.

Ferkiss, Victor C. 1969. Technological Man: The Myth and the Reality. New York: The New York Times Company.

Fusfeld, Herbert, ed. 1979. Science and Technology Policy: Perspectives for the 1980's. New York: Annals of the New York Academy of Sciences, Vol. 334.

Garvey, Gerald. 1972. Energy, Ecology, Economy: A Framework for Environmental Policy. New York: W. W. Norton and Company.

Heilbroner, Robert L. 1977. The Economic Transformation of America. New York: Harcourt, Brace, Jovanovich.

Henderson, Hazel. 1978. Creating Alternative Futures: The End of Economics. New York: Berkley Windhover Books.

Hughes, Thomas P. 1975. Changing Attitudes Toward American Technology. New York: Harper and Row.

Kahn, Herman. 1978. World Economic Development: Projections from 1978 to the Year 2000. Boulder, CO: Westview Press.

Laszlo, Ervin, et al. 1977. Goals for Mankind: A Report to the Club of Rome. New York: New American Library.

Meadows, Donella H., et al. 1972. The Limits to Growth: A Report of the Club of Rome's Project on the Predicament of Mankind. New York: Universe Books.

Mesarovic, Mihajlo and Eduard Pestel. 1974. Mankind at the Turning Point: The Second Report to the Club of Rome. New York: E. P. Dutton.

Mumford, Lewis. 1966, 1967. Technics and Human Development. New York: Harcourt, Brace, Jovanovich.

Mumford, Lewis. 1964, 1970. The Pentagon of Power. New York: Harcourt, Brace, Jovanovich.

Opie, John, Ian Barbour, Sanford Lakoff, and Harvey Brooks. 1982. Finding Our Way: Energy and American Values. New York: Addison-Wesley.

Potter, David. 1950. People of Plenty: Americans and Abundance. Chicago: The University of Chicago Press.

Rosenberg, Nathan. 1972. Technology and American Economic Growth. White Plains, NY: M. E. Sharpe, Inc.

Schurr, Sam S., et al. 1979. Energy in America's Future: The Choices Before Us [Resources for the Future]. Baltimore: The Johns Hopkins University Press.

Science and Technology: Promises and Dangers in the Eighties [President's Commission for a National Agenda for the Eighties]. 1980. Washington, DC: U.S. Government Printing Office.

Stobaugh, Robert and Daniel Yergin, eds. 1979. Energy Future. New York: Random House.

Teich, Albert H., ed. 1977. Technology and Man's Future (2nd ed.) New York: St. Martin's Press.

Tinbergen, Jan, ed. 1976. RIO: Reshaping the International Order: A Report to the Club of Rome, New York: New American Library.

Woodruff, William. 1966. Impact of Western Man: A Study of Europe's Role in the World Economy, 1750-1960. New York: St. Martin's Press.

Moral Reasoning on Environmental Issues by Secondary Science and Social Studies Teachers and their Students

Bryan Pierce, Michael Gross, and Richard Wilke[1]

Abstract

The principled moral reasoning or "P" scores of a random sample (N=33) of central Wisconsin teachers and their students were examined. A statistically significant difference (p<.0001) was found between the teacher and student means. About 15.2 percent of the teachers, however, scored less than the student mean of their own classes. Implications are discussed.

Introduction

One of the primary goals of Environmental Education is the "development of those skills necessary for complex environmental problem solving" (Iozzi and Cheu, 1978, p. 2). Environmental problems are not merely technological or scientific in nature. They are also directly linked with value judgments. Kohlberg's (1975) theory of moral reasoning has received considerable attention by educators as a comprehensive working model for moral/values education.

Moral reasoning on environmental issues was regarded as an implicit process in the recently validated "Goals for Curriculum Development in Environmental Education" formulated by Hungerford, Peyton, and Wilke (1980). Moreover, the applications of Kohlberg's six-stage moral reasoning model for environmental education have recently been outlined (Dispoto, 1977; Harshman, 1978; Kauchak, et al., 1978; LaHart and Tillis, 1974; Miles, 1978).

Iozzi (1978) suggested that "the bulk of our environmental problems stem from the fact that we have been making environment-related decisions and exhibiting behaviors typical of Kohlberg's lower, self-serving/self-interest stages at the expense of our surroundings and our resources" (p. 2). The use of principled (stage 5 and 6) moral reasoning, however, would allow environmental conflicts to be resolved on the basis of environmentally sound, universally equitable decisions.

Environmental educators can apply the moral reasoning model to their teaching. A primary application of the model is to stimulate the moral development of students to higher reasoning stages. Students would then develop more comprehensive and complex means of resolving value conflicts. Environmental education curriculum materials are currently being designed and evaluated to encourage this moral development (Iozzi, 1980; Iozzi and

[1]College of Natural Resources, University of Wisconsin, Stevens Point, WI 54481.

Cheu, 1978). Intervention results using these curriculum materials indicate that they do have the potential to affect development in moral reasoning (Iozzi, 1980).

"Kohlberg argues that children must be exposed to a stage of reasoning one stage higher than their current stage if stage development is to be fostered. To do this a teacher must listen to several responses of each student, figure out what stage of reasoning these responses suggest, and then either frame an appropriate 'one stage higher' response during on-going class discussions, or mix the students with others who are reasoning one stage higher so they may hear their arguments" (Fraenkel, 1976, p. 218-219).

Iozzi (1976) summarized the need for further research on the moral reasoning abilities of teachers:

> "Very little research has been reported regarding the moral reasoning ability and existing levels of educators. Are teachers capable of stimulating the moral maturity of students in their classrooms? Are teachers at the high school level reasoning at a higher moral level than their students? How do the moral reasoning levels of teachers compare with those of their students at various grade levels?" (p. 124).

Wilkens (1980) used Rest's Defining Issues Test to assess the moral reasoning of 55 Australian preservice high school teachers, and found that "the moral reasoning capacity of some of these preservice teachers is below some junior high students, and a much larger proportion is below many senior high students" (p. 549). Hiett (1977) used Kohlberg's Moral Judgment Scale interviews to study the moral judgment of eighth grade students and their teachers. The teachers showed significantly higher levels of moral judgment than their students. Jacobson (1977) found similar results using the Defining Issues Test with teachers scoring significantly higher than their students in a Department of Defense middle school.

Cornett (1977), however, described the moral judgment of 14 sixth grade teachers and their students using Kohlberg interviews. Results indicated that only 6 of the 14 teachers were reasoning at least one stage higher than the students sampled in their classrooms. No studies directly compared high school teachers and students, or the moral reasoning of teachers and students in an environmental context.

Based on the review of literature cited above and others, the present study was designed to answer the following principal research question: Are there significant differences in principled moral reasoning on environmental issues between secondary science and social studies teachers and their students? In addition, the following ancillary research question was posed: Are there significant differences in principled moral reasoning on environmental issues between preservice and inservice secondary science and social studies teachers?

Methodology

This research was designed as a descriptive study of the use of principled moral reasoning on environmental issues by secondary science and social studies preservice teachers, inservice teachers, and the students of those inservice teachers.

A. Preservice Teachers. Students at the University of Wisconsin-Stevens Point enrolled in Teaching Techniques in Secondary Education-Science (N=10) and Teaching Techniques in Secondary Education-Social Studies (N=11) were selected. Tests for these subjects were administered by the researchers. Complete responses were obtained from all subjects.

B. Preliminary Sample of Inservice Teachers and their Students. Volunteer junior and senior high school science teachers were used for a pilot study (N=13). The teachers were asked to select their highest grade level and/or ability class to serve as the student samples. The researchers administered the test to the teachers. The teachers then administered the test to their own classes of students. Complete responses were obtained from 10 of the teachers (76.9 percent) and from 12 of the classes.

C. Random Sample of Inservice Teachers and their Students. A 15 percent random sample of secondary science and social studies inservice teachers in 24 school districts located in the Cooperative Educational Services Agency No. 7 in central Wisconsin was generated from a Wisconsin Department of Public Instruction computer list of teachers and schools (N=40). These teachers were asked to take the test themselves and then administer it to one of their classes of students. Again they were asked to select their highest grade level and/or ability class to test. Completed responses were received from 33 of the teachers (82.5 percent) and their classes. One additional teacher with an incomplete test also returned completed tests from the selected class.

Instrumentation

All subjects were tested using the Environmental Issues Test (EIT) validated by Iozzi (1976). The EIT was developed to assess moral/ethical reasoning development in an environmental context. The EIT consists of five moral dilemma stories using environmental issues in a format identical to that of Rest's (1976) Defining Issues Test (DIT).

After reading each story subjects rate the importance of 12 statements on the issue and then rank the four most important statements. The statements represent Kohlberg's stages 2, 3, 4, 5A, 5B, and 6. "M" or meaningless statements, and "A" or anti-establishment statements (stage 4-1/2) are also included. A "P" score interpreted as percent of principled moral reasoning is calculated by weighting the rankings for each test: $"P" = \frac{5A+5B+6}{50} \times 1$

The following criteria were used by Iozzi (1976) to validate the Environmental Issues Test. The EIT has considerable "face validity" due to its similarity to the previously validated DIT. The reliability coefficient for test-retest stability of the EIT (N=40 9th grade Ss) was

reported to be .84 with a time interval of seven days. Age trends data indicated a statistically significant difference between ninth grade, twelfth grade, and college students (N=193). A correlation of r=.36 with attitudes on environmental issues was reported using the Affective subscale of Maloney and Ward's "Ecology Attitude Inventory" (1973). Moral comprehension correlated with the DIT at .63, and since the issue statements utilized in the EIT are essentially the same, this correlation was considered to be applicable to the EIT as well. The EIT correlated at r=.73 with the DIT. Finally, the EIT is sensitive to increases in scores after intervention which should accelerate higher stage development (Iozzi, 1980).

All responses to the EIT were hand scored by the principal author. A consistency check developed by Rest for the DIT and used in scoring the EIT was conducted during the scoring process.

Methods of Data Analysis

T-tests, Analysis of Variance, Pearson Product-Moment Correlation, and the Scheffe' test for post-hoc multiple comparisons among means were used to analyze the principal and ancillary research questions. An α level of .05 was established for all analyses. The SPSS batch system served as the computer software package. All analyses were performed by the Computer Science Department at the University of Wisconsin-Stevens Point.

Results: Principal Research Question

The primary purpose of this study is to determine if there are significant differences in principled moral reasoning on environmental issues between secondary science and social studies teachers and their students. Analyses were performed using both the preliminary and random samples of inservice teachers and their students for this research question.

Analysis of variance results (Table 1) indicate that a statistically significant F-ratio (F=7.60, $p < .0001$) was obtained for the preliminary sample of teachers and their students. Further analysis using the Scheffe' test revealed statistically significant ($p<.05$) differences between the mean "P"score of the teachers and the mean "P"score of each grade level of students (7-12). A significant difference was also found between grade 12 and grade 8 student means. No significant differences were found between student means at any other grade levels.

Analysis of variance results (Table 2) also indicate that a statistically significant F-ratio (F=9.17, $p < .0001$) was obtained for the random sample of teachers and their students. Further analysis using the Scheffe' test revealed statistically significant ($p<.05$) differences between the mean "P"score of the teachers and the mean "P"score of each grade level of students (9-12). No significant differences were found between student means at any of the grade levels.

Iozzi (1980) has noted that there is a concern regarding the possible differences between statistical and educational significance. Additional

Table 1

Analysis of Variance Results for Mean "P" scores of Preliminary Sample Teachers and Students Grades 7-12

Sample Population	n	M	SD
Teachers	10	53.00	12.97
Grade 12	49	41.43	13.78
Grade 11	15	29.60	9.95
Grade 10	71	37.66	11.83
Grade 9	42	34.33	13.24
Grade 8	63	31.60	10.43
Grade 7	11	33.09	8.55

ANOVA Summary

Source	df	SS	MS	F	F Prob.
Between	6	6548.28	1091.38	7.60***	0.0000
Within	254	36464.81	143.56		
Total	260	43013.09			

***Significant beyond the 0.0001 level.

Table 2

Analysis of Variance Results for Mean "P"scores of Random Sample Teachers and Students Grades 9-12

Sample Population	n	M	SD
Teachers	33	49.39	16.31
Grade 12	216	37.41	13.45
Grade 11	208	35.25	13.39
Grade 10	204	35.40	13.47
Grade 9	95	34.99	10.73

ANOVA Summary

Source	df	SS	MS	F	F Prob.
Between	4	6451.90	1612.97	9.17***	0.0000
Within	751	132173.06	176.00		
Total	755	138624.95			

***Significant beyond the 0.0001 level.

Table 3

Preliminary Sample Teacher and Student "P"score Comparisons

Teacher "P"score	Grade	n	Student Mean	SD	#	%
64	12	14	42.86	14.20	2	14.3
53	7	11	33.09	8.55	0	0
44	10,11,12	21	33.24	14.29	4	19.0
68	8,9	25	36.08	11.04	0	0
62	11,12	10	35.02	12.59	1	10.0
30	9,10,11,12	38	39.21	12.07	29	76.3
34	10	31	38.71	11.31	23	74.2
56	9	31	32.90	13.74	3	9.7
62	8	27	29.56	9.63	0	0
58	8	21	32.62	11.28	0	0
na	12	11	45.27	11.64	na	na
na	10	11	30.73	10.96	na	na

Number of students at or above the teacher's "P"score.

% Percent of students at or above the teacher's "P"score.

na.Data not available.

Table 4

Random Sample Teacher and Student "P"score Comparisons

Teacher "P"score	Grade	n	Student Mean	SD	#	%
50	12	48	38.46	14.66	10	20.8
40	10,11	20	29.40	12.07	3	15.0
36	11	17	38.59	11.83	9	52.9
68	10,11,12	27	47.11	12.76	1	3.7
62	10	26	47.92	11.35	2	7.7
72	10,11,12	19	33.58	14.54	0	0
66	10,11,12	11	42.73	16.23	0	0
34	10,12	14	31.00	9.11	5	35.7
64	10,11,12	8	33.25	10.58	0	0
46	11,12	14	35.43	11.41	3	21.4
66	10,11,12	21	34.10	11.94	0	0
44	10	18	32.89	10.52	3	16.7
58	12	8	34.25	12.26	0	0
68	9	11	29.64	7.26	0	0
34	10,11,12	33	32.42	12.11	14	42.4
38	10	22	33.64	13.82	6	27.3
52	9	26	37.92	12.46	4	15.4
72	9,10,12	20	36.20	11.01	0	0
52	12	20	31.00	12.49	0	0
24	11	28	29.29	13.02	17	60.7
18	11,12	18	35.22	12.43	15	83.3
28	9,10,11	29	33.93	9.85	24	82.8
48	12	12	36.17	10.94	1	8.3
40	12	11	35.45	11.90	4	36.4
48	10	20	30.20	12.55	2	10.0
18	11	14	38.57	13.35	13	92.9
52	10,11,12	48	35.17	12.47	6	12.5
68	11,12	14	43.43	15.40	0	0
62	11	21	30.29	11.44	0	0
78	11,12	38	43.53	13.89	0	0
34	9	24	32.08	10.57	10	41.7
52	11,12	21	36.95	13.05	2	9.5
38	12	21	33.14	9.97	9	42.9
na	10	22	35.73	14.17	na	na

Number of students at or above the teacher's "P"score.

% Percent of students at or above the teacher's "P"score.

na Data not available.

comparisons were made between individual teachers and their classes to try to assess this educational significance.

Table 3 shows the breakdown between individual preliminary sample teachers and their students. The number of students from each of the classes with "P"scores at or above the "P"score of their own teacher was tabulated and then calculated as a percentage. The mean percentage of students with "P"scores at or above the "P"score of their own teacher was 20.4 percent. In two of the ten comparisons with complete data (20.0 percent) the teachers had "P"scores below the mean "P"score of their own classes and the overall mean "P"score of the students. Four teachers (40.0 percent) had "P"scores above all of their own students.

Table 4 shows a similar breakdown and analysis between individual teachers from the random sample and their students. The mean percentage of students with "P"scores at or above the "P"score of their own teacher was 22.4 percent. Four of the teachers (12.1 percent) had "P"scores below the mean "P"score of their own classes, and seven of the teachers (21.2 percent) had "P"scores below the overall mean "P"score of the students. Eleven of the teachers (33.3 percent) had "P"scores above all of their own students.

Results: Ancillary Research Question

An ancillary research question was posed to determine if there are significant differences in principled moral reasoning on environmental issues between preservice and inservice secondary (science and social studies) teachers. The mean "P"score of the combined preservice group (N=21) was analyzed with the mean "P"score of the random sample of inservice teachers (N=33).

T-test results are presented in Table 5. No statistically significant differences between the two groups were found ($p>.05$).

Table 5

T-test for Mean "P"score Differences Between Preservice and Inservice Secondary (Science and Social Studies) Teachers

Sample Population	n	M	SD	t	df	p
Inservice	33	49.39	16.31	0.08	52	0.94 ns
Preservice	21	49.05	13.59			

Note. Two-tailed probability reported.

Discussion

Controversy currently exists in the literature regarding the question of how educationally important the teacher's moral reasoning abilities are for stimulating the moral reasoning development of students. It has been argued that in order to stimulate this development, teachers need to be able to recognize the reasoning stages of their students and present "plus one" stage arguments (Fraenkel, 1976). Cornett (1977), however, found that only 6 of 14 sixth grade teachers were reasoning at least one stage higher than the students sampled. Wilkens (1980) further indicated that the moral reasoning capability of some of the 55 preservice high school teachers he sampled is below some junior high students, and a much higher proportion is below many senior high students.

In a recent paper Berkowitz (1981) criticized the Wilkens study specifically and the "plus one" convention in general. Since the points addressed by Berkowitz relate directly to the present study, his arguments will be discussed in detail.

Concerning the Wilkens study, Berkowitz first critized the use of the Defining Issues Test and "P"score index. He asserted that since the DIT assesses the ability of subjects to recognize and evaluate moral reasoning rather than spontaneously produce those reasonings, the instrument is inappropriate. "Wilkens intent... is to question the ability of classroom teachers to produce rather than recognize plus-one moral judgments" (Berkowitz, 1981, p. 488).

It appears, however, that Berkowitz's conclusion regarding the use of the DIT (and by their similarity, the EIT) does not logically follow. Berkowitz himself states that "while students and teachers may be able to recognize and value stereotyped principled arguments, they cannot produce them". (p 488). Recognition of any given stage of reasoning is a necessary, if not sufficient, condition for producing that stage reasoning. If a preservice teacher, as found by Wilkens, is recognizing and evaluating fewer principled reasoning responses (and thereby scoring a lower "P" score) than a junior or senior high school student, it should follow that the teacher would also not be able to produce higher reasoning than the student.

Berkowitz (1981) also contends that Wilken's "teachers" are actually graduate students preparing to become teachers, therefore "one might reach the conclusion that, while these graduate students may not be significantly advanced beyond the level of their would-be students, experienced practicing teachers might be" (p. 488). While Wilkens' (1980) sample did consist of preservice teachers, the results of the present study indicate that some 20.0 percent of the preliminary sample and 12.1 percent of the random sample of inservice teachers had lower "P"scores than the mean "P"scores of their own students. Further, results from the ancillary research question indicated that there was no statistically significant difference in mean "P"scores between the preservice and inservice teachers tested. These results would appear to favor Wilkens' conclusion that at least some to the teachers would be incapable of understanding the reasoning of some of the students, let alone reason one stage higher than those students.

Berkowitz (1981) also questioned the "plus one" convention from two standpoints: "1) Is the one-full-stage disparity really the most appropriate teacher/student difference for successful moral education in the classroom? 2) Is a teacher/student disparity necessary at all for successful moral education?" (p. 488).

Regarding the first question Berkowitz (1981) cited a previous study of his in which it was observed that "a difference much smaller than one full stage was optimal in producing individual moral growth. We concluded that the optimal difference depended upon the presentation of novel reasoning in the context of same-stage overlap. We found that plus-one differences led partners to 'talk past' each other" (p. 488). He also noted however that "while this refines the plus-one convention, it does not solve the problem of a teacher who is at a lower stage than his or her students" (p. 488), which seems to be the case with the Wilkens study and our data as well.

In questioning the necessity of a teacher/student disparity, Berkowitz suggested that classroom heterogeneity of students' stages of moral reasoning may be a more important factor in stimulating moral development than the teacher's role. A study by Blatt and Kohlberg (1975) was cited as evidence that students in a heterogeneous leaderless discussion group may experience "nearly as much moral development as their peers in the teacher-led groups" (Berkowitz, 1981, p. 489). Berkowitz also noted that a previous study of his revealed significant pre/post gains in moral reasoning development using leaderless peer dyads. From these examples Berkowitz (1981) concluded the following: "It seems that plus-one teachers are not necessary for moral growth, and further, that teacher reasoning may not be related to students' moral growth at all!" (p. 489).

A study by Plymale (1977) however seems to contradict the peer-led discussion results. Based on results from classroom interventions following teacher training programs, it was concluded that "students who engaged in moral dilemma discussion sessions employing teacher-leadership technique ... showed greater forward movement in moral reasoning ability than those in peer-led and control groups" (p. 2062-A).

From the arguments presented above, these researchers believe that further research is needed in this area. The importance of the moral reasoning ability of the teacher in stimulating the moral development of his or her students has not yet been established one way or the other.

If future studies indicate that the teacher's moral reasoning ability is not as important as the moral reasoning of the student's peers, then moral reasoning development programs in general, and those related to environmental issues in particular, can emphasize the development and dissemination of curriculum materials. If the teacher's moral reasoning ability is found to be an important factor in the moral reasoning development of his or her students, then the present study indicates that a moral reasoning development program would be necessary for at least some of the teachers before they could be expected to effectively conduct such a program for their own classes.

Conclusions

Based on the results and discussion of the data analyses presented above, the following conclusions were made:

1. Related to environmental issues, the mean use of principled moral reasoning ("P"score) by secondary science and social studies teachers was statistically significantly higher ($p<.0001$) than the mean use of principled moral reasoning by their students (grades 9-12). Over 12 percent of the teachers, however, scored less than the mean "P"score of their own students. The educational significance of those results has not yet been established, and further research is needed in this area.

2. Related to environmental issues, there was no statistically significant difference ($p>.05$) in mean use of principled moral reasoning between preservice and inservice secondary (science and social studies) teachers.

REFERENCES

Berkowitz, Marvin W. 1981. A Critical Appraisal of the 'Plus-One' Convention in Moral Education. Phi Delta Kappan 62(7):488-489.

Blatt, M. and L. Kohlberg. 1975. The Effects of Classroom Moral Discussion upon Children's Level of Moral Judgment. Journal of Moral Education 4(2):129-161.

Cornett, Claudia E. 1977. A Descriptive Study of the Moral Development of Selected Teachers and Their Students. Ph.D. Dissertation, Miami University, Dissertation Abstracts International 37:7629-A.

Dispoto, Raymond G. 1977. Moral Valuing and Environmental Variables. Journal Research in Science Teaching 14(4):273-280.

Fraenkel, J. R. 1976. The Kohlberg Bandwagon: Some Reservations. Social Education 40(4):216-222.

Harshman, R. 1978. Value Education Processes for an Environmental Education Program. Journal of Environmental Education 10(2):30-34.

Hiett, Sharon L. 1977. Moral Judgment of Disruptive and Non-Disruptive Students and Their Teachers. Ph.D. Dissertation, University of Florida, Dissertation Abstracts International 38:4047-A.

Hungerford, H. R., R. B. Peyton, and R. J. Wilke. 1980. Goals for Curriculum Development in Environmental Education. Journal of Environmental Education 11(3):42-47.

Iozzi, Louis A. 1980. Evaluation of "Preparing for Tomorrow's World"-Science/Technology/Society for Grades 7-12: Methodology and Results. Current Issues VI: The Yearbook of Environmental Education and Environmental Studies:341-361.

Iozzi, Louis A. 1978. The Environmental Issues Test: A New Assessment Instrument for Environmental Education. Current Issues in Environmental Education IV:200-206.

Iozzi, Louis A. 1976. Moral Judgment, Verbal Ability, Logical Reasoning Ability and Environmental Issues. Ph.D. Dissertation, Rutgers-The State University of New Jersey. Dissertation Abstracts International 37:7662-A.

Iozzi, Louis A. and Janey Cheu. 1978. Interfacing Science, Technology and the Social Sciences: A Holistic Approach to Environmental Education. Paper presented at the seventh annual conference, National Association of Environmental Education, 9 pp.

Jacobson, Lowell T. 1977. A Study of Relationships among Mother, Student, and Teacher Levels of Moral Reasoning in a Department of Defense Middle School. Ph.D. Dissertation, Michigan State University, Dissertation Abstracts International 38:5824-A.

Kauchak, Don, Flo Krall, and Kim Heimsath. 1978. The Need for Education, Not Indoctrination. Journal of Environmental Education 10(1):19-23.

Kohlberg, Lawrence. 1975. The Cognitive-Developmental Approach to Moral Education. Phi Delta Kappan 56:670-677.

LaHart, David E. and C. Richard Tillis. 1974. Using Wildlife to Teach Environmental Values. Journal of Environmental Education 6(1):43-48.

Maloney, M. P. and M. P. Ward. 1973. Ecology: Let's Hear from the People. American Psychologist 28(7):583-586.

Miles, John C. 1978. The Study of Values in Environmental Education. Journal of Environmental Education 9(2):5-17.

Plymale, Sallie C. 1977. The Effects of a Developmental Teacher Training Program on the Moral Reasoning Ability of Third and Sixth Grade Students. Ed.D. Dissertation, West Virginia University, Dissertation Abstracts International 38:2062-A.

Rest, James. 1976. New Approaches in the Assessment of Moral Judgment. In Thomas Lickona (ed.), Moral Development and Behavior: Theory, Research, and Social Issues. New York: Holt, Rinehart, and Winston.

Wilkens, Robert A. 1980. If the Moral Reasoning of Teachers is Deficient, What Hope for Pupils? Phi Delta Kappan 61(8):548-549.

APPENDIX: Kohlberg's Moral Reasoning Stages

I. Preconventional level

At this level, the child is responsive to cultural rules and labels of good and bad, right and wrong, but interprets these labels either in terms of the physical or the hedonistic consequences of action (punishment, reward, exchange of favors) or in terms of the physical power of those who enunciate the rules and labels. The level is divided into the following two stages:

Stage 1: The punishment-and-obedience orientation. The physical consequences of action determine its goodness or badness, regardless of the human meaning or value of these consequences. Avoidance of punishment and unquestioning deference to power are valued in their own right, not in terms of respect for an underlying moral order supported by punishment and authority (the latter being Stage 4).

Stage 2: The instrumental-relativist orientation. Right action consists of that which instrumentally satisfies one's own needs and occasionally the needs of others. Human relations are viewed in terms like those of the marketplace. Elements of fairness, of reciprocity, and of equal sharing are present, but they are always interpreted in a physical, pragmatic way. Reciprocity is a matter of "you scratch my back and I'll scratch yours," not of loyalty, gratitude, or justice.

II. Conventional level

At this level, maintaining the expectations of the individual's family, group, or nation is perceived as valuable in its own right, regardless of immediate and obvious consequences. The attitude is not only one of conformity to personal expectations and social order, but of loyalty to it, of actively maintaining, supporting, and justifying the order, and of identifying with the persons or group involved in it. At this level, there are the following two stages:

Stage 3: The interpersonal concordance or "good boy - nice girl" orientation. Good behavior is that which pleases or helps others and is approved by them. There is much conformity to stereotyped images of what is majority or "natural" behavior. Behavior is frequently judged by intention - "he means well" becomes important for the first time. One earns approval by being "nice."

Stage 4: The "law and order" orientation. There is orientation toward authority, fixed rules, and the maintenance of the social order. Right behavior consists of doing one's duty, showing respect for authority, and maintaining the given social order for its own sake.

III. Postconventional, autonomous, or principled level

At this level, there is a clear effort to define moral values and principles that have validity and application apart from the authority of

the groups or persons holding these principles and apart from the individual's own identification with these groups.

Stage 5A: The social-contract orientation, generally with legalistic and utilitarian overtones. Right action tends to be defined in terms of general rights and in terms of standards which have been critically examined and agreed upon by the whole society. There is a clear awareness of the relativism of personal values and opinions and a corresponding emphasis upon procedural rules for reaching consensus. Aside from what is constitutionally and democratically agreed upon, the right is a matter of personal "values" and "opinion." The result is an emphasis upon the "legal point of view," but with an emphasis upon the possibility of changing law in terms of rational considerations of social utility (rather than freezing it in terms of Stage 4 "law and order"). Outside the legal realm, free agreement and contract is the binding element of obligation. This is the "official" morality of the American government, and finds its ground in the thought of the writers of the Constitution.

Stage 5B: Higher law and conscience orientation. Orientation to internal decisions of conscience but without clear rational or universal principles. Conform to avoid self-condemnation.

Stage 6: The universal-ethical-principle orientation. Right is defined by the decision of conscience in accord with self-chosen ethical principles appealing to logical comprehensiveness, universality, and consistency. These principles are abstract and ethical (the Golden Rule, the categorical imperative); they are not concrete moral rules like the Ten Commandments. At heart, these are universal principles of justice, of the reciprocity and equality of human rights, and of respect for the dignity of human beings as individual persons.

Guidelines for Authors

Manuscripts to be considered for publication in Current Issues in Environmental Education and Environmental Studies must be accepted for presentation at the annual conference of the National Association for Environmental Education (NAEE). Such acceptance is a function of the Program Committee for the conference.

Current Issues is divided into two sections for submitted conference papers. Section I, "Environmental Education Applications--The Practitioner's Perspective," is comprised of short papers which offer information, observations, and program reviews deemed of interest to the community of environmental educators broadly interpreted. Section II, "Research and Evaluation--Refereed Papers," is comprised of scholarly articles representing the findings of original research and thought. Papers in Section II must be fully documented and must show an awareness of existing research. Papers will be accepted for publication in this Section only after review and recommendation by two independent reviewers and the editors.

Manuscript Preparation

1. Manuscripts: Manuscripts for Section I, "Environmental Education Applications--The Practitioner's Perspective," must not exceed 1500 words in length. Manuscripts for Section II, "Research and Evaluation-Refereed Papers," must not exceed 5000 words in length. All manuscripts must be clearly marked indicating the specific section to which it is being submitted for consideration. Five copies of all manuscripts must be submitted, typed using a standard type-face, double spaced, with standard margins and approximately 250 words per page. Single-spaced typed papers will not be considered.

2. Abstract: All papers submitted for Section II must include an abstract of approximately 50 words which presents the salient points covered in the paper. Abstracts will not be printed for papers appearing in Section I. Abstracts should appear immediately following the paper's title and name of the author, and directly preceding the text (on the same page).

3. References: All reference must be presented using the author-date-page reference system within the body of the text (Sacks and Davis, 1979: 31); with each paper followed by a Reference Section listing full references in alphabetical order according to the last name of the author.

4. Figures: All figures, drawings, and graphs must be sequentially numbered (Arabic) and must be cited in the text. Provide camera-ready copy in black ink (preferably India), on heavy white paper or blue-lined coordinate paper, and on separate sheets. Place labels parallel to the axes, using initial capital and lower case letters. Plan your figures for the smallest possible printed size consistent with clarity. Care should be taken to make lettering large enough to be readable after reduction to the 5 x 7 inch print format of Current Issues.

5. Tables and Photographs: Tables must be sequentially numbered (Arabic), titled, and cited in the text. Photographs cannot be printed.

6. Title and Author(s). For the format of the first page and the listing of title and author, see examples contained in this volume.

7. Additional Typing Instructions: Place the name of the senior author and the page number in the upper right corner of each page of the text. This will assist the editors should pages of the paper become separated. Insert subheads at appropriate places in the text to mark main ideas. Keep subheads short. Proofread manuscripts thoroughly before submitted them. Poorly written and poorly proofread papers will be returned to authors.

Deadline for Submission for Current Issues Volume VIII

Manuscripts must be received by the editors by June 30, 1982.

Send to: Dr. Arthur B. Sacks
Institute for Environmental Studies
70 Science Hall
University of Wisconsin-Madison
Madison, WI 53706

If you wish confirmation that your manuscript has been received, please enclose a stamped, self-addressed post card.

The "Current Issues" Series

"Selected Papers" volumes from conferences of the National Association for Environmental Education have been published by the ERIC Clearinghouse for Science, Mathematics, and Environmental Education annually since 1975. Copies of each volume are available as follows:

IRC 013E - Current Issues in Environmental Education 1975: Selected Papers from the Fourth Annual Conference of the NAEE (New Orleans, 1975). Robert Marlett, editor. 129 pages; IRC price $3.60. Also available in ERIC microfiche collections as ED 119 982.

IRC 020E - Current Issues in Environmental Education II: Selected Papers from the Fifth Annual Conference of the NAEE (Atlanta, 1976). Robert Marlett, editor. 202 pages; IRC price $4.70. Also available in ERIC microfiche collections as ED 135 665.

IRC 029E - Current Issues in Environmental Education III: Selected Papers from the Sixth Annual Conference of the NAEE (Estes Park, 1977). Robert H. McCabe, editor. 279 pages; IRC price $5.50. Also available in ERIC microfiche collections as ED 150 018.

IRC 038E - Current Issues in Environmental Education IV: Selected Papers from the Seventh Annual Conference of the NAEE (Chicago, 1978). Craig B. Davis and Arthur B. Sacks, editors. 252 pages; IRC price $5.50. Also available in ERIC microfiche collections as ED 167 407.

IRC 047E - Current Issues V: The Yearbook of Environmental Education and Environmental Studies. Selected Papers from the Eighth Annual Conference of the NAEE (Blacksburg, 1979). Arthur B. Sacks and Craig B. Davis, editors. 306 pages; IRC price $6.00. Also available in ERIC microfiche collections as ED 180 822.

IRC 058E - Current Issues VI: The Yearbook of Environmental Education and Environmental Studies. Selected Papers from the Ninth Annual Conference of the NAEE (Albuquerque, 1980). Arthur B. Sacks, Lei Lane Burrus-Bammel, Craig B. Davis, and Louis A. Iozzi, editors. 420 pages; IRC price $7.50. Also available in ERIC microfiche collections as ED 197 947.

Orders may be placed with:

SMEAC Information Reference Center (SMEAC/IRC)
The Ohio State University
1200 Chambers Road, 3rd Floor
Columbus, OH 43212
(614) 422-6717

Copies of Current Issues V and Current Issues VI may also be ordered from NAEE, P.O. Box 700, Troy, OH 45373, at the same prices.

1982 Conference

Global 2000: Modifying Projected Futures through Environmental Education has been identified as the theme of the Eleventh Annual Conference of the National Association for Environmental Education, scheduled for October 15-20, 1982, at Silver Bay (on Lake George), New York. Members of the Association wishing to present papers, develop workshops and/or symposia, make other presentations, or otherwise participate in the program are encouraged to submit proposals by April 15, 1982 to the Conference Program Chairperson:

David L. Hanselman
State University of New York
College of Environmental Science and Forestry
311 Marshall Hall
Syracuse, New York 13210
(315) 470-6511

Each of NAEE's three sections is represented on the 1982 Conference Planning Committee. Program components related directly to the professional interests of specific sections may be discussed with:

Alan Schwartz, St. Lawrence University, representing the Environmental Studies section;

Duane Toomsen, Iowa Department of Public Instruction, representing the Elementary and Secondary Education section;

Thea Teich Townsend, Ohio River Valley Water Sanitation Commission, representing the Non-formal Environmental Education section.

Those wishing to submit papers for consideration for publication in Current Issues in Environmental Education and Environmental Studies Volume VIII should send them to Arthur B. Sacks, as detailed on pages 229-230 of this volume. Other conference-related information, including registration information, may be secured from:

Joan M. Heidelberg, Executive Vice-President
National Association for Environmental Education
P. O. Box 400
Troy, Ohio 45373

National Association for Environmental Education

Section Chairpersons

Elementary and Secondary Education....Lillabelle Holt, Ohio State University, Newark

Environmental Studies.....Arthur B. Sacks, University of Wisconsin-Madison

Non-formal Education.....Edward McCrea, U.S. Fish Wildlife Service, Washington, DC