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ABSTRACT

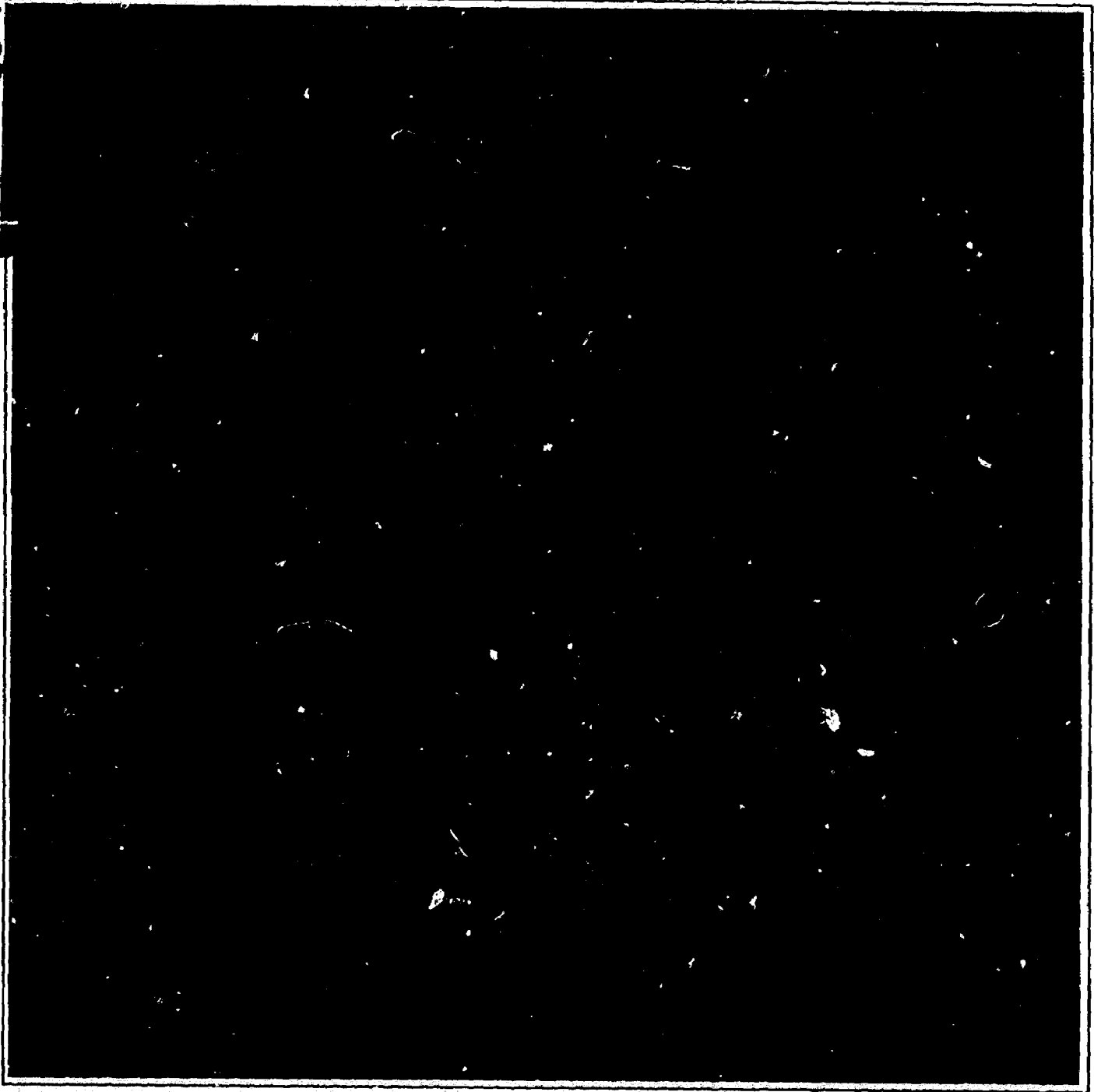
The third of this series of three volumes on interdisciplinary environmental learning experiences for elementary students is aimed at grades 5 and 6 and deals with the community environment of the student. Titles of the eight units included in this volume are: Problem Solving; How to Plan a Clean-up Campaign in the Local Community; Scars upon the Land; Water: Life Blood of the Earth; Noise Pollution; Succession and the Pond Community; Animals and Their Habitat; and Our Native Lands: Conserve and Preserve. Objectives are specified for each unit, a series of learning activities is described, and appendixes giving teacher background information and listing references and teaching resources are provided. (DT)

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# Environmental Learning Experiences for Grades Five and Six

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17 962



Ohio Department  
of Education  
Columbus, Ohio  
1973

*Prepared by*  
Center for the Development  
of Environmental Curriculum  
Willoughby-Fastlake City Schools  
Willoughby, Ohio  
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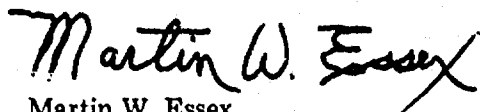
The continuing thrust toward environmental awareness has brought increasing realization that environment encompasses the totality of man's surroundings, both living and non-living, natural and man-made. Environmental concerns should not be separated from other areas of knowledge.

Increasingly, the need has been felt for teaching materials which would assist educators to infuse environmental concepts into existing curricula in a meaningful way. Environmental education should be a part of learning at all grade levels.

In response to this need, the Ohio Department of Education has developed a series of publications to assist schools in implementing an interdisciplinary approach to environmental education. The publications encompass a resource catalog; guides to distinct Ohio environmental study areas; a series of experience units; and a planning guide for outdoor education.

A Center for the Development of Environmental Curriculum was established in August, 1971, in the Willoughby-Eastlake City School District under an ESEA Title III grant administered through the Department of Education. The units in this volume were generated from materials developed by the Center and pilot tested in sixteen elementary schools in Ohio.

This collection of units is one of three volumes designed to assist teachers in bringing relevant, interdisciplinary environmental learning experiences to Ohio elementary students.



Martin W. Essex  
Superintendent of Public Instruction

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## Introduction

In order to provide a basis for construction of these units, the Center for Development of Environmental Curriculum analyzed several new curriculum programs in environmental education and science. One, the National Environmental Education Development program, was responsible for developing the strand approach to education. This approach is a strategy of looking at the world that ties the various fragments (like mathematics, music, history, and biology) into an understandable whole. Through the strands — patterns, adaptation, change, interdependence, and diversity, or PACID — a child begins to see that the world really is an indivisible fabric of matter and energy into which he himself is firmly stitched.

*Man and His Environment*, a National Education Association publication (Washington, D.C., 1970), provides the following definitions of the PACID strands:

**Patterns:** Organizational patterns are kinds of structures that may be found in rock formations as well as in social groups of people and animals. Functional patterns include traffic movement and classroom schedules. Spatial arrangements are patterns that often please us. Such patterns occur both in nature and in artistic design.

**Adaptation:** Over extensive periods of time, a great number of changes come about in order to enable an organism to adapt to the environment. Hereditary factors then preserve the continuing elements. The characteristics that enable the organism to adapt best are apt to be the traits passed on from generation to generation, thus ensuring survival of the species.

**Change:** Living and non-living things are constantly changing, whether among galaxies and planets or within body cells and body systems. Some things remain the same in spite of change. Matter and energy may change in form, but they can never be created or destroyed.

**Interdependence:** Nothing exists in isolation. Each individual is constantly interacting with living and non-living things: his family, his belongings, his friends and his world. These people and things also depend on the individual in order to function properly. The process is continuous as part of the life cycle even after death, for dead life forms nourish the living.

**Diversity:** Many likenesses and differences occur among living and non-living things. A variety of functions, sizes, and structures exist in plants and stars, rocks and animals, processes and people. Yet there are sufficient similarities to permit their classification into orderly patterns. These classifications increase one's understanding of his world.

PACID, then, provides the conceptual orientation for units. These principles form a basis for identifying, organizing, and studying the workings of the

world as they manifest themselves in any body of knowledge.

Since environmental education impinges on every aspect of living and learning, these units are not intended to be taught as a separate subject, but to be integrated into the existing curriculum. Also, their arrangement in these pages implies no pre-ordered sequence in which they should be presented, though certain units have been placed before others because they present concepts basic to further understanding (for instance, Food Chains precedes Food Web).

For an environmental program to be successful, objectives must be identified in order to direct the experience toward the desired outcome. The Center for Development of Environmental Curriculum has identified the following objectives of an environmental curriculum for kindergarten through grade six:

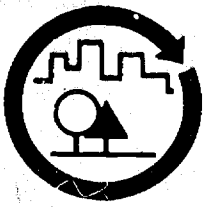
- Critical thinking skills
- Problem identification and solution skills
- Knowledge of the biophysical and socio-cultural concepts
- Decision making
- Value and value formation
- Definition of priorities
- Personal environmental philosophy
- Avenues for maintaining or changing the environment

For a program to be effective, it must also have an organizational strategy. The direction in these units is from a heavy emphasis on affective experiences in the early grades to development of skills and content in grades five and six. In order to relate the curriculum to the conceptual development of the student, the environmental units consider progressively larger and more complicated environments.

The first level, from kindergarten through second grade, deals with the immediate environment. This is the environment that a student can directly experience in his immediate vicinity, on his level, one concept at a time: one tree, one kitten, one terrarium.

The units for grades three and four are concerned with the local environment, which includes what the student can directly experience by moving from one location to another: from the classroom to the cafeteria; the school building to the school yard; the forest to the meadow. Students consider both individuals within the community as well as community organization.

The third level includes grades five and six, and deals with the community environment. This environment may be a woodlot, a pond, a city block, a town, or a city. Students directly experience portions of the material, but they also have vicarious experiences through audio-visual materials or readings. Emphasis on socio-cultural and biophysical concepts increases. The skills of problem solving and critical thinking receive additional attention at this level.



# Problem Solving

Throughout our educational process, one hears of the importance of being able to solve a problem objectively. The relation of this process to the investigations and problems of the environment is important.

Problem solving attempts to analyze a situation or problem from an objective position. Certainly we are all emotional about some situations, but objectivity and rationality are necessary.

The purpose of this unit is to introduce the students to one strategy of the problem solving process. The topic of solid waste in the school area is recommended because it is an area in which students can become involved and take a personal responsibility in the solution. Solid waste can be considered in the classroom in conjunction with the amount of paper and other disposable supplies that are used in the average classroom, or the amount of solid waste that results from the cafeteria. Other suggestions are also provided.

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## PROBLEM SOLVING

### Unit Objectives:

Students will be able to

1. select a problem which can be analyzed in the community and carry it out from beginning to end.
2. demonstrate by a report or presentation the process by which one would analyze a problem or situation.

### Steps Towards Solving a Problem:

#### Step I: Select the problem.

- A. Identify and define the problem precisely. This aids in
  - Focusing attention in the proper direction.
  - Understanding the relationship between the data and the total problem.
  - Structuring the study of the problem.
- B. Gather information about the problem by surveying the literature concerning the problem. This aids in determining what areas need additional study and educates the researcher about the information already available concerning the problem.
- C. Investigate how the problem relates to the five PACID concepts of Patterns, Adaptation, Change, Interdependence, and Diversity.
- D. Consider if the problem fits certain requirements such as the following:
  - Researcher's knowledge of the problem and ability to cope with it.
  - Researcher's personal interest.
  - Researcher's temperament, patience, and precision.
  - Facilities, equipment, supplies, and space.
  - Time schedule.

#### Step II: Design the approach to the problem.

- A. Procure the tools and equipment.
- B. Decide what and how much data is to be collected and by what method.
- C. Decide where the data is to be collected.
- D. Decide how the data is to be analyzed.
- E. Develop the time schedule for the entire study.

#### Step III: Research the problem and collect the data.

- A. Be sure the collection of the data does not affect the results of the study (e.g., observation of the number of traffic accidents that occur at an intersection could be influenced if the researcher was standing on the roadway instead of on the sidewalk).
- B. Be sure that the researcher has the proper tools to collect and record the data before going out.
- C. Record all of the data on the spot.
  - Do not trust your memory to record the data.
  - The nature of the information and the amount depends on the study being conducted. It is always better to collect too much than too little.
  - Record when, where, who, what, why, and how.

#### Step IV: Analyze the data.

#### Step V: Interpret the data.

#### Step VI: Propose alternative solutions.

#### Step VII: Prepare the report.

Be sure the report is properly and clearly prepared. The following is one suggested format that may be used.

- A. Introduction—clear statement of the problem and the background information.
- B. Acknowledgements—names of people and agencies who provided assistance to the researcher.
- C. Methods, techniques and materials—what was done, how was it done, and what was needed to conduct the study.
- D. Results—presentation of the data collected.
- E. Discussion—explanation of the data; suggestions and recommendations.
- F. Summary of the data and the study.
- G. Bibliography—citation of all the references used during the study.

### Example of an Environmental Problem in the Community Environment: Solid Waste Disposal in the School Area.

The problem is one in which students can become actively involved. It is used only as an illustration for the teacher as to the process by which a study is conducted. The process would be similar regardless of the problem identified.

Please note that there are numerous methods of conducting a study, each with variations. The importance is that the researchers are objective about the approach, and that the data and conclusions are both reliable and valid.

#### Step I: Select the Problem.

- A. Identify and define the problem precisely.

What problems face your school or neighborhood that you as a class or individual would like to know more about? For example, suppose that your class seems to fill up the waste basket faster than the custodians can empty it. What is the problem here? Is the waste basket too small or are the custodians too slow? Perhaps the class just uses or wastes too much paper. What is the problem? Identify the problem and write it in the form of a question.

#### The Problem:

*How can the solid waste from the school area be safely disposed of or removed?*

- Focus attention in the proper direction:

What is the main focus of your problem? As stated here, the focus and direction of the problem you want to research is the safe and environmentally sound disposal of the school's solid waste. You could have focused on how your school rates with other schools in their waste problems, or solid waste problems of the nation. Limit your consideration to a problem you can handle easily. As stated now, the problem has been limited to your school area.
- Understand the relationship between the data and the total problem:

What is the total problem? Is solid waste a problem in your town? Is solid waste a problem in the nation? How does your school fit into the picture?
- Structure the study of the problem:

How do you want to study the problem? Will you gather information only from books and reports of other schools, assuming that your school is similar?

Will you interview other students and teachers about the problem and how they feel about it? Or will you set up test situations and experiments to measure the volume and types of solid waste in your school?

- B. Gather information about the problem by surveying the literature concerning the problem.

Determine what areas need additional study.

While the problem has been limited to the school area, there are many secondary problems that must be answered before the main problem can be answered. Outline the parts of the main problem and how they are related.

Secondary problems:

- What is solid waste?
- Is there a general classification of solid waste or will your class have to create its own categories?
- What is the chemical make-up of solid waste?
- What are the origins of the solid waste in your school? Are they organic, synthetic, or both?
- What kinds of solid waste does your school have? Classify the different types using a general classification or one of your own creation.
- What is the volume of solid waste in your school? in one day? in one year? for one class? for two or more classes? for different subject matter (Is there more solid waste from an art class or a math class?)
- Where and how is solid waste collected in your school building? (waste baskets in each classroom, in each hall, in a dumpster)
- How is solid waste removed or disposed of in your school? Is it burned in an incinerator, removed by city garbage trucks, buried in a land fill?
- What are safe and environmentally sound methods for disposing of solid waste? Are any used in your school?

Learn the information already available about the problem:

Visit the library, your local sanitation department, or environmental quality board and obtain information and printed matter dealing with solid waste and waste disposal. Read the information comparing and gathering information relevant to your school's problem.

- C. Investigate how the problem is related to the five PACID concepts: Patterns, Adaptation, Change, Interdependence, and Diversity:

**Patterns:** What is the functional pattern of waste disposal in your school? Who removes the waste, when, and how often?

**Adaptation:** How is the students' use of paper adapted to the amount of paper available or the time of the year? Can the students use less paper? Do they demand or need as much paper as they use? How much paper was used in the past by students in your school?

**Change:** How has the amount of paper used in your school changed over the years. Obtain the purchasing records of your school and calculate the amount of paper per student and whether it has changed over the years.

**Interdependence:** What subjects are dependent on the use of paper? Could the subject be taught without the use of paper? How were these subjects taught in the past before the availability of paper?

**Diversity:** What different kinds of paper are used in your school? How much of each? For what purposes are they used?

- D. Consider if the problem fits certain requirements such as the following:

- Researcher's knowledge of the problem and ability to cope with it:

Eliminate the problems that are too difficult for your students. For example, the chemical make-up of solid wastes.

- Researcher's personal interest:

If your class is interested only in the disposal of paper, limit your investigation to that aspect of the problem.

- Researcher's temperament, patience and precision:

Can your class spend many hours reading and researching the problem? Will they count and tally the amount of paper thrown away everyday? Limit the investigation to fit your class's characteristics.

- Facilities, equipment, supplies and space:

Do you have room to collect all the solid waste from your school for one day or one week? Do you have room to divide the types of waste into individual containers?

- Time schedule:

How much time can your class allocate to the study of this problem — an hour a day, two weeks, a month?

*Step II: Design the Approach to the Problem.*

- A. **Procurement of the tools and equipment:** you will need four barrels, garden gloves, and a large scale.

- B. What and how much data is to be collected and by what method:

In investigation of one aspect of the problem, the class will collect and count the waste basket contents of four classes for two weeks. Waste will be collected at the end of each day and separated into barrels in the categories of paper, glass, metal and organic materials. The number of pieces will be counted and weighed.

- C. Where the data is to be collected:

The barrels will be located in a convenient and safe area of the school and all tabulation will take place there.

- D. How the data is to be analyzed:

The counts and weights will be tallied and an average taken for each week.

- E. The time schedule for the entire study:

- Set up research methods and designs (step 1, part A).

- Research background materials dealing with the problem.

- Decide on other considerations bearing on the problem.

- Investigate types of solid waste in your school and develop a classification system.

- Measure the volume of solid waste in the school for two weeks using a counting and weighing method.



- Visit and observe the different methods of waste disposal in your town, investigating the safe and environmentally sound methods.
- Analyze data collected and report on the safety and environmental soundness of waste disposal for your school.
- Recommend alternatives and improvements in solid waste disposal for the school through visits to the principal or school board. Prepare display board showing the results of the study.

**Step III: Research the Problem and Collect the Data.**  
Using precise and objective methods, collect all relevant data needed in the study.

**Step IV: Analyze the Data.**  
Analyze the data resulting from the experiments and research dealing with the problem.

**Step V: Interpret the Data.**  
Using the results from the experiments and other research, interpret whether your school does dispose of its solid waste safely and soundly.

**Step VI: Propose Alternative Solutions.**  
Recommend alternative methods in disposal of solid waste. Suggest ways in which the students can help in this problem by conserving paper.

**Step VII: Prepare the Report.**  
Using good report style, write up the findings of your study of the problem.

### How To Write A Report

After the facts have been collected, they should be written in report form so other people can use them too. This should be done in an organized way so the report is as clear as possible.

First, select a title that says just what the report is about. This makes it easy for anyone to find the report he wants to use.

Next, write a short introduction. This is to tell what the report is about or the purpose of the report. Usually

it is no longer than one paragraph. Any additional details are in the main part of the report.

Then, in the acknowledgement section, give credit to anyone who helped in making this report.

If the report is about experiments, mention the materials used, and how the experiments were conducted.

After reporting on the procedures, write your observations from the experiments, but without explaining the results.

When all of the observations are written, explain and interpret their meanings. These are the results of the experiments, and should be about only the experiment used in the study.

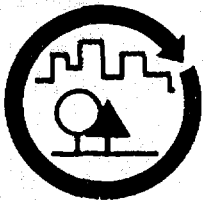
Finally, prepare a short summary of the entire report. This should be no more than one paragraph in length. Sometimes this summary (or abstract as it is called) is put near the front of the report, before the introduction.

Last, the report should include a bibliography, which is an alphabetical list of the books and articles from which facts were obtained.

Each entry in this list should include the author, title, publisher, and copyright date, in that order.

Some interesting problems that may be researched by a class:

- How can students assist in maintaining a quality environment in the school?
- Is the hall traffic system in your school safe and efficient?
- How can the noise pollution problem of your school be reduced?
- How can the students help beautify the school and school lawn?
- How can the lunch time in the school be made more enjoyable?
- How can student/student and student/teacher relations be improved in the school?
- What is vandalism and how can it be reduced in the school?
- How can the class become environmentally oriented and concerned?
- How can the school or class start a recycling center?



# How to Plan a Cleanup Campaign in the Local Community

The purpose of this unit is to introduce the student to the planning, research, organization, and execution of a local litter campaign. The students conduct their own research, design their own interview forms and select their site for the litter campaign. This is an activity oriented unit that involves the students in direct community action.

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## HOW TO PLAN A LITTER CAMPAIGN IN THE LOCAL COMMUNITY

### Unit Objectives:

At the end of this experience, the student will be able to

1. compile a series of reports used in planning a successful cleanup campaign.
2. describe three different patterns of litter which could be found in an area which needs cleanup.
3. formulate a hypothesis on how an individual's life style might have a direct relationship to how he has accepted or adapted to his local environment.
4. describe the changes which take place after a cleanup campaign has been conducted.
5. give examples of the various types of vermin which depend upon littered areas for their subsistence (diversity and interdependence).
6. evaluate the statement, "Good planning is essential to the success of any endeavor," in terms of their own campaign's success or failure.
7. evaluate whether a better quality of life will exist for the residents of a local area as a direct result of an anti-litter campaign (conclusions necessarily follow).

### Taking a Look at the Community Environment: Planning and Permission

#### 1. Introducing the Experience

Students should be made aware of the necessity of good planning for the success of any exercise, especially a field trip. Considering that this trip may be taken close to the school building, obtaining parental permission is up to the discretion of the teacher or principal. If, however, the trip is to be taken some distance from the school, it will probably be mandatory that permission be obtained. Most schools have a standardized form for the permission slip; however, you may want the class to participate in designing its own personal field trip form. (Public relations are important in any school endeavor, and informing parents, of the potential learning of a field trip — especially if that information has been designed by the parents' son or daughter — is an excellent form of public relations.)

#### 2. Developing the Experience

Present the class with the situation of taking a field trip and the necessity of obtaining permission to do so. What suggestions might they have for designing a permission slip for this purpose? Appoint one student to keep a list of suggestions on the blackboard. Things which should be suggested are the following:

- purpose of trip
- date of trip
- place for parent's name
- destination of the trip
- date by which permission is needed in order to construct a roll of attendees
- place for teacher's signature
- place for child's name

P slip with permission granted or refused

#### 3. Extending the Experience

The teacher can now appoint several groups to design the permission slip. Groups should be given full latitude in arriving at their own designs. When designs are complete, the entire class can vote on the acceptability of the permission slip. A representative sample of a permission slip should resemble this:

#### A Sample Cover Letter and Returnable Permission Slip

October 3, \_\_\_\_\_

Dear \_\_\_\_\_

The children in (Teacher's Name) room at Elmwood School are planning to visit (destination)

on (date) as a part of their scheduled school experience. We will appreciate having you sign the bottom portion of this letter and return it to school

by (date). This indicates that you have granted permission for your child to go on the trip. The purpose of the trip is \_\_\_\_\_

Yours truly,

\_\_\_\_\_  
(Teacher's signature)

-----  
(cut here and return with student)

October \_\_\_\_\_

I hereby give my permission for (child's name)

to go on a school field trip to (destination)

on (date)

\_\_\_\_\_  
(parent's signature)

#### Materials

- Blackboard
- Chalk
- Typewriter
- Typing paper
- Stencil or dittomaster

#### Designing a Checklist

##### 1. Introducing the Experience

Students should be made aware that in order to do something about pollution in their community, they must first define the problem and collect information about it. It is important to convey to the students that accurate information can be collected in a variety of ways:

- by means of observation and interviews
- by recording and classifying information
- by defining the problem

These preliminary instructions will insure the success of the field trip.

## 2. *Developing the Experience*

Have students design a checklist which surveys the problem in their local community. Tell them that not until they have made a careful list of where the litter is, and what it is, can they begin to think about a possible solution to the problem. As with the design of the permission slip, the students should be given full latitude in arriving at their designs. Appointing one student as recorder, the class should list suggestions for topics to be included on a checklist. Topics should include:

- types of litter
- places where litter is found
- various categories of litter
- kinds of vermin observed

## 3. *Extending the Experience*

The teacher can now appoint several groups to design the checklist, taking into account the class suggestions. When designs are complete, the entire class can vote on the acceptability of the checklist and reproduce enough copies for each member of the class. A sample checklist should resemble the sample following this section.

### *Materials*

Blackboard  
Chalk  
Typewriter  
Typing paper  
Stencil or dittomaster

## Completing the Checklist

### 1. *Introducing the Experience*

The teacher should now instruct the students to complete the checklist that they designed. This exercise should be prefaced with the comments that in order for the students to conduct a successful cleanup campaign, they must know the types and sources of litter they are going to attack, and their locations.

### 2. *Developing the Experience*

Allow the students to relate personal examples of where they think the greatest sources of litter will be found in their community. Do they know from personal experience where these sources are? What are the major causes of litter accumulation? What might the students suggest to be the best method of recording their findings on the checklist? Do all the students understand the purpose of the checklist?

The students may be given a time, such as three days, to complete the checklist on their own. They should go to a spot which is familiar to them, which they know is littered, and complete the checklist after school.

The teacher should check with the students on a daily basis to find out if they have completed their checklists. If they have completed them the first day, the teacher can go on immediately to the next portion of the unit, for the children may be eager to get to the next phase. If all children haven't completed the forms, encourage those who haven't to complete the assignment so you can progress to the next step.

### 3. *Extending the Experience*

When the students have completed their checklists, compare the results, and allow them to report their findings. What was the most prevalent type of litter? What do they think is the most littered area? Students are now ready to think about the next step involved in their campaign: deciding on the clean-up spot and enlisting the help of others.

### *Materials*

Blackboard  
Chalk  
Checklist forms

## Designing an Interview Form and Producing a Litter Data Report

### 1. *Introducing the Experience*

The teacher will tell the students that it's always a good idea, when you're making a plan to do something in the community, to talk to other people to find out what they think needs to be done and to see if you can secure their help. Allow students to discuss how they might go about this. What would be the most accurate method of obtaining the information from others? How might they keep track of the results? If no one mentions it, the teacher should suggest the construction of an interview form for these purposes, and a litter data report to disseminate the information.

### 2. *Developing the Experience*

Once again, appoint a student to record ideas on the design of the interview form and the litter data report form. Allow for suggestions from the class and submit these to the design committee. Present designs to the class in general, and vote on the most appropriate ones. A sample form is included. Each student in the class should interview as many members of the school as he can. Care should be taken not to interview someone who has been interviewed by another member of the class. Students will complete their interview forms during recess or after school and report the results to the class. By pooling the information from individual interview forms, the class should come up with a consensus of opinion.

**LITTER**

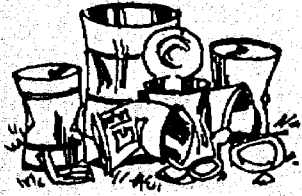
**School and  
Schoolyard**

**Parks and  
Playgrounds**

**Vacant Lots**

**My Street**

**Cans**



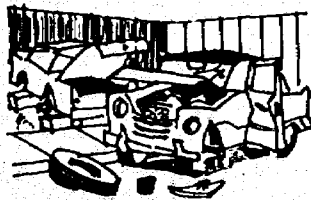
List Types of Litter Found


**Bottles**



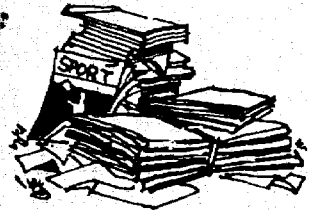
List Types of Litter Found


**Junked Cars**



List Types of Litter Found


**Paper**



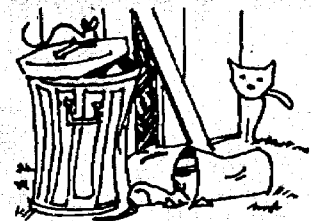
List Types of Litter Found


**Plastics**



List Types of Litter Found


**Old Clothing, Furniture  
and Other Things**



List Types of Litter Found




### Interview Form

Everyone in your class should talk to someone from another class.

Write his/her name here \_\_\_\_\_

Grade \_\_\_\_\_

Ask him/her these questions:

Do you know what pollution is? (If answer is no, tell him about it) \_\_\_\_\_

Do you think the streets are clean enough? \_\_\_\_\_

Do you think the parks and playgrounds are clean enough? \_\_\_\_\_

What do you think needs cleaning up most of all? \_\_\_\_\_

What do you think should be done about it? \_\_\_\_\_

Will you help my class clean it up? \_\_\_\_\_

How do you think we can get other students to help? \_\_\_\_\_

What other local agencies and organizations would cooperate in a litter cleanup campaign? \_\_\_\_\_

### 3. Extending the Experience

Each student will read the answers which he or she has obtained. The teacher will appoint one student to record the results on the blackboard.

Statistics which should be recorded are the following:

- How many students were interviewed?
- How many are willing to help?
- From which grade did most of the students willing to help come?
- How many of the students who were interviewed thought the streets weren't clean enough?
- What ideas were offered for getting other students to help clean up?

When all the students have read their answers, and the results have been tabulated, these tabulations will become the basis of a litter data report.

The litter data report can also be designed by the class, using the same procedure as before. A sample is included.

### Materials



### Interview forms

### Pollution data report form

### Litter Data Report Form

Our class talked to \_\_\_\_\_ people.

Of this number, \_\_\_\_\_ said they would help clean up.

The class with the most students ready to help was grade \_\_\_\_\_.

Of the number interviewed, \_\_\_\_\_ students thought the streets weren't clean enough.

Of the number interviewed, \_\_\_\_\_ students thought the parks and playgrounds weren't clean enough.

The three places mentioned most often as needing a good cleanup were:

This is what most people thought should be done:

Here are some ideas for getting other students to help clean up:

Other organizations and agencies that might cooperate in a litter cleanup campaign:

### Environmental Experience 5: Taking a Look at the Community Environment: Taking Action

#### 1. Introducing the Experience

Now is the time for the preliminary steps to culminate in action. Students have been planning their field trip for a long time; now that planning will pay off.

Students have identified the problem areas in their community and have determined whether they can get help from other students. All that is left for them to do before they begin their actual cleanup campaign is to determine what area they will clean up, when, what they'll need, and which students will be responsible for doing what. (By this time, all permission slips should be returned.)

#### 2. Developing the Experience

The teacher begins by writing on the board the names

of the three places that most need cleaning up, according to the results of the pollution data report. The students should vote to decide which area they want to clean up. (If there are a number of classes in the school using this unit, make sure that they don't all choose the same place to clean up.) A few basic things should be considered before the actual cleanup takes place. For example:

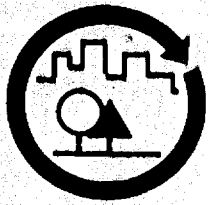
- How much time will be available to accomplish the task?
- How many people will assist?
- What type of litter will they be most likely to encounter?
- What will the litter be put in?
- Who will take charge of obtaining trash receptacles? (Large cardboard boxes will suffice.)
- What tools might be needed? Who will take charge of supplying tools?
- Who is responsible for contacting cooperating agencies and organizations and making arrangements?
- Who is to secure adult supervisors and transportation?
- Who is in charge of newspaper, radio, and television publicity?
- Has permission been secured if the land is privately owned?
- Where should the class meet? What time?

The teacher should work closely with the students as they discuss the plan. If students decide they need help from other classes, they should contact them immediately to enlist volunteers.

### 3. *Extending the Experience*

Students will most likely be carrying out their cleanup campaign outside of school hours. Be certain they get permission from land owners or local authorities, if it is needed, and that they work under adequate adult supervision.

A group of students should be put in charge of making sure that there are enough litter baskets in the area and asking the sanitation department for more if necessary. Encourage students to take follow-up action to make sure the area they cleaned up stays clean. They should try to determine who is responsible for the area — the city? a private landlord? Suggest that students write letters to whoever they find is responsible for the area, telling him what they have done and asking him to maintain the area. If they don't get results, they might write a letter to a local newspaper describing their cleanup project and the problems they're having in trying to make sure it stays clean. You might suggest that the students take "before" and "after" pictures of the cleanup area — or see if the local paper will do so. A little publicity goes a long way in rewarding student efforts.



## Scars Upon the Land

In the first environmental experience of this unit the discussion concerns the needs, methods and the controversies of strip mining.

Strip mining is being practiced in a portion of the State of Ohio. For this reason, students should become aware of direct and indirect effects of this type of mining.

In the second part of this unit, the conservation of our soil is stressed. Facts about soil erosion and the prevention of it are presented as a part of a conservation education process permeated with field trips and practical experiences.

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## SCARS UPON THE LAND

### Unit Objectives:

At the conclusion of this unit, the student will be able to

1. describe the normal pattern of contour farming.
2. list two ways in which the farmer adapts to changing conditions in farming.
3. describe the change taking place on a crop land as a consequence of soil erosion.
4. name at least five ways in which soil erosion can be prevented.
5. explain how the soil depends on the plants in order to avoid erosion.

### Environmental Experience 1: Strip Mining

#### 1. Introducing the Experience

The discussion should start with a film on strip mining. Before the teacher takes the students on a field trip to a strip mine, the following questions should be discussed:

What is a strip mine? Description.

Where are mines to be found?

What is a "seam" of coal? A layer of coal? Appoint a group of several children to prepare a report on strip mining and read it to the class when it is ready.

#### 2. Developing the Experience

What is the basis for using strip mining techniques. Should we use them?

What are socio-economic aspects of strip mining? List on the board the contradictions arising from strip mining.

When and how was the coal formed? (Coal was formed from the remnants of plants under great pressure and high temperatures about 300,000,000 years ago.)

Take a field trip to a strip mine.

Why are strip mines developed?

How are they developed?

Take the students, if it is possible, on an airplane ride over a strip mined region. (The airplane ride may be substituted by a bus ride.) Let them see the total picture from the air including the environmental impact of this method of mining.

Describe the effects of strip mining on the land, water, people, and agriculture.

What can be done in other areas to prevent this from happening? (We can restore the area by planting grass, bushes, or trees.)

Can all kinds of plants be used for reclamation purposes? Not all plants can adapt to the acidic soils in an area where the topsoil is missing. Such replanting should be considered carefully, and experts on the matter should be contacted.

#### 3. Expanding the Experience

Based on the following case study, discuss such questions as:

Should we abandon strip mining? Reclamation of the area? Which is acceptable?

Discuss the various aspects of the rights of the farmer.

What legal action could he take?

Ask the students to tape, make a movie, or express their feelings in writing.

### Materials

A map of strip mining operations.

Film on strip mining

### Case Study:

"When They Take a Man's Garden . . ."

The day was warm and bright when the bulldozers reached Cecil Combs' 30-acre farm in the Cumberland Mountains of eastern Kentucky. For days he had heard their coughing in the distance, growing ever louder.

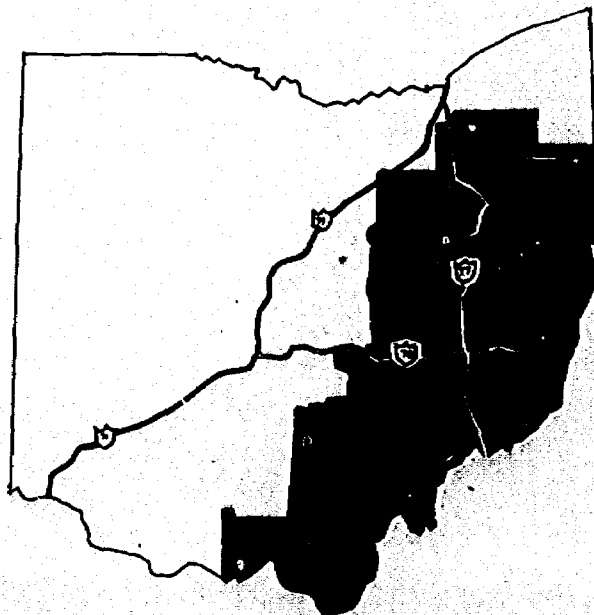
Combs was 57 years old and gray haired—his front teeth were missing. He had never gone to school and could not read or write—even to sign his name. He had been a coal miner. But now he was out of work—displaced by new machines. Combs depended on the farm for his family's livelihood. It was all he owned.

The soil was rich, and Combs grew potatoes, peas, onions, and tomatoes. He also had a large cornfield on a steep slope.

Combs watched as the bulldozers pushed into the trees at the top of the slope, upending them by the roots. Then the bulldozers shoved the trees and dirt aside to form a large pile on the hillside.

Next, drilling rigs bored into the cut to reach the coal seam that lay near the top of the slope. Then came explosives. Power shovels heaved the rubble onto the ever-growing heap that clung to the side of the hill looking down on Cecil Combs' farm.

When the coal was uncovered, huge machines shoveled it by the ton into trucks. And before long, bulldozers came again to cut into new ground, and the process



Ohio's strip mining country.



began all over again. In this way the operation moved around the mountain and passed beyond Cecil Comb's farm.

But the slag heap the miners left behind soon broke away and crashed down the mountainside into a creek not far from Comb's house. The water backed up and covered his vegetables and seeped into his house, forcing him out. Combs finally moved into a deserted two-room shack in his cornfield.

"They 'stroyed me, that's all there is to it," Cecil Combs said. "When they take a man's garden, I guess they take the last thing he's got that counts for anything."

Did the mining company have the right to gouge the mountainside for coal, or was this an illegal act subject to prosecution? Did the mining company have the right to destroy the home and livelihood of Cecil Combs, or could the mountain farmer sue successfully for full damages?

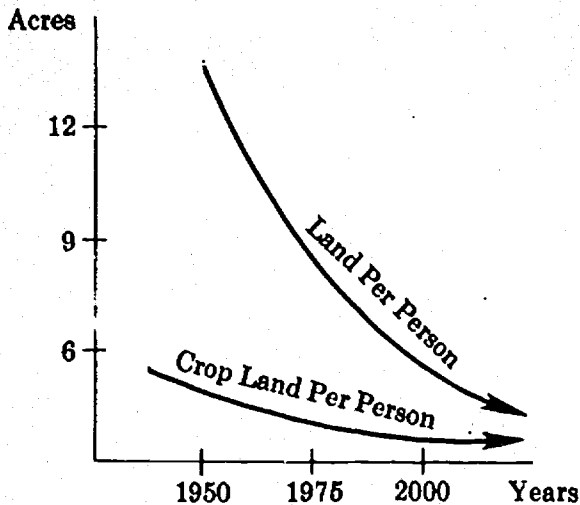
## Environmental Experience 2: Conservation of Soil

### 1. Introducing the Experience

From the previous environmental experiences, we know something about soil and soil erosion. We have studied the destructive effects of water and wind erosion, and the importance of soil to us. Now, let us learn how to conserve the soil.

Start by reading the following statistics to the class:

In 1950 there were approximately 12.5 acres of land, and 3.1 acres of crop land per person in the U.S. It is estimated that in 1975, we will have 8.3 acres of land and 2.2 acres of crop land per person. For the year 2000, the estimation is 5.7 and 1.6 acres respectively.



Clearly, total land and crop land in our country are decreasing in proportion to population. One of the best ways to stop losing crop land, and total land, is to learn how to conserve our soil. Cultivated and covered with grass and trees, land is protected from erosion.

### 2. Developing the Experience

Take the class out in the school yard, and spray a sec-

tion of the lawn with a hose. Then spray an area without any vegetation.

Where is the soil easily removed?

Why do you think grass growing on the soil protects it from wind and water erosion? How? (The force of the rain and the wind is reduced by the stems and leaves of the plants, and the running water is slowed down by the vegetative parts. Also, the roots of the plants hold the soil particles together.)

Even if some soil is damaged by a strong rain or storm, the grass returns the stability of soil rather quickly. Why? How? (Dead vegetation and the root system improve the content and structure of the soil.)

From the discussion above, the dependence of the soil upon vegetation is obvious. The amount and type of vegetation on crop land depends on man. At the same time, man depends on the crop which will be produced by the land. This interdependence between man and land must be pointed out by the teacher.

Conservation farming (farming part of the land) also improves the soil and maintains the diversity of life in the area. Take the students on a field trip to a nearby field and visit a farm. Ask the farmer what he is doing in order to conserve his valuable farm land.

Does he practice conservation farming? To what extent?

Does he practice contour farming? Why? How good is it? Is it a form of adaptation of farm practices to soil requirements and changing farming conditions? The normal pattern of contour farming is to plow the land perpendicular to the slope. How does this prevent the erosion of the soil?

Contour farming slows down and holds the water which is absorbed more efficiently and prevents erosion.

Parallel terraces protect the soil from erosion. How? Terraces are rounded, leveled ridges.

Strip cropping protects the soil from wind erosion. Strip cropping is planting strips of tall plants (corn) and short plants (wheat).



A. Contour furrows.

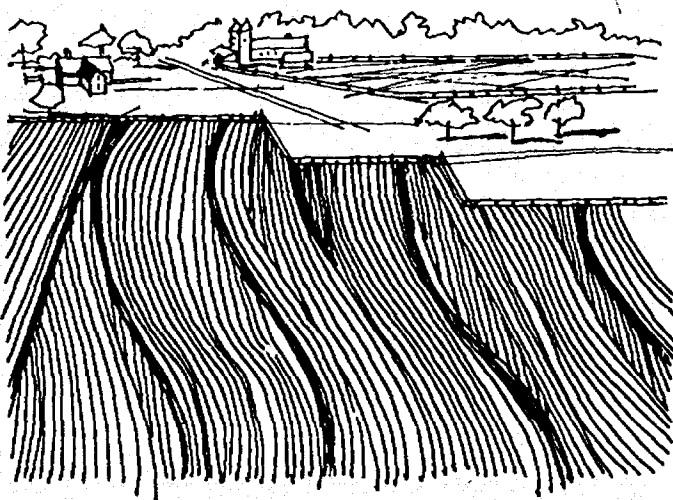




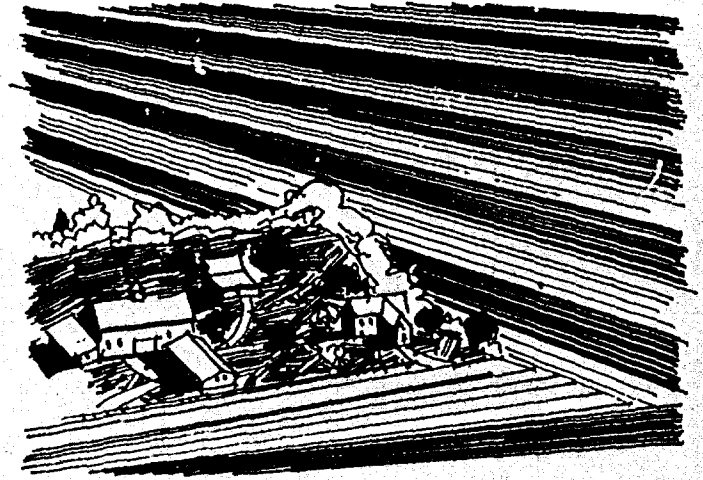
B. Strips of close-growing crops between strips of row crops.



C. Terraces.



D. Strip cropping at right angles to prevailing wind.



E. Strips at right angles to the prevailing wind help control wind erosion.

### 3. Extending the Experience

Consider and discuss the following conservation practices:

Grass waterways

Broad, sloping channels carrying water slowly away from the field.

Farm ponds.

Crop rotation — changing the crop every year.

Leaving the stalks of plants or shredding the corn stalks on the ground.

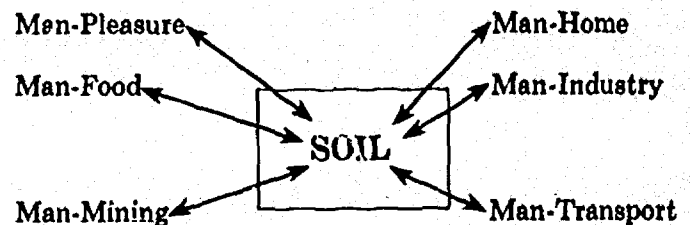
Mulching

Covering the field with plant remnants (corn or grass) prevents water evaporation, and when it decays enriches the soil with organic material.

Which of these practices are applicable and acceptable for your area? Ask the students for ambiguous and contradictory points concerning conservation farming. After discussing all these conservation methods, what are the conclusions that follow?

#### Additional Activities

- Call a speaker from the County Soil Conservation office.
- Visit a farmer in the area.
- Have an oral report from a child living on a farm.
- Show pictures of erosion and different conservation practices.
- If the teacher has the time and desire, the following diagram should be discussed in class:



Which uses cause the least damage?

Which uses are wise?

Which uses are necessary?

Which uses can we improve?

- Ask several students to make a compost pile and make a report later.
- Assign the task of reporting about organic gardening to a group of students.
- On land that must be cultivated and cannot be kept in grass all the time, farmers can keep the land covered as much of the time as possible by using crop rotation. With a cultivated crop like corn, followed

by a small grain crop and one or more years of grass-legume meadow, the land can be covered much of the time.

To perform the following experiment, you will need two small boxes about 16 inches long, 12 inches wide, and four inches deep. (These boxes can be used for several activities so they are worth making and keeping on hand.) Make them watertight by lining them with plastic material, tin, or tar paper.

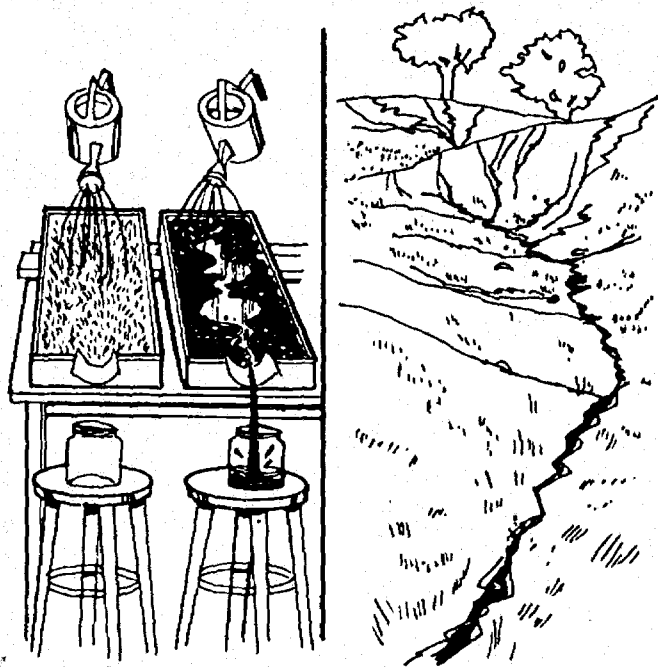
At one end of each box cut a V-notch to 1½ inches deep and fit with a tin spout to draw runoff water into a container (see drawing).

You will also need two flower sprinklers, at least a quart in size (half gallon is better); two half-gallon wide-mouth fruit jars; and two sticks of wood about one inch thick.

Cut a piece of sod from a pasture, lawn, fence row, or the like, to fit one of the boxes. Trim the grass with scissors so that it is not more than an inch high. This makes it easier to handle. Fill the other box with soil from the same place — no grass, just soil, but don't try to pick a very poor soil. The idea is to have the same kind of soil in the boxes, one with grass, the other bare. Set the boxes on a table so that the spouts extend over the edge. Place the sticks under the other end to give them slope.

Put the empty fruit jars on stools placed beneath the spouts.

Fill the two sprinklers with water and pour the water on both boxes at the same time. Pour steadily and at the same rate for both boxes. Hold the sprinklers at the same height from the boxes. After a few minutes, take a look at the jars. Which one contains more soil? Which box loses more soil?



This is what happens when heavy rains fall on bare fields.

**Materials**  
Transparencies  
Water hose  
Films or filmstrips

## Appendix

### TEACHER BACKGROUND INFORMATION

#### Part 1:

Very often coal deposits are covered by only a thin (two to five or 10 feet) layer of soil. The most profitable way for removing the coal is to "strip" the layer of soil to uncover the coal — hence, strip mining. Because the coal is near the surface, it is not possible to dig tunnels.

Strip mines are, therefore, found in areas rich in coal, covered by thin layers of soil.

Coal is needed for our economy. We must utilize this resource wherever it is possible. The mining of coal enriches many communities.

The peeled off upper layers of dirt and rock, together with the coal itself, may contain large amounts of pyrite which has a high content of sulfur. Once exposed to the air and moisture, the sulfur forms sulfuric acid —  $H_2SO_4$  — a highly corrosive chemical.

The disruptions of the soil layers cause many trace metals such as copper, aluminum, iron, mercury, calcium, manganese, to be concentrated and released into the drainage system. Disrupting the soil also destroys its water-retaining capacity. Thus, the soil may lose all of its valuable nutrients and become useless for hundreds of years. Also, you may consider the "panoramic" view of strip mining — high cliffs, large piles of rocks and hills denuded of trees and grass. Throughout strip-mined lands are found red, blue, green, and yellow "strip pits"—man-made ponds left between steep cliffs after operations. The yellow water contains sulfur, blue indicates traces of aluminum, bright green is copper, red is iron.

Other environmental damages include:

Fish populations — reduced or wiped out.

Blast damages.

Drinking water worsens.

Surface ugly — desperately needs reclamation.

#### Part 2:

Conservation farming and farming the land with concern for its conservation, i.e., improvement and use of natural resources in such a way as to assure the continued protection of their highest economic and social benefits.

Contour — An imaginary line connecting points of the same elevation.

Contour Farming — Following the contour of the land in farm operations such as plowing, planting, cultivating.

Crop Rotation — Growing of different crops in recurring succession on the same land.

Grass Waterway — A path, usually broad and shallow, covered with erosion resistant grasses and used to conduct surface water from crop lands.

Mulching — Use of a layer of plant residues or other materials on the soil surface.

Parallel Terraces — Parallel embankments, or systems of embankments, with runoff channels constructed across a slope for the purpose of diverting and controlling surface runoff water.

Strip Cropping — Dividing a sloping field into strips or belts of crops, following the contour of the land to hold rain water and protect the field below.

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#### Films

*Before the Mountain Was Moved*, 58 min., Color, McGraw Hill Textfilms, 330 W. 42nd St., New York, N.Y. 10036.

*Conservation is Everybody's Business*, Learning Arts, P.O. Box 917, Wichita, Kansas 67201.

*Man Makes a Desert*, 10½ min., B/W, Color, BFA Educational Media, 2211 Michigan Ave., Santa Monica, Calif. 90404.

*Miner's Ridge*, 22 min., Color, CCM Films, Inc., 866

3rd Avenue, New York, N.Y. 10022.

*Problems of Conservation: Soil*, 14 min., Color, B/W,  
Encyclopedia Britannica Educational Corp., 425 N.  
Michigan Ave., Chicago, Illinois 60611.

**Filmstrips**

*Conservation*, 36 frames, Color, Shapiro (Edwin) Co.,

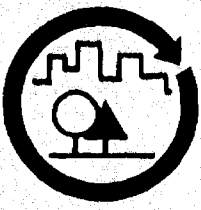
43-55 Kissena Blvd., Flushing, New York 11355.

*Conserving Our America, Soil Conservation Set — A  
Series*, Color, Society for Visual Education, Inc.,  
1345 Diversey Parkway, Chicago, Ill. 60614.

*Saving the Soil*, 55 frames, Color, McGraw Hill Text-  
films, 330 W. 42nd St., New York, N.Y. 10036.







# Water: Life Blood of the Earth

The purpose of this unit is to introduce the students to the importance of water as part of our everyday environment. The experiences included in this unit discuss the use of water by people, the characteristics of flowing water, and a clarification of the effects a watershed has upon a local environment. The students will develop an understanding about water, its importance for all living organisms, and its relationship with climate and soil erosion.

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## WATER: LIFE BLOOD OF THE EARTH

### Unit Objectives:

At the end of this unit, the student will be able to

1. describe a watershed (drainage basin) pattern in the area.
2. compare the adaptive characteristics between plants living in an abundance of water and those living in a scarcity of water.
3. explain the change in the type and in the number of living organisms if some of the streams in a watershed dry out.
4. list several ways in which most living organisms depend on water.
5. construct a simple hypothesis about the amount of water in the watershed and the diversity of plants in the area.

### Environmental Experience 1: Water Use

#### 1. *Introducing the Experience*

Illustrate the ways in which plants use water by displaying the following items. Arrange the items before the class begins.

A glass of drinking water.

A plant in a pot that has been watered regularly and is fresh and green looking.

A plant in dry soil (wilted).

A group of dry bean seeds.

A group of sprouting bean seeds that have been in water for three days.

Variations are possible. (Keep a piece of celery on the table for several days and one piece of celery in water.)

A diagram of a plant, roots, stem and leaves.

*Introduce the experience by asking the following questions:*

How do the plants use water?

Examples:

Put a carnation in colored water for two days and it will pick up color.

Cover a plant with a plastic bag and observe the moisture in the bag. Remove all the leaves and see if moisture appears on the bag.

Where do plants get water from?

Why do plants need water?

Can they adapt to more or less water? If yes, how?

How do plants living in plenty of water differ from those living in dry conditions? (green, healthy looking, rigid leaves, crisp when broken, small root systems)

Too much water in the soil usually harms a plant. Why? (interferes with the air needs of the roots and also harmful fungi develop in the soil)

How do animals and people use water?

Do we depend on water? How?

For: Drinking

Washing

Removing waste materials

Watering plants

Swimming

Travelling

Industry

Cooling

What will happen if we run out of water?

#### 2. *Developing the Experience*

Allow each child to go to the board and list the ways in which we use water.

What is the source of usable water in your community? In your area? How is it made usable? How much does it cost?

Is the water in the rivers and the lakes drinkable? Is the sea water drinkable? Can we make sea water drinkable? How? (desalinization) (Use salt water on plant to show the effect.)

What is the main source of drinking water? (ground water and lakes)

How do we treat water in order to make it clean and usable for people? (filtering and chlorination) Boil water from different sources and check for residue. Do we conserve water? Do we have to? When do we do it?

How do we collect usable water? In our state? In some countries like Algeria in North Africa?

How do we prevent water pollution? How do we protect the water from being polluted?

Could we melt snow for water?

How do we affect the water cycle? (run-off water, irrigation, cloud salting, sea polluting)

What is the individual home's impact on water?

#### 3. *Extending the Experience*

Assign a group of students to do research and establish that food contains water in different quantities. Ask a group of students to investigate the source of their community water and make a report. Supply information on the depth of the well, amount of water it produces per day, how the water tastes and so on. After the completion of the report, discuss it in the classroom.

Ask several boys and girls not to drink water for a day and ask them to explain how pleasant or unpleasant the experience was.

Appoint three girls and three boys to keep a record of how much water they have drunk and used for approximately a week. Discuss with the class how they would have felt if they did not have the necessary amount of water for this week.

#### *Materials*

Several potted plants (any type)

Bean seeds

Pieces of celery

Plant diagram

Several carnations

Several plastic bags

### Environmental Experience 2: Watershed

#### 1. *Introducing the Experience*

A topographic map should be displayed on the wall, on which the teacher can point out a large or small watershed area. An overhead projector may be used. Explain to the students exactly what a watershed is (an area in which the surface and ground water is drained by a system of streams and rivers).

Explain how large watersheds are made from smaller ones. Give an example with one in the local area. Point out the main direction of the water flow in the system, how small systems form bigger watersheds, and how and where small streams begin.

Let students try to figure it out. Trace the streams to their sources. Connect sources. Measure angle at which small streams enter large ones.

## 2. Developing the Experience

Take a field trip. (The teacher may combine the field trips for experiences 1 and 2.) Visit a local stream where it enters a river. Observe the direction of the water flow. Notice the speed of the water in the stream and river and point out the change to the students. Observe what happens to suspended materials when water flow is slowed.

How does the purity of the water change? Determine it by observations at different locations (in the woods as compared with the water flowing at the end of the town).

On what does it depend? (amount of water, the bed of the stream, plants in the area, pollution sources — observe the color).

What are the existing problems and what are the needed improvements? Are any changes needed?

How is the watershed important for all living organisms in the area, including people? How do they depend on it?

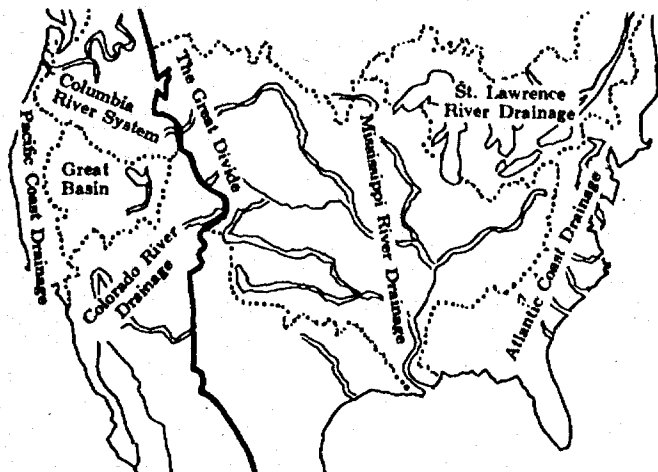
How does the watershed influence the local people? (type of vegetation, waterways, influence upon the micro-climate, fishing, irrigation and farming, animal life, hunting, and the diversity of organisms). Can some plants adapt to a poorly developed watershed? (Cacti)

Do the streams undergo changes? (Yes, after rain and during dry years)

Look for life diversity during the field trip.

## 3. Extending the Experience

The students may be asked to contact some local land owners and find out what, if anything, they are doing in order to preserve or even improve the condition of



the local watershed. Are there contradictions between the interests of the local farmers and the preserving of the watershed condition?

Find out what the main pollutants in the local area are. Is the erosion here extensive? What are the preventive measures taken? How efficient are they? Are there any other ways in which the watershed can serve the area?

Use a "case study" of a local land owner's purposeful efforts to improve or preserve the watershed.

## Additional Activities

### Art

- Draw ways that people depend on water.
- Leave the list of ways that people use water on the board.
- Have each child get out his crayons, water colors, pencil, and eraser.
- Distribute one piece of drawing paper to each child.
- While the children are drawing, prepare an area to hang up their art work.

### Language Arts

- Write a cinquain about water. (A cinquain is a five line poem simple form)
- Have a child count in Spanish to five "uno, dos, tres, cuatro, cinco."
- Say "Cinco means five. The name of the kind of poem we are going to do is cinquain."
- Ask "How many lines will the poem have?"
- Say "The first line is the word 'water'."
- Have them copy "water" on the first line of their paper.
- Continue having the children think of and write words on the next lines of their papers.

### Math

- Tell the children to bring in pictures of water or uses of water.
- Show them in an opaque projector.
- Sort them and have the children display them on charts.
- Ask "What fractional part of the pictures show patterns, adaptations, change, interdependency, and diversity?"

### Materials

Topographic map

Transparencies

Overhead projector

Opaque projector

For a topographic map of a watershed, write to:

Ohio Petroleum Council

88 East Broad Street

Columbus, Ohio 43215

Also available:

Student worksheet sample topographic map of watershed area.

Conservation — picture and discussion

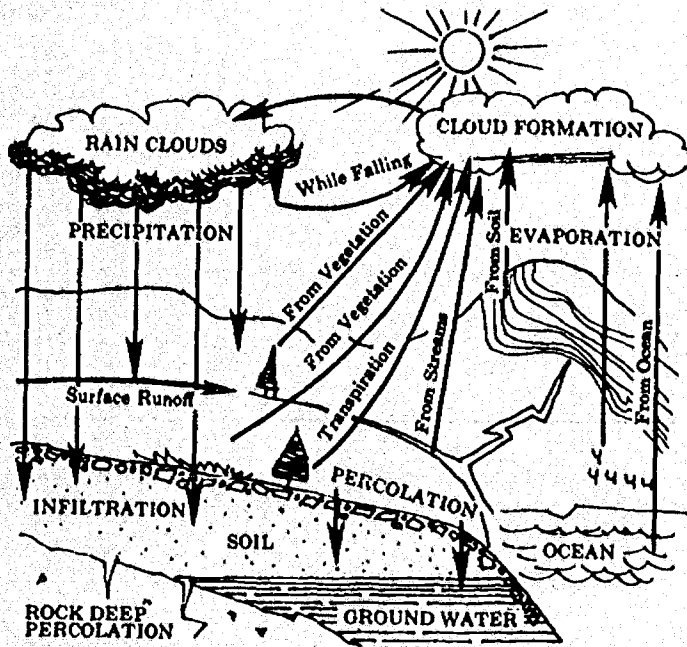
Portfolio, 11" x 14", one per classroom, containing seven full-color plates:

Nature's way

Soil and water resources

Forest and wildlife resources

Oilmen play their part  
 Conservation in petroleum production and recovery  
 Mineral resources  
 Conserving our waters



The Hydrologic Cycle

### Environmental Experience 3: The Characteristics of Flowing Water

#### 1. Introducing the Experience

Have the students state their ideas of how water moves and how water carries other materials. Have them formulate questions about those ideas of which they are not sure. By reading, try to find information related to these ideas and then try making guesses about what they will find when they examine the streams flowing into Lake Erie or some other lake.

#### 2. Developing the Experience

Take the students on a field trip. Visit several different streams and some entering a lake. There are many small creeks flowing into large rivers or into Lake Erie. Some of these creeks have their source in nearby springs (places where water flowing underground comes to the surface). Investigate the springs. What causes them? When these creeks reach the beaches, some of them again go underground into the sands and gravel.

Have the students look carefully at the bottom of a small stream and notice what materials are moving along the bottom and how they move. Place a shovel full of material (rocks, sand, pieces of wood) in the stream and ask the students to collect a sample of water from the surface farther downstream.

Let the sample sit until the particles settle out and then see what kind of particles are carried. Have another group of children follow where the materials shoveled into the creek are finally deposited.

Measure the speed of water in various creeks by see-

ing how long it takes a piece of wood to float a measured distance. This can be stated in feet per second or meters per second.

Form three groups of children and appoint a leader (captain) for each group.

Tell the second member of each group to stand where the wood will be released.

Tell the captain in each group to release the wood when you start the stop watch. (Make sure the pieces of wood are similar for more exact results.)

Time for 10 seconds. Tell a third child of each group to follow the wood and stop when you call the end of 10 seconds.

Ask the fourth child to measure the distance between the two children.

Have the fifth child record the distance for his team. You can repeat the procedure if two recordings and more accuracy are desired.

How does the water flow change the shape of the stream? (Here the teacher may point out how fish select breeding areas based upon bottom characteristics).

Find different types of organisms at different spots of the stream. Examine algae.

Follow a small stream to its source, which can probably be found a short distance above the beach. The students should be able to recognize that these fresh water streams originate from springs in many cases. (Notice that sometimes small streams may actually disappear into the sand and gravel).

#### 3. Extending the Experience

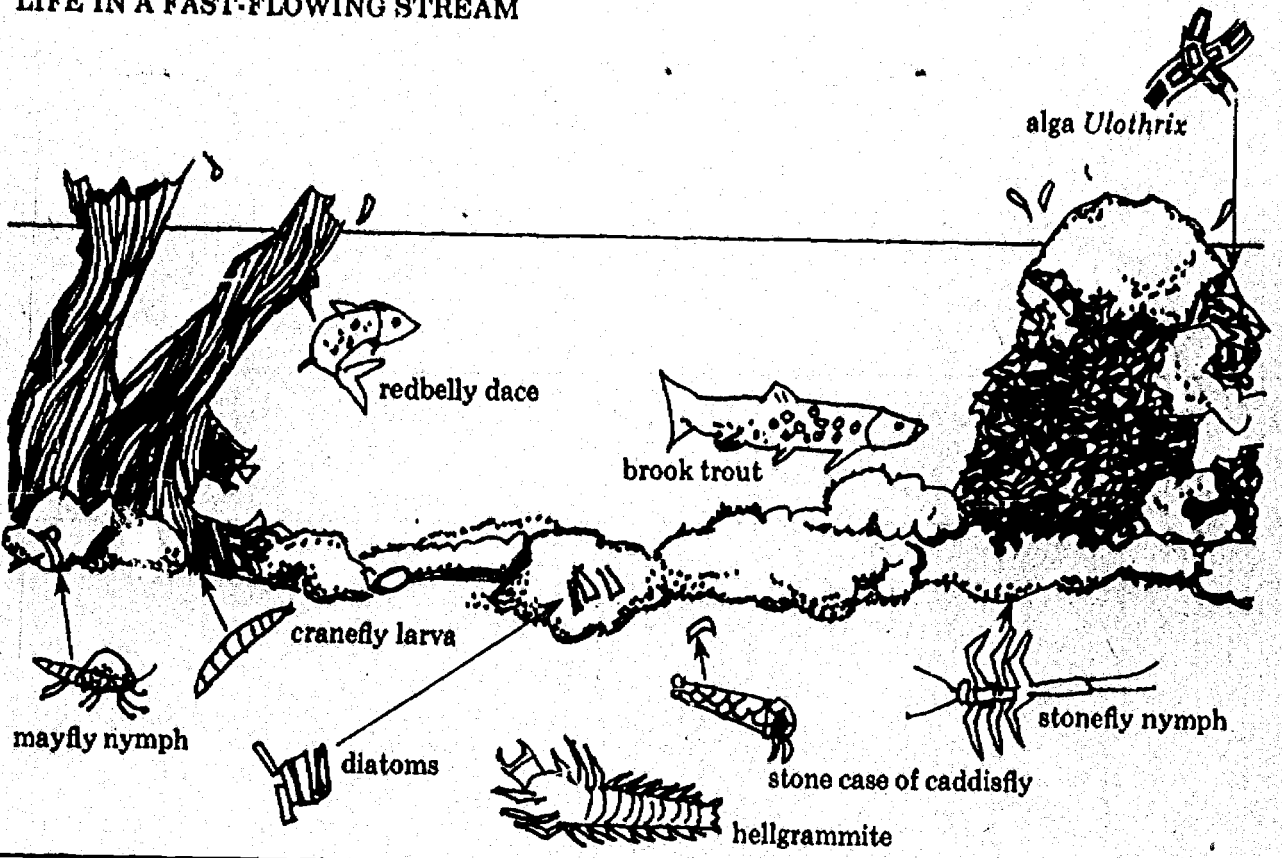
The students could make a stream model in a sand box and dirt, and show the effects of slope, shape, and vegetation on the stream shape.

In relation to the disappearing streams, it might be feasible to test the length of time it takes water to run through clay, sand, and gravel. This experiment also will show how much water is retained in the soil if the amount of water in the drip pan is measured after the experiment is finished. You could use dyed water.

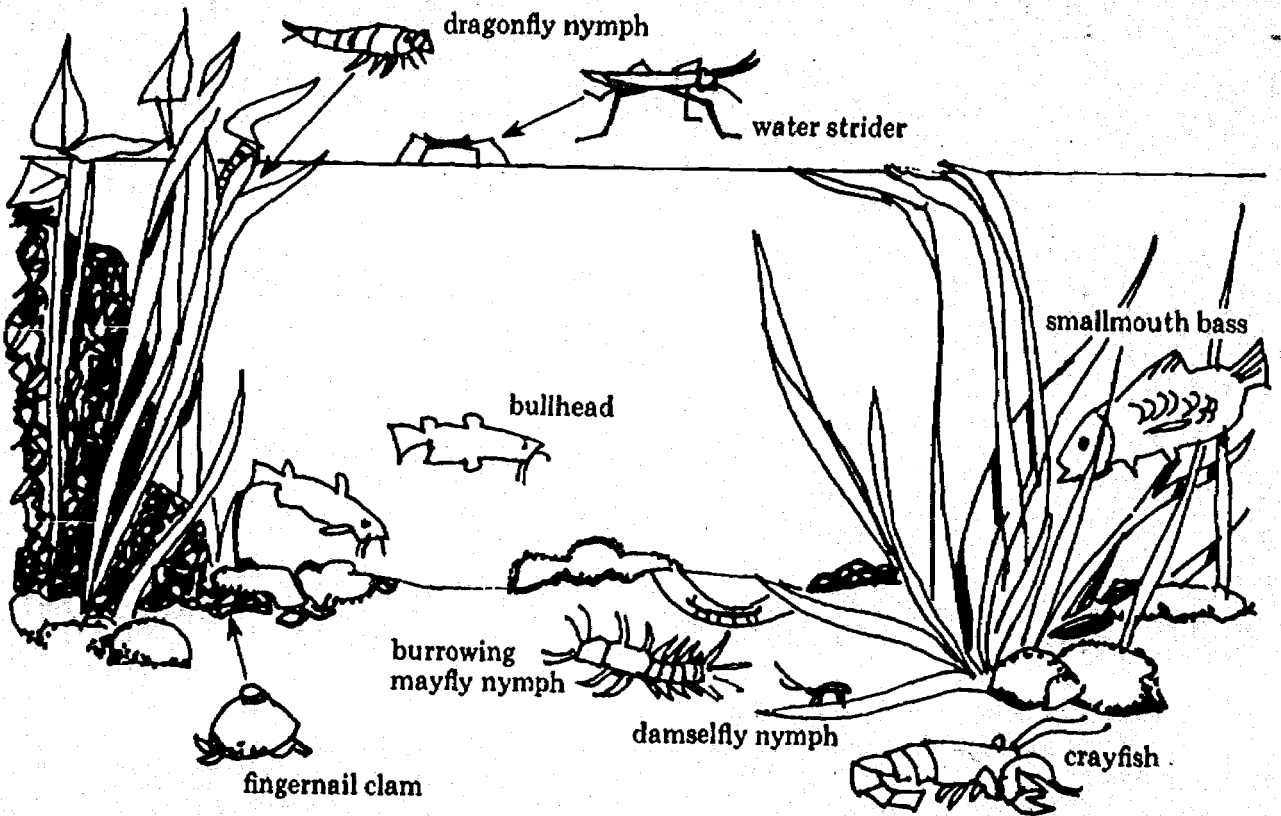
- Materials**  
 Record sheet  
 Measuring device  
 Stop watch



LIFE IN A FAST-FLOWING STREAM



LIFE IN A SLOW-FLOWING STREAM





## Appendix

### TEACHER BACKGROUND INFORMATION

Water is held in the soil or slowly moves through the soil. The water is in the spaces between the soil particles where the roots of plants are able to come in contact with and absorb it by the simple process of osmosis.

Water is essential for life. All living cells need water for many reasons. A cell is held in shape by water in the same way a balloon is held in shape by air. It is the water pressure in cells which gives celery or carrots their crunch. Water is needed to transport nutrients in and waste out, much in the way a river or railroad serves a city. Water in the soil dissolves out and transports the minerals that the plant needs to carry on its life processes. A plant needs additional water to replace that which evaporates through its leaves (transpiration), and at the same time, this in-coming water brings in minerals. Virtually every life function that every cell carries on is in some way dependent on water.

A single living plant can adapt only to slight changes in the amount of water it gets. It can control the amount it loses by opening or closing the pores in its leaves. Its roots will grow towards a water supply to insure adequate moisture. Over very large numbers of generations, plants have made many changes in their inherited structure to control water. Cacti have leaves that are merely spikes so that little water is lost through them, while at the same time their stems are swollen to store lots of water and their roots are very long.

Many hot climate plants lose their leaves in summer to avoid water loss in the dry season. On the other hand, plants that grow in extremely cold climates grow very little since they carry on their life functions only while the water is not frozen.

#### *Watershed Condition*

Simply put, a watershed is a drainage basin, an area of land from which a stream gets its water supply. The watershed may be as small as the upland drainage of a farm pond or as large as the Mississippi River Basin. It then becomes more than a combination of hills, valleys, streams, forest, grass, farm crops, and soil. A large watershed also includes cities, people, roads, and animals. Wherever you live, you are in a watershed and are part of a watershed community.

You can easily recognize a watershed that is in good condition. Except in arid and semi-arid areas, plants and organic residues protect most of the soil surface on wild lands. Leaves and branches of trees, shrubs, grasses, and other plants break the force of falling raindrops, and dead plant material on the ground prevents rain from loosening soil particles and splashing them about. Under these materials the soil is soft and porous because it is mixed with organic matter. Water seeps

into channels made by plant roots and burrowing insects and animals. Going deeply into the ground, clear water can return to the surface as springs, seeps, and streamflow—sometimes even during the driest seasons.

Quite a different situation prevails on watersheds where protective plant cover is absent. Falling raindrops gouge and batter the soil like many small bombs. Soil is lifted and splashed back and forth, and the churning action of the drops beats the soil into a pasty mud. Pores and channels through which water might enter the soil become clogged, and water collects on the ground surface. Soon this water races overland to streams, carrying large amounts of topsoil to be dumped into reservoirs or on lowlands. Water polluted with sediment is all but useless without expensive treatment.

The condition of a watershed determines how well the watershed works for us. When it rains, a watershed covered with vigorous plants and a layer of dead and decayed vegetation (humus) acts like a blotter or sponge. Water sinks deeply into the ground instead of rapidly flowing off the surface and washing soil away.

Occasionally even a well-conditioned watershed may not control all the water. Floods may occur during extremely heavy rainfall, rapid snow-melt, or when soils become saturated. But well-forested and well-sodded watersheds will delay the water in its passage to the streams. On these watersheds only small amounts of injurious sediment and debris are carried by floodwaters.

#### *Watershed Uses*

The simplest way to safeguard watersheds might be to lock them up — exclude everybody and everything for all time — and let nature take care of them. There is evidence that water is cleaner and the yield better regulated on undisturbed watersheds.

But water is only one product of the land. Watersheds provide other valuable and necessary benefits and uses — trees for lumber, paper, and other wood products; crops, forage for livestock and game animals; minerals; hunting and fishing, driving, hiking and strolling, and other recreation. If carefully planned, these other uses need not impair the yield of water from a watershed.

Other uses must be made of watershed lands, but with caution. Farmlands require proven farming practices to prevent soil erosion and water waste. On uncultivated lands — the most important water-yielding areas — activities like grazing, logging, hunting, and camping can be carried on so that surface runoff and erosion are not speeded up and streams or underground water supplies are not polluted.

Watershed lands in the National Forest System are

managed for "multiple use." Under this concept all resources are utilized for the greatest benefit to the most people in the long run. Only by matching population needs to available resources through careful long-term planning can this objective be met.

### **Watershed Programs**

Today, watershed programs are in existence and others are developing throughout our country to achieve control of water and conservation of soil. Such programs begin where the raindrop falls. Good land use and the application of soil conservation practices such as contouring, terracing, strip cropping and grass waterways are of first priority in order to hold more of the water where it falls. Water that soaks into the ground can't run off and it is available for growing crops and to replenish underground supplies.

Under today's watershed programs small dams and large dams may be necessary in addition to land practices in order to catch and hold water. Excess water which runs off the land during heavy rains can be held temporarily behind dams to prevent floods. Then it can be released and allowed to drain away slowly without damage. In some areas it may be desirable to hold water in permanent pools or lakes behind dams to provide farm or community water supplies or to create lakes for fishing, boating, swimming and other recreation. Every citizen of the community benefits from such programs.

Watershed development stresses the protection and development of all natural resources in a watershed. The soils are conserved on farm land, floods are minimized, damage to streams and reservoirs is prevented, wildlife is protected, fishing and recreation are enhanced. The entire drainage area is treated according to the capabilities of the land and the desires of the people involved.

Laws have been passed by federal, state and local governments to encourage watershed development. As a result, money and technical assistance are available to help share the cost and work of communities and individuals in carrying out watershed programs.

In most cases, full responsibility for starting watershed projects is in the hands of local people. By working through soil conservation districts, people can learn about the benefits of watershed programs and how their problems can be solved in the most efficient manner.

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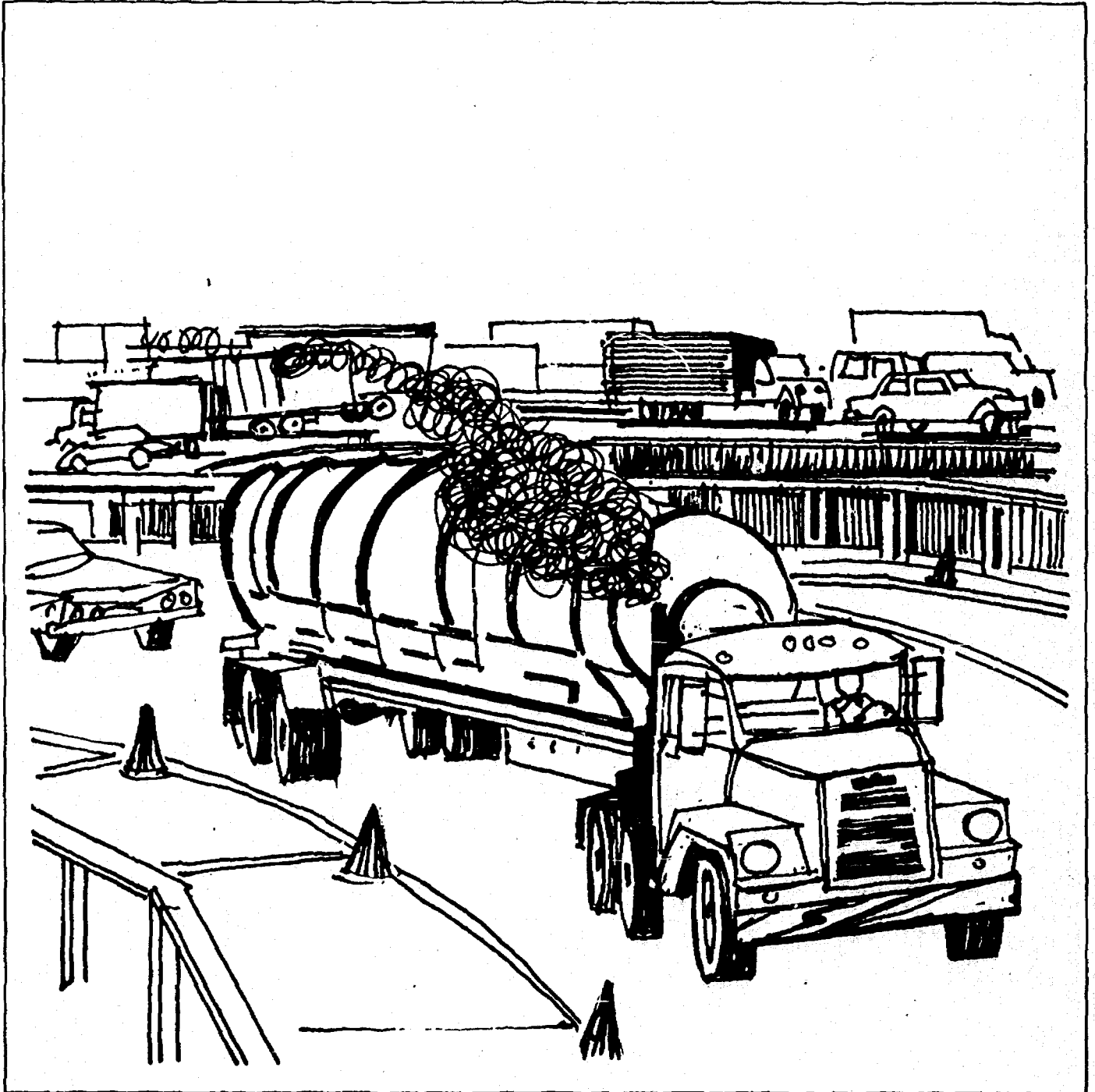
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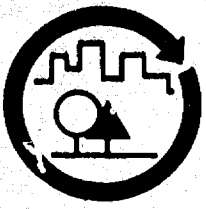
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# Noise Pollution

This unit proposes to familiarize students with sound and the noise pollution problem in modern society. The teacher should emphasize the practical experiments suggested in the text which will help the students notice the noise pollution problem and be aware of its effects on people and other living organisms.

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## NOISE POLLUTION

### Unit Objectives:

At the end of this unit the student will be able to

1. describe the pattern of sound transmission.
2. explain how the change in frequency and amplitude of a sound wave changes the pitch and intensity (loudness).
3. describe the interdependence between a vibrating object, a material medium, and an ear which receives it.
4. distinguish between different sounds in the environment and their properties. (frequency, amplitude, pitch, and intensity)
5. discuss statements about sound and man's ability and necessity to adapt to it.

### Environmental Experience 1: Sound: What Is It?

#### 1. Introducing the Experience

Basic information: Prepare a drawing describing how sound is transmitted in the form of sound waves and explain some of the basics of sound. (Use transparencies and charts.) Show a film on sound and its structure.

The teacher must explain and emphasize that an object must produce the sound, a material medium must transmit it and an ear must receive it, after which the brain will interpret it.

#### 2. Developing the Experience

Ask the students to be quiet and listen for sounds. Then ask them to list and label all natural and man-made sounds. Do they believe that the structure of both types of sounds is the same?

Listen for high or low pitch.

Listen for soft or loud sound. Let them distinguish between the pitch of the sounds and the loudness, (frequency and intensity). Which sound is more disturbing? Which is more pleasant?

Ask them to make a list of pleasant and annoying sounds.

#### Questions For Discussion:

What do they think the material environment has to do with the transmission of sound?

Does the wall of the classroom stop the sound waves more effectively than the door and the windows? Why?

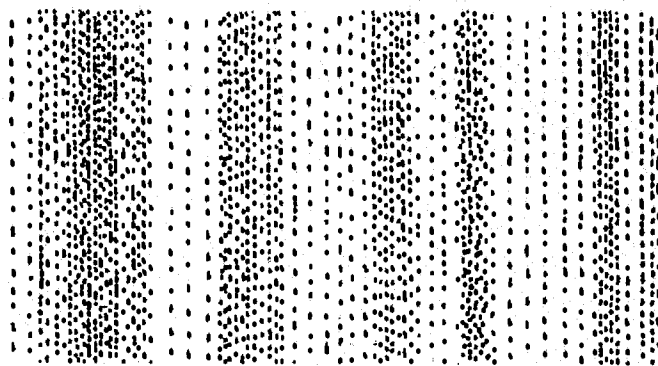
Can sound waves be transmitted through space? There are only about a dozen air molecules per cubic inch in space, which is almost a perfect vacuum.

Add information as needed. Use the teachers' background information.

#### Experimental Activities

- Give the students a piece of rope or string. Ask them to place it on the floor and form a wave. First create a low frequency wave and then a high frequency wave. Ask the students to distinguish the different parts of the wave (wave length, amplitude). Which indicates intensity? Energy? Frequency? Change the frequency and then the amplitude. What characteristics of the wave are measured with c.p.s.

(cycles per second)? What do we measure with db. (decibels)? Use about 100 marbles or any similar sized structures, even cubes, to explain how sound waves displace air molecules. Arrange them accordingly.



#### 3. Expanding the Experience

Have the children find information about c.p.s. and db. in magazines or other printed materials concerning amplifiers and sound equipment.

If the teacher has the time and desire, he can explain the structure and the function of the human ear. Explain the general structure of the outer, middle and inner ear and how sound waves are transmitted to the auditory nerve and the brain, which actually interprets the sounds around us. How detailed this explanation will be depends on the time available and the ability of the students in the classroom.

### Environmental Experience 2: Noise and Noise Pollution

#### 1. Introducing the Experience

Pleasant sound: discuss what constitutes a pleasant sound. Different students will explain it differently. Following a short discussion, the class should come to a generalization which can be accepted by most students. Write the definition on the board. Show a film illustrating noisy areas and quiet, peaceful places.

Noise: Determine a definition of noise and try to distinguish between noise and pleasant sound.

Ask a soft-spoken student to explain something about sound in a nice, soft, quiet way. Ask a boy with a powerful voice to repeat the explanation by shouting.

Play a record at a low volume for awhile. Then increase the volume gradually until the sounds from the record become so loud that they are even unbearable; then turn it off completely. By now the difference between pleasant sound and noise should be apparent. However, it must be realized that very often what is pleasant for one person is noise for another. Using teenagers' and parents' reactions to rock music is a good way to compare values. Can we really give a definition of noise? Have the class answer the following:

Some people tolerate noise better than others. Why? Are people capable of adapting to noise? Do they have to?

What are the major sources of noise in the classroom?



Noise is disturbing to people. Could you list several ways in which noise bothers people and in which people react to noise? Have a contest. See how many people list the same types of sound as being considered "noise."

Can excessive noise injure one's ear?

## 2. Developing the Experience

**Sources of Noise Pollution:** Students should name the major sources of noise pollution and discuss as many as time allows. Also, a discussion about an individual's ideas of the relationships between noise and power should be included.

### Human Noise:

**Shouting** — People shout in halls, at sports games, in their homes, on the street. The noise from shouting can easily reach the disturbing level of 120 db.

### Home and residential noise makers:

Vacuum cleaners

Blenders

Repairing tools

Stereo amplifiers

Trash compactors

Radio and T.V. sets

Metal garbage cans

Playing children

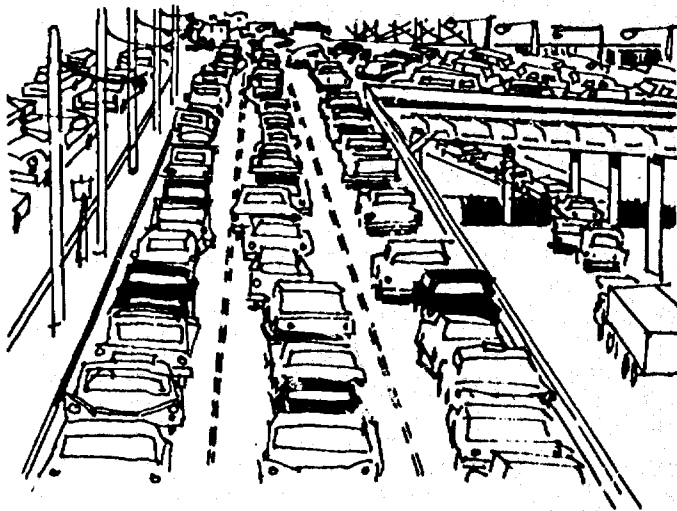
Lawnmowers

All these noise-makers disturb not only the members of the family but very often are even more annoying to the neighbors. These noises may never become painful, but they certainly can make life uncomfortable and damage hearing in the long run. Compare values again (happy sounds, sad sounds). This can help the teacher relate to the children in a more meaningful way.

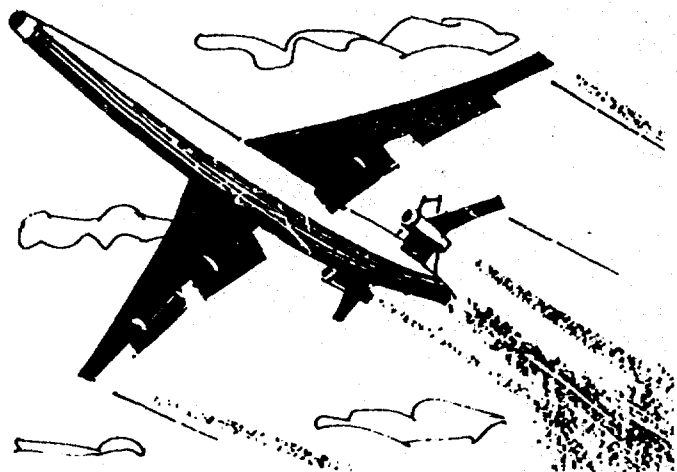
### Transportation — One of the most persistent and constantly increasing sources of noise pollution involves transportation. This source can be divided into three major groups:

**Auto traffic** — the number of motorcycles, cars, buses, and trucks increases every year. In spite of the efforts made by the manufacturers to decrease the noise, the level is actually rising. Engines, horns, tires, and rattles can make traffic noise reach 90 and more db. on a busy street. Some of the excessive

noise is due to bad mufflers and lack of mechanical maintenance by owners.



**Air traffic** — Aircraft can make much more noise than any other kind of transportation. While they are high in the sky, people can barely hear them, but when they take off or land at the airport, the noise is often unbearable. There are more than 8,000 civil, private and military airports. The people living in the areas near these airports suffer most. Many schools in such areas are affected, and, because of the noise, their effectiveness decreases. The sonic booms created by many military aircraft are especially disturbing because they affect large areas.



**Trains** — Trains are noisy and disturbing when the track goes through a populated area. Especially disturbing are the elevated trains in some large cities.

### Other sources:

**Construction** — It is all too well-known that building new and bringing down old buildings is accompanied by a great amount of noise. Construction tools like hammers, jackhammers, moving machines like bulldozers, and machines used for demolition can create considerable noise for people in the area.

**Industrial Noise** — It is estimated that more than 15 million workers in our country work under noisy



conditions. The teacher could have a class discussion and ask some students to explain the conditions under which their parents work in some factories. Find out if any ear protection devices are provided and whether or not they use them. Provide db. levels for each of the five noise sources if it is possible. These are also good topics for role-playing and imitation of the sounds.

### 3. Extending the Experience

Take the class for a trip in the area. Select a quiet place and ask the students to mark in their notebooks the sources of even the most insignificant sounds. All the sounds should be recorded, and after this is done, ask the students to separate the pleasant sounds from the noise. After this is completed, take the students to a noisy area (airport, train station) where they should repeat the previous operation. Use tape recorders. Keeping notes should be stressed to develop skills in collecting data.

Ask the following questions, which will encourage discussion:

In which area would you like to live?

After being in two different areas, what are your findings?

What are the differences in the two areas?

What sounds did you like most?

Are some sounds meaningless?

Did you hear any high-pitched and any low-pitched sounds?

Group the sounds in your own way and compare the grouping with those by other students.

Does a sudden loud noise scare you?

Use a big bulletin board in your classroom and ask the students to collect and mount all kinds of pictures taken from magazines expressing either quiet or noisy situations. Give the students several weeks to complete the project, after which there should be a discussion on which pictures are most pleasant and why, and which are noisy. By now, you must have determined that noise is unpleasant, damaging and unwanted. What are the positive conclusions that must follow? (We have to reduce noise in our environment.)

Some typical noise levels which you can discuss in your classroom are:

Quiet home	— 40 dbs.
Normal conversation	— 60 dbs.
Loud radio	— 85 dbs.
Traffic noise	— 85 dbs.
Screw-heading machine	— 100 dbs.
Power saw	— 100-115 dbs.
Metal saw	— 110 dbs.

Ask the children to learn how to recognize how noisy their surroundings are if they start from a base of 50-60 dbs., which is normal human conversation. It will be very useful if you can get a sound meter which will help you to measure the intensity of every sound.

## Environmental Experience 3: The Noise Pollution Problem

### 1. Introducing the Experience

#### Part I — Effects of Noise Pollution

Experience can be of a discussion — explanation

procedure. The damaging effects of noise pollution can be divided into four groups:

**Physical** — If a person is exposed to noise for a prolonged period of time or to a sudden unexpected noise of high intensity, he may suffer a temporary or even a permanent loss of hearing without becoming totally deaf. For centuries, it was believed that some hearing loss was a normal aging process. Recently, some scientists have proved that this may be questionable. They investigated certain tribes in Africa where noise is almost absent and found that even the oldest members of the tribes have almost unimpaired hearing. This is not so with older people in our country and many other well-developed countries in Europe and Asia. It has become obvious and scientifically proven that under long exposure to noise the microscopic hair cells located in the cochlea of the inner ear, which transmits the sound to the brain, deteriorate irreversibly which results in a slow, but permanent, loss of hearing.

Skin discoloration is another visible effect of noise pollution. It is usually caused by the constriction of the blood vessels and the slowing down of the blood stream.

Tightening of the muscles and an increase of the heartbeat is also a result of noise pollution.

**Physiological** — The following physiological changes have been noticed under the influence of noise:

Blood pressure increases

Saliva ceases flowing

Gastric juices decrease

Digestion is disturbed

Perspiration increases

Visual sharpness decreases

The mouth becomes dry

Hormone releases in the blood stream increase

**Psychological** — The following psychological effects have been attributed to noise pollution:

Decreased working efficiency

Greater irritability

Domestic difficulties

Symptoms of hypertension

**Material, financial and other damages from noise pollution:**

Several airplane crashes have been attributed to noise. Excessive vibrations cause acoustic fatigue, or the weakening of the airplane structure.

Sonic booms cause structural damage on buildings (crack metal, walls, glass and other materials).

Mistakes and inaccurate work cause financial loss to employers.

Noise interferes with learning in schools.

Property values have decreased around airports.

### 2. Developing the Experience

#### Part II — Prevention and Elimination of Noise Pollution

In discussion, the class should talk over the methods that can be used in order to decrease noise. Ask the students about their ideas and help them by leading the discussion and suggesting the available prevention measures.

Here is some information on this topic:

- Ways to reduce the output of noise:
  - Improving and soundproofing some machines or their parts. (See if anyone suggests a form of insulation.)
  - Installing better mufflers or riding a bicycle.
  - Procedure of operating the machine.
  - Installing sound suppressors on some jet aircraft reduces the noise considerably, but it is expensive and increases operating costs.
  - Writing new rules and laws will induce people to pay more attention to noise pollution and not to create noise during specific hours (night time). (Discuss hospital zoning as an example.)
  - Educating people about the negative effects of noise pollution. If people know more about these effects, they will be more careful about creating noise.
  - Buying home appliances and devices which are less noisy and even replacing the noisy ones.
- Ways to reduce the transmission of noise:
  - Building porous walls or insulating them with foam, acoustic tiles, cinderblocks, curtains, and other soft materials will help absorb the sound waves.
  - Building walls of shrubs and trees along the highways will decrease the noise from traffic.
  - Locating new airports and runways away from populated areas and erecting sound baffle walls at the ends of runways can reduce the noise considerably.
  - Forbidding airplanes to fly with speeds higher than the speed of sound, which creates sonic boom.
  - Using protective devices like ear plugs and ear muffs where excessive noise exists (around airplanes, in factories).

### 3. Extending the Experience

- Assign several students to write to the Federal Aviation Agency in Washington, D.C. for further information on jet aircraft noise problem. (Good for language arts assignment.)
- Assign another small group of students to write to

the Environmental Protection Agency for more information on noise abatement procedures in heavily populated areas.

- Ask your students to do some research on the Supersonic Transport in our country and have a discussion in class on whether we should have it or not. Discuss the major contradictory points about SST. Give sufficient time for research, after which the students should be able to support their statements and positions with facts. After such a discussion, the students should be able to judge the desirability of having the Supersonic Transport in our domestic air fleet.
- Assign several students to investigate the school noise problem and present an explanation (report) on the major sources of noise in the school and how the noise can be reduced.
- Assign students to investigate whether there are any local regulations banning noise pollution (auto straight pipes, Hollywood mufflers.)

### Additional Activities

- Set up a tape recorder without the class being aware of it. Play it back after you tape the class coming back from recess. Discuss.
- Study the effect of barking dogs. In an inner-city area, some dogs are kept as watch dogs, not pets, and when someone approaches an alley where dogs are confined the noise is frightful and very disturbing. Ask the students to find possible solutions to this noise problem. Contrast this situation with suburban dogs which are kept mostly as pets.
- The teacher might note that the first comprehensive federal legislation to control noise emissions was signed into law recently by President Nixon. The Federal Environmental Protection Agency estimates that noise has risen to such a high level in parts of the U. S. that the hearing of 40 million Americans is in danger.



## Appendix

### TEACHER BACKGROUND INFORMATION

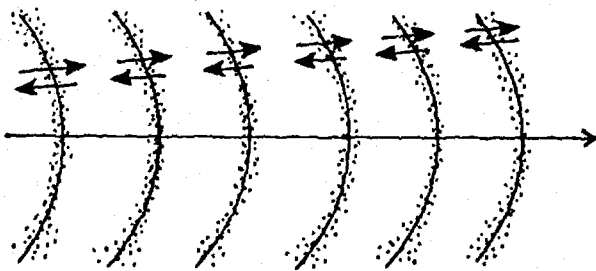
Sound is a form of energy which travels as sound waves through matter and occurs as a three part phenomenon: source, transmission and effect.

The air is actually made up of many extremely small molecules with nothing (a vacuum) between them. As a sound wave passes through, they move closer together and further apart.

**Source:** Sound is produced by a vibrating object, which causes the air molecules to compress in one direction, which compels the next group of molecules to squeeze together; this movement of the air particles is transmitted further to the next group and so on. At the same time, the vibrating object has moved back and has left an empty space into which the originally compressed molecules expand. The next group of molecules also expand, then the next ones and so on. The areas of compression alternate with the areas of expansion, spreading outward just like water ripples created when a rock is thrown in a body of water.

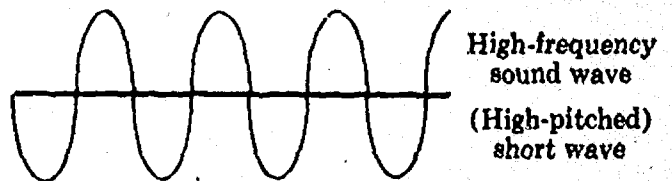
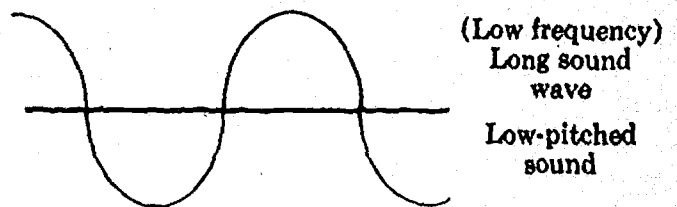
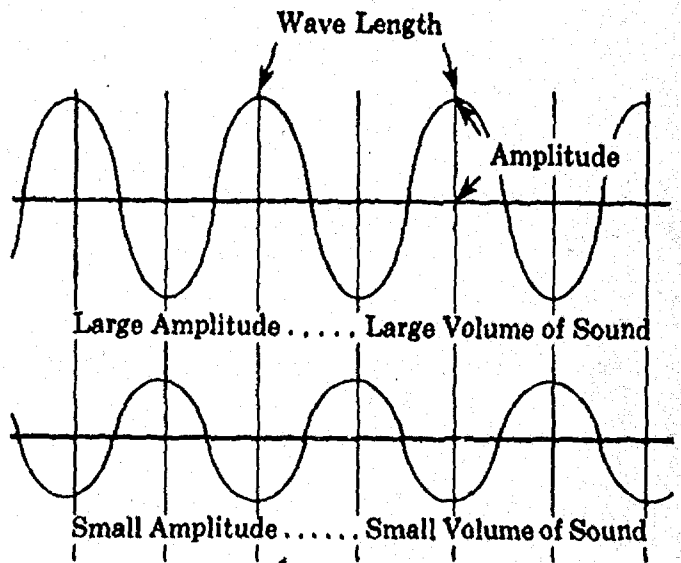
**Transmission:** Sound waves cannot spread in a vacuum; they require a material medium with elasticity such as steel in order to spread around. Air molecules transmit sound waves well, but steel is 2,000,000 times more elastic than air. Some of the sound energy is dissipated in the form of heat. Also, raising the temperature increases the speed with which sound is propagated, which is about 1100 feet per second.

### SOUND WAVES



A good way to demonstrate sound waves is to use a slinky. Have two students gently stretch the slinky out on the floor or other smooth, flat surface. Then have a student at one end shove his hand rapidly along the line of the slinky and quickly pull it back to where it was. At this point, the class should be able to see the waves travel down the slinky. They can bounce off the other end (echo) and cross each other in the middle.

**Frequency (pitch):** Frequency is determined by how fast a source vibrates, or how many waves pass a point per second. If a tuning fork vibrates 200 times per sec-



ond, we say that the sound waves have a frequency of 200 cycles per second (c.p.s.). If the frequency is increased, the pitch is increased (the sound becomes more shrill). As the number of waves that pass through a point become less, the pitch decreases (the sound is deeper).

**Intensity (loudness):** Intensity is the amount of energy flowing in sound waves. This intensity is translated by the brain as loudness. The intensity of a sound wave is measured with db's. and depends on the amplitude of the wave.

The faintest sound which the human ear is capable of hearing is about 1 db. The loudest is 120 db's. Above that, the sound will cause pain. The most comfortable range is between 40 and 60 db's. We can measure the intensity of sound with a sound meter.

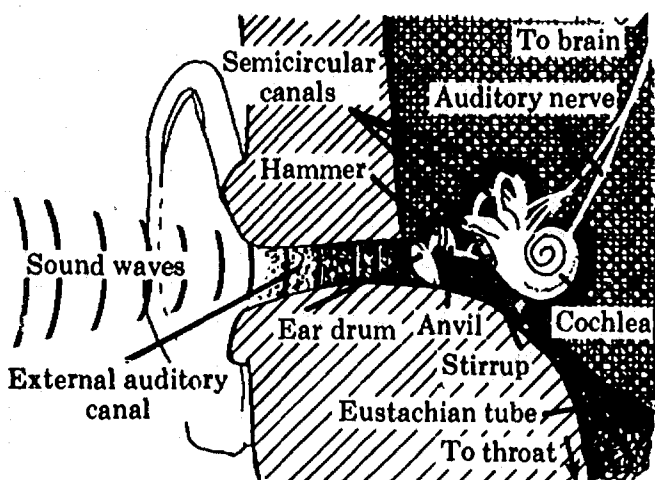
**Effect:** Sound waves must be created and transmitted, but they must also be received and interpreted

in order to be heard by a human being. The ear receives and transmits sound waves to the brain and the brain interprets them (loud or low noises, speech, music).

**Frequency:** The human ear is able to handle sound frequencies between 15 and 20,000 c.p.s., but is most acute in the range of between 500 and 4,000 c.p.s. Many bad effects have been attributed to sounds at frequencies below the range of human hearing (subsonics). Certain of these frequencies might cause mental or physical discomfort such as nausea and extreme irritability. This device has been used by the British police for breaking up dangerous crowds by inducing panic. Subsonic sounds are used to create pain.

#### *The Structure of the Human Ear*

Sound waves coming at a person are funneled by his outer ear into a tube called the external auditory canal. At the end of this tube is a very thin piece of skin called the eardrum or tympanum. When sound waves hit the eardrum, it vibrates. The vibrations are then passed on to three very small bones, called the anvil, hammer, and stirrup because of what they resemble. These bones carry the vibration to a snail-shaped organ called the cochlea. This is where the vibrations are turned into a signal for the brain. The cochlea is filled with liquid. The liquid carries the vibrations to little hair-like structures, which are of different lengths like the strings of a piano. Each of them is sensitive to a different pitch. Each one of these that picks up a vibration at its pitch sends a signal to the brain along a nerve handle called the auditory nerve. This signal tells not only pitch, but intensity. Also, within the ear, there is a pressure equalizing system, so everything can vibrate without the air holding it back. When the eardrum vibrates, it pulls on the air inside. A tube called the Eustachian tube connects the throat with the ear. This allows air to move freely in and out from the space inside the head behind the eardrum. On the cochlea is a small oval window, which stretches to give the fluid inside room to vibrate.



#### **GLOSSARY**

**Acoustic Fatigue** — The weakening of a substance due to vibration.

**Tiles** — Tiles which control sound by stopping

it from reflecting.

**Amplifier** — A device to make sound louder.

**Auditory Canal** — The channel from the outer ear to the eardrum.

**Cochlea** — The part of the inner ear which looks like a snail shell and is concerned with hearing. It is a spirally coiled tube filled with liquids and nerves which change the vibrations to electric signals which travel to the brain.

**C. P. S. Cycles per Second (now called Hertz)** — The unit which measures frequency.

**Decibel** — A unit for measuring the intensity of sound. 120 decibels is the threshold of pain.

**Frequency** — The number of waves which pass a given point in a given time. The frequency of a sound wave is its pitch.

**Glass Paks** — A kind of muffler which consists of a perforated pipe enclosed in a larger pipe. The space between them is packed with fiber glass which absorbs sound. The amount of sound absorbed is affected by the holes, the packing and the age of the glass pak. The older it gets, the less sound is absorbed because carbon accumulates on the fibers.

**Hammer, Anvil, Stirrup** — The three very small bones which transmit vibrations from the eardrum to the inner ear. Also called malleus, incus and stapes.

**Hollywood Muffler** — An obsolete term for glass paks.

**Intensity** — The amount of force with which sound waves are travelling. (loudness)

**Molecule** — The smallest unit into which matter can be divided and still retain its identity. A chemical combination of atoms.

**Pitch** — The pitch depends on frequency. The sound may be high or low.

**Return Flow Muffler** — The muffler generally used on cars. The exhaust pipe goes into the muffler and ends a short distance from the front of it. The exhaust then goes through perforated baffles to the back of the muffler where it is pushed into another pipe and carried out.

**Sonic Boom** — The loud noise made by an airplane which is traveling faster than the speed of sound.

**Sound Suppressor** — A device which reduces sound — as on a jet plane.

**Straight Pipe** — On a car: An exhaust pipe without a muffler.

**Subsonic** — Below the threshold of human hearing in frequency.

**Supersonic** — Above the threshold of human hearing.

**Tympanum** — Eardrum.

**Vacuum** — Space which is empty or almost empty.

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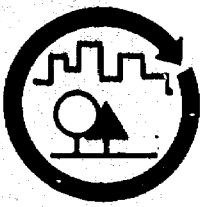
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# Succession and the Pond Community

The purpose of this unit is to introduce the student to the principles of plant ecology and the concepts of primary and secondary succession. Ecological factors that affect plant community growth and distribution are emphasized. Field study activities concentrate on the investigation of the pond plant community.

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## SUCCESSION AND THE POND COMMUNITY

### Unit Objectives:

At the conclusion of this unit, the students will be able to

1. distinguish between primary and secondary succession.
2. recognize stages of succession at field sites.
3. describe stages of succession (hydroseres, xeroseres).
4. know common ecological terms by definition.
5. list the factors contributing to plant growth and distribution.
6. summarize the reasons for plant dependence upon climatic factors such as light, heat, precipitation, and soil.
7. analyze the relationships between plant community succession, number of animal species present, and the population of a species.
8. predict the consequences of an interruption in the succession process.
9. explain the reasons for different plant communities existing in the same climate area.
10. identify and classify plants common to their environment.
11. evaluate the effects of man and animals upon their environment.
12. describe the effect upon a plant community of the invasion of a new species.
13. understand the concept of competition that exists between plant species and between individuals of the same species.
14. give examples of common aquatic plants found in the local ponds.
15. list the common animals associated with different plant communities.

### Environmental Experience 1: Succession

#### 1. Introducing the Experience

The teacher should review and present the essential information and vocabulary from the material included in the Teacher Background section which is included in the Appendix of this unit. After exposing the students to the material, the teacher may choose to raise the following questions:

What is the definition for the following terms: succession, primary succession, secondary succession, lichens, algae, pioneer plants, climax community?

What are the two types of primary succession?

Trace the stages in both types of primary succession.

List examples of plant species present at each stage.

Why are moisture and the amount of soil formation and accumulation important to succession? Are these limiting factors?

What other factors aid the process of primary succession?

Why is succession important? To plants? To animals? To man?

How does succession relate to food chains and webs?

How does succession assist in soil formation and accumulation?

Does succession have any relationship to the animals

in a given area? Number of species? Animal population?

How does plant succession influence:

- erosion
- runoff
- water table
- deposition
- soil fertility

What are the consequences of the interruption of the succession process?

How long does the succession cycle last?

By what means are new plants introduced to a given habitat?

Why can a number of different plant communities exist at the same time in a particular climatic region?

#### 2. Developing the Experience

The students might consider their own environment in connection with the concept of succession. Take the students to a wooded area and investigate and observe the following:

What is a plant community? What is the composition of the community in your area? Is there more than one community?

What type of succession is affecting your area?

Can you identify the stages of succession?

Are there several overlapping stages observed in the area?

List and collect examples of the different plant species.

Use field manuals to identify and classify plant types.

Describe the climate of the area.

Investigate the soil in the area. Can you find evidence of soil formation? Is there dead and decaying plant and animal debris accumulation? Is humus present?

Did you observe any animals?

Describe the food chains and webs of the area.

Is there any evidence of interruption in the succession cycle?

What do you think the pioneer plant of this area was called?

What type of climax vegetation will eventually be present?

What type of climax vegetation was present in the past?

How would you explain the diversity or lack of diversity of species in this area?

How have plants adapted to the area observed?

### Environmental Experience 2: Ecological Factors Affecting Plant Growth and Distribution

#### 1. Introducing the Experience

Effects of water, light, and soil on plant growth. Materials for this experiment include: several dozen bean seeds, a dozen paper cups, soil, sand, gravel, vinegar, paper towels, and two aluminum (recyclable) pie plates.

The first step is to determine whether the seeds will germinate. Soak the seeds in water overnight and then place them between six and eight sheets of paper towels. Enclose the beans and towels inside the two pie plates to prevent light from entering. Check the beans daily (two to three days) until at least 12 sprout.

Number the paper cups from 1 to 12 and plant the sprouting bean seeds under the following conditions:

Cup 1                      Cup 6  
Soil                        Soil  
Good light                Good light  
No water                 Water when dry  
Add tsp. of vinegar

Cup 2                      Cup 7  
Soil                        Sand  
Good light                Good light  
Water when dry         Water when dry

Cup 3                      Cup 8  
Soil                        Gravel  
Good light                Good light  
Water every              Water when dry  
Friday

Cup 4                      Cup 9  
Soil                        Soil  
No light                 Good light  
Water when dry         (Punch holes in bottom of paper cup  
and place cup in a pan of water)

Cup 5                      Cups 10-12  
Soil                        Do your own thing!  
In shade  
Water when dry

Have the students maintain a daily log book for observation of the growing plants. At the end of two weeks, compare the differences in the growth of the bean sprouts under different environmental conditions. What happens to the bean sprouts under different conditions?

Good light, shade, no light  
Soil, sand, gravel

Adequate water, occasional water, no water, too much water

When soil has high acid content

Other factors that could be manipulated in conjunction with this experiment are:

Temperature — grow indoors and outdoors

Soil fertility — highly fertile versus infertile soil

## 2. Developing the Experience

### Effects of animals

Materials needed for this experiment are sunflower seeds, a flower pot, felt-tip pen, and a small plastic ruler. Plant the seeds in the pot. After the plant grows about two inches tall, use the felt-tip pen to draw a circle around the plant stem about one inch above the soil. As the plant grows taller, re-measure the height of the circle above the soil.

The following questions may be raised:

What portion of the plant is growing?

What happens to the plant if the growing portion is damaged or destroyed?

What effect would browsing and grazing animals have on the plants they feed on?

What effect would over-grazing have on a specific area?

A similar experiment to the one above would be to beans and grass in the classroom. Simulating

grazing and browsing animals, the students could cut off various lengths of upper parts of the plant and observe the effect on growth.

Numerous other activities may be located in elementary science books. The junior and senior high school science teachers might also be contacted for ideas.

## Materials

Several dozen bean seeds

Twelve paper cups

Soil

Sand

Gravel

Vinegar

Paper towels

Two aluminum pie plates

Sunflower seeds

Flower pot

Felt-tip pen

Small plastic ruler

## Environmental Experiment 3: Succession in a Pond

### 1. Introducing the Experience

Identify and organize a field trip to several local ponds showing different stages of succession and plant communities. Preparing the students for this experience might include the following suggestions:

Give the history of the pond. When was it formed? How was it formed? How old is the pond? Where does the water in the pond come from?

Review primary succession and the background material on hydrarch succession and hydroseres.

Introduce the students to the proper use of plant identification field manuals. Identify ahead of time the common species of pond plant life. Have a sufficient number of field guides available for use in class and on the field trip. (*Pond Life: A Guide to Common Plants and Animals of North American Ponds and Lakes*, Golden Press, New York.)

Review factors which influence plant community growth and succession.

Information on aquatic plant adaptations.

Student activities and observations on the field trip might include the following:

Collect and observe plant species for identification in the field or in class.

Collect samples of pond water and plant life for later observation and investigation in the classroom. Aquatic plants can be grown in the classroom aquarium. Pond water can be examined for microscopic plant and animal life.

Identify and note differences between:

1. submerged plants                      7. shrubs

2. floating plants                         8. trees

3. emerging plants                        9. ferns

4. sedges                                    10. moss

5. herbs                                     11. lichens

6. grasses                                  12. algae

Identify the stage(s) of succession the observed pond is going through. How much time did it take for the pond to reach this stage?

What stages of succession has the pond already

passed through? What were the earlier forms of plant life? What will the climax vegetation be like?

- What kinds of animal wildlife are observed in the area?
- What relationships exist between animals and plant communities.
  1. Producers-consumers
  2. Shelter and protective cover
  3. Stage of succession and diversity of species in area
- Is there evidence of soil formation and accumulation? Collect soil samples for analysis in class.

## 2. *Developing the Experience*

- An optional field trip could be taken to a fast-moving stream to observe the different plant communities and succession stages at the edge of the stream and on the stream bank.

- Maps of the pond could be developed by students. Distribution of vegetation in the water and on land could be shown.
- A separate study of climate and weather effects upon the plant pond community could be developed. Topographical factors could be included also.
- Separate life histories of plants, their characteristics and adaptations, could be developed by the students. The plant invasion of an area and its effects upon plants already existing in the area can be studied. Competition with later invading plants and eventual replacement by the succession of new species would reinforce the concept of primary succession.
- The students can develop food chain charts for the animal and plant life in the pond area.
- The stages of succession a pond goes through could be charted or diagrammed.



# Appendix

## TEACHER BACKGROUND INFORMATION

### Environmental Experience 1: Succession

Succession is the gradual replacement of one community by another. It affects and involves both the plant and animal members of the community. A community can be defined as a group of living organisms having mutual relationships among themselves and their environment. Succession involves the following concepts:

1. The composition of the species in the community is constantly changing
2. No plant community is completely stable.
3. Within a given climatic area, the plant community is a given habitat which has predictable trends toward a climax community
4. Similar habitats support similar communities.
5. The orderly species change can be interrupted and stages of succession are skipped under certain circumstances

Basic types of succession are:

1. primary succession
2. secondary succession

#### Primary succession:

Primary succession occurs on bare soil or rock areas, or lakes and streams where no vegetation has grown before. Typical areas include: a newly emerged coral atoll, a volcanic lava bed, an area scoured by a glacier, an outcrop of bedrock or a landslide area. Primary succession starts with the establishment in the area of highly adaptable plants which have the ability to grow under extreme conditions. The first plants to establish themselves are called "pioneer" plants. The amount of moisture present is a limiting factor. Primary succession proceeds through many stages (series) until it reaches a relatively stable and mature stage which is called the climax stage. The climax stage and climax community vary depending upon the climate (temperature and precipitation), soil, and other ecological factors at work in a specific habitat. Primary succession is a slow and gradual process.

#### Secondary succession:

Secondary succession occurs in areas where the normal primary succession process has been interrupted by fire, cultivation, lumbering, floods, or wind. Secondary succession takes place at a much faster rate because it begins at a higher stage and builds on a base that has been already established.

#### Representative primary successions:

- Hydrarch succession (succession occurring in ponds, lakes, marshes, and elsewhere in water)

#### Stages of succession (hydroseres)

1. Submerged stage (underwater plants)  
Occurs near shore or in areas where water is less

than 20 feet deep. Pioneer plants grow completely submerged, mainly rooted in the mud and sand lake bottom. Typical plants include: waterweeds, pond weeds, hornwort, naiads, buttercups, bladderworts, eelgrass, and numerous forms of algae. The plant community forms a dense tangled growth. Dead plant remains and eroded stream materials sink to the bottom and form partially decomposed humus. In time, the bed builds up and the water in the pond becomes shallower.

2. Floating stage (floating plants)

Where the water is shallow, various floating plants invade the area occupied by the submerged pioneer plants. The floating plants include waterlilies, pond weeds, and smart weeds. The floating plant roots are anchored to the bottom. As their numbers increase, their broad floating leaves decrease the amount of sunlight available to the submerged plants. Humus and soil formation continue.

3. Reed and swamp (emergent plants)

At this stage, rooted, partially submerged plants such as the bullrush, cattail, burr reeds, and wild rice invade the habitat. They are tall plants and their density of numbers reduces the light to the floating plants, forcing them to move outward or entirely disappear. The reed-swamp plants' dense growth also aids in retention of eroded materials and rapid accumulation of dead plant remains.

4. Grass-meadow stage (grass and wildflower plants)  
Carices, rushes, and spike rushes appear. The amount of surface water now varies seasonally and eventually disappears as soil formation and accumulation continue. Mints, marsh marigold, blue flag, bedstraw, water hemlock, cotton grass, and bellflower develop and assist in holding water and wind eroded soil particles, decaying plant debris, and animal remains. As the area begins to dry up, succession proceeds to a grassland climax in very dry climates or to a forest climax in more moist climates.

5. Woodland stage (shrubs and trees)

Shrubs and trees such as willows, dogwoods, button-bush, alders, tree willows and cottonwoods take root and grow. Shade-enduring or tolerant herbs also grow and develop among the shrubs.

6. Climax forest (trees)

As more humus develops and the soil becomes more fertile, other trees invade the area. Alder, willow, cottonwood, elm, ash, oak, and hickory stands develop. Shrub and herb communities change, adapting to the drier conditions and less sunlight. Eventually, stands of beech and maple will replace the mixed forest and be considered the climax vegetation.

- Xerarch succession (succession occurring in bare areas in dry climates)

Stages of succession (xeroseres)

1. Crustose — lichen stage

Crustose — lichens (fungus symbiotically living on algae) are adapted to temperature extremes, little water and food, and exposure to sunlight. Lichens produce carbon dioxide, which when mixed with water forms a weak carbonic acid that eats into the rock. Lichens aid in the chemical decomposition and mechanical weathering of rock and start the formation of soil.

2. Foliose — lichen stage

After a small amount of soil has formed, foliose lichens invade the area. Their leaf-like shapes shut out sunlight which causes the crustose lichen to die. Chemical and mechanical weathering continues.

3. Moss stage

After enough soil has formed, species of black moss, hair moss, and twisted moss appear. Soil formation and accumulation continue.

4. Herbaceous stage

Annuals such as the common field and garden weeds begin to appear. They are followed by the biennials and the perennial grasses. Soil formation and accumulation now occur more rapidly.

5. Shrub stage

Snowberries, poison ivy, sumac and nine bark begin to develop.

6. Climax forest

Burr oak, bitternut, and hickory stands first appear. They are followed by red oak and shellbark hickory. Eventually, they are replaced by maple and beech forests.

Environmental Experience 2: Ecological factors affecting plant growth and distribution.

A. Climatic factors

1. Temperature

Plant species have developed a tolerance to temperatures ranging from  $-80^{\circ}$  F. to  $140^{\circ}$  F. At the temperature extremes, the plants either become dormant or die. The optimum range for plant growth is between  $75^{\circ}$  F. to  $85^{\circ}$  F. Cellular chemical processes and production of structural protein and enzymes are optimally functioning in this range.

Temperature varies depending upon:

- latitude
- altitude
- topography
- atmospheric conditions

2. Light

Plants change sunlight into potential energy (fats, carbohydrates, protein) through the process of photosynthesis. Sunlight is necessary for photosynthesis to occur. Light affects a plant's rate of growth, auxins, leaf size, formation of chlorophyll, physiological processes. The daily amount of exposure to light (photoperiodism) affects reproduction. The intensity of sunlight is another factor. Light varies depending upon:

- latitude
- altitude

topography  
atmospheric conditions

Only about one percent of available sunlight is converted into potential energy by plants.

3. Precipitation

Moisture is essential to plant growth. Photosynthesis, digestion, growth and assimilation are affected by the amount of water available. Cellular processes need water as a medium, raw material, solvent, absorbent or agent of transportation. Plants are often classified according to their adaptation to the amount of water present in their habitat.

*Hydrophytes* (plants living in water or very wet soil)

Adaptations:

- weak-stemmed (thin epidermis)
- poorly developed root structure
- numerous breathing pores (stomata)
- large, thin leaves
- cuticle thin or absent

Examples:

Cattails, water lilies, pond weeds

*Xerophytes* (plants living in arid or semi-arid regions)

Adaptations:

- leaves absent or reduced size
- thick cuticle
- smaller plants
- water storage tissues
- fewer stomata

Examples:

Cacti, sagebrush

*Mesophytes* (plants living in moderately moist soils)

Examples:

Common field and forest plants  
roses, elms, bluegrass, violets, oaks

B. Physiographic factors

1. Soil

The amount of water, organic and mineral content, and oxygen and carbon dioxide present in soil affects plant growth and distribution. Plants need oxygen for respiration, carbon dioxide for photosynthesis. Soil acidity or alkalinity influences absorption.

2. Wind

Wind causes asymmetric and one-sided growth. High winds can damage and destroy plant life. Wind increases plant transpiration. It aids in the dissemination of spores, seeds, fruits, and entire plants (tumble weeds). Wind is also a factor in soil erosion.

3. Topography

Topographic factors influencing plant growth and succession include direction of exposure surface, slope, altitude, and amount of drainage.

C. Biological factors

1. Competition

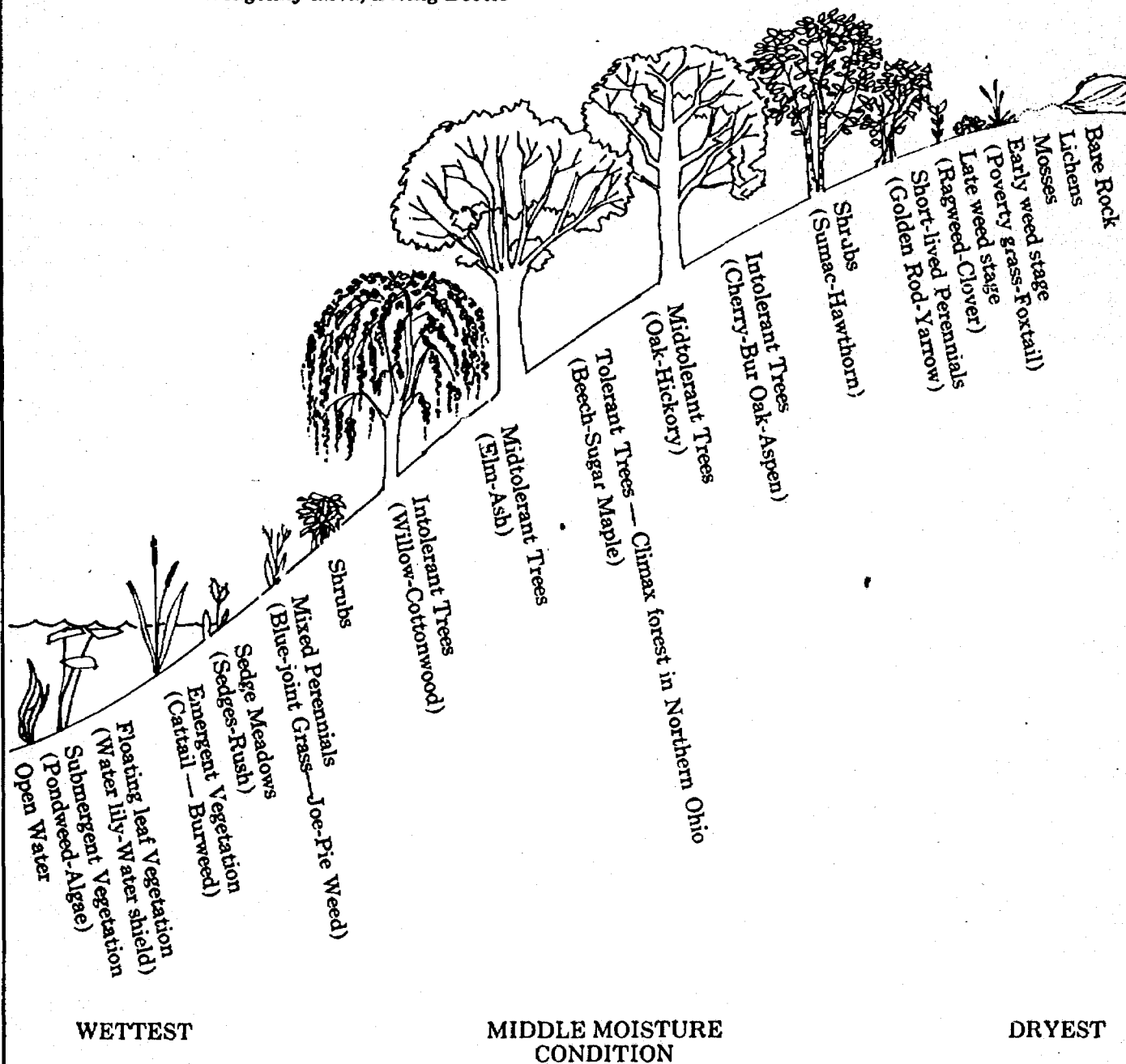
There is competition in the plant world between species and individuals within a species for the following factors:

- water
- sunlight
- nutrients and minerals
- temperature

**Primary Successional Stages from Hydrosere (Open Water) and Xerosere (Bare Rock) Conditions Toward a Climax Community for Northern Ohio**

**Animals Associated with Successional Stages:**

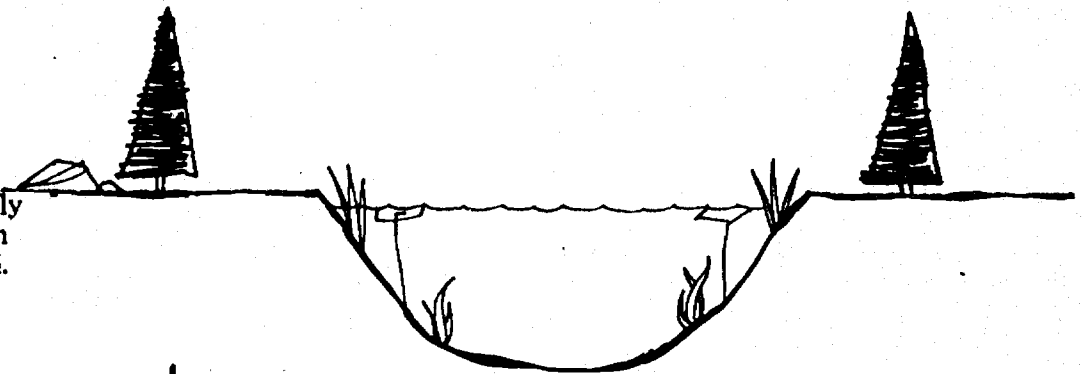
- Forest-Woodland = Bark Beetle, Woodpecker, Squirrel, Owl
- Shrubs = Bobwhite Quail, Cardinal, Catbird, Assassin Bug, Rabbit
- Prairie = Grasshopper, Badger, Ground Squirrel, Meadow Lark, Field Sparrow
- Sedge Meadows-Emergent = Mink, Muskrat, Red-winged Blackbird, Bobolink
- Aquatic Stages = Bullhead, Bluegill, Crappie, Bass, Dragonfly larva, Diving Beetle



# POND SUCCESSION — THE AGING OF A POND

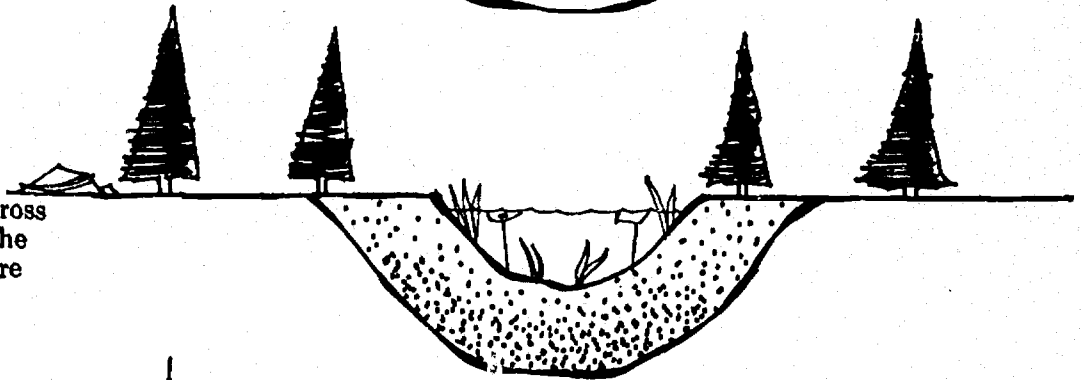
## YOUNG POND

Plants are growing only on the edge and not in the center of the pond.



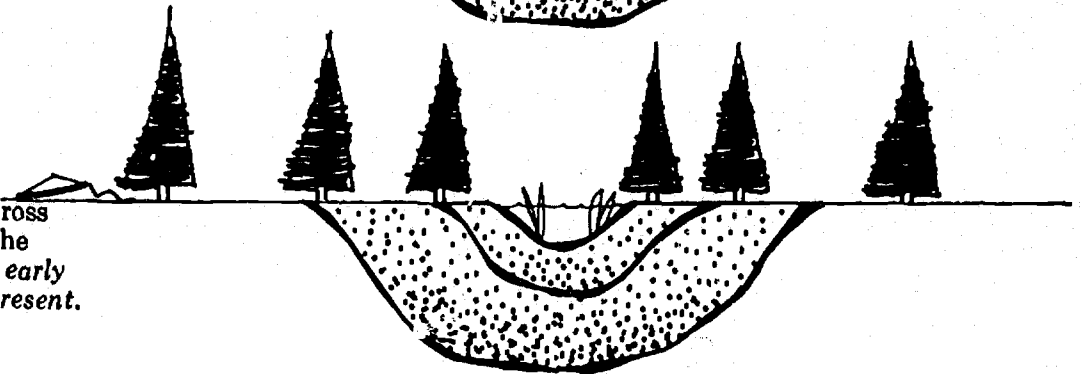
## MATURE POND

Plants are growing across the entire bottom of the pond, and all stages are present.



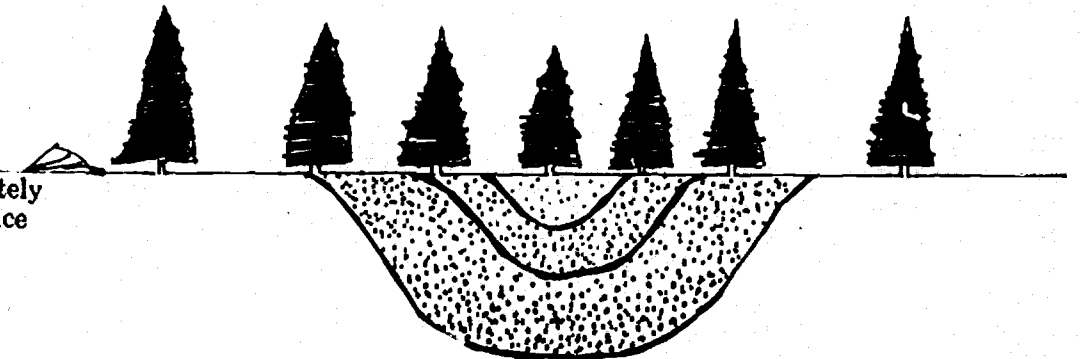
## OLD POND

Plants are growing across the entire bottom of the pond, but some of the early stages are no longer present.



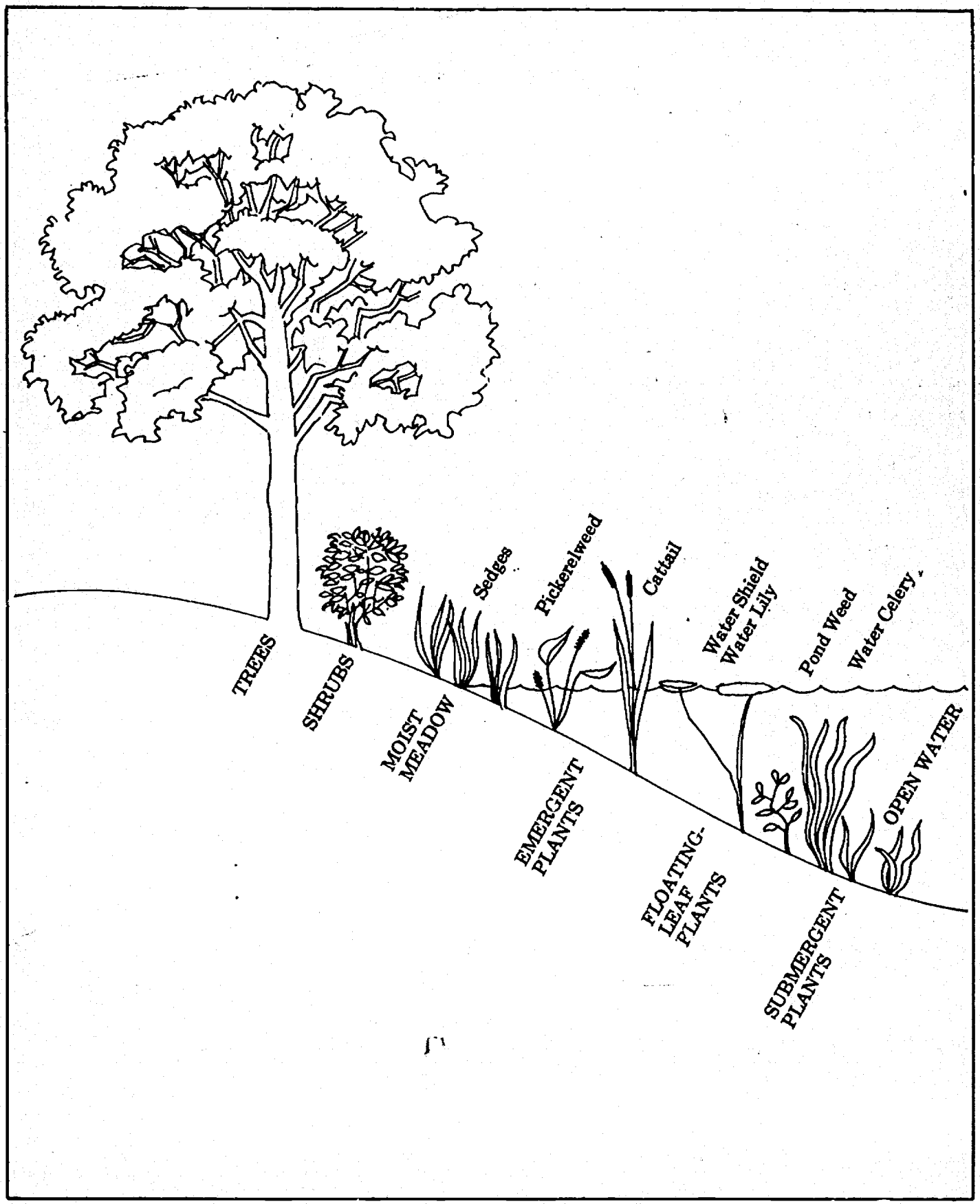
## DRY LAND

The pond has completely filled in leaving no trace of the original basin.





# PLANT ZONES OF A POND



humidity  
air movement

Examples:

**Direct Competition** — The roots of a strangling fig, a tropical epiphyte, envelop tree trunks and eventually strangle and *kill* the tree.

**Introduction of new species**—Rapidly reproducing Eucalyptus trees were introduced to California. They are rapidly invading and replacing the *grasses*.

**2. Parasites (organisms that obtain their food from other living organisms)**

Parasites cause disease in plants that will stunt their growth, cause abnormal growths, or decrease plant populations even to the point of extinction.

Examples:

Dutch Elm disease has all but eliminated elm trees in the Midwest. Chestnut blight has all but destroyed chestnut trees in the northeastern United States.

**3. Symbiosis (association for mutual benefit)**  
lichens — composed of algae and fungi  
mycorrhizal fungi are necessary for the growth of azalea, rhododendron, and blueberry.  
some types of seeds will not germinate without presence of mycorrhizal fungi.  
nitrogen fixing bacteria and legumes have symbiotic relationship.

**4. Animals**

insects

pollinate, destroy leaves, stems, and roots.

larger animals

grazing stunts growth, removes food-making organs

trampling destroys plants

porcupines and beavers chew bark and kill trees

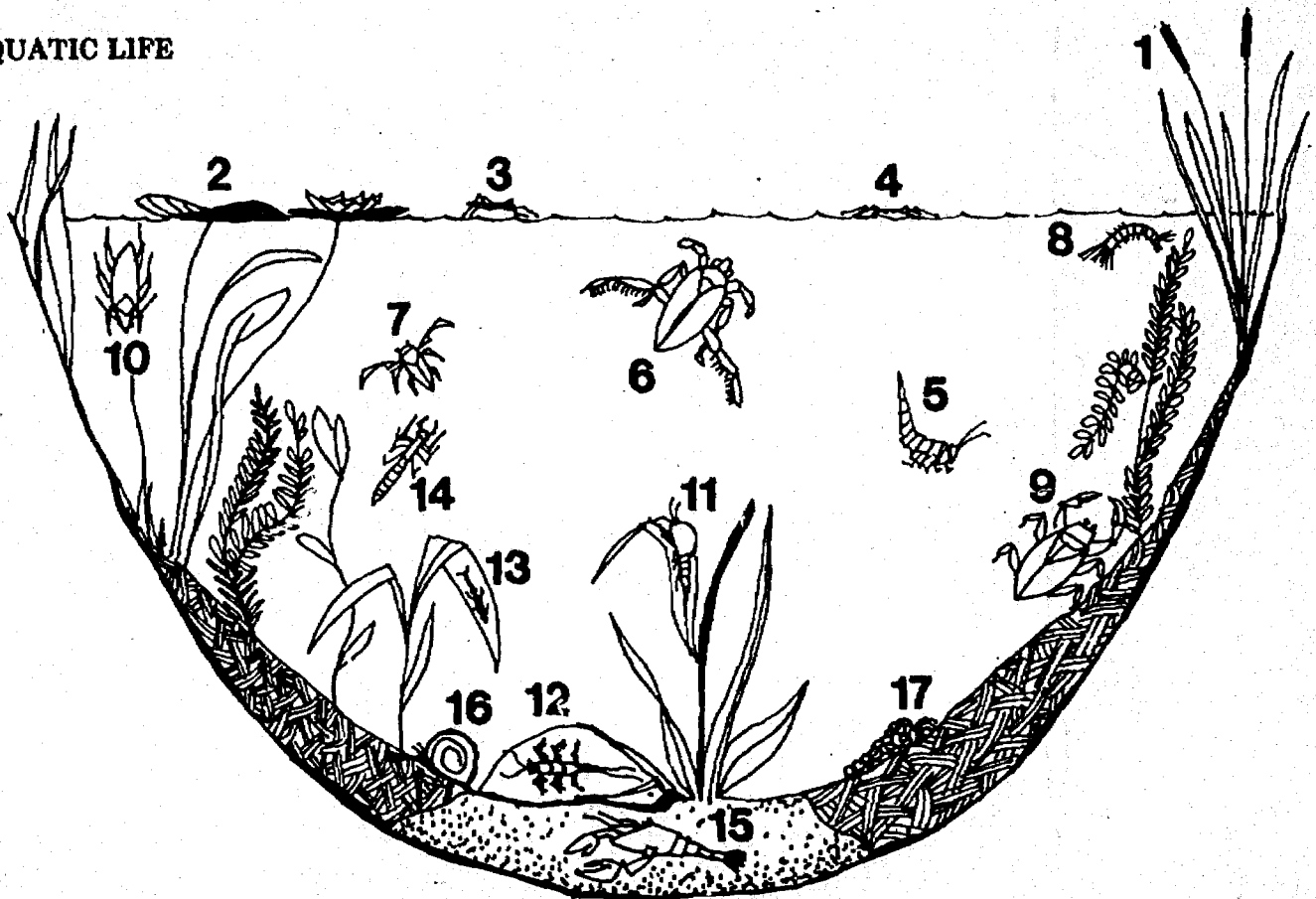
man

cultivation

logging

urbanization and industrialization

**AQUATIC LIFE**



**CROSS SECTION OF A POND**

**I. SURFACE LIFE**

1. Standing emergent aquatics. Cattail (*Typha*)
2. Rooted aquatics with floating leaves. Water lily (*Castalia*)
3. Animals which walk on the surface. Water Striders (*Gerris*)
4. Animals which lie on the surface. Whirl-i-gig Beetles (*Gyrinus*)  
Animals which live below and get oxygen from the surface.

5. Beetle larva
6. Back swimmers (*Notonecta*)
7. Water boatman (*Corixa*)
8. Mosquito larva (*Culex*)
9. Giant water bug (*Benacus*)
10. Diving beetle (*Dytiscus*)

**II. SUBMERGED**

- Animals which breathe through gills on the thorax.
11. Mayfly (*Ephemera*)
  12. Stonefly (*Plecoptera*)

10. Animals which breathe with three caudal gill plates. Damselfly. (Odonata)
  14. Animals which breathe with internal anal chamber. Dragonfly. (Odonata)
- III. LIFE ON THE BOTTOM
15. Crayfish (a Crustacean — Decapoda)
  16. Mollusk
  17. Caddis Fly (Limnophilus)

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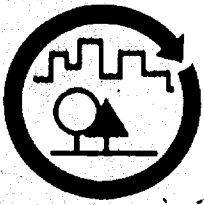
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# Animals and Their Habitat

The purpose of this unit is to introduce the student to some of Ohio's animal populations. The interrelationships between the animals and the plant communities are stressed. The adaptation of mammals and insects to their habitat are studied, along with man's adaptation to and impact upon his own environment. Field studies are also an integral part of this unit.

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## ANIMALS AND THEIR HABITAT

### Unit Objectives:

At the conclusion of this unit, the students will be able to

1. list the reasons for the increase or decline of Ohio wildlife populations.
2. understand the interdependence of animals and the plant world.
3. distinguish between producers and consumers.
4. identify other environmental factors that animals are dependent upon.
5. summarize the effects of man upon his environment and wildlife populations.
6. categorize examples of animals' adaptations.
7. relate the principles of plant community succession to diversity of animal species.
8. identify and name the characteristics of the major animals comprising the Ohio wildlife population.
9. analyze man's cultural adaptation to his own environment.
10. describe the habits and habitat of common Ohio mammals.
11. analyze the effects of insects on the plant and animal world.
12. identify and classify common insects found in the environment.
13. demonstrate an awareness of the diversity of insect species.
14. recognize insect adaptations and give examples.

### Environmental Experience 1: Animals and Their Habitat

#### 1. Introducing the experience

- Have the students read the selection titled "Ohio Wildlife and the Changing Landscape" which is included in the appendix. Have the students compile a list of reasons for the decline or increase in Ohio wildlife populations. Their reasons could be categorized as natural or man-made consequences. Focus their attention and discussion on the relationship of animals to their natural environment. A number of the following questions could be raised for discussion: Must you have plant life in order to support animal life? How important is plant life to the food chain of animals? Does the importance of plant life indicate any further relationships between animals and climate, vegetation, fertile soils and soil formation? Are there any general patterns of animal types associated with climate, vegetation, soil? What are some common examples of animal food chains? Who are the producers? Who are the consumers? Are the animals dependent upon the environment they live in? In what ways, other than food, are the animals dependent upon their environment? Why do you think some animals always live in a specific type of environment? What are examples of typical animals that live in Ohio? What types of typical environments are present in Ohio? Can animals survive a major change in their environment? What are some of the natural and man-made changes in our Ohio environment that have affected animals? How have animals adapted to changing local conditions? What

is the relationship between the concept of evolution and adaptation? Are animals able to survive a change of the environment? How much can they adapt? What happens to animals who cannot adapt to changing situations quickly? What is the relationship of animals to plant community succession? How does secondary succession affect animals?

#### 2. Developing the experience

##### Diversity and adaptation

Have the students list on the blackboard a large variety of animals. Let the students generate ways of classifying animals. The students should be able to generate a large number of simple classification schemes.

Examples:

Size

Shape

Single cell — complex and many-celled

Terrestrial, aquatic, amphibious

Swim, fly, crawl, run, burrow, glide, hop

Carnivores, herbivores, omnivores

Dry climates — wet climates

Hot climates — cold climates

Vertebrates — invertebrates

The students will be able to note the great diversity that exists within the animal world. They may also encounter frustration in trying to develop a system of classification that is comprehensive. Briefly expose them to the major classification categories and emphasize that the classification of animals and the categories are constantly being revised as more knowledge about animals becomes available.

- Narrow the focus to the *identification* (not classification) of animals native to your own geographical area and the State of Ohio. Have the students write the Ohio Department of Natural Resources and secure information pamphlets and publication lists. Many maps may also be obtained from various state agencies. Students may also utilize the school and public libraries if adequate resources are available. After identifying the major animals in Ohio, the students might choose different animals and conduct independent or group research to learn more about their chosen animal. The student reports could include the following types of information:

Description, diagram, drawing, photograph, picture

Food chain and the animal's location in the chain

Description of the plant community and the stage of succession

Animal's life cycle

Reproduction

Adaptations

For survival

To environment (climate, topography)

For food

How and in what ways is man effecting changes in this animal's natural habitat?

- Arrange an outdoor field trip. Possible sites are: a pond, a field, woods, or a stream. Have the students carefully observe and record the following kinds of information:

Kinds of plant life observed

Animals sighted  
Animal traces (see appendix)  
Animal shelters

The following are some suggested activities for the classroom utilizing the observed information from the field trip:

Define the relationships that exist between the animals and the plant life observed.

Develop food chains for the animals observed or known to be in the area.

Were any predators sighted?

Was there any evidence of man-made changes affecting the environment?

What is the status of the total animal population and the individual animals? Is the population stable? Is the population decreasing? Increasing?

The students could also report on the animal life in different habitats or environments such as oceans, ponds, streams, desert, tundra, forest, grasslands, underground, mountains, seashore. The teacher should have the students emphasize the relationships of the animal to these different environments and also the importance of climate, vegetation, topography, and soil, where they apply. For student reference, we suggest:

Life Nature Library Series — Time, Inc.  
Silver-Burdett Reading and Research Program  
Our Living World of Nature Series, McGraw-Hill

## Environmental Experience 2: Animal Adaptation — Mammals

### Introducing the Experience

Adaptation is present among all animals in the animal kingdom. Some adaptations are a result of centuries of evolutionary development while others may be seasonal adaptations. The Class Mammalia offers many interesting examples for the students' further study. For the purpose of this activity, the students can choose a particular mammal and do a research report on its unique adaptations or the class can be divided into smaller groups to investigate types of adaptations. Some suggested categories are as follows:

Environment  
Shelter  
Food gathering  
Protection  
Mobility  
Reproduction

The results of the individual or group research should be shared with the entire class. Encourage the students to be creative in their presentations and to use audiovisual techniques.

Man is a mammal and has achieved a high degree of development and adaptation. Concepts from various social science disciplines could be introduced to illustrate man's adaptation to his own species. Emphasize man's biological and cultural adaptations and his current adaptations to his own environment. A follow-up activity would be to allow the students to exercise their imaginations and logic by having them hypothesize about man's adaptation in the future. What man's internal and external structure

and functions change? Will his brain and head grow larger? Will average height and weight continue to increase forever if man's diet improves? How might man adapt to or modify his environment in the future? Will man's ability to adapt decrease as his knowledge and ability to control elements of his own environment increase?

## Environmental Experience 3: Insects

### 1. Introducing the experience

Insects are a very important part of our lives. More than half of all living organisms (plant and animal) on earth are insects. There are over 800,000 species. They belong to the Class Insecta, which is the largest class in the largest group (phylum) of organisms, namely Arthropods (animals with jointed legs). They are so numerous and so adaptable that they can be found almost anywhere. Insects have six legs and three body parts (head, thorax, and abdomen). They originated from the worms around 320,000,000 years ago. Differences in their structures divide them further to 26 orders — the largest one, the beetles, with 260,000 species. Questions and topics that should initially be raised include the following:

What are the main reasons for the successful proliferation of insects on earth?

reproduce in large numbers  
negligible food and shelter requirements  
ability to adapt

What role do insects play in plant and animal food chains? What are some examples of food chains that include insects? How do we identify and classify insects? How do insects reproduce and how can we describe their life cycles? What is the basic structure of an insect? How do insects move around? A variety of activities may be chosen to answer the preceding questions. Many audio-visual materials are available for the topics.

The diversity of insect species offers another good example of animal adaptation to different circumstances and needs. Have the students utilize a variety of references to identify adaptations of a particular insect or to look for examples illustrating categories of adaptations. Typical insect adaptation categories include:

Protection  
Food gathering  
Climate  
Mobility  
Reproduction  
Vegetation  
Specialization of labor  
Shelter  
Parasites

The teacher can utilize one of the many good films available on insects to point out some of the more common adaptations which the students may use as guidelines for their presentations.

Insects are helpful and harmful to man. United States Department of Agriculture estimates indicate that overall, insects are more beneficial than destructive in terms of dollars and cents. Students could be encouraged to develop case studies on the

harmful or beneficial aspects of insects. The following illustrations are for the teacher. It is hoped the examples will provide potential topics for the students' further investigation.

*Insects — Friends of Man*

- Improvement of soil.  
Air penetrates soil through burrows of ants, grubs, and beetles.  
Earth is brought from lower levels to the surface. Decaying matter is mixed in the soil.  
Beetles, ants and termites are tearing apart leaves, twigs and trunks of trees.  
Hasten the decay of animal bodies and their return to the soil.
- Predators — Control numbers  
Dragonflies, lady beetles, wasps, ants, praying mantises.
- Plant pollinators  
Butterflies, ants, beetles, flies, wasps, bees. Over 50 seed and fruit crops depend upon honey bees for pollination.
- Producers  
Bees — honey  
Silkworms — silk  
Other insects — dyes, tanning, medicines, ink, mortar.
- Destroy weeds  
Australian prickly pear checked by moth introduced from Argentina.  
Kalamath weed checked by beetles in California.

*Insects — Enemies of Man*

- Damage to crops  
reduce yield                      european corn borer  
lower quality                      grasshoppers  
increase costs                      aphids  
   weevils
- Damage to livestock  
horses                                  horn flies  
cattle                                    cattlegrubs
- Damage to humans  
mosquitos                            flies  
malaria                                tularemia  
yellow fever                         anthrax  
encephalitis                         cholera
- Damage to food contamination  
   flies  
   cockroaches
- Damage to homes  
clothes                                moths  
carpets                                carpet beetles  
wood                                    termites  
   crickets

These are just a few of the possible examples. For further detailed information, the teacher may consult the United States Department of Agriculture 1952 Yearbook titled *Insects*.

2. *Developing the Experience*

Field trip—insect collecting

A trip to a wooded area, park, field or even a back

yard will yield numerous opportunities to observe and collect insects. Students may even collect insects on their own time at home or in their neighborhood. The teacher should take time to explain how to go about locating insects and the materials needed for the collecting, killing and mounting of their catch. Insects can be found almost everywhere. (Under rocks, rotten logs, wood piles, bushes, on trees, under leaves, even indoors.) Collection equipment can be inexpensively purchased or, better yet, made (from common household items and products) as a class activity in the classroom. (More information and sources are included in the Appendix.) In-class activities after the field trip may include the following:

- Mounting the insects
- Classifying the insects
- Labeling the insects
- Displaying the insects

The students may want to construct some inexpensive insect rearing cages to keep and observe insects in the classroom. Research should be done by the students to identify the habitat, climate conditions, and food needs for the captured insects. Proper care is very important for the survival of the insects. Several methods may be used to construct an insect rearing cage. A simple idea is to find a gallon jar, place small gravel, sand, or dirt in the bottom, and put a screened lid on the top. This container could be used to house crickets if a few rocks and twigs were available in the jar for hiding places. Be inventive! Construct your own insect rearing cages. A "lamp chimney" can be made with simple materials: a flower pot, soil, plant, hurricane lamp, and a screen. The lamp is placed directly over the plant in the pot and provides an area in which to house the insect for study. The screened top prevents escape of the insect.

*Additional Activities*

- Another interesting observation activity for the classroom would be to build or purchase an ant farm or termite farm.
- Demonstration beehives are sometimes available for classroom use.
- Life-cycle collections can be made for individual insects common to the school location.
- Enlarged diagrams and drawings of the internal and external structure of insects may be produced by the students for display in the classroom.
- Biographies of insects can be written by the students as a creative or imaginative writing activity.
- Insect sounds could be collected using tape recorders.
- Art work illustrating insect protective coloration and structure could be produced.
- A collage of insect pictures organized around various themes could be made by the students.
- Food chain charts for common insects could be displayed.



## Appendix

### TEACHER BACKGROUND INFORMATION

#### *Ohio Wildlife and the Changing Landscape*

Soon after white men settled the Ohio territory, productive farms were carved in the wilderness, and factories started to appear along the major streams. Commerce and industry expanded rapidly. In less than 200 years we have used the resources of the land—soil, forests, water, minerals, and wildlife—to bring our living to its present standards.

During those years of development many of our resources were misused. Others were destroyed and wasted. Timber was stacked and burned to clear the land. Farms were often operated in such a manner that soil eroded, and land made infertile was soon abandoned. Wildlife was destroyed for unsound or inadequate reasons. There is a story, still told, of a great hunt held at Hinckley in 1818. Some 600 men and boys are said to have driven before them in a great circle all the wildlife they could flush from cover. They finally converged on this concentration of game and killed 17 wolves, 21 bears, 300 deer, and unnumbered dozens of smaller animals.

It took many years for Ohio citizens to realize that natural resources were not inexhaustible. During the early days of Ohio's settlement only men with foresight could have predicted a future shortage of game. For all about them game was in abundance. When Marietta, the first settlement of the Northwest Territory, was founded in 1788, the Ohio country was unexploited wilderness. The land was more than 90 per cent forested, primarily with hardwoods. The remaining land was either prairie, bogs, or swamps. There were about 90 ponds and lakes. Early accounts assure us that the countryside was populated with many kinds of game, and that the cool clear streams were filled with fish. We have little way of knowing how accurate these observations of travelers and settlers were, but we do know that among the wildlife that inhabited the state, bison, elk, bears and wolves were present. There were also panthers, moose, and Canada lynxes, as well as trumpeter swans, whooping cranes, passenger pigeons, prairie chickens, swallow-tailed kites, and Eskimo curlews—all long since vanished from the state.

The first settlers in the Ohio country made their living much as the Indians had done for centuries. They kept gardens, hunted game for food and trapped fur animals. But while the Indians had taken little more than they could use in their daily lives, the white man went a step further and took wildlife for trade and commerce. Professional trappers harvested muskrats, beavers, and mink and shipped the furs to the East where they commanded a high price.

The total number of Indians that lived in Ohio prior to the coming of the white settlers is thought to have been less than 10,000. By 1800 the state was also supporting 45,000 white men. The Indians were forced out by 1845, and within the following five years most of the counties in eastern Ohio reached their maximum farm population.

The state was almost completely settled by 1880, and already some of the land first settled was abandoned because erosion had taken some of the topsoil. Industry was growing, and by 1930 Ohio had become an industrial leader with only one-sixth of its population still living on farms. Today about eight per cent of Ohio's employed population operates the 177,074 farms in the state.

It was about 1788 that large scale clearing of the forests began in southeastern Ohio. Trees were cut to supply fuel for the furnaces of industry. Forests were cleared to make room for corn and wheat. The removal of the forest cover left the slopes exposed to uncontrolled water, and erosion became a great problem.

Deforestation continued until eventually much of Ohio's remaining timber was concentrated in small blocks on individual farms. The land once cleared of its timber and gullied by erosion returned gradually, following abandonment, to permanent pasture or second growth forests.

Northwestern Ohio was the last part to be cleared. The swamp lands were gradually etched with open drainage ditches which converted this fertile area into some of the most valuable farmland in the world.

Eventually, Ohio farmers started using power-driven machinery to replace their horses and slow-moving equipment. As farm technology advanced, one farmer could till an ever-increasing acreage. Fence rows were removed and fields grew larger. Clean field borders became the mark of a good farmer; and fires, mowing machines, and more recently, chemicals, helped the farmer clear the brush from his fence rows. Every time a fence row was cleaned, wildlife food and cover were destroyed.

Because we cleared the forests, drained the swamps, grazed our remaining woodlots, let soil erode, and kept farms clean of all plants that would not yield a cash crop, wildlife populations underwent drastic changes. Of the 70 kinds of mammals known to have lived in Ohio in historic times, 11 have disappeared.

The forest-dwelling birds also decreased. The once common wild turkey disappeared from Ohio before 1890. The ruffed grouse decreased with continued logging and is only now building up its populations in some sections of the state. Drainage of swamps and lowlands led to the disappearance of sandhill cranes and prairie chickens, and reduced waterfowl population.

As these native kinds of wildlife gradually diminished or disappeared, a few foreign species were introduced, including the house sparrow, ring-necked pheasant, Hungarian partridge, European starling, carp, brown trout, Norway rat, and house mouse. Thus, Ohio wildlife of today has little similarity to that of 1800. Once a primary product of the state, wildlife has necessarily become a secondary crop.

Nevertheless wildlife is still abundant in Ohio. Balanced against the loss of 11 kinds of mammals and eight kinds of birds are the increase in farm game and the man-made lakes that are heavily populated with fish. Even though ten million people now live in Ohio and share its wildlife resources, the length of the open hunting season on some of our more important game species is increasing gradually. After long periods of no hunting of ruffed grouse and white-tailed deer, open seasons have been set on these forest-dwelling game species. Fishing laws have been liberalized to permit people to fish for all kinds of fish the year around. Our land, as it changed from forest to farm land, supported growing numbers of rabbits, pheasants and other farm game at the same time hunting pressure was steadily increasing.

Ohio now has 173 kinds of fish, 189 kinds of nesting birds, 61 kinds of mammals, 33 kinds of amphibians and 38 kinds of reptiles. On an average 100-acre farm we can expect to find at least 50 kinds of wild animals with a total population of over 2,000 individuals; these figures, however, take into account many animals the average person seldom sees, such as small birds, mice, moles, shrews, and salamanders. Such statistics should not lull us into a feeling of security for the welfare of our wildlife depends on constant research and continued effort to put our knowledge to work.

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### *Animal Traces*

Animal signs and traces consist of any change made in the environment by an animal. Usually "experience" is the best teacher in helping one to become familiar with reading animal signs. Most of the animals that live in small holes or cracks and crevices or under stones are so well hidden that they are difficult to find. Those which are larger are nocturnal, foraging for food at night. Some animals are shy and fast-moving, and are generally heard crashing through the underbrush, splashing in the water, or making a great whir of wings in taking off. Fortunately, however, most animals leave traces of their presence . . . and by studying those traces we may learn a great deal about them and their habits. The following are examples of animal traces that are interesting to learn.

### *Snake Skins:*

Mammals, birds, reptiles, amphibians and most insects shed portions of their bodies as they live and grow. Snakes shed their skins all in one piece. These skins are hard to find in nature, as they are quickly used in the case of the Crested Flycatcher, eaten by other ani-

mals, or just decay. The type of snake who shed the skin can usually be identified by the scalation (pattern of the scales) on the body.

### *Scat:*

One of the most widely scattered and yet most useful clue to an animal's habits is its droppings. Those undigested remains of what the animal has eaten are sometimes the only evidence about the food habits of a species, because certain wild animals are seldom seen while eating.

Many experts have learned to use scat identification for tracking animals while hunting. Rabbit droppings look like round, brown pellets. Mouse droppings are dark brown, and the size of rice grains. Fox scat is half-mooned shape and contains cherry pits, mouse fur and berry seeds. Skunk droppings often contain numbers of beetle wings. Deer droppings have pointed ends to the pellets. With a little bit of good observation, such characteristics should become obvious to students.

### *Cherry Pits:*

A cluster of nuts found in the crotch of a tree or at the base of a stump mark the presence of a "middens" (eating area) for mice or squirrels. A close inspection of the seeds or nuts will usually identify the species involved. The size of the seed is of course important — as the larger animal would be associated with the larger seeds. But another factor is involved; mice usually gnaw a hole in the end of a nut or acorn. The pointed nose of a mouse can get at the nut meat through smaller holes than the larger, more blunt nose of a squirrel.

### *Gnawing:*

Gnawing animals gnaw not only for food and shelter, they need to gnaw to keep their incisors (gnawing teeth) worn down. These gnawing teeth grow the animal's entire lifetime and curve upward into the skull if not worn down.

Gnawing animals work on hard material such as antlers which are shed each year by deer. Acorns and other hard seeds also serve the same purpose.

### *Tracks:*

Tracks are one of the easiest ways to recognize animals. It is fairly easy to see tracks in the soft mud and snow, and the pattern tells many things about the maker. From the size of the track, the size of the animal can be determined. The spacing of the track gives an idea of the body length. The following characteristics can also be used:

1. Dog family — nail print clear (fox, wolf, coyote)
2. Cat family — nail print not clear (bobcat)
3. Two different front and back prints (opossum, raccoon, bear)
4. Track in straight line, back foot in front position (dog and cat family)
5. Track at side angles (skunk)
6. Track with tail dragging (fox, white-footed mouse)

### *Owl Pellets:*

At the base of some trees, oval, grey wads that look like fuzzy droppings are sometimes found. They are pellets from hawks and owls. These birds of prey eat large

quantities of mice and are unable to digest the hair and bones. The compact pellets of undigested remains are spit up and contain the skull, bones, fur, teeth and claws of the mice.

#### *Reptile Eggs:*

Most snakes hatch from eggs. Egg clutches vary in number from a few to more than seventy. The mother snake may deposit them in the sheltered lee of a boulder, hide them in an old stump, or bury them in sand. The egg is not brittle, but slightly leathery. It increases in size after being laid. It may grow as much as one-third before hatching. Some hatch within four days—others as long as ninety days. Most snakes lay their eggs in June and July and the babies hatch in August and September. Research has discovered that a mother snake may lay fertile eggs even though not being fertilized that year. She may continue fertile for several years after mating.

#### *Squirrel Nuts:*

Squirrels gnaw through the husk and hard shuck of walnuts and hickory nuts to get the sweet meats inside. If the shucks are in pieces, the gnawing was probably done by a squirrel. To find the species of squirrel which left its mark on a seed, look for:

1. Black walnuts, hickory nuts (4 holes) — flying squirrel
2. Black walnuts (2 holes) — fox squirrel

#### *Skulls:*

Skulls can be examined from road kills, hunting remains, and natural deaths in the outdoor habitats. By knowing certain skull characteristics, one can identify the type of animal.

Examples are:

1. White incisors — ground hog
2. Brown incisors — rodent family
3. Large canine teeth — dog, cat, raccoon, fox
4. Ten incisors in upper jaw, eight in lower — opossum
5. No incisors — grazers, browsing animals

Through this outline students can begin to learn the signs left by animals and to investigate new traces from their own explorations. With keen observation and experience, the art of nature detection can be a fascinating event.

#### *Other Common Animal Signs*

- a. Basswood seed (cut in half) — chipmunk
- b. Basswood seed (small hole) — white-footed mouse
- c. Black raspberry (cut at angle) — cottontail rabbit
- d. Grass (2" strips) — meadow mouse
- e. Grass (4" strips) — jumping mouse
- f. Snail shell (top removed) — probably short-tailed shrew
- g. Tunnels (inner bark) — engraver beetles
- h. Tunnels (inner leaf) — leaf miners
- i. Swelling (leaves, stems) — insect galls
- j. Nail marks (trees, logs) — squirrels, raccoons, opossum
- k. Tree holes — woodpeckers, squirrels, mice, raccoons

#### *Trail Observations and Activities*

- a. Locate animal homes (brooks, trees, holes, tunnels)
- b. Discuss material used in animal homes
- c. Discuss purpose of nests, dens
- d. Emphasize basic needs of all animals (food, shelter, water)
- e. Adaptations of animals (eyes, smell, hearing, claws, teeth, body shape, special adaptations)

PLANT AND ANIMAL RELATIONSHIPS

NAME OF COMMUNITY	TREES & SHRUBS	HERBACEOUS PLANTS	MAMMALS	BIRDS	OTHER ANIMALS
Agricultural Field (in use)	None	Corn, Oats, Wheat Clover, Alfalfa	Field Mouse Rabbit Groundhog Mole	Red-winged Blackbird Song Sparrow Field Sparrow Vesper Sparrow Killdeer Pheasant Bobwhite Quail	Pilot Blacksnake Blue Racer Black Racer Garter Snake American Toad Fowler's Toad
Newly abandoned agricultural field (1 to 5 yrs.)	Blackberry Raspberry Wild Rose Elderberry	Cinquefoil Goldenrod Thistle Teasel Ironweed Wild Carrot Yarrow Dandelion Wild Mustard Blue grass Orchard grass	Field Mouse Rabbit Groundhog Mole	Song Sparrow Field Sparrow Vesper Sparrow Meadowlark Pheasant Bobwhite Quail Bobolink Horned Lark	Pilot Blacksnake Blue Racer Black Racer Garter Snake American Toad Fowler's Toad
Old abandoned agricultural field (5-15 yrs.)	Poison Ivy Hawthorn Black Locust Red Maple Slippery Elm Poplars Box Elder Blackberry Raspberry Wild Rose	Blue Grass Orchard Grass Cinquefoil Goldenrod Thistle Ironweed Wild Carrot Yarrow Mustard Teasel	Field Mouse Rabbit Red Fox Groundhog Mole Deer Opossum Skunk	Song Sparrow Field Sparrow Vesper Sparrow Pheasant Quail Robin Bluebird Cardinal Indigo Bunting Goldfinch Woodcock Kinglets	Pilot Blacksnake Blue Racer Black Racer Queen Snake Garter Snake Northern Ringneck Snake Ribbon Snake American Toad Fowler's Toad



PLANT AND ANIMAL RELATIONSHIPS—Cont'd

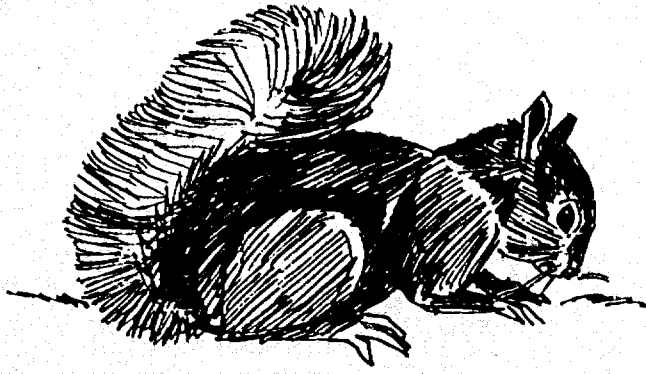
NAME OF COMMUNITY	TREES & SHRUBS	HERBACEOUS PLANTS	MAMMALS	BIRDS	OTHER ANIMALS
Woodland Border (Over 15 yrs.)	White Ash Slippery Elm Blue Beech Red Maple Honey Locust Black Locust Box Elder Hop Hornbeam Blackberry Raspberry Wild Rose Poison Ivy	Spring Beauty Hepatica Bloodroot Phlox Bluets Rue Anemone Adder's Tongue	White Footed Mouse Raccoon Red Fox Gray Fox Eastern Chipmunk Fox Squirrel Red Squirrel Skunk Opossum Deer Groundhog	Song Sparrow Robin Wood Thrush Hermit Thrush Scarlet Tanager Prairie Warbler Northern Yellowthroat Yellow Warbler Red-eyed Vireo Cardinal Bluebird Indigo Bunting Goldfinch	SAME AS ABOVE
Oak-Hickory	Red Oak White Oak Black Oak Shagbark Hickory Chestnut Oak Bitternut Hickory Mountain Laurel Rhododendron	Wintergreen Partridge Berry Lady's Slipper Rattlesnake Plantain Trailing Arbutus Pipsissewa	Gray Squirrel Short-tailed Shrew Raccoon Eastern Chipmunk Red Fox Gray Fox Skunk Opossum Deer	Rose-breasted Grosbeak Baltimore Oriole Scarlet Tanager Summer Tanager Robin Wood Thrush Hermit Thrush Cardinal Red-eyed Vireo Flycatchers	Northern Fence Lizard Copperhead Timber Rattlesnake
Beech-Maple Forest	American Beech Sugar Maple Red Maple Black Maple Hop Hornbeam Blue Beech Black Cherry Slippery Elm White Ash Dogwood	Beech-drops Bellwort Cardinal Flower Solomon's Seal Adder's Tongue Trillium Bittercress Harbinger-of-Spring Greek Valerian	Gray Squirrel Red Squirrel Fox Squirrel Eastern Chipmunk Raccoon Red Fox Gray Fox Opossum Deer Skunk	SAME AS ABOVE	SAME AS ABOVE

PLANT AND ANIMAL RELATIONSHIPS—Cont'd

NAME OF COMMUNITY	TREES & SHRUBS	HERBACEOUS PLANTS	MAMMALS	BIRDS	OTHER ANIMALS
Glacial Relic	Eastern Hemlock Canadian Yew Yellow Birch Black Birch	Partridge Berry Bunchberry Indian Cucumber Root Club Moss	SAME AS ABOVE	SAME AS ABOVE	SAME AS ABOVE
Swamp	Willows Swamp White Oak Bur Oak Buttonbush Silver Maple Red Osler Dogwood	Swamp Buttercup Marsh Marigold Skunk Cabbage Monkey Flower Jewelweed Cattails Nettles	Raccoon Opossum	Louisiana Water Thrush Northern Water Thrush Marsh Wren Winter Wren Wood Peewee Phoebe Yellowthroat Prothonotary Warbler	Massasauga Rattlesnake Spring Peeper Chorus Frog Cricket Frog Wood Frog
Ponds and Lakes	Willows Cottonwood Sycamore Boxelder	Cattails Water Lily Coontail Wild Iris Arrowhead Duckweed	Muskrat Mink Raccoon Beaver	Rails Coot Diving Ducks Puddle Ducks Great Blue Heron Bitterns Swallows Green Heron	Leopard Frog Pickerel Frog Bull Frog Green Frog Large Mouth Bass Sunfish Bluegill Lake Trout Perch
Running Streams	Willows Cottonwood Sycamore Boxelder	Water Willow Watercress	Muskrat Mink Raccoon Beaver	Kingfisher Puddle Ducks Great Blue Heron Bitterns Green Heron	Bull Frog Green Frog Crayfish Small Mouth Bass Green Sunfish Suckers Darters Brook Trout Rainbow Trout

## MAMMALS OF THE OHIO COUNTRYSIDE

### The Tree Squirrels



Squirrels are frequently seen by many park visitors while other mammals are not; this is because squirrels are diurnal animals (ones that eat and play during the day instead of at night) rather than nocturnal which most animals are. Squirrels were of great importance to the early settlers of Ohio. They were a very important food item and also a tremendous pest to the crops and gardens of early farmers. Then there were many times more squirrels than there are now. Bounties were paid on squirrels and so many squirrel scalps had to accompany your taxes or you were fined. During the early 1800's a good hunter could kill a thousand squirrels on a good day and almost anyone could bag a hundred a day. Mass hunting parties eliminated thousands and thousands of the animals.

The "acrobat of the treetops" is a small to medium sized animal, depending on what type of squirrel it is. They live mainly in hollow trees which they enter through small holes. Some squirrels spend the summer in a nest made of leaves and anchored high in the branches. They eat just about any type of fruit or seed, but nuts are their favorite food. Behind nuts come various fruits, seeds, fungi, tree sap, bones, insects, and an occasional bird egg in their diet. They often store and dry many mushrooms in tree forks. In spring they cut into the bark of maple trees and drink the sweet sap that flows out. When squirrels are in the trees their only enemies are hawks and owls, and in the north—the marten, but on the ground they are easy prey for many animals.

Unknown to most the squirrel is not as perfect a tree climber as he usually seems to be; infrequently he slips falling many feet to the hard ground below. He can absorb a great amount of shock and almost invariably is back in the tree a second or two after his fall. His big bushy tail, one of his best characteristics, serves several purposes: a parachute, a rudder, an umbrella, and a blanket. His means of defense include flattening out on a limb so that he is invisible from below, keeping on the opposite side of a tree trunk from his enemy, hiding in dense foliage, and making a dash to his den tree.

In spring anywhere from one to nine young are

born after a 45 day gestation period. The babies are blind and naked and are helpless for about two months. After this they begin venturing out into the world and feeding on seeds rather than milk. The average squirrel lives to be about five years old, with 10 years being very old.

The following are the kinds of tree squirrels found in Ohio. The Flying Squirrel (10" —  $\frac{1}{4}$  pound) is the smallest of the four and is nocturnal being active only at night. He is brownish in color with a pale belly. He has flaps of skin between his front and hind legs and with these is able to "glide" from one tree to another — he cannot "fly".

The Red Squirrel (14" —  $\frac{1}{2}$  pound) is by far the noisiest of the four, as he is almost always heard before he is seen. His loud staccato call noisily exposes any intruder in his domain. He is reddish with a white belly and is much brighter in the summer than in the winter. By far the most unsociable of the squirrels, he usually lives alone. Sometimes he lives in tunnels he digs in the ground rather than in hollow trees. "Reddie" is well known for his food caches — sometimes he has several bushels of nuts in a hollow tree or stump — and for his habit of being a pest by liking to live in attics.

The Gray Squirrel (20" —  $1\frac{1}{2}$  pounds) is the one that was so common when white man came to Ohio. He prefers living in the large forests that once covered Ohio and has declined with their decline. His mass migrations when food becomes scarce are characteristic of grays. His coloration varies from gray marked with fulvous to black, but he always is recognized by having his tail bordered with white hairs. He is the most social of the squirrels (several often live together) and is usually the one found in city parks.

The Fox Squirrel (25" —  $2\frac{1}{2}$  pounds) is the largest of our squirrels and the handsomest. He prefers living in scattered woodlots in agricultural country. The fox squirrel has a larger range of coloration variations than most other mammals—from white to yellow to red to black; normally he is a rusty red color. He is recognized by having his tail bordered with fulvous hairs. The fox squirrel is the awkwardest climber of the tree squirrels. He buries every nut separately rather than caching them in one spot.

### The Raccoon

This ringed-tail, black-masked bandit is common throughout Ohio and all of the United States except for some mountainous and desert areas in the Rockies. The raccoon, or "coon" as he is more commonly called, makes his home wherever he can find the necessary food and shelter whether it be wilderness, farm land, forest, or the center of a metropolis. A woods with a stream running through it or a swamp in it is the number one home choice of the coon. A hollow tree is the preferred spot for a den, but fissures and cracks in cliffs, drainage tiles, abandoned groundhog holes, old barns and buildings, and deserted machines and vehicles are often used.

Raccoon comes from the Algonquin Indian name "arakunem" — one who scratches with his feet — referring to the coon's habit of turning over rocks while



looking for crayfish. Unknown to most people a raccoon has several noises he makes, ranging from a fierce squall to a contented cat-like purr.

Omnivore (eating all) describes his diet as he feeds on both plants and animals. Crayfish and corn are the biggest items in his diet but berries, fruits, nuts (acorns especially), insects, snails, worms, frogs, fish, eggs, birds, and young mammals are frequently eaten. A 'coon is a great glutton, sometimes stuffing himself so much that he has difficulty returning to his den, especially if it's high in a tree. A raccoon is probably more widely known for its habit of washing its food before eating than anything else; in fact his scientific name "lotor" means "the washer." If water is readily available a coon will wash his food before eating it, but he won't go out of his way to wash his food. Actually the feeling among naturalists is that he isn't washing his food but enjoys playing with it and feeling it under water with his sensitive fingers.

A raccoon could be described as a medium-sized animal weighing from 10 pounds in the south to 25 pounds in the north (15 is average for Ohio) with a record weight of 49 pounds. He has long thick grizzled fur, prominent ears, and five long toes on his human-like hands and feet. Coloration varies from yellowish, brownish, grayish, to blackish, being darker on the back and lighter on the belly. A white face bears a black mask and the bushy tail has four to six black rings. The cream-colored, pink-eyed albinos are not uncommon but the all black forms are quite rare.

A "ringtail" is a creature of the night seldom venturing out in the daytime unless it is a few steps to a limb for a good sunning. His long toes make him an excellent climber in any tree — big or small. He goes up rapidly but comes down much slower, head or tail first. He can go straight up the side of a barn if necessary. In cold climates the 'coon sleeps most of the winter, waking up and feeding only on warm days. This is not a hibernation because the animal is not metabolically depressed; he is only taking a long sleep.

January and February are the mating season for raccoons. One male will mate with several females, but each female will only accept one male. After a 63 day gestation period the three to six blind, but fully furred, are born in March and April. After three weeks

their eyes are open and in two months they are out roving with their mother. Mother is a very devoted parent, teaching her young how to hunt, capture food, climb, and how to escape from their enemy — the dog — by wading creeks, walking logs, going through tree tops, and knowing where all the places of safety are. Father usually never sees his youngsters. The young stay with the mother for a full year.

Fall is the time of peril for raccoons for that is the time men with their dogs and traps go after the raccoon for sport and his pelt. The thick heavy fur is much used by coat manufacturers. The price per pelt has varied from \$15.00 to \$.25 in recent years. The strong crafty 'coon is no easy prey though.

A 'coon makes a wonderful pet when young, but the older he gets the rougher and meaner he becomes.

### The Skunk



Because of his unusual method of defense, the striped skunk is one of our best known animals. Common throughout all of Ohio, the skunk lives in every part of the United States. Occasionally found in any habitat, the skunk prefers to live in grassy or weedy fields, along brushy fencerows and ditches, and in the margins of woods. His actual den is found in a hollow log, in an underground burrow (either one abandoned by a woodchuck or one that he has dug himself), or under the floor of a barn or other building. The skunk is one of the animals that has increased since white man came as he is more suited to an agricultural life, than one in the deep forest.

The skunk or "polecat" as he is sometimes called is a stout-bodied, cat-sized animal weighing from four to 10 pounds with a small head and large bushy tail. He has poor eyesight, but good hearing and smelling. He cannot climb, but is a fair digger; he hates water but can swim if necessary. Normally he is voiceless, but he growls and barks when mad. A skunk's coloration varies considerably. The normal pattern is a white stripe on the head, a white stripe on the bushy tail, and two stripes down the back which join near the shoulders. This varies to animals with only a white spot on the head and one on the tip of the tail and at the other end to animals with one broad stripe from



the nose to the tip of the tail. Extreme variants of all black or all white forms are sometimes found.

The skunk usually hunts all night and sleeps all day. During cold winter spells he goes into a semi-hibernation in his den. His food consists mainly of insects and mice. Sometimes he will eat berries and fruits, carrion, eggs, birds, toads, snakes, or whatever small animal he can easily capture. His infrequent raids on poultry houses have earned him a bad reputation. No other animal unless it is starving will prey on the skunk, except the great horned owl which frequently does.

Mating occurs in February and March. After an eight week gestation period three to eight (usually five or six one-half ounce, blind, hairless, toothless, and earless young are born in a grass lined underground nest. After a month the babies resemble tiny skunks and in another month they are ready to begin exploring with mother. The young stay with the female until that fall or the following spring. In their semi-hibernation the young are the first, then the females, and finally the males to retire until warmer weather. A young skunk may sleep for three months while an old male may only sleep a week or two.

Basically a skunk has a very pleasant disposition and only uses his "secret weapon" when cornered or attacked. The actual musk is a yellowish-green phosphorescent liquid produced in two scent glands, one on each side of the tail, carried through a tube, and controlled by a nozzle on the end of each tube. When angered enough to use his weapon, the skunk normally turns his body in a U-shape and squirts a spray or fine stream of liquid towards his enemy's eyes. The spray is very accurate up to ten feet and can be carried as much as a hundred yards by the wind. On a warm, moist night the odor may be noticeable for two or three miles and sometimes lasts several weeks. Except for being extremely nauseating and causing temporary severe burning if the spray contacts the eyes, there is no ill effect from being "skunked." The skunk can operate both nozzles or one independently; they can be used up to five times a day. Usually the skunk will stamp his front feet alternately, click his teeth, hiss or growl, and raise his tail straight up as warnings before he sprays. The tail is erect and stiff when the spraying occurs. The animal is very clean and never soils his fur with his own spray.

Contrary to popular belief, there is *no* safe way to hold a potent skunk. If you are unfortunate enough to be sprayed by a skunk, there is no way to remove the odor. Soap and water are useless. A solution of oil of bergamot and oil of citronella will effectively cover up the skunk odor temporarily. Clothes can be cleaned by washing them in gasoline or in ammonia.

A simple "deskunking" operation transforms the skunk into fine, affectionate, gentle pet. Though seldom seen, skunks are permanent residents of all our metropolitan parks.

the groundhog slowly wakes up from his long winter sleep and ventures outside his den. If the sun is shining and the groundhog sees his shadow, then he quickly hurries back into his den for six weeks more sleep because there are another six weeks of cold, snowy win-



ter yet to come. However, if the sky is cloudy and he does not see his shadow then he awakens fully and begins his season's activities, for the rest of winter will be mild. Actually Groundhog Day is an old legend that has no truth to it whatsoever. Groundhogs from the southern part of the country never hibernate, those from the far north don't awaken until April.

Groundhogs were very scarce when the white man first settled Ohio. They are an animal of agricultural lands, not a forest species. With the clearing of most of the forests and their conversion to agricultural lands the groundhog prospered. They prefer living in open fields and meadows, in slightly rolling country. Fence rows and brushy areas near the green fields are the preferred den spots. Dens or holes are elaborate home sites. The animal does all the digging with his front legs, using his teeth to chew through roots and to dislodge stones. The home has from one to four entrances. The main tunnel is usually about six feet deep and up to 50 feet long. Off the main tunnel, there may be as many as six chambers, most of which are closed at the far end. Definite uses are assigned to each of the chambers, a bedroom, a living room, a nursery, or a toilet. Often the sleeping quarters are heavily lined with dried grass. Being a neat housekeeper, there is always a mound of fresh dirt at the main entrance to the groundhog's home. This is an excellent way of telling whether a groundhog occupies a hole system, or whether it has been deserted for rabbits, skunks, or opossums to move in.

Grasses and juicy green plants make up the woodchuck's diet. Clover, alfalfa, bean and corn plants are his favorites. Very seldom does he ever eat any woody or animal material. For safety the animal very seldom feeds more than 100 yards from his den. They are most active early in the morning and late in the afternoon, but can be seen occasionally at any time of day. The woodchuck is constantly looking for danger while he feeds; every few minutes he stands up on his hind feet and carefully looks and listens in all directions. Besides

### Groundhog or Woodchuck

This mammal is best known because of his "ability" to predict the weather. On February 2, Groundhog Day,

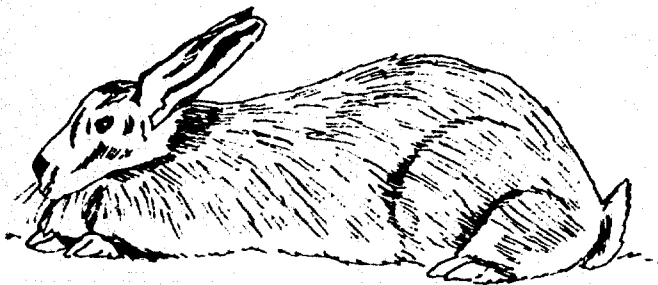
man, he has few enemies. A fox, coyote, or wildcat might catch an occasional 'chuck, but diseases and parasites are his major enemies.

As far as man is concerned the groundhog is of considerable economic importance. Many cows and horses have broken legs by falling in his dirt holes, much farming equipment has been damaged by striking his mounds of dirt, and his feeding consumes many crops and garden plants causing tremendous cash losses. On the positive side, his usefulness lies in that his abandoned holes provide safety shelters for many animals and in certain areas his meat is often used as a major food source.

Unknown to most people the groundhog is really a member of the squirrel family, the largest living in Ohio. He is a fair climber and can climb the tallest tree he encounters. Calling him a heavy bodied, short legged, short tailed, yellowish, reddish, or blackish brown animal sometimes with a frosted appearance, weighing five to 10 pounds, and being 20 to 27 inches long is a good description of a groundhog. His range includes all of Ohio and most of the eastern United States; in the west his cousin the marmot replaces him. One to nine (usually four or five) blind, naked young are born in April after a four-week gestation period. About July they leave home and dig their own burrows.

In late summer the woodchuck really stuffs himself and becomes very fat in preparation for his hibernation. In Ohio this is from October to February. The animal curls himself into a tight ball and goes into a deep sleep. His heart beat and breathing rate fall to about two or three a minute. His temperature may fall to 40°. He knows nothing that is happening about him; other animals may be sharing his den. In fact he is just barely alive. But come the warmth of spring and he slowly awakens, weighing less than half what he did when he went into hibernation. Now he will travel far and wide hunting a mate before he feeds again. His shrill call has earned the groundhog or woodchuck the nickname of "whistling pig."

### The Cottontail Rabbit



Familiar to everyone, the rabbit is one of the commonest mammals in Ohio. He lives everywhere, from the

heart of metropolitan cities to the remote wilderness. He eats a greater variety of plants than any other North American mammal. In summer his diet is about half grasses and sedges and half herbaceous plants, with clover being his favorite food. In winter his diet is twigs, bark, and whatever buds he can reach. In summer rabbits often are pests in vegetable gardens, but they cause much worse damage to orchards in winter by eating bark and thus killing the trees.

The rabbit may be described as a small mammal 10 to 20 inches long, weighing two to four pounds, with the female being slightly larger. He has grizzled brown fur, long ears, big dark eyes set way back on his head, a cotton tail, a twitching nose, and a white belly. Rabbits have the large incisors typical of rodents, but have four in the upper jaw instead of two as the true rodents do. For the most part rabbits are nocturnal animals, feeding and playing at night, but occasionally wander about during the day. Dusk and dawn are the most active times.

Normally the rabbit spends the day in a nest or "form", a slight depression dug about nine by six inches by ½ inch deep with some grass blades for a roof. This is always in an area where the rabbit blends into the background very well. His main defense is freezing and remaining absolutely motionless in his form, when danger is near. If danger approaches too closely then his swift, erratic run will take him to a nearby shelter - a brushpile, briar patch, or abandoned groundhog hole. Rabbits can be fierce fighters, kicking violently with their hind legs, when cornered.

The bunny is preyed upon a great number of predators, including snakes, weasels, foxes, owls, wolves, mountain lions, and many more including man. In fact he is the biggest game animal in North America and in many areas is an important food source for people. Many predators would perish during the lean winter months if it weren't for the rabbit.

When the time for the female to have her baby rabbits nears, she selects a site and digs a nest about six inches deep. This she lines with grass and finally she plucks fur from her chest for the inside lining. Often the young are born while the mother is away from the nest; she merely picks them up in her mouth and carries them to the nest. She doesn't stay at the nest but is always nearby, guarding it. Only at night does the mother return to feed her young, and then only at dusk. At first the babies are blind, naked and helpless, but they develop rapidly and in two weeks leave the nest and venture into the world on their own.

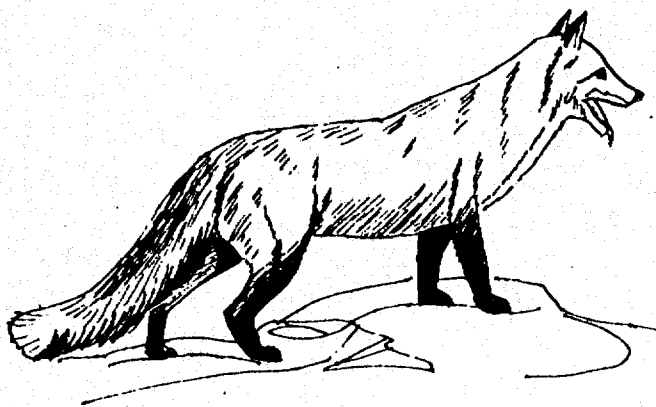
A tremendously high birth rate and in balance a very short life characterize the reproductive habits of this animal. Only one rabbit out of twenty ever reaches his first birthday - three years old is almost unheard of for a wild rabbit. During this short life the average bunny never gets more than a half mile from the spot where he was born. The following gives the rabbit his high birth rate: a short gestation period of only 30 days; a litter size of up to eight, with five being the average; an eight or nine month breeding season here in Ohio; the fact that the young are mature and breeding at five months; and that the female breeds the same day her young are born. All these factors combine to



give the rabbit a birth rate so high that one pair of rabbits in five years can produce a total of 322,000 offspring. However, on the negative side of the balance predators, rains, and dampness, and farming operations kill one out of three of the babies before they ever leave the nest; predators, diseases, and accidents soon take their toll wiping out the other two-thirds. Thus at the end of the year, a territory ends up with approximately the same number of rabbits that were there when the year began.

Rabbits are among the commonest mammals in our parks — watch for them, especially at dusk or dawn.

## The Fox



Foxes are animals of extreme cunning and slyness. They have existed and even increased their population, despite man's constant struggle to kill them either for their fur or to reduce the amount of game and farm animals which they kill. Fox fur is valuable, especially the northern pelts. An average skin would bring \$20 a few years ago, but the price declined to a low of about \$.50 but has recovered and now is approaching \$10.00. The highest price ever paid for a single fur pelt was paid about 1920 for an unusual colored fox skin — \$11,000.00.

A fox is greatly overblamed as far as his role of reducing game populations is concerned. He will rob nests and take a game animal if the opportunity exists, but what he takes is a small factor in the number of these animals. He is a good object of blame for the disappearance of game animals, that really is due to lack of food and cover. A few foxes will develop a great liking for the easy pickings of the farmer's poultry house and become a great problem — some farmers losing 300 or more chickens a year.

Foxes are dog-like animals with pointed noses, large erect ears, and a big bushy tail. They feed on mice, rats, rabbits, ground squirrels, ground birds, eggs, turtles, insects, frogs, earthworms, grass, berries, fruits, nuts and carrion. Often they find dead animals and drag them to their dens to eat them. When someone finds their bones, fur or feathers there, he naturally assumes these animals were killed by the fox. Hunting by their keen eyesight, smelling, and hearing;

their quick movements; and by hunting in pairs. Their only enemies, besides man, are wolves, coyotes, bobcats and eagles.

Winter is the barking season for foxes. Their dog-like barks are part of catching a mate. Usually foxes stay mated for life. The pups are born in March and April and are very playful their first summer. Mother and father both help in raising the family and teaching them the ways of life until that fall when the young leave home. Home is almost always an underground burrow; either an abandoned groundhog hole or one that the fox has dug himself.

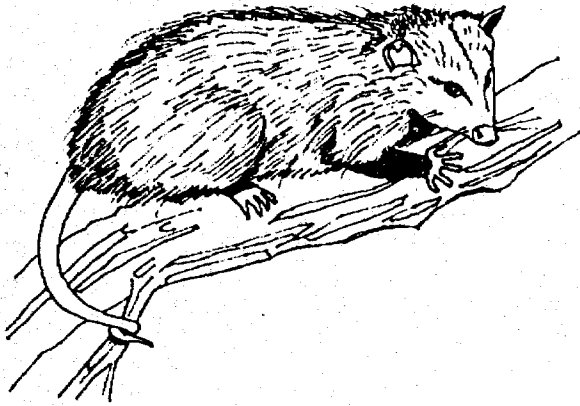
Two kinds of foxes live in the Columbus area: the red and the gray.

Gray foxes are secretive animals of the forests, deserts, and wilderness areas. They are found primarily across the southern part of the United States. As the name implies, they are mostly gray, with a reddish belly and a faint black stripe running down the back from the nose to the tip of the tail. A gray has two to five young after a 63 day gestation period. When pursued he will den (in a hole) or tree quickly and is unpopular with fox hunters. His pelt is worth far less than that of the red fox. The only dog that climbs trees, the gray fox is quite a skilled climber especially if the tree is leaning or has many branches.

Red foxes are animals of agricultural lands living in open and brushy fields and along the edges of woods. They are found primarily in the northern part of the United States. Usually the red fox is a reddish color with black ears and feet and a white belly. Four distinct color variations exist; the normal phase, the black phase (all black), the silver phase (black with white tips on all the hairs giving the animal a silver appearance), and the cross phase (reddish with a black cross on his back). All the red fox phases can be recognized and distinguished from the grays by the fact that red foxes all have a white tip on their tails. The reds have five to 10 young after a 51 day gestation period. Unlike his smaller gray cousin the red fox is very playful and enjoys a good chase. When pursued by hounds he will run for hours employing several tricks to outfox his pursuers. Only when extremely desperate will the red attempt to find shelter. He will walk logs and rail fences, wade creeks, back track, criss-cross his trails, and circle around. Then from a good vantage point he often will watch the confusion he has caused among the dogs. Many will befriend farm dogs and often will playfully chase cows, horses, or deer. Also unlike the grays they will cache any extra food they have instead of letting it spoil. Both types of foxes are found in our parks. They see you but how often do you see them?

## The Opossum

Common throughout the central Ohio area, found even in the midst of heavy residential sections, the opossum is probably observed by more people than any other medium size animal with the possible exception of the cotton-tailed rabbit. Not so many years ago the opossum was a native of the southeast, but it has now moved as far north as Canada and as far west as Colorado. Possums of our area are frequent victims of frost-



bite of the ear margins and tail. Being able to adapt to different climates would be about the only superior quality of this animal — a moron among mammals.

As part of the work done on cranial capacity by the U.S. Biological Survey, the number of beans required to fill the brain case of various animals was checked. A comparison of opossum to red fox revealed: opossum — 21, and Red Fox — 198. Although the opossum may be a “bean brain,” he roamed the continent with the dinosaurs seventy to one hundred million years ago. This pouched marsupial has changed appearance very little over all this time.

In 1612, Captain John Smith described the opossum as follows: “An opossum hath a head like a Swine, a tale like a Rat, and is the bigness of a cat. Under the belly she hath a bagge wherein she lodgeth, carrieth, and sucketh her young.” The common name opossum comes from the Algonquin Indian term *apasum*, meaning “white animal.” Its colors include yellow, black, cinnamon and albino.

Fifteen to forty acres of land including woods and water, with swamps and wet bottom land as special favorites, make up the home range of a 'possum. He will take up living quarters in any area, not particular as to den site. Unused or vacated burrows, leaf nests of squirrels, tree cavities, caves, or discarded overstuffed furniture are all attractive to Mr. 'Possum. Dried grasses and leaves to line the nest are carried in the opossum's prehensile tail.

Local 'possums bear their young once a year, in March or April. At the end of the shortest pregnancy of any North American mammal, 12 and  $\frac{1}{2}$  days, five to sixteen small, hairless young are born. Scarcely two-thirds the size of honeybees, sixteen or seventeen of the young could fit comfortable into a tablespoon! After birth, the young find their way into the mother's fur-lined pouch, where they become firmly attached to their milk source.

After two months, the young are covered with a coat of fine fur and the eyes are open. At this time they leave the protection of the pouch and climb around mother's back, or even more adventurous indi-

viduals will try their skill among tree top branches. At the end of the third month the young are on their own, and are mature by the following February.

The 'possum, a solitary silent animal, spends the daylight hours asleep in its den site. With the coming of darkness the 'possum sets off in search of food. He is not particular about eating, and anything that crosses his nose, either animal or vegetables, dead or alive, is fare for the evening. (As long as the meal is not larger nor half as aggressive).

Natural enemies are comparatively few compared to most animals due perhaps to the repellent odor secreted from musk glands and the well known trait of “playing possum.” It is a generally accepted fact that this act is not deliberate but an automatic reaction caused by shock. Although pelts are not of any great value, 'possum ranks sixth among fur bearers due to the larger number taken by trappers and hunters.

The 'possum is a permanent resident of our Metropolitan Parks. Look for him when you are next on the park trails.

Reprinted courtesy of Columbus Metropolitan Park Board

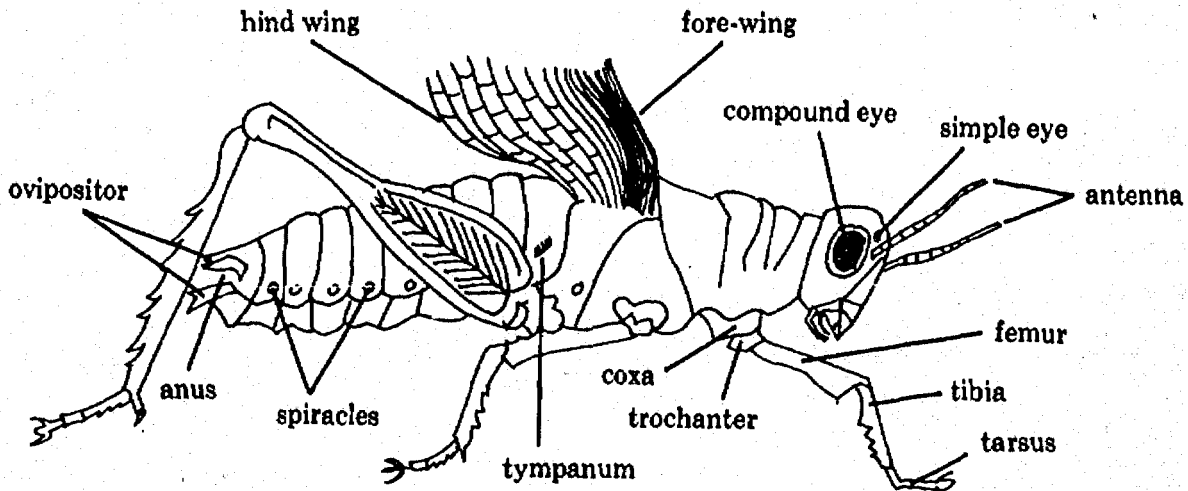
## DISTINGUISHING CHARACTERISTICS OF INSECTS

Insects are characterized by:

1. three pairs of legs: This is the most important single characteristic that distinguishes insects from all other Arthropods. Legs are practically always present in the adult stage; however, certain immature stages may be legless, while others may possess more than three pairs.
2. three body regions:
  - head — This region contains six fused segments which bear the eyes, antennae, and mouth parts. It is connected to the rest of the body by a short flexible neck known as the cervix.
  - thorax — The middle section of the body is composed of three segments known from anterior to posterior as the *prothorax*, *mesothorax*, and *metathorax* respectively. Each of these segments bears a pair of legs, and each of the latter two usually has wings.
  - abdomen — The last division of the body is typically composed of ten or eleven segments. The abdomen comprises over half of the entire length of the body and is relatively devoid of appendages.
3. wings: Insects are the only winged invertebrates, and the success with which they have survived is largely due to this characteristic. Insects, however, never have functional wings until they become full-grown adults. No insect has more than four wings, although some orders have only two wings. Many are wingless throughout life.
4. antennae: All true insects have one pair of antennae located on the head. Although these appendages function as a sense organ, they are homologous with legs.
5. spiracles: Unlike higher animals, insects do not breathe through nostrils or the mouth, but through a series of paired holes along the sides of the abdomen and thorax called spiracles. Typically, there are two pairs on the thorax and eight pairs on the abdomen; no spiracles are located on the head.



**PARTS OF AN INSECT**



**TYPES OF MOUTH PARTS**



Chewing



Piercing-Sucking



Siphoning



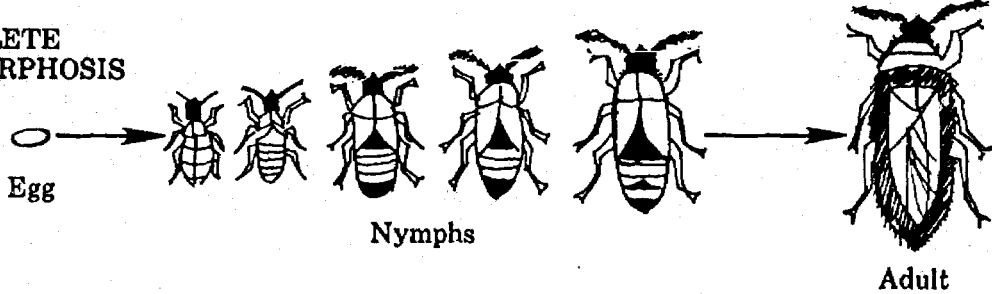
Lapping



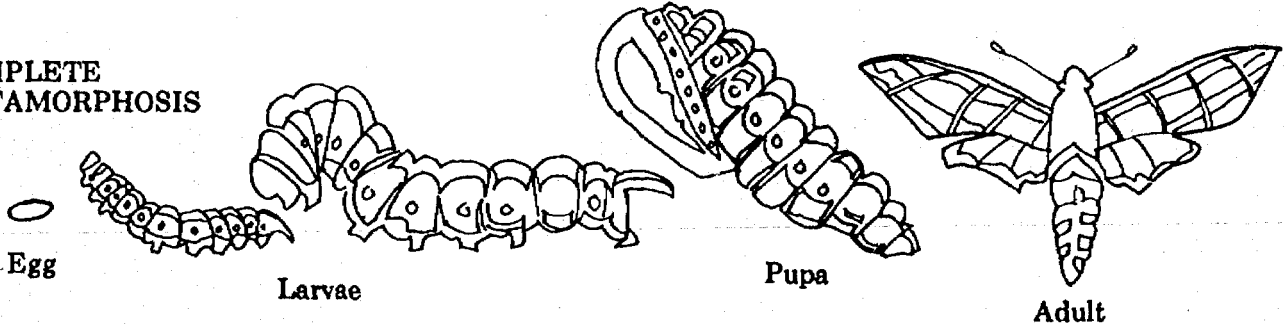
Sponging

**DEVELOPMENT**

**INCOMPLETE METAMORPHOSIS**



**COMPLETE METAMORPHOSIS**



**WILLOUGHBY-EASTLAKE CITY SCHOOLS  
PROJECT P.L.E.A.S.E.**

*Insects and Insect Collecting — Richard S. Phillips*

If you were asked what an insect is, what would you say? A kind of bug. A thing like a spider. A wooly worm. A crawling thing.

Many people have the mistaken idea that only living things with hair or fur are animals, but this is not true. Anything that is not a plant has to be an animal, and an insect is an animal with three body regions, three pairs of legs, and a hard external shell that we call an exoskeleton. An animal with this set of characteristics is an insect. If the creature has only two body regions, but four pairs of legs, it is a spider, a close relative of the insect group.

Insects and their relatives have inhabited the earth for millions of years and they have had plenty of time to change so that now they are adapted to fit into a great variety of habitats. Approximately 800,000 insects have been named and classified, and many biologists feel that there may be as many as 200,000 insects scattered around the world that remain undiscovered and unnamed.

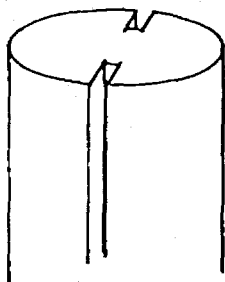
Insects are invertebrates; they lack backbones, and animals of this type have a simple type of nervous system. They are unable to feel pain as we know it. Biologists have observed grasshoppers feeding on leaves as they, in turn, were being devoured by praying mantids.

Boys and girls like to collect things — dolls, pictures of baseball players, rocks, leaves, postage stamps, Indian relics, etc. — and one of the most interesting hobbies you can undertake is that of collecting insects. There is no reason why insect collecting cannot be a lifetime hobby, and it might lead into a life's work. There are many professional biologists who specialize in entomology (insect study). If you are interested in collecting insects the next several pages of this booklet will tell you how to begin and what you will need in the way of equipment.

**How to Make an Insect Collection**

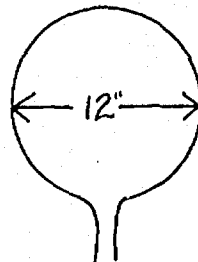
There are three pieces of equipment that are absolutely necessary in the collecting of insects — a net, a killing jar and a box or boxes in which to mount the specimens. All of these may be made at home.

The handle of the net should be between 3 and 4 feet long, no more and no less. It may be made from an old broomstick, or a length of bamboo fishing rod. If you use a broomstick a deep groove should be cut on each side of one end of the stick, like this . . . . .



If you use a bamboo pole, cut off one end of the pole just beneath one of the nodes or ridges that encircle the rod. The center will be hollow and will serve to contain the ends of the wire hoop.

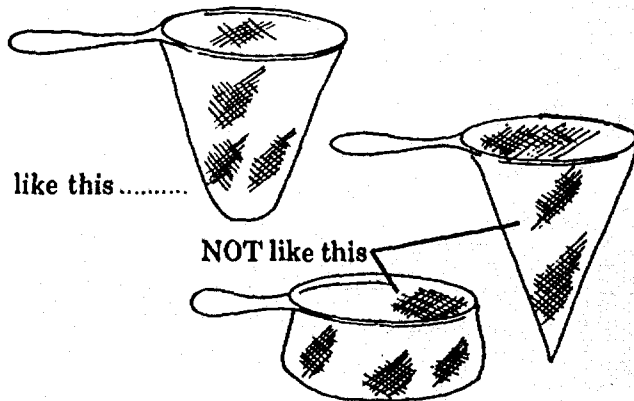
The wire that supports the net should be at least as heavy as the wire of a coat hanger, heavier if possible. The wire should be shaped like this . . . . .



and should be either 12 or 14 inches in diameter. The two straightened ends of the hoop are then placed either in the grooves of the broomstick or down into the hollow of the bamboo rod and bound in place with a good many turns of bicycle or friction tape.

The bag of the net should be made of nylon net or mosquito netting. An old piece of sheeting or a pillowcase will do if they are cut down to the proper shape and size. However, the cloth should be white or green, not red or yellow or some other color that will frighten the insects.

The length of the bag or net should be 1½ times the diameter of the hoop to which it is sewn, and should be shaped . . .



At the lower end it should not be pointed, nor rounded too much, but gently tapered. A quart fruit jar, or a wide-mouthed peanut butter jar, makes a good killing bottle. Into the bottom of the jar pack one inch of cotton. Above this place 1 or 2 rounds of blotting paper, cut a little larger than the interior of the jar. Bend these circles slightly and force them down over the cotton in the bottom. They should completely cover the cotton so that insects cannot get their legs and feet entangled in it.

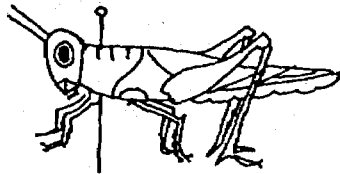
For collections made by students, one of the best killing fluids is lighter fluid. Thoroughly saturate the cotton with the liquid, but do not use so much that it collects in the jar unabsorbed. When not in use, keep

the lid of the jar tightly stoppered. Captured insects are dropped into the killing jar, where they will die within a few minutes. It is a good idea to wrap a piece of adhesive tape twice around the jar and another strip down one side, across the bottom, and up the other side. If you drop the killing bottle, it will not shatter and throw pieces of sharp glass in all directions.

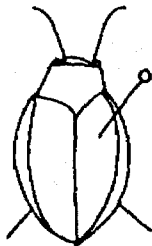
Very excellent insect boxes may be purchased from any of the suppliers listed below. The best boxes are made of wood and are vermin-proof. There are several destructive insects, usually called museum pests, that make their way into collections and feed on dried specimens. Moth balls prevent this, but they must be fastened down, otherwise, in rolling about the box they will break up your specimens or knock them from the pins.

Good temporary storage boxes can be made from candy cartons, in which 24 candy bars are shipped. A heavy piece of corrugated pasteboard should be fastened into the bottom of each box. **THIS MUST BE PASTEBOARD**, not cardboard or blotting paper. Neither of these is thick enough to hold the pins upright.

The thorax is the part of an insect's body immediately behind the head. As a general rule, insects are pinned through this region, like this . . . .



Beetles are always pinned through the right wing cover, like this . . . .

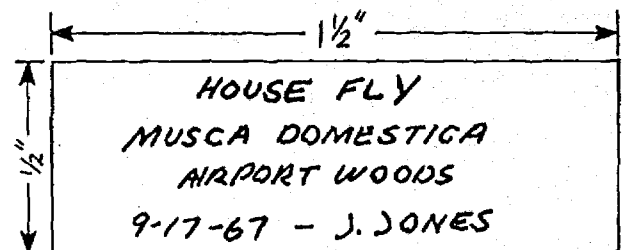


True bugs, members of the order Hemiptera, are pinned just where the wings fold together on the back to form a rough letter X, like this . . . . .



Insects should be placed high enough on the pin so that a label can be attached to the shaft of the pin below the body of the insect. Usually, about  $\frac{1}{4}$  inch of the pin is allowed to project above the insect's body. All labels should be cut to exactly the same size —  $\frac{1}{2}$  inch by  $1\frac{1}{4}$  inches.

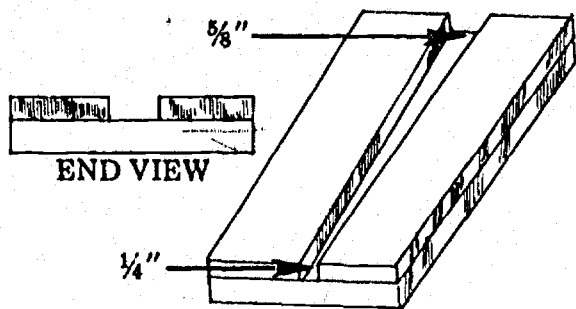
On this label should be printed, with a very fine pen point and in permanent (waterproof) ink, the common name of the insect, its scientific name if you can find it, the date the specimen was collected, the locality where it was collected, and the name of the collector. It is often advisable to include the name of the species of plant on which the insect was found.



In collecting butterflies, it is advisable to kill them inside the net by placing a drop of lighter fluid just behind the head. Better specimens are obtained in this way than by reaching into the net for them and pulling them out. In fluttering about they often break their wings and knock the colored scales from them. Butterflies should not be placed in the killing jar, but should be carried in an envelope. Before being placed in the collection a butterfly must be dried on a spreading board for several days.

A good spreading board may be easily put together from three pieces of wood, one wide board and two nar-

row ones. From the top, a spreading board should look like this, with the groove narrow at one end and wider at the other, to accommodate insects of different sizes.



Strips of paper are placed over the wings, the wings are moved into the desired position, and the paper strips pinned to the board with straight pins. Handling the wings with the fingers will remove the coloring from them. It is better to manipulate the wings with tweezers.

Killing jars, insect pins, nets and display boxes may be purchased from any of the following suppliers of scientific equipment: Coe-Palm, 1126 N. Milwaukee Ave., Chicago 2, Illinois, Carolina Biological Supply Co., Elon College, N. Carolina, General Biological Supply House, 8200 S. Hoyne Ave., Chicago, Illinois.

Here is a list of reference books that will be useful in the identification of your specimens:

*How to Know the Insects*, Jacques, Wm. C. Brown Co., Dubuque, Iowa

*How to Know the Beetles*, Jacques, Wm. C. Brown Co., Dubuque, Iowa

*An Introduction to Entomology*, J. H. Comstock, Comstock Publishing Co., Ithaca, New York

*How to Make an Insect Collection*, Service Leaflet No. 1, General Biological Supply House, 8200 So. Hayne Ave., Chicago, Illinois

*The Insect Guide*, Swain, Doubleday & Co., Garden City, New York

*The Butterfly Book*, Holland, Doubleday & Co., Garden City, New York

*Manual for the Study of Insects*, Comstock, Comstock Publishing Co., Ithaca, New York

#### Key to Most Common Orders of Insects

First be sure that your specimen is an insect. All insects have these characteristics: (1) body of three parts — head, thorax, and abdomen; (2) three pairs of legs; (3) exoskeleton of chitin; (4) breathing tubes called spiracles. Most insects have wings (usually two

pairs), except in immature forms.

Next, determine the kind of mouth parts, whether A or B type, listed below.

Then check the wing characteristics to follow the rest of the key.

#### I. Insects with jawlike mouth parts (biting and chewing).

##### A. Wings unlike in structure and appearance.

1. Forewings hard, covering hind pair of wings which are twice folded.

All beetles, potato beetle, pinching beetle.  
Order COLEOPTERA (shield wings).

2. Forewings heavy, meeting in a ridge over the abdomen. Hind legs fold fanlike. Grasshopper or cricket. Order ORTHOPTERA (straight wings).

##### B. Wings alike in structure and appearance.

1. Wings of nearly the same size and shape.

a. Wings light and gauzy with many fine veins and coarse veins; with no abdominal bristles. Dobson fly, and lion lacewing fly.  
Order NEUROPTERA (nerve wings).

b. Wings heavier, with more prominent veins. Eyes large. Skillful fliers. Usually found near water.

2. Anterior pair of wings much larger than the posterior pair.

a. Wings gauzy with many veins. Held vertically when at rest. Long bristles. Adults lack mouth parts. Short-lived. May Fly.  
Order EPHEMERIDA (for a day).

b. Wings with few veins. Often with stings. Usually with a proboscis-like tongue as well as jaws. Bee, ant, wasp.

Order HYMENOPTERA (membrane wings).

#### II. Insects having tubelike mouth parts (sucking).

##### A. Having two pairs of wings.

1. Both pairs of wings covered with powdery scales, which rub off easily. Moth, butterfly.  
Order LEPIDOPTERA (scale wings).

2. Thin, membranous wings (some forms lack wings) folded horizontally at rest.

a. Front part of forewings hard, membranous at end. Squash bug, stink bug.  
Order HEMIPTERA (half wing).

b. Wings of same material throughout.  
Cecada, plant louse, leaf hopper, scale insect.

Order HOMOPTERA (like wing).

##### B. Having only one pair of wings. Fly, gnat, mosquito.

Order DIPTERA (two wings).



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- Adaptation of Insects*, 13 min., Color, Sterling Films, P.O. Box 8497, Universal City, Calif. 91608.
- Animal Predators and the Balance of Nature*, 10½ min., Color, Journal Films, 909 Diversey Parkway, Chicago, Ill.
- Caterpillar*, Color, Learning Corporation of America, 711 Fifth Ave., New York, N.Y. 10022.
- Death of a Legend*, 50 min., Color, National Film Board of Canada, 680 Fifth Ave., New York, N.Y. 10019.
- The Hidden World*, 26 min., Color, Aetna Life & Casualty, Audio-Visual Services, 151 Farmington Ave., Hartford, Conn. 06115.

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### Filmstrips

- Animals and Their Ways*, A set of nine filmstrips. Eye Gate House, 146-01 Archer Ave., Jamaica, N.Y. 11435.
- Animal Babies and Families*
- Animals Fit Themselves to Their Surroundings*
- Animals of Far Away Lands*
- Animals of Our Continent*
- Animals Pests*
- Animals Struggle to Live*
- Care of Animals*
- Insects and Their Way of Life*
- We Protect Animals*
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- Food from Insects: Story of Honey*
- How Insects Help Plants Grow*
- How Insects Protect Plants*
- Insects and You*
- How Insects Live and Grow*, 51 frames, Color, Society for Visual Education, 1345 Diversey Parkway, Chicago, Illinois 60614.
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*The Honey Bee*  
*The House Fly and Its Relatives*  
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*Insects That Destroy Plants*  
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*Odd Insects the World Over*  
*Some Useful Insects*

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*How Insects Adapt and Survive*  
*How Insects and Birds Care for Their Young*  
*How Insects Eat*  
*How Insects Reproduce*  
*Insect and Plant Partners*  
*Insect Camouflages*  
*Insect Defenses*  
*Insect Hunters and Trappers*  
*Nature's Tiny Scavengers*  
*Predators and Parasites*  
*What Is Metamorphosis?*

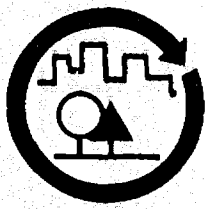
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## Our Native Lands: Conserve and Preserve

The purpose of this study is to familiarize the students with the positive influence plants have upon us and our total environment. It is suggested that this unit be studied in late spring.

While studying this unit, the teacher should emphasize the conservation practices suggested in the text and take as many field trips as possible. On the trips, the children should be permitted to investigate their natural surroundings and think of ways to preserve our natural resources. In class, sufficient background information accompanied by films and filmstrips will be presented to the students, after which general discussions should be held. It is not necessary to cover all the material presented. The teacher is the one who will decide what parts of the unit are important for his class and locality.

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## OUR NATIVE LANDS: CONSERVE AND PRESERVE

### Unit Objectives:

At the end of this unit, the student will be able to

1. describe the pattern of tree distribution according to their soil, topographic and climate requirements.
2. explain how grass helps change and improves the soil and prevents erosion.
3. describe how the adaptive abilities of the wildflowers helps them to spread in almost any environment.
4. specify how the diversity and enormous numbers of wildflowers helps them survive harsh environmental conditions.
5. describe three ways in which people **DEPEND** on renewable resources, such as trees.

### Environmental Experience 1: Grass

#### 1. Introducing the Experience

Have a class discussion.

What is grass? There are many different species of grass, which belong to a group of plants. It includes some organisms which we call weeds. Actually, there is no such thing as a weed. It is a word coined for our own convenience. According to man, a weed is "a plant out of place." Grass is found in every land, growing under almost any condition.

#### 2. Developing the Experience

We use grass in the following ways:

It is used as food for cattle. Cattle need volumes of food, and grass satisfies this requirement. It has nutritional value, is abundant, and is easily grown. Its transportation is no problem, and it can be stored and preserved in a dry condition. We also use grass as a tool against erosion and for improving the soil.

Can the students imagine what cattle would do without grass:

How would our diet suffer? Grass is the most inexpensive commodity on earth.

What do you think it needs in order to grow year after year without any assistance? (Water and sunshine)

How does grass help preserve soil by preventing erosion? (The roots of the grass form a net which binds the soil particles together.)

How does the grass help improve the soil? (The roots break the big chunks of soil into smaller pieces, improving the physical structure of the soil.)

#### Ornamental Use of Grass

Have your students look at homes with beautiful lawns. Are they pleasant to look at? Have you seen houses without grass? Do they look as nice? Would you enjoy having a picnic on bare ground? Think a little. Remember how attractive the expressway looks with a well kept grass medium strip. Do you like it as green as it is?

#### 3. Extending the Experience

Take the students out of the classroom. Visit the school lawn and observe the grass. Investigate its color (does it have water?) and root system, and compare it with



some bare ground cover. Take the class on a field trip to a city or state park, or a cattle farm. On the way, ask the students to pay attention to the surroundings, comparing grassy land with bare ground to determine the aesthetic value of each. Perhaps a farmer or a ranger may answer questions about the value and importance of grass for the farm, cattle, or park. If you are in contact with a ranger, ask him about grassland conservation. What are we doing for preservation of grass? How is grass spread? It would be useful after the trip to show a film about the utilization of grass, some Alpine meadows, or well-kept lawn structures.

#### Additional Activities

- Plant small patches of fast growing grass in various patterns (crosswise rows, lengthwise rows, helter-skelter). At the end of the school year, or at the beginning of the next one, students will see the effect grass has on erosion. Observe how the rain and sunshine influence the growth of grass.
- Plant grass in small pans in the classroom. Place some on the window and some away from the window. Make observations.
- Plant grass on an eroding hillside. Use burlap to hold the seeds in place until the grass is grown. Observe the effects.
- Pull grass plants and examine the root structure. Compare it with the root structure of common weeds. Note any differences. Discuss the impact of grass root structure on soil erosion and soil improvement.

### Environmental Experience 2: Trees

#### 1. Introducing the Experience

In class, with the help of charts, diagrams and books, study some of the internal and external structures of a tree. Study the functions of roots, stems, and leaves.

Study the pattern in which the different types of trees are distributed. One kind of tree will grow around water. Another kind grows on a hill. Still a third group likes rich soil. Emphasize the adaptation of trees. Investigate how many different kinds of trees are spread around the state.



Discuss with the students the relationships of the tree with other plants and animals. There is competition for minerals, water, light, and air. When the tree dies, it decays and supplies other plants with needed minerals. Trees provide food and shelter for animals and man.

Study the dependence of humanity on trees. List the diversity of ways in which we use trees and how a living tree can be of use to us. Products from trees have changed our lives considerably. Discuss it.

### 2. Developing the Experience

Take the class on a field trip to a wooded area or forest (if there is a field with some trees, it can also be used). If a field trip cannot be undertaken, study the school yard or a neighborhood park.

Study the usefulness of a living tree.

Do we use the shade of a tree? Is it really more comfortable to stay in the shade during the summer when the sun is strong? Try to stay for a while under direct sunlight, and then in the shade. Also, trees refresh the air.

What is the usefulness of the tree for soil? Do you believe that trees somehow improve the soil? Check some soil from an open, treeless area and compare it with some soil from a wooded area. The soil in the forest is much better. The trees also control the water. Trees are used to thwart erosion. If you can find a gully without trees around, you will see the results of erosion. Show a stream whose banks are covered with trees. The difference is obvious.

How are the trees valuable for the animal life in the area? Many birds live in the trees, and many small animals are sheltered by the trees. A comparison of bird and animal life, between an open area and an area with trees, will help the student realize the importance of the trees in this regard.

#### Use of Tree Products

Ask: "What do trees supply?"

While a tree is living we use its fruits. Some trees (sugar maple) supply us with syrup. Rubber trees produce rubber, and so on. The students, of course, can give a few more examples.

Trees also supply us with materials for furniture, construction and paper. If there is a paper factory in the area, the teacher should try to take his/her students to visit it.

Can you imagine what our life would be like without the products from trees? Can you imagine what the earth would look like without any trees?

### 3. Extending the Experience

Discuss with the students the length of time it takes a tree to grow. Some trees, like the poplar, become sizable in less than 20 years. Others, like the oak, need more time.

Do you know the oldest living organism on earth? The big redwood trees in California can reach 4,000 years of age. Has anyone seen them? Show some pictures, if they are available.

If time permits, you can discuss with the students how a tree grows in width and height by using a chart from the Forestry Department.

If some students are interested, and if it is possible, take them out to plant a few trees.

## Environmental Experience 3: Wilderness

### 1. Introducing the Experience

Before you discuss this environmental experience, ask the children to read the book, *The Conservationists*, by Douglas H. Strong, published by Addison-Wesley Company. Actually, it is highly advisable to discuss this book in class. Have wildflower illustrations. Have a class discussion.

Ask the following questions:

What is wilderness?

Where do we find it?

What are the components of a wilderness (include plant and animal organisms)?

A wilderness is a natural area with living organisms in it. Plants and animals are included. Did they have to adapt to the present biotic and physical conditions? Are they in a relationship with each other? A suggestion: This paragraph could be used for a creative writing exercise in language arts.

What do you think this country looked like almost five centuries ago when our forefathers first landed on the east coast. What animals were present then in this area that no longer exist?



### 2. Developing the Experience

(Correlate with Social Studies)

Learn something about the history of northeastern Ohio, especially the Western Reserve. Teach the students about the wilderness that existed in this area during the late 18th century.

Take a field trip to a wilderness area. If such an area is not available, take the students to a state or city park, or a neglected area with wild plants and trees. After investigating and observing the area, ask the students the following questions:

Do we have to have wilderness area? Why? (Answers will vary.)

Name some of the trees, shrubs, and wildflowers in the area.

What animals do you think are in this area? In the wild areas of the state?



What is the relationship between these wild plants, animal organisms, and the human population? Does it cost us anything to have and maintain the wilderness areas? What are the rewards for doing this?

Do you like to look at and enjoy the wildflowers? Do you like their colors? (Red, yellow are cheerful colors; green is relaxing and good for the eyes; blue suggests coolness.) Show the film "Miner's Ridge."

### 3. Extending the Experience

Find out what has been done in your area or your state in order to preserve wilderness areas.

What are the state tree and state flower?

Learn, with the help of a field guide, how to identify and classify twenty different trees and wildflowers. Emphasize not picking the wildflowers.

While out on a field trip in the wilderness or park, follow a nature trail. Take pictures. Think of how the trail has been built; study the signs of the trail, ponds, and streams. Look at everything you might encounter on the trail. What changes do you think will take place in the next ten years? The next one hundred years?

Should you build trails through wilderness areas? How is the wildflower adapted for survival? (Low temperature endurance, negligible food and water requirements, diversity, and seed reproduction.)

### Additional Activities

Appoint a group of several students to prepare a report on how to preserve the existing wilderness.

Identify various wildflowers.

Learn which animals have become extinct and why. Learn which animals are becoming extinct or are in danger of extinction. Find out what can be done about the problem. Take action if interest and concern merit this course.

Value Inquiry — read quotation from Old Yeller, by Fred Gipson . . . "killing for meat."

" . . . And right beside them went my doe running all humped up and with her white, pointed tail clamped right to her rump. Which meant that I'd hit her but hadn't made a killing shot."

"I didn't like that. I never minded killing for meat. Like papa had told me, every creature has to kill to live. But to wound an animal was something else. Especially one as pretty and harmless as a deer. It made me sick to think of the doe's escaping, maybe to hurt for days before she finally died."

Discuss or write implication.

What is man's place in the food chain?

(Keep thought sheets throughout this unit. Record students' thoughts about conservation from the beginning to the end. Note changes.)

## Environmental Experience 4: Conservation of Renewable Natural Resources

### 1. Introducing the Experience

What is conservation? Brainstorm about the meaning of conservation.

Conservation is using the renewable resources effi-

ciently and in such a way as to keep them producing for man as long as possible. How do you like the following quotations that are most often used? "Use without abuse," "Wise use of our resources." The teacher must make sure that the students understand the meaning of conservation.

### 2. Developing the Experience

What are renewable resources?

water

plants

animals

Discuss the conservation of the three major renewable resources separately in class. Then, on a field trip, you can observe and follow the successful and unsuccessful conservation practice of man, noting the interrelationship of all three renewable resources.

**Water** — People should try to conserve water by preventing it from running off. If runoff water is not controlled, it can cause soil erosion, create muddy streams, make springs and wells go dry, and cause floods. Ask the following questions:

Can dam building conserve and control the use of water? How do you think planting trees and grass will conserve water and prevent it from running off? (Roots improve the physical structure of the soil, enabling the soil to absorb and retain much more water, which can be used for a longer period of time.) By using correct farming practices, we conserve the soil.

Is that also helping the conservation of water? (Yes, these practices also prevent water from running off.)

Is the demand for water by our nation increasing with the years? Why?

Do we have to be careful in using our water supplies?

Discuss an account of shortage of fresh water in Miami, Florida, or Tokyo, Japan. (current events)

Take a field trip to the water plant or the reservoir that supplies your town. On the spot, ask: How is the water kept clean and purified? What is the source of this water? Does it matter what the geologic structure of the reservoir is? Why? (Some types of bedrock retain water better than others.) Investigate how a sewage disposal plant can assist us in better use of water.

**Plants and Animals** — Take a field trip to a field and wooded area. Through farming and cattle raising, people learn to do a good job conserving usable plants and animals. However, many of our mountainous and wooded areas are in need of improved conservation methods. We have studied in other subjects the use of plants and animals. Let's ask a few questions about their conservation. How are plants, animals, and water related? Does the correct handling and use of one help the other? Plants help the water control and give shelter to wildlife. Give examples. How do animals help the plants in a forest? (In seed dispersal; flesh-eating animals control the herbivorous animals that damage young trees, thinning out certain species.) Investigate fully one square yard of ground in a wooded area. List all the living organisms found: trees, bushes, grass, flowers, insects, and other animals on or in the ground. What will happen to them if a fire breaks out? How do people enjoy natural wooded areas and wild life? (Hiking, camping, bird-watching, hunting, boating, fishing)

### **3. *Extending the Experience***

In order to develop and instill correct attitudes in the students about conservation, ask them to engage in some of the following activities by using a corner of the school lawn:

Plant a few trees, shrubs, or grass in an eroding patch of land, and observe the results. This can also be done with an existing vacant lot after permission is granted.

Make posters showing conservation practices.

Ask the students to write themes and articles for the local newspaper on conservation. Notice whether or not some of the following statements are made:

We must conserve our environment.

We must be careful in the use of our environment.

We must not be wasteful with our environment.

We must be wise in handling our environment.

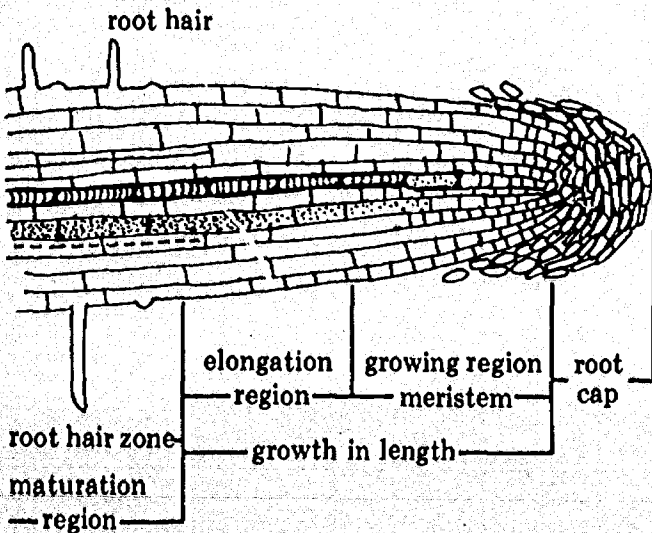
If some of the answers given by the students are clever and correct in meaning, ask them to write them and put them on the wall, using large letters.



## Appendix

### TEACHER BACKGROUND INFORMATION

Roots have a hard callous growth at their tips called a root cap. This helps protect the root as it pushes through the soil. It is pushed with a tremendous force merely by the pressure caused by cells being added behind the root cap. In this way, the root can force its way deep into the earth or even into cracks in rocks. This serves to anchor the tree, but its real function is to grow to a depth where there will be water. The root is the part of the tree which absorbs the water from the soil, along with all the mineral nutrients dissolved in it. This absorption takes place at the root hairs (see diagram). These are long thin extensions of single epidermal cells in the root. Their shape gives the root a great deal more surface area from which it can absorb water. The roots also serve as a storage place for carbohydrates in the winter when the leaves no longer can make them.



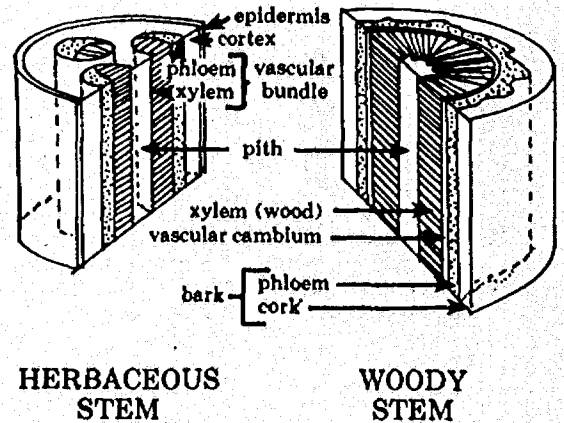
The stem (trunk) of a tree is the structural support and transport center of the plant. The trunk consists of several types of tissue, each with its own function.

On the outside of the tree is the bark. This is composed of two types of tissue: cork and phloem. The cork is the tough outer protective covering of the tree composed mostly of dead cells. Underneath the cork is the phloem. This tissue conducts the carbohydrates from the leaves down to the rest of the plant. If you peel off the bark of a tree in a band all the way around, the tree would soon die because this flow was cut off.

The next layer is the cambium. This is the only place where new cells are added to the width of the trunk (secondary growth). This very thin layer forms cells of the phloem and the wood (xylem). Those

cells formed on the outside of the cambium become phloem. Those formed on the inside become wood.

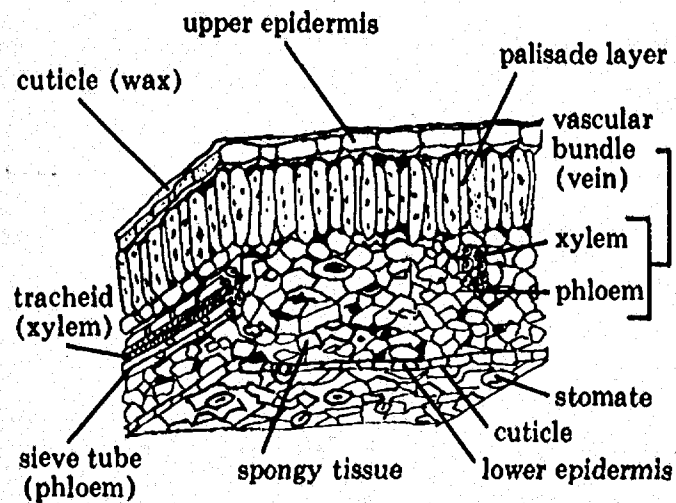
Most of the trunk of a large tree is made up of xylem. The xylem cells are long narrow tubes which transport the water and minerals up to the leaves from the roots. As the xylem cells grow older, their walls harden and thicken. Then, the cells die. These dead cells, which make up most of the wood, work perfectly well as tubes for water transport. The xylem formed in the spring has larger diameter cells than that formed in the rest of the year. This is the cause of the annual rings in the wood.



The leaves of a tree are where the tree produces carbohydrates to supply it with the energy it needs to live. They are produced by a process called photosynthesis. In the leaf, water and carbon dioxide ( $\text{CO}_2$ ) are combined with the aid of chlorophyll and sunlight to make sugar (a carbohydrate). The leaf is usually arranged so it has a layer of cells, called the palisade layer, near its upper surface, which has lots of chlorophyll. In this layer, much of the photosynthesis takes place. Bundles of xylem and phloem, sometimes called veins or vascular bundles, run through the leaf to bring in water and to take out sugar. On the lower side of the leaf are openings called stomata with guard cells controlling their diameter. The carbon dioxide enters through these openings, and water, in the form of vapor, leaves through these holes (stomata). Since photosynthesis does not occur in the dark, no carbon dioxide is needed at night, so the stomata close to prevent loss of water. In the daylight, the guard cells open the stomata to let the carbon dioxide in. The guard cells also help protect the leaf from losing more water than it can be supplied. When a leaf has lost water so fast that it may



wilt, the guard cells close down to retain the water, even at the expense of photosynthesis.



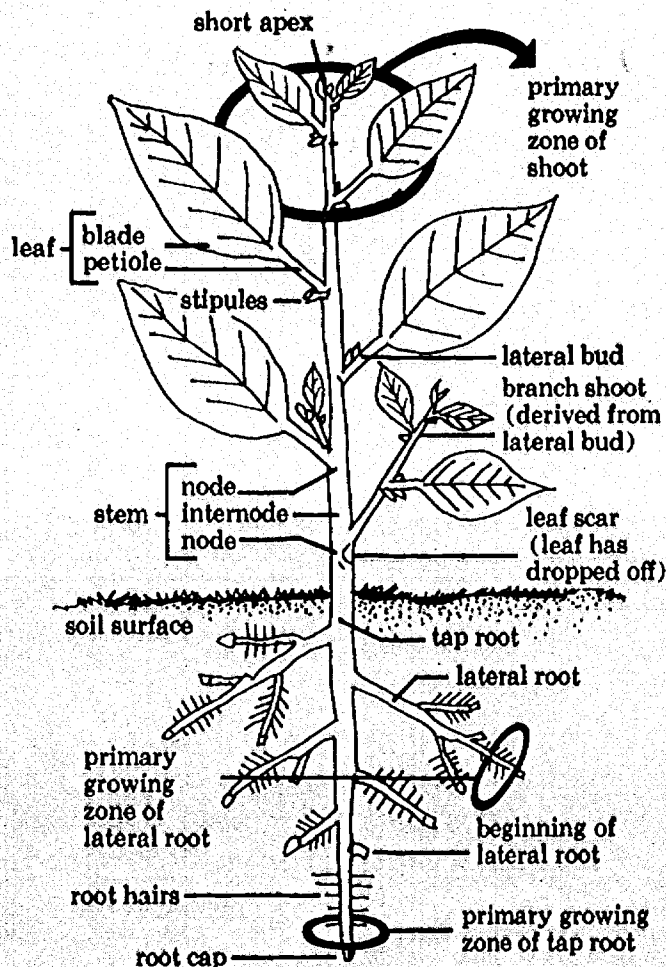
the root and the shoot. Everything that grows down is the root, and that which grows up is the shoot. Both grow in length only at their tips.

Along a twig, which is part of the shoot, leaves grow. The places where the leaves grow are called nodes, and the spaces between are the internodes. At the tip of the shoot is the region of growth called the apical meristem. This is where new cells lengthening the shoot are added. This is also where each leaf is started. Trailing down from the apical meristem is the procambium which a little further along can be seen to become the vascular cambium, which gives rise to the xylem and phloem. This is also the place where the cork cambium originates.

At some nodes there are other apical meristems, called lateral buds. These will give rise to other twigs which will eventually grow into branches. You also will find scars where old leaves had been attached in previous seasons, and if the bark is smooth, you may see small pits called lenticels which are air vents for the young twig.

### Environmental Requirements of Trees

Different trees are best suited to different environments. Deciduous trees (those that lose their leaves in the fall) need some moisture year round, while conifers (evergreens) can get along with only the water from the snow that falls in the winter. Some trees, such as the maple, can grow in areas of deep shade, while others, like the Douglas fir, need full sunlight for growing. Soil conditions vary for different trees. Hardwoods, such as oak, hickory, and maple, grow best in very fertile deep humus soil that holds moisture well. Some trees, like the Ponderosa pine, can survive a drought so severe that it has only the dew of the night upon which to survive. One of the most extreme cases of drought resistance is the Joshua tree which is found only in the hottest deserts in the United States. At the other end of the scale, there are trees such as the cypress which grow right out of swampland. The dryer the soil, the deeper the trees will drive their roots to get water, so Ponderosa pines will have very deep roots while willows and cypress trees have broad shallow mats.



### Conservation of Renewable Natural Resources

Conservation is using the renewable resources—water, plants, and animals—efficiently and in such a way as to keep them producing for man as long as possible. The conservation of these three resources is interrelated. To conserve one properly, man must conserve all three. For example, plants help prevent water runoff and give shelter to wildlife.

Water conservation includes control of pollution, returning used water to the ground for reuse, storing water, and controlling floods.

Plant conservation includes reforestation, wise crop farming, selective planting and other varieties of scientific management.

Animal conservation includes protection of wildlife through hunting laws, control over the availability of food, shelter and cover, and careful methods of refuse disposal.

### SIMPLIFIED SHOOT AND ROOT SYSTEM

#### External Structure of Trees

A tree can be thought of as having two main divisions,

## GLOSSARY

**Alpine meadow** — A grassy meadow above the timberline.

**Conservation** — The use of natural resources in ways which protect and improve them in order to gain the most from them economically and socially.

**Decay** — The decomposition of dead plants and animals into simpler compounds by microscopic life.

**Erosion** — The wearing away of the surface of the land by water, wind, ice, or gravity.

**Extinct** — No longer present in living form.

**Rubber tree** — A South American tree whose sap is used to make natural rubber.

**Seed dispersal** — The scattering of the parts of a plant which contain the embryo (seeds).

**Water plant** — A plant which grows in water. It may float or be completely submerged.

**Wilderness** — A region which is uncultivated and uninhabited.

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Dr. Bertram Masia

Schools participating in the pilot program between October 1, 1972, and February 15, 1973

### Central or inner city:

Cleveland City Schools  
Almira Elementary School  
Charles Dickens Elementary School

### Suburban:

Chagrin Falls Exempted Village Schools  
Sands Elementary School  
Gurney Elementary School  
Chagrin Falls Middle School

Shaker Heights City Schools  
Malvern Elementary School

Willoughby-Eastlake City Schools  
Garfield Elementary School  
(Willoughby Hills)  
McKinley Elementary School  
(Willoughby-on-the-Lake)  
Royalview Elementary School  
(Willowick)

Euclid City Schools  
Glenbrook Elementary School  
Upson Elementary School  
Wells Elementary School

### Rural:

Berkshire Local Schools (Burton, Ohio)  
Burton Elementary School

Jefferson Local Schools (Jefferson, Ohio)

### Non-public schools:

Saint Mary's School (Mentor, Ohio)  
Immaculate Conception School (Willoughby, Ohio)

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