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ABSTRACT

This series of activity units was written especially for elementary school teachers in Massachusetts. The material is divided into units--glaciation, topographic maps, parts of a flower, wildflowers, bog ecology, insects, freshwater flora, and marine ecology--many of which would be of interest to teachers in other locales. An annotated bibliography is divided into topic areas and an annotated listing of related ERIC documents is included. (LS)

ENRICHMENT ACTIVITIES IN ENVIRONMENTAL EDUCATION

prepared for

The Merrimack Education Center

by

Nicholas J. Evangelos

July 27, 1973

SCOPE and PURPOSE

Despite volumes of information available through the ERIC system, school personnel are still largely unaware of alternatives that exist in the information resources that would help improve educational practices.

The effective dissemination of these information resources at the local education level, and therefore, the improvement of knowledge utilization, is dependent upon two major factors:

* awareness
* accessibility

Within this scope, the Merrimack Education Center undertook a project to investigate local utilization of the ERIC information bank. In cooperation with the National Center for Educational Communication, this TIP (Targeted Information Project) was initiated to prepare packages of information targeted to pre-identified, high priority need areas.

Local practitioners are selected to locate and identify alternatives for solving educational problems through an application of available information. At the awareness level, the purpose of a TIP is to stimulate an interest in acquiring information available in these high priority areas. The TIP project provides exemplary models of ways in which the information resources of the ERIC system can relate to specific needs of a particular locale. A major purpose, then is to provide local educators with early access to:

* needs identification
* specific practices
* interpretations of available research

The practitioner/authors demonstrate that the local school building staff can learn how to deal with problems by utilizing available data bases. In this manner, other practitioners are encouraged to relate potential resources of information to the specific needs identified in their own situations.

CHAPTER I

INTRODUCTION

This paper is written to provide ideas for teachers wishing to do field work in science. The ideas are not new but provide some fresh approaches to biological, geological and ecological aspects of science teaching. The paper is directed mainly towards elementary school teachers, but there may be some areas applicable to the secondary school teacher.

Many of the materials and methods noted in this paper have been used and tried at Brooks School, North Andover, Mass. for at least forty years, and for 15 years by the author. The approach presented is really one of natural history, the more modern term being ecology. For the past eight years the activities in this paper have been used at the Brooks Summer Institute for the children of the Greater Lawrence, Mass. area. In addition, the materials were used in a course for elementary school teachers in 1972 and 1973. As a result of this course, it was discovered that some of the material was applicable to the first grade level. The target population generally has been grades 4, 5, 6, 7, 8, and 9. The course for elementary teachers resulted from the fact that many teachers with little or no science background were reluctant to take their children into the field. Also, there was an attempt to help them perform individual or group projects relating to the environment. The use of these materials has helped to alleviate some of the apprehensions of the non-scientist, elementary school teacher.

The main objectives of the activities provided are: to provide a variety of experiences in elementary aspects of the environment; to have the student appreciate the esthetics of the environment; to enable the student to develop techniques for collection and identification of living organisms; to appreciate the diversity of plant and animal life as well as land forms; to understand basic vocabulary and concepts relative to living organisms and the interrelationships with their environment.

The weather is a most important factor in the use of these materials and it has been found that September and October or May and June are ideal months to carry on these activities. Obviously the summer months of July and August would be perfect, but not many schools carry on summer enrichment programs of this type.

ACTIVITY I - GLACIATION:

Introduction: The activities presented are for the Greater Lawrence area, however many of the glacial features can be seen in any community in New England. It might be necessary for the teacher to locate resource personnel in the town or where she teachers, in order to help set up the activities there. Such resource people might be local high school teachers or university professors living in that town. This is how the author found the many glacial features noted in this paper. Consult the bibliography for background reading on glaciers and glaciation.

Roche Moutonnee:[1] About one quarter of a mile from the State Police barracks in Andover, Mass. on route 125 and near the overpass, one can find this formation. It is located on a triangle of land and is partially bounded by the exit road from route 28. See AAA Map[2] Quadrant N 29. It is well hidden by trees and shrubs, but it is one of the best examples of this formation in the area and worth the effort to locate it. As the glacier passed over this outcrop of rock it scratched, rounded and polished the rock on the northern end and cracked and "plucked" boulders from the southern end. Glacial scratches and striae can still be seen on the northern portion of this rock indicating the direction the glacier moved.

If possible, teachers wishing to combine mountain climbing and viewing roche moutonnee as well as glacial grooves and striae might consider an all day field trip to Mt. Monadnock[3], Monadnock State Park, Jaffrey Center, N.H. 03454. A two hour drive from Lawrence, Mass. Contact

[1] George E. Zink, Waldo H. Holcombe ROCKS AND MINERALS, GLACIATION, Andover, Mass.: Town Printing Co. 1960 pp. 27, 28.

[2] AAA Map of Greater Haverhill, Lawrence, Lowell area Automobile Club of Merrimack Valley, 155 Parker St., Lawrence, Mass. 01842 (Map available from AAA at a cost of 50¢ plus tax.)

[3] Katherine Fowler-Billings, THE GEOLOGY OF THE MONADNOCK QUADRANGLE NEW HAMPSHIRE (State of New Hampshire: Department of Resources and Economic Development, State Office Building, Concord, N.H. 03301.

the Monadnock Ecocenter at the above address for more details. They cater to school groups at a minimal cost of 20¢ per person. The climb is relatively easy and most groups can make it to the summit in less than two hours. If the trip is taken in the summer a swim in Lake Contoocook, a public swimming area nearby, would be a fine end to a most worthwhile trip.

Lake Cochichewick: This lake is located adjacent to route 133 in North Andover, Mass. and is the reservoir for that town. See AAA map Quadrante P 16, P 17, Q 17, Q 18.

There are three basin types of natural lakes in this area. (1) Rock basin or ice scoured lakes, (2) drift damned lakes and (3) kettle hole lakes.

(1) Rock basin lakes are found in depressions where valleys have been scoured out and overdeepened at favorable places by the advancing ice. Water would accumulate in the depressions to form lakes. Usually the long axis of the lake runs parallel to the direction of movement of the glacier.

(2) Drift damned lakes are the most common ones in the Merrimack Valley. These basins were formed either during ice advance or recession by deposition of more drift in one part of a valley than in another. Some parts of the valley may lack drift completely. This drift deposition damns up the valley trapping the water in the lake. According to G.E. Zink[1] this may explain the formation of Lake Cochichewick which was damned by drift to the north thus cutting the lake off from the Merrimack River.

[1] George E. Zink op. cit. p. 34

(3) Kettle hole lakes are found in depressions left by the melting of ice blocks around or over which outwash material was deposited by streams of meltwater from the waning glacier or its remnants. Most lakes of this type have low, sandy or gravelly shores. They also tend to be shallower than other kinds of lakes. Actually they might be called a sub-variety of drift-damned lakes because they are encircled by higher drift held in the ice which then slumps down as the ice melts. J. H. Sears[2] and other geologists believe Lake Cochichewich to be a water filled kettle hole. It may be a combination of both because it is known that some lakes take on this dual character, and this lake certainly has the sandy or gravelly shore and is fairly shallow except for one spot off the shore of Osgood Hill to the West.

Ground Moraine: A large fluvio-glacial deposit covering some 400-500 acres in Groveland, Mass. and extending as far north as Concord, N.H. and as far south as Georgetown, Mass. can be seen on land owned by the Merrimack Transportation, Paving, and Materials Co., Inc., Yemma Road, Groveland, Mass. (See AAA map quadrant V 12). Capped by 8-20 feet of gravel, the moraine is about 50 feet deep in this area. Examination of the rocks and boulders here indicate they have been glacially

[2] John H. Sears, THE PHYSICAL GEOGRAPHY, GEOLOGY, MINERALOGY AND PALEONTOLOGY OF ESSEX COUNTY, MASS. Essex Institute, Salem, Mass. 1905. (Out of print)

worn. Their angularity and glacial striae are indicative of this. Garnets have been found in some specimens here. Mr. James Grimes is in charge of sand and gravel operations on Yemma Road and permission to visit the glacial moraine must be obtained from him.

Eskers: Adjacent to the Merrimack Transportation, Paving, and Materials Co., Inc., is an esker to the northeast. It is in the backyard of a local farmer and permission must be obtained from the resident at 483 Main Street, Groveland, Mass. (See AAA map quadrant V 12.)

Although the esker is disconnected, as most are because they are a good source of gravel, enough of this one remains so that the characteristics are retained. The exposed portion of the esker shows the gravel not well sorted probably due to lack of fluctuation in the flow of melt-water streams and also due to lack of extremes between summer and winter temperatures. The rapidly melting glacier stagnated before the esker was built, thus giving the melt-water streams enough time to build up these deposits.

Another good example of eskers can be seen on Andover St. going into Ballardvale. (See AAA map quadrants J 25, J 26.) Running parallel with the esker is a railroad embankment which is quite similar to the esker in many respects. This formation is part of a disconnected chain of eskers running through the Indian Ridge Section of Andover, Mass. and extends from Wakefield, Mass. into New Hampshire.

Glacial Delta: The formation of a glacial delta is much like the formation of the Mississippi River delta where the river empties into the ocean. Similarly, meltwater streams from a glacier emptying into ponded water make a glacial delta. The delta (outwash plain) covers an area of one square mile, in that section of Ballardvale known as the "Plains." It is estimated to be approximately 75-100 feet in depth. To the north of the delta is Pomp's Pond a water filled kettle hole.[1] (See AAA map quadrant K 25.)

Perhaps a large block of ice broke off from the main glacier and melted in place leaving this characteristic form. Meltwater streams dumped fluvio-glacial drift at the southern end of the block of ice, in the form of a delta as the streams flowed into a ponded body of water. When the block of ice melted, stream deposits slumped down reversing their surface slope. This slope representing the former contact of drift with ice is known as an ice contact face and is very steep. Perhaps the best way to approach the delta is to arrive via Andover St., Ballardvale. You are now on the outwash plain and if you stop at 232 Andover Street you will find a dry kettle hole in the backyard. (See AAA map quadrant K 26.) Permission must be obtained from the residents. There are other dry kettle holes on the "Plains" but most of them have been filled in by townspeople.

Continue to the end of Andover Street and take a left on Abbott Street. Look for a sign (partially hidden by bushes) on the left which says Essex Sand & Gravel Co., Inc., Andover

[1] G.E. Zink op. cit. p. 34

Plant. Take a left at the entrance and go to the end of this paved road. You will now see the former operations of the Essex Sand And Gravel Co., a hole in the delta about 75-100 feet deep. (See AAA map quadrant K 26.) If you now walk due north this will lead you to Pomp's Pond and the steep ice contact face. (See AAA map quadrant K 25, K 26.)

Drumlins:[1] Perhaps the most conspicuous and prevalent glacial formation in New England is the drumlin. It has a characteristic steep northern end and tapering southern end and takes on the shape of an inverted spoon. One cannot mistake the drumlin. There are many in the Greater Lawrence area and perhaps the best shaped is Frost Hill, opposite Brooks School on Great Pond Road. (See AAA map quadrant R 17.) Bear Hill, Boston Hill, Osgood Hill, Weir Hill are just a few of the many drumlins in the area. Consult a topographic map[2] to determine other drumlins in the area.

[1] G.E. Zink op. cit. pp. 31, 32

[2] South Groveland Quadrangle Mass. - Essex County 7.5 minute series U.S. Dept. of the Interior, Wash., D.C.

ACTIVITY II - TOPOGRAPHIC MAPS:[1]

Introduction: A worthwhile activity which can be conducted in conjunction with glaciation is the following topographic map exercise. Maps of the Sou roveland Quadrangle may be obtained locally at the Totem Pole Inc, route 114 North Andover, Mass. If your area is not included in this map others are sold which include your town or city. Further information concerning maps may be obtained from the Map Information Office, Geological Survey, Washington, D. C. If ordering maps from the government, they should be ordered from the Washington Distribution Section, Geological Survey, Washington, D.C. 20225. Be prepared to wait months before getting the maps which have to be paid for when the order is sent in. The price of the standard topographic map was 30¢ per copy. It should also be noted that the new maps do not have legends on the reverse side to explain the various map symbols and any good geology textbook such as Longwell's[2] book should be helpful.

[1] ED 063 151 "Environmental Center For Our Schools, Curriculum Guide Grades 4, 5, 6." (Springfield Public Schools, Mass. Sept. 71, 157p) Additional map activities are presented such as; map skills, compass and map activity, telling time with a compass and others.
ED 042 636 "Environmental Education Units. Photography for Kids, Vacant Lot Studies, Contour Mapping." (Minneapolis Independent School District 275, Minn. '70 86p) Included is an interesting unit on contour mapping in the field for elementary classes.

[2] Chester R. Longwell et. al. PHYSICAL GEOLOGY New York: John Wiley & Sons, Appendix D p. 631

NAME: _____

TOPOGRAPHIC MAPS

Study carefully the South Groveland Quadrangle of the U.S. Geodetic Survey Maps, and the information on the back of the map. Then answer the following questions.

1. What is the contour interval of the South Groveland Quadrangle. _____

2. What is the height of Byer's Hill? (NE of Lake Cochichewick) _____

3. What is the height of the circular hill on the East Bank of Johnson's Pond? (N rectangle) _____

4. What is the lowest elevation on the sheet? (In feet) _____

5. What is the highest elevation on the sheet? (In feet) _____

6. What is the maximum relief? (Greatest difference in elevation) _____

7. There is a depression in Georgetown (NE rectangle) located about one mile south of Rock Pond. What is the elevation of the bottom of this depression? _____

8. What is the greatest length of Stiles Pond? (E rectangle) (feet) _____

9. What is the airline distance between Woodchuck Hill (S rectangle) and Shaven Crown Hill? (E rectangle) (in miles) _____

10. Where is the closest triangulation station to Brooks School? _____

11. The scale on this map is given as $\frac{1}{31,680}$. Is this exactly 1/2 mile to the inch? _____

12. How high would a tower on Holt Hill (SW rectangle) have to be to be seen from the ground at Brooks School if trees do not get in the way? Plot on graph paper the profile of this section. _____

13. What are the approximate geographical co-ordinates of Brocks School? Latitude? _____
Longitude? _____

ANSWER KEY:

1. 10'	5. 420'	9. 3.61 miles	13. Latitude 40° 42' 30" N
2. 314'	6. 415+5'	10. Osgood Hill	Longitude 71° 05' W
3. 175 + 5'	7. 215+5'	11. Yes	
4. 5 + 5'	8. 3800'	12. No Tower is needed	

ACTIVITY III -PARTS OF A FLOWER

Introduction: This activity should be performed prior to the Wildflowers because it allows the student to learn the names and functions of the flower parts and also how flowers reproduce. The teacher should have a flower model or large diagram of flower parts and then proceed to discuss the model prior to the flower dissection. The snapdragon, although not a wildflower, is large enough so that stamens, pistils, etc., are readily seen. Greenhouses will often supply these free if they are to be used for classroom purposes. Each student should receive one blossom. The activity will really test the student's power of observation. Once they have learned the flower parts, using the dichotomous key will be made much easier.

PARTS OF A FLOWER

PURPOSE: To examine the structure of a flower and note the reproductive functions of the parts.

MATERIALS: snapdragons, razor blades, dissecting microscope or hand lens.

PROCEDURE:

Note: Consult a flower diagram or model of a flower.

1. Locate the sepals. These are the outermost floral parts which protect the flower in the bud stage.
2. Notice, inside the sepals, the banner and keel petals. What function do the petals serve? (1) Are the petals regular or irregular? (2)
3. Both the sepals and petals are attached to enlarged portions called the receptacles. These three parts are called accessory parts because they are not involved in sexual reproduction.
4. Open the corolla and rip the banner petal far enough to expose the stamens. How many stamens can you count? (3) To what are the stamens attached to at their bases? (4) The stamen, made up of the anther (containing the pollen) and filament, is the male part of the flower.
5. What are some of the ways in which the pollen is carried from the anthers to the female part of a flower? (5)
6. Strip all the petals and stamens from the flower being careful not to tear off the central stalk which is the female portion of the flower called the pistil.
7. The pistil is made up of a filament called the style, a sticky stigma at one end (Top) and a bulbous part at the bottom end called the ovary. What is the purpose of the sticky stigma? (6)
8. Using the razor blade or scalpel cut the ovary lengthwise. Scoop out the ovules and count them on the uncut side using a dissecting microscope or hand lens. How many ovules can you count inside the ovary? (7) Each of these ovules contains an egg cell. How can the sperm cell fertilize the egg cell which is protected inside the ovary? (8)

ANSWER KEY:

1. show presence of pollen and nectar to insect.
2. irregular
3. four
4. petal
5. insects, birds, wind, water, gravity
6. trap pollen grain and provide a medium for growth of the pollen tube
7. hundreds
8. via pollen tube

ACTIVITY IV - WILDFLOWERS[1]

Introduction: This is an activity which has wide applications. The main objectives of this activity are; to learn how to identify, press and mount wildflowers; to learn how to use a dichotomous key and to learn something about flower characteristics and their habitat. This activity has been used from the 9th grade to the 1st grade with modifications.

Materials: Flower press; plastic bags approximately 8"x12"; scotch tape; identification books; folder to make flower album cover; paper.

Method:

1. Place a few drops of water in a plastic bag to provide a humid atmosphere so that flowers will remain fresh while collecting in the field.

2. Do not pull up plants by their roots.

3. Specimens must be at least 6" in length. Tall plants should be picked at their base because when keyed out reference is sometimes made to the lower leaves.

4. Specimens must be flowering and not gone to seed.

5. Do not pick more than three or four specimens at a time in order to provide ample time for identification.

ED 063 151 "Environmental Center For Our Schools, Curriculum Guide Grades 4,5,6."(Springfield Public Schools, Mass. Sep '71 157P) Seed Dispersal activity for the Fall. Tree Identification by leaf scar and tree silhouette method.
ED 054 129 "Science Experience Unit: Conservation." (Ferguson-Florissant School District, Ferguson, Mo. Sep '70 46P) Study of one tree through the four seasons of the year and how to identify and label leaves.
ED 068 310 "Sixth Grade: Fall and Winter Curriculum Guide." (Joel Robert Jacobs. ED. Harrisburg City Schools, Pa. Outdoor and Environmental Education Center '72 86P) Activity on Poisonous Plants.

6. After coming in from the field, place the flower stems in a bottle of water. Then proceed to identify them.

7. Read the introduction of Newcomb's[2] wild flower book and proceed to make an initial identification. Once this is done consult pictured flower keys[3] for positive identification.

8. Using scotch tape sparingly, tape down petals, leaves and stem to paper provided. (see sample flower sheet which follows)

9. Print the necessary information at the bottom of the flower sheet.

10. Carefully place the mounted flower into the flower press for a period of 48 hours.

11. After 48 hours remove the pressed flowers and place in a suitable folder which will become the flower album.

12. Number the pages of your specimens and provide an index (common names only) or table of contents.

13. A minimum of 10 specimens will be required.

14. If there is time and interest, students may write a short paragraph about each flower on the back of the flower sheet or insert an extra sheet into the album.

[2] Lawrence Newcomb, POCKET KEY TO COMMON WILDFLOWERS, Framingham, Mass: The New England Wildflower Preservation Society.

[3] See annotated flower book bibliography.

Comments:

Flower presses have been made by the author for 20¢ each. However, materials are so expensive today the cost of the materials for the press are higher. Two pegboard squares (with holes) 12"x12"x1/4" are used to hold 10 pieces of cardboard (cartons can be obtained free from grocery stores), 10 pieces of newspaper cut to size (leave the folded side intact), and two large rubber bands cut from old automobile inner tubes (obtained free from any gas station). These presses work very nicely and one can pile books, or put the leg of a bureau or bed on top of the press to get a better pressing job. Insert the flower sheet with the mounted flower between the pages of the newspaper which in turn is placed between two pieces of cardboard.

FLOWER ALBUM SHEET

COMMON NAME:_____ HABITAT:_____

SCIENTIFIC NAME:_____ DATE:_____

ACTIVITY V BOG ECOLOGY - THE BOG NATURE TRAIL

Introduction: After sampling the kinds of wildflowers around your school it would be interesting to take your class to a bog to observe the diversity of plant life there and note how it differs from the plants they have already looked at. Perhaps the most interesting plants to see are the insectivorous pitcher plant and sundew.

The Bog Nature Trail is a part of the Charles W. Ward Reservation, Andover, Mass. and is easily accessible from route 125 in Andover, Mass. A board walk is provided so that it is perfectly safe for students. Write to The General Headquarters of the Trustees of Reservations, 224 Adams St., Milton, Mass. 02186 for pamphlets (cost 25¢) which provide a self guided tour of the bog. A worthwhile experience indeed.

ACTIVITY VI - Insects[1]

Introduction: Although there are wide applications this activity involves collection, identification and mounting of insects.

[1] ED 063 151 "Environmental Center for our Schools, Curriculum Guide, Grades 4,5,6." (Springfield Public Schools, Mass. Sep '71 157P)
Field Community - an activity involving both insects and flowers.
The Gall Dwellers - an activity dealing with insect galls.
ED 054 129 "Science Experience Unit: Conservation." (Ferguson-Florissant School District, Ferguson, Mo. Sep '70 46P)
Activity demonstrating the proper care of insects in the classroom. Also, Insect Key - how to use a key to eight common orders of adult insects.
ED 068 310 "Sixth Grade: Fall and Winter Curriculum Guide." (Joel Robert Jacobs. Ed. Harrisburg City Schools, Pa. Outdoor and Environmental Education Center. '72 86P)
Activity - Insects Friends or Enemies?

Materials:[2] Insect pins; insect killing jars; insect nets; pinning blocks; spreading boards; labels; cardboard; shirt box; white paper; insect identification books[3]; Elmer's glue, wax paper; magnifying lens or microscope.

Method:

1. Each student should have an insect net and a killing jar charged with a killing agent. ("Raid" will do, however, the author has successfully used chloroform.) Sweeping should be done in the tall grass - open fields, near flowering plants (caution - stinging insects), or in wet areas so that a good sampling of habitats is made. Evening insects are attracted by light and a collection can be made very easily.

2. When students come in from the field, they should empty the killing jar on to a piece of white paper and proceed to separate the insects according to Orders.[4]

3. The insects should now be pinned through the thorax except for beetles which are pinned through the right wing and as close to mid center as possible and tiny insects which are place on a small wedge shaped piece of paper. The body of the insect should straddle the apex of the wedge and held with Elmer's glue.

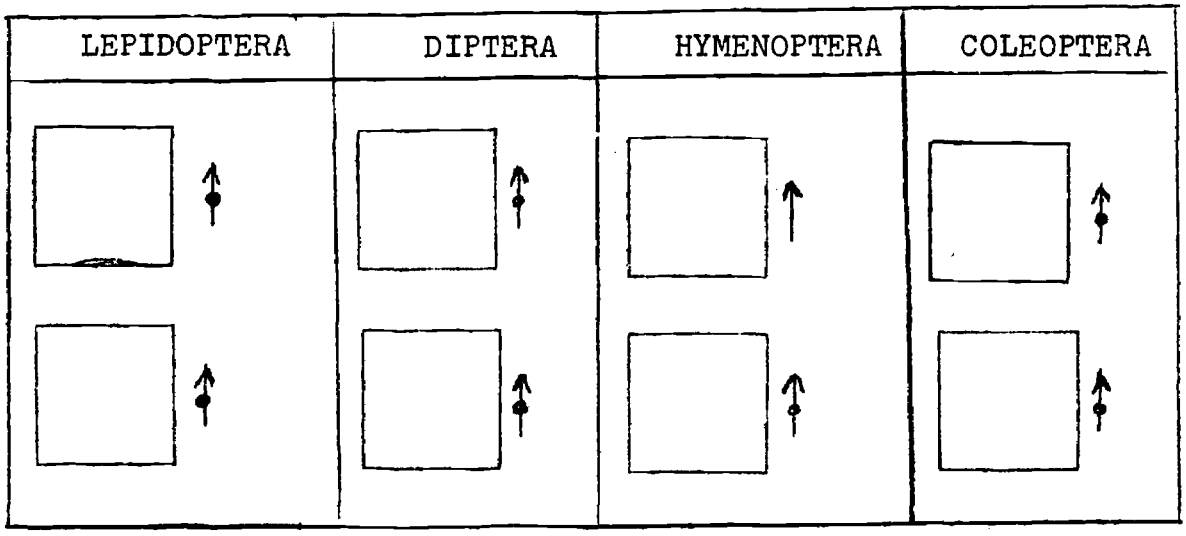
4. Identification should now be made using insect handbooks.

5. In order to protect and house the insects it is suggested that students obtain a shirt box and cut a piece of cardboard to fit the bottom of the box. White paper should be taped to the cardboard and proper nomenclature printed on the paper. (See sample which follows.)

[2]Materials can be obtained from: Ward's Natural Science Establishment Inc., P.O. Box 1712, Rochester, N.Y.

[3]See annotated bibliography for field guides to the insects.

[4]E. John DeWaard, WHAT INSECT IS THAT? Columbus, Ohio: American Education Publ. Education Center



It should be noted that each column is headed by the appropriate Order of insects.

6. When mounting insects, all heads should point away from you and placed to the right of the label. Small pressure labels used by librarians work well. The common name and the date collected are placed on the label. Labels are printed.

7. A minimum of 15 adult insects plus one butterfly of any species, properly spread is usually required of every student.

8. Butterflies, moths, damsel and dragon flies are all spread so as to give them a natural look. Leave them on the spreading board for at least 48 hours. Use wax paper or glass microscope slides to hold wings in place.

9. The shirt box cover can be cut out and replaced with cellophane to give a more professional look. It is also suggested that a small box of moth balls be included inside the box to preserve the insects.

Comments:

Most of the material needed for insect collecting can be made or obtained locally.

Insect nets - can be made by bending a coat hanger into a circle and taping or tying it on to a stick. Fine mesh nylon or other cloth can be obtained from local shops and sewn on to the coat hanger. One leg of mother's panty hose might work.

Killing Jar - can be made from a small peanut butter jar by boring a hole through the cover and cutting a sponge to fit the inside of the cover. The sponge is secured by a nut and bolt. The sponge can be charged with chloroform or "Raid" can be sprayed on until the sponge is saturated.

Insect Pins - instead of the more expensive insect pins from a biological supply house, long common pins can be used.

Spreading Boards - can be made from balsa wood obtained at specialty stores. A groove should be made down the middle just wide enough to accomodate the body of the insect.

Pinning Blocks - can be made out of softwood. Using the smallest bit, a hole is drilled into the wood to an appropriate depth. When insects are first pinned, the pin is put into the thorax and then into the hole in the wood. Thus all insects will be at the same height.

ACTIVITY VII - FRESHWATER[1] FLORA AND FAUNA

Introduction: The key to this activity is the use of a microscope which might be a hindrance to the elementary school teacher unless, she can borrow them from the high school in that school system.

Group #1 - Use of Seine. A 20 foot seine is used to sample macroscopic specimens near shore. Three students are needed for this. Students may wish to wear bathing suits or waders. The teacher should insist that all students entering the water wear old sneakers or shoes. This will reduce the possibility of cut feet. They will need a bucket and possibly a dip net. Usually small shiners and sunfish are caught with this method, although freshwater clams, snails and turtles have been caught also. The fish can be added to the aquarium. This can be a project in itself for a group of interested students.

Group #2 - Plankton Net and Grappling Hook. A boat (with life preservers) should be used for this part although its not absolutely necessary. Plankton nets can be made (see information sheet which follows) and grappling hooks can be fashioned from bent spikes which are welded together. The rope should

[1]ED 063 151 "Environmental Center for our Schools, Curriculum Guide. Grades 4,5,6." (Springfield Public Schools, Mass. Sep '71 157P)
Pond Community is an activity very similar to the one in this paper except this is specifically designed for grades 4,5,6.
Investigating the Winter Pond look like an interesting activity and a follow up to the above activity on Fresh water Biology.
ED 068 310 "Sixth Grade: Fall and Winter Curriculum Guide." (Joel Robert Jacobs, Ed. Harrisburg City Schools, Pa. Outdoor and Environmental Education Center. '72 86P)
Winter activity - Invertebrate Animals.

be long enough to reach the bottom in the case of the grappling hook. Two students are needed for this part. The plankton sample should be really concentrated as this will provide most of the organisms for this whole study.

Group #3 - Shore. The remainder of the class can go along the shore turning over rocks and looking for crayfish, blood suckers, flatworms and other organisms.

Comments:

1. Once identifications are made, students should make a drawing and include information as noted on the following page. A brief description of each organism should be made including interrelationships.

2. This activity is also applicable to a study of streams or swamps.

FLORA & FAUNA OF LAKE COCHICHEWICK

Purpose: To discover and identify the many kinds of plants and animals which inhabit fresh water.

Materials: Microscopes, slides, cover slips, methyl cellulose, grappling hooks, seine, boat, collecting jars, plankton net, forceps, dissecting kits. Note: Wear old sneakers and shorts.

Method: 1. Obtain a collecting jar from your instructor. When we arrive at the collecting area you will be assigned a specific job to do. When you collect a sample of water, make sure you properly label the habitat. Use pencil in making all labels on bottles.

2. These are some of the areas we will investigate: open water below surface, water surface near shore, bottom near shore, under rocks in water and near shore, plants growing near shore and under water. (Replace overturned rocks.)

3. If time permits when you come back from the field, do the following: Using your medicine dropper, place a drop of the sample on a slide and cover with a cover slip. Examine under low first, then switch to high. Be careful when focusing. See your instructor if you find it difficult to identify any specimen. ONCE identification has been made, make a drawing of the specimen and label it. Put down all information requested by your instructor.

4. If you find it difficult to view your specimen because the organisms are moving too rapidly, dilute some methyl cellulose with your sample and this will slow down the movement.

Report: 1. In your lab. notebook you should include the following: Labeled drawings of all specimens you saw. See sample lab sheet.
2. Conclusions: What general conclusions can you make about the organisms found and their habitat?
3. Coloring specimens is optional. See your instructor for colored pencils.

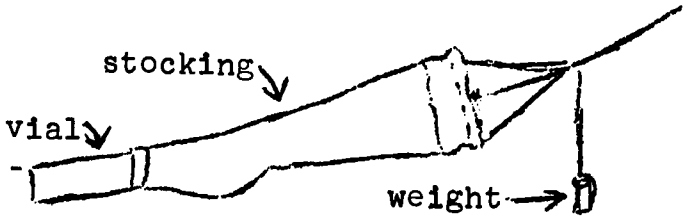
PROJECT

Two Simple Tools for Collecting Plankton or Other Small Fry from the Water.

A PLANKTON NET

You will need:

A discarded nylon stocking
Wire coat hanger
Needle and thread
Narrow glass or plastic vial
String
3 pieces of light rope about 2' long
Small weight or sinkers



Shape the coat hanger wire into a ring 6 - 9" in diameter, depending on the size of the stocking top, and sew the stocking to the ring. Cut off the tip of the toe and tie the opening around the neck of the vial. Attach the ropes to the ring, equal distances apart. Tie the free ends of rope together and fasten to a tow line.

Tow the net very slowly (1 - 2 miles per hour) through the water. The plankton will collect in the vial. If the net rides at the surface, you may want to fasten weights to it.

A SCREEN SIEVE

You will need:

2 pieces of lath, about 12" long
fine mesh window screening 12" square
tacks and hammer.

Bend the edges of the screen over about 1/2" and tack them to the two laths. This will keep the screen stiff.

SAMPLE LAB. SHEET

DRAWINGS:

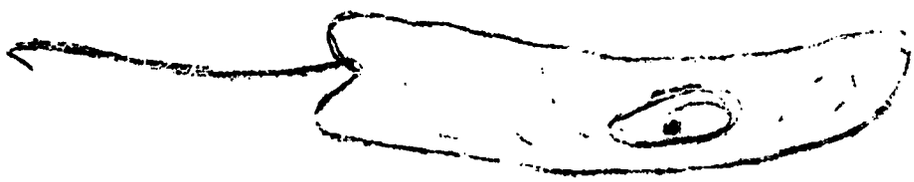


FIG. 1 EUGLENA sp? 400X
Habitat: water near shore
Magn. Drawing: 50X

DESCRIPTION:

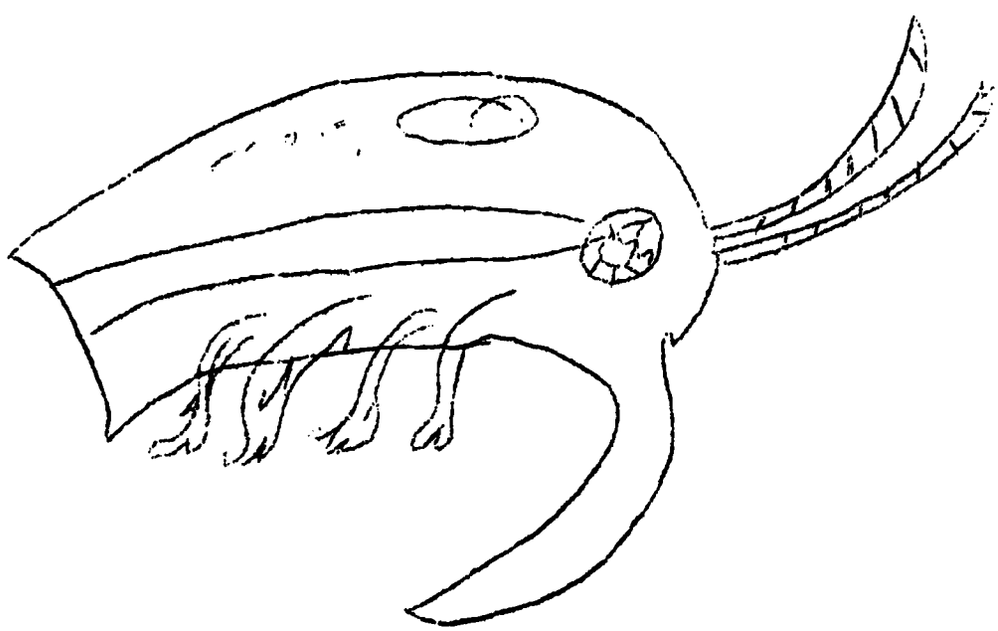


FIG. 2 BOSMINA sp? 400X
Habitat: deep water
Magn. Drawing: 60X

DESCRIPTION:

CHIEF PHYLA OF THE FRESHWATER INVERTEBRATES FOUND IN THE

NORTH ANDOVER AREA

A. PHylum PROTOZOA
   Class Mastigophora
      Examples: Volvox sp.

      Eudorina sp.

      Euglena sp.

   Class Sarcodina
      Examples: Ameba sp.

      Arcella sp.

      Foraminafora sp.

   Class Ciliata
      Examples: Paramecium sp.

      Stylonychia sp.

      Vorticella sp.

      Stentor sp.

B. Phylum PORIFERA
   Class Calcarea
      Example: Leucosolenia sp.

C. Phylum Coelenterata
   Class Hydrosoa
      Example: Hydra sp.

D. Phylum PLATHEMINTHES
   Class Turbellaria
      Example: Euplaneria sp.
      (flatworms)

E. Phylum ASCHELMINTHES
   Class Nematoda
      Example: nematode or roundworms

   Class Rotifera
      Example: rotifers

   Class Gastrotricha
      Example: gastrotrich

(A little larger in size than a parameclum.
Note bifurcated tail.)

F. Phylum BRYOZOA
Class Ectoproct
Example: Pectinatella sp.

G. Phylum NOLLUSCA
Class Palecypoda
Example: Anodonta sp.
(clam)

H. Phylum ANNELIDA
Class Oligochaeta
Example: Lumbrious sp.
(earthworm)

Class Hirudinea
Example: Hirudo sp.
(leech)

I. Phylum ARTHROPODA
Subphylum Mandibulata
Class Crustacea
Subclass Branchiopoda
Order Cladocera
Example: Daphnia sp.
(water flea)

Subclass Ostracoda
Example: Cyprus sp. (ostracod)
(Looks fairly large under low power. Looks like a clam.)

Subclass Copepoda
Example: Cyclops sp. (copepod)

Subclass Malacostraca
Division Peracarida
Order Isopoda
Example: Porcellio sp. (sow bug)

Class Chilopoda
Example: (centipede - flat body)

Class Diplopoda
Example: (millipede - round body)

Subphylum Tardigrada
Example: water bears

ACTIVITY VIII - MARINE ECOLOGY

Ipswich Sand Flats: In order to use these restricted clam flats permission must be obtained from: Mr. Arthur Moon, 13 Arrowhead Trl., Ipswich, Mass. Telephone: 356-4621. Mr. Moon will lead any school group if given sufficient notice. It is a good idea to arrive at the collecting site at least 1/2 hour before low tide.

Directions: Rt. 133 to High Street, East Street, Jeffrey Neck Road, Bay View Road.

If Mr. Moon is not at home call the Ipswich Police Department. A transect can be attempted at the collecting site. See the lab. sheet which follows. Identification books are listed in the annotated bibliography. If you intend to preserve any specimens it might be a good idea to bring a gallon of 10% formalin plus preserving jars. Consult the list of invertebrate animals commonly found off the Massachusetts coast. Many of the worms listed will be found at the clam flats.

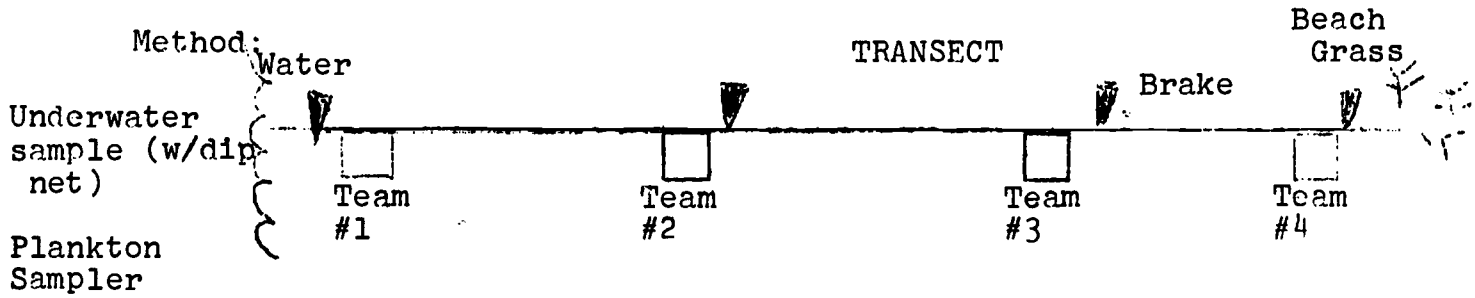
Place: Ipswich Sand Flats

Title: What Organisms Live in Sand Between Low and High Water Lines?

Materials:

- ball of twine
- four stakes
- meterstick
- spray paint
- plankton net
- dip net
- plastic buckets
- collecting jars w/aprons
- pencils
- notebooks (field)
- sieves- two kinds
  - screen and next size
  - **mesh** size 16"x18"
- plastic bags
- tape measure
- clam forks or garden fork
- garden trowels
- picnic cooler
- plastic jars (mayonnaise)
- identification books
- first-aid kit
- thermometer (air)
- magnifier

Method:



Teams #1, #2, #3, #4

1. Sample area equals 1 meter X 1 meter.
2. Put each organism found in jar containing sea water and insert label including depth at which found and team number.
3. Put sand on double sieve-a little at a time-run saltwater through. Large mesh is placed above small mesh.

Dip net man

1. Collect all organisms found in shallow water. Ex. hermit crabs, egg collers of moon snail.
2. Record air temperature, water temp., and temp. of sand (6" down) at each group.
3. Record relative hardness of the sand at each group.

Plankton net man

1. Collect highly concentrated plankton sample at end of transect.

Everyone

1. Book for castings, holes, tracks, and mounds.

2. Record temperature, wind direction and velocity

Labeling: (in lab)
Location: Date: Scientific Name: Common Name: Tide:
Temperature: Wind Direction: Wind Velocity:

At site: label where organism was found and your name.

Report:

1. Title Page: Date, your name.

2. Body of Report: Brief description of the trip include:
   a. length of time of trip
   b. weather conditions - temperature, wind velocity and direction
   c. map showing where organisms were found and what kind
   d. try to describe any interrelationships if possible
   e. make a sketch of each specimen found and under each specimen list the following:

      Scientific Name:
      Common Name:
      Habitat:
      Brief Description:

3. Bibliography page:

INVERTEBRATE ANIMALS COMMONLY FOUND

OFF THE MASSACHUSETTS COAST

Taxonomic Names	Common Names: Comments
PORIFERA:	
Cliona Celata	Boring sponge, sulfur sponge
Halichondria panicea	Crumb of bread sponge
Haliclona (Chalina) oculata	Deadman's fingers
Microciona prolifera	
COELENTERATA:	
Class Hydrozoa:	
Hydractinia echinata	(Hydroids on hermit crab shell)
Pennaria tiarella	
Sertularia pumila	Wreathed hydroid, (Often growing on seaweed)
Campanularia	
Class Scyphozoa	
Aurelia aurita	Moon jellyfish, white jellyfish
Class Anthozoa	
Astrangia danae	Local coral
Metridium senile	Common sea anemone
Sagartia	(Small anemone, several species)
CTENOPHORA:	
Mnemiopsis	Sea walnut
PLATYHELMINTHES:	
Bdelloura candida	(Commonly found on gills of horseshoe crab)
RHYNCHOCOELA:	
Cerebratulus lacteus	Ribbon worm, (very long)
ANNELIDA:	
Arenicola cristata	Lugworm
Amphitrite ornata	Ornate worm
Chaetopterus pergamentaceus	Parchment worm
Clymenella torquata	Jointed worm
Hydroides uncinata	(Relatively straight calcareous worm tubes)
Nereis (Neanthes) virens	Sandworm
Pectinaria (Cistenides) gouldii	Trumpet worm
Spirorbis borealis (spirorbis)	Coiled worm (Coiled worm tubes)
MOLLUSCA:	
Class Amphineura:	
Chaetopleura apiculata	Chiton
Class Pelecypoda:	
Anomia simplex	Jingle shell
Ensis directus	Razor shell clam
Mya arenaria	Soft shell clam
Mytilus edulis	Edible mussel
Pecten irradians	Atlantic Bay Scallop
Venus mercenaria	Hard shell clam, quahog

Class Gastropoda:	
Busycon canaliculatum	Channeled whelk
Crepidula fornicata	Common slipper shell
Littorina littoria	Common periwinkle
Littorina obtusata	Obtuse periwinkle
Littorina saxatilis	Northern rough periwinkle
Nassarius (Nassa) obsoleta	Mud snail
Polinices duplicata	Moon shell
Thais lapillus	Atlantic dogwinkle
Urosalpinx cinereus	Oyster drill
Class Cephalopoda:	
Loligo pealii	Common squid
ARTHROPODA:	
Balanus balanoides	Rock barnacle
Idothea baltica	(Isopod)
Gammarus locusta	(Amphipod)
Orchestia agilis	Eastern sand hopper (Amphipod)
Callinectes sapidus	Blue crab
Carcinides (Carcinus) maenas	Green crab
Homarus americanus	Lobster
Libinia emarginata	Spider crab
Pagurus longicarpus	Hermit crab
Uca pugnax	Fiddler crab
Anurida maritima	(Insect, collembola or springtail)
Limulus (Xiphosuza) polyphemus	Horseshoe or king crab
ECHINODERMATA:	
Asterias forbesi	Starfish
Henricia sanguinolenta	Blood sea star
Amphipholis squamata	Long armed snake star
Ophioderma brevispinum	Green brittle star
Arbacia punctulata	Purple sea urchin
Echinarchnius parma	Sand dollar
Leptosynapta inhaerens	Common synapta
Thyone briareus	Sea cucumber
CHORDATA:	
Saccoglossus knowleviskii	Acorn worm
Amareucium constellatum	Sea port
Botryllus schlosseri	Common ascidian
Ciona intestinalis	Sea squirt
Mogula manhattensis	Sea grapes

TIDAL POOL ECOLOGY:

Although there are many places along the Massachusetts coast to observe tidal life, one of the best areas is Seapoint Beach, Kittery, Maine. Directions: Route 495 to Route 95 to the new Kittery Bridge. Take Exit 1 from the Maine Turnpike which will lead you to Route 103. Stay on Route 103 until it forks and take the right fork following this road to the beach. Look for a sign at the fork which says Seapoint Beach 2 miles. Drive your vehicle as far as you can or until you can see the rocks where collections will be made. There is swimming available as well as rest rooms. Use the same equipment that you used at the Ipswich sand flats. You will find buckets easier to use than jars. A list of organisms found in the tidal pools follows. The driving time from North Andover to the beach is 1 hr. and 15 min.

INTERTIDAL LIFE OF ROCKY COASTS

I. Upper Beach Zone: transition between true seashore and land. Only a few animal species inhabit this zone. Mainly snails of Littorina or close relatives. Sometimes called the "Littorina Zone." Algae and lichens encrust the rock at this point. Other organisms.

Limpets (Acmaea) feed on algae by radula
Isopods (Ligia)
Amphipods (beach hoppers or sand fleas) (Orchestia)

Rocks Covered with (in splash zone) (in descending order)
1. Microscopic blue-green algae (Calothrix or Lyngbya)
2. Green algae (Enteromorpha).

II. The Middle-Beach Zone: The true intertidal zone. This is the Balanoid zone because of the predominance of barnacles (Balanus). Animals must have the following in order to exist at this zone.
1. Strong holdfasts or protective shells or both.
2. Be able to seek shelter among other organisms.

Animals:

clam worm (Nereis)
Barnacles (Balanus at different levels)
purple shore crab (Hemigrapsus)
Small rock crab (Pachygrapsus)
Hermit crab (Pagurus)
Limpets (Acmaea at different levels)
dog whelk or dogwinkle (Thais)
periwinkles (Littorina different species at different levels)
mussel (Mytilus edulis)
book starfish (Asterias forbesi)
purple starfish (A. vulgaris)
purple sea urcin (Arbacea punctulata)

Plants:

green alga (Cladophora)
sea lettuce (Ulva)
Rock weeds (Pelvetia, Fucus - several species)
Coelenterates
Sponges

III. The Lower Beach Zone: Bared only by the lowest tides. Rich in plant and animal species. Large brown alga predominates (Laminaria) hence called the Laminarian zone.

brown rockweed (Laminaria)
Irish moss (Chondrus)
filamentous red alga (polysiphonia)
calcareous coraline algae (Lithothamnion)
calcareous coraline algae (Corallina)

Sand Dune Ecology:

Cranes Beach in Ipswich, Mass. provides a fascinating area for the study of succession and sand dune ecology. The Trustees of Reservations have established the Pine Hollow Interpretive Trail amongst the dunes. It is a self guided tour and pamphlets (25¢) can be obtained at the office at Crane's Beach or from the General Headquarters of the Trustees of Reservations, 224 Adams Street, Milton, Mass. 02186. Admission fee for Crane's Beach is $1.50 per car or $5.00 for a bus.

Directions: Rt 133 to Crane's Beach.

Rest rooms and snack bar are available (in season) and swimming (excellent beach) is also available. A publication of the Museum of Science, Boston, called Life in the Shifting Dunes by Lawrence B. White, Jr., is a must for this trip. See annotated bibliography.

CHAPTER III

ANNOTATED BIBLIOGRAPHY

GLACIATION

Longwell, Chester R. et. al. Physical Geology New York: John Wiley and Sons, Inc. pp. 254-284.
Provides a good background for glaciation field trips. Diagrams give the reader a clear view of the glacial formations discussed in this paper.
Appendix D pp. 631-641. A good reference for the topographic map exercise.

Sears, John H. The Physical Geography, Geology, Mineralogy and Paleontology of Essex County, Mass. Salem, Mass: Essex Institute. 1905.
A difficult book to find because it is out of print. Check your local library. A worthwhile reference for the glaciation of this area.

Wolfe, C. Wroe et. al. Earth and Space Science Boston: D.C. Heath Co. pp. 192-207.
Provides a simple explanation for glacial formations, pp. 21-27 Topographic map information.

Zink, George E., Holcombe W. H. Rocks and Minerals, Glaciation. 3rd Edition. Andover, Mass.: Town Printing Co., 1960. pp. 24-34.
An excellent pamphlet written specifically for the students of Brooks School and the supply is limited. Single copies only may be obtained by writing to the author of this paper. The section on glaciation is well done.

WILDFLOWERS

Gleason, Henry A. The New Britton and Brown Illustrated Flora of the Northeastern United States and Adjacent Canada. 1963. 3 volumes.
Highly technical and expensive. Outstanding as a source book. Not recommended unless serious work on wildflowers is to be done.

Newcomb, Lawrence. Pocket Key to Common Wild Flowers (Pamphlet) Framingham, Mass.: The New England Wild Flower Preservation Society. A non-pictured key, but simple and easy to use. 104 pages.
It is a handbook which can fit into the pocket and taken into the field for preliminary identification. The author uses this pamphlet extensively.

Peterson, Roger Tory & McKenny, Margaret. A Field Guide to Wildflowers of Northeastern and North-Central North America. 1968. Boston: Houghton Mifflin Co.
A visual approach to wildflower identification, arranged by color, form, and detail. The best of a number of handbooks. Worthwhile having this book in the classroom.

Rickett, Harold W. Wildflowers of the United States. 1966. New York: McGraw-Hill 2 volumes.
These two pictured wildflower books cover the Northeastern States. They are perhaps the best pictured keys available which are in the laymen's language. They are expensive but highly recommended.

Wherry, Edgar T. Wild Flower Guide Northeastern and Midland United States. 1948 Doubleday & Co., Inc., and the American Garden Guild, Inc.
A pictured key with some colored plates.

Zim, Herbert S. & Martin A.C. Flowers 1945. New York: Simon & Schuster. One of the Golden Nature Guide Series.
A guide to the familiar American wild flowers. Very easily used by elementary classes. All pictures are in color. Buy the hard cover edition.

BOGS

Kimball, John W. Bog Nature Trail (Pamphlet) Milton, Mass.: General Headquarters of the Trustees of Reservations, 224 Adams Street, Cost 25¢.
An excellent pamphlet and necessary for a self guided tour of the bog in the Charles W. Ward Reservation, Andover, Mass. The pamphlet contains other reading references to bogs, which should be helpful.

INSECTS

Borror, Donald J. & DeLong, Dwight M. An Introduction to the Study of Insects. Revised Ed. 1954. New York: Holt, Rinehart and Winston.
An excellent reference book and usually very helpful when the field guides do not give sufficient information.

Borror, Donald J. and White, Richard E. A Field Guide to the Insects of America North of Mexico. 1970. Boston: Houghton Mifflin Co.
Outstanding and probably the best field guide on insects. Some colored plates. A good buy for classroom reference.

DeWaard, John E. What Insect is That? (Pamphlet) 1969. Columbus, Ohio: American Education Publication.
One of the series on Biology Unit Books. Very simple text and useful for elementary grades. Cost 40¢. Used by the author to introduce the study of insects.

Fichter, George S. Insect Pests. 1966. New York: Golden Press. Organized according to the type of plant attacked by insect pests. A little difficult to use because of this method of arrangement but it is in color and useful.

Jaques, H.E. How to Know the Beetles. 1951. Dubuque, Iowa: Wm. C. Brown Co. Publ.
One of the Pictured Key Series and very helpful for the beetle enthusiast. No color however, which is a drawback.

Klots, Alexander B. A Field Guide to the Butterflies of North America, East of the Great Plains. 1964. Boston; Mass: Houghton Mifflin Co.
An excellent field guide for butterflies. Well illustrated with many color paintings. Good classroom reference.

Lutz, Frank E. Field Book of Insects. 1948. New York: G.P. Putnam's Sons. 3rd Ed.
Rewritten to include much additional material, with many illustrations in color. A classic fieldbook used by many insect enthusiasts.

INSECTS (cont'd.)

Mitchell, Robert T. & Zim, Herbert S. Butterflies and Moths. 1964. New York: Golden Press.
A guide to the more common American species. In color and well issustrated. Mostly the larger species are included. A good book to have. Buy the hard cover edition.

Oman, P.W. Collection and Preservation of Insects. 1964 (Pamphlet). Washington, D.C.: Superintendent of Documents, U.S. Govt. Printing Office. Cost 25¢. Publication #601.
Excellent and inexpensive.

Zim, Herbert S. & Cottam, Clarence. Insects. 1956. New York: Golden Press.
A guide to the familiar American insects. One of the Golden Nature Guide Series. Well illustrated in color and simple to use. By the hard cover edition. Invaluable reference text.

FRESH WATER BIOLOGY

Edmondson, W.T. Ward and Whipple's Fresh-Water Biology. 1959. 2nd Ed. New York: John Wiley & Sons, Inc.
A classic text and a must for the serious student and an excellent reference. This is known as the "bible" of freshwater biology.

Garnett, W.J. Freshwater Microscopy. 1965. New York: Dover Publications Inc.
An outstanding British test and very applicable to the organisms found in the United States. All illustrations are photomicrographs so that if serious microscopy is attempted this would be an excellent reference.

Klots, Elsie B. The New Field Book of Freshwater Life. 1966. New York: G.P. Putnam's Sons.
A very comprehensive guide to the recognition and study of the aquatic plants and animals of North America North of Mexico. Over 700 illustrations. Very few in color, however, a readily usable field guide.

Needham, James G. and Paul R. A Guide to the Study of Fresh-Water Biology. 1962. (Pamphlet) San Francisco: Holden-Day, Inc., 5th Ed. revised and enlarged.
A classic text in the study of freshwater biology. Excellent for the elementary school as a reference. This is one of the texts used extensively in the author's courses.

Palmer, Mervin C. Algae in Water Supplies. 1962. (Pamphlet) Washington, 25, D.C., U.S. Department of Health, Education, and Welfare Public Health Service. Division of Water Supply and Pollution Control.
Outstanding for algae identification and pollution studies. Inexpensive and a must for the classroom.

Pennak, Robert W. Fresh-Water Invertebrates of the United States. 1953. New York: The Ronald Press.
Excellent reference text for serious study of fresh water. Expensive.

Prescott, G.W. How to Know the Freshwater Algae. 1964. Dubuque, Iowa: Wm. C. Brown Co. Publ.
One of the Pictured-Key Nature Series. A detailed key to the algae and necessary for serious work. No colored plates.

Reid, George K. and Fichter, George S. Pond Life 1967. New York: Golden Press.
One of the Golden Nature Guide Series. This is a guide to the common plants and animals of North American Ponds and Lakes. In color and excellent for elementary school. Buy the hard cover edition.

MARINE ECOLOGY

Arnold, Augusta Foote The Sea-Beach at Ebb-Tide. 1968. New York: Dover Publications Inc.
A guide to the study of the seaweeds and the lower animal life found between tide-marks. This test is designed to be an aid to the amateur collector and student of the organisms, both animals and plant, which are found on North American beaches.

Barrett, John H. and Yonge, C.M. Collins Pocket Guide to the Sea Shore. 1970 Paterson, N. J.: Oceanography Unlimited, Inc., 91 Delaware Ave.
A British text but applicable to organisms found on the Atlantic Coast.

Bousfield, E.L. Canadian Atlantic Sea Shells. 1960. (Pamphlet) Ottawa: The Queen's Printer and Controller of Stationery.
Outstanding reference for the shells of the North Atlantic coast. Applicable to the Mass. coast. Cost $1.00.

Carr, Arnold H. The Shellfish Predators of Massachusetts. (Pamphlet). 1968. Boston, Mass.: Department of Natural Resources, Division of Marine Fisheries, State Office Building, 100 Cambridge St.
A popular pamphlet and excellent reference for sand flat ecology field trips. Cost 6¢.

MARINE ECOLOGY (Cont'd.)

Miner, Roy Waldo Field Bood of Seashore Life. 1950.
New York: G.P. Putnam's Sons.
A compact manual of all the more common invertebrates inhabiting the Atlantic coast. Designed for the more serious student. It is known as the "bible" of seashore field books.

Morris, Percy A. A Field Guide to the Shells of Our Atlantic and Gulf Coasts. 1951. Boston: Houghton Mifflin Co.
Written for the amateur or expert. 102 illustrations in color. Sponsored by the National Audubon Society and the National Wildlife Federation.

Morris, Percy A. Nature Study at the Seashore. 1962.
New York: The Ronald Press Co.
Exploring the seashore with a camera. Many of the photographs are excellent. Another popular book for the layman.

Petry, Loren, C. A Beachcomber's Botany. 1968.
Chatham, Mass: The Chatham Conservation Foundation Inc.
A popular book for the layman. Mainly about Cape Cod shores and the plants that grow there but certainly applicable to other areas of the Mass. coast.

Reid, George K. Ecology of Intertidal Zones. 1967. (Pamphlet)
Chicago: Rand McNally & Co.
Excellent popular pamphlet of the Patterns of Life Series. Indispensible for tide pool field work. Inexpensive.

White, Lawrence B.,Jr. Life in the Shifting Dunes. 1960.
(Pamphlet) Boston: The Museum of Natural Science.
A popular field guide to the Natural History of Castle Neck, Ipswich, Mass. with attention to the unusual ecological relationships peculiar to the area. It is a handy reference if a field trip is taken to Crane's Beach, Ipswich, Mass.

Zim, Herbert S. and Ingle, Lester Seashores. 1955.
New York: Golden Press.
One of the Golden Nature Guides to animals and plants along the beaches. Excellent for all elementary grades. Color. Buy the hard cover edition.

EQUIPMENT AND MATERIALS FOR ACTIVITIES

CCM: Cambosco, Inc.
342 Western Avenue
Boston, Mass. 02135

Ask for Life and Physical Science catalogue.

Ward's Natural Science Establishment, Inc.
P.O. Box 1712
Rochester, N.Y. 14603

Ask for Biology and Earth Sciences catalogue.

CHAPTER IV

ERIC DOCUMENTS - ANNOTATED BIBLIOGRAPHY

ED 018 376 "The Field Study Notebook for the Outdoor School." (Gilfillan, Warren C. Burgess, Robert A. Report No. DPSC - 66-441. '66. 62P)

Prepared for elementary school science students for studying ecology. Four major areas are covered; (1) Soil; (2) Plants; (3) Aquatic habitats; (4) Terrestrial vertebrates and invertebrates.

ED 042 636 "Environmental Education Units. Photography for Kids, Vacant Lot Studies, Contour Mapping." (Minneapolis Independent School District 275, Minn. '70. 86P)

Especially good unit on contour mapping. The vacant lot studies should be helpful to city schools.

ED 043 510 "Environmental Education Units." (Minneapolis Independent School District 275, Minn. '70. 50P)

Discusses the methods of teaching elementary school children the principles of sampling to show biological diversity in a population.

ED 046 735 "The Sea and its Boundaries." (Frank L. Chapman, Carteret County Public Schools. Beaufort, N.C. '70. 31P)

Emphasis is on ecological aspects of oceanography. It discusses tides, beaches, the off coast profile and testing of water, currents, etc.

ED 054 129 "Science Experience Unit: Conservation." (Ferguson-Florissant School District, Ferguson, Mo. Sep '70. 46P)

A laboratory guide made up of 24 experiments and activities on conservation. Equally divided between classroom and outdoors it is directed toward the intermediate grades.

ED 063 151 "Environmental Center for our Schools, Curriculum Guide, Grades 4,5,6." (Springfield Public Schools, Mass. Sep '71. 157P)

Outdoor and environmental study activities for forest, pond, and field. Classroom and on-site activities and suggestions are provided.

ED 063 989 "Environment - A Way of Teaching (Grades K-12)." (Donald Lundstrom, et. al. Alameda County School Dept. Hayward, California, '71. 99P)

Resource guide for elementary and secondary teachers. Ideas for environment curriculum are presented.

ED 066 336 "Environmental Education Curriculum Materials." (Minnesota State Dept. of Education, St. Paul, '72. 34P)

This document presents an annotated directory of environmental education curriculum materials for elementary school teachers.

ED 068 310 "Sixth Grade: Fall and Winter Curriculum Guide." (Joel Robert Jacobs, Ed. Harrisburg City Schools. Pa. Outdoor and Environmental Education Center. '72. 86P)

Activities for sixth grade outdoor education such as; amphibians, insects, poisonous plants, wilderness ecology and others.

ED 068 367 "Fourth Grade: Late Fall and Early Spring Curriculum Guide." (Joel Robert Jacobs, Ed. Harrisburg City Schools, Pa. Outdoor and Environmental Education Center. '72. 83P)

Activities for fourth grade outdoor education such as; vertebrate animals, seed dispersal, water pollution and others.

ED 068 368 "Fifth Grade: Winter and Spring Curriculum Guide." (Joel Robert Jacobs, Ed. Harrisburg City Schools, Pa. Outdoor and Environmental Education Center. '72. 66P)

Activities for fifth grade outdoor education such as; reptiles, birds, flowers and others.

ED 049 946 "Environmental Education for New Hampshire Elementary and Secondary Schools."(New Hampshire State Dept. of Education, Concord. Div. of Instruction. '71. 22P)

Guidelines for the development of Environmental Education Programs, and an annotated list of seven programs in existence in the state of New Hampshire. Suggests steps for developing environmental study sites, and some possible interdisciplinary uses of such sites are given.

ED 045 437 "Environmental Education Instructional Activities, 7-12." (New York State Education Dept., Albany. '70 59P)

Teacher's guide dealing with Environmental Education, this publication for grades 7-12 contains basic concepts, activities, and questions designed to emphasize the primary role of man as a participant in, rather than master of, his natural surroundings.

ED 045 380 "A Curriculum Activities Guide to Water Pollution and Environmental Studies." (Tilton School, N.H. '70 641P)

This activity oriented environmental guide is the result of cooperative efforts of high school teachers, students, scientists, and technicians.

ED 036 450 "Teaching Tips on Current Environmental Problems." (Ulster County Board of Cooperative Education Services, New Platz, N.Y. '69. 17P)

Contains suggestions for introducing elementary school students to current environmental problems.

ED 042 607 "Environmental Education, Curriculum and Teaching Activities." (Cooperative Educational Service Agency 12, Portage, Wis. '70. 169P)

A curriculum guide and teaching activities for a K-12 program in environmental education. The program is based on forty-four important environmental education concepts.

National Wildlife Federation. NWF has developed over 20 units for teacher preparation in the field of ecology. Each unit, contained in its own paper-bound booklet, treats a different topic, providing necessary factual background and outlining procedures for setting up field trips and class activities. Individual and small-group projects are also described. Whenever the text suggests that the students collect data or record observations, the booklet provides pages designed as masters for such worksheets. Questions for discussion, lists of needed equipment and suggestions for further reading round out the contents of each unit. Topics are listed for a wide range of ages--K through 12. The booklets are Teacher Resource Units, not student materials. Topics include such areas as "Contour Mapping" , "Stream Profiles", and "The Rise and Fall of a Yeast Community." Inquire about their free brochure: National Wildlife Federation, Environmental Discovery Units, 1412 16th Street N.W., Washington, D.C. 20036.

RECYCLE, tells how to make lots of "somethings" from practically nothing. This teacher resource is a collection of more than 40 ideas for simple arts-and-crafts projects; games and activities all compiled by the Resource Center of the Children's Museum in Boston. Order from: RECYCLE, The Children's Museum, Jamaicaway, Boston, Ma. 02130.

Environmental Series...SIGHTS and SOUNDS. A comic strip character, Eco-Kid, helps young children fight the evil forces of pollution in this multimedia kit developed by C. Richard Hatch Associates. This activity-oriented program is interdisciplinary, dealing with concepts and skills in social studies, art, science, and language arts. Materials developed for Grades K-9 can be ordered from The Creative Teacher, Inc. P.O. Box 5187, Grand Central Station, New York, N.Y. 10017. Grade K-9 "Save the Earth ($30.00); Grades 3-5 "No Time to Waste " $20.00; and "Recycling Resources" Grades 6-9 $25.00. Kits include color filmstrips, records, student handbooks and a teacher's manual.

JOHNNY HORIZON '76... a free elementary classroom kit helps teachers promote environmental awareness, interest students in environmental challenges, and introduce activities into the classroom. This kit is distributed by the U.S. Department of the Interior and contains materials for elementary classroom use . Department of the Interior, Army Corps of Engineers, Tennessee Valley Authority; or Coordinator, Department of the Interior, Washington, D.C. 20240.