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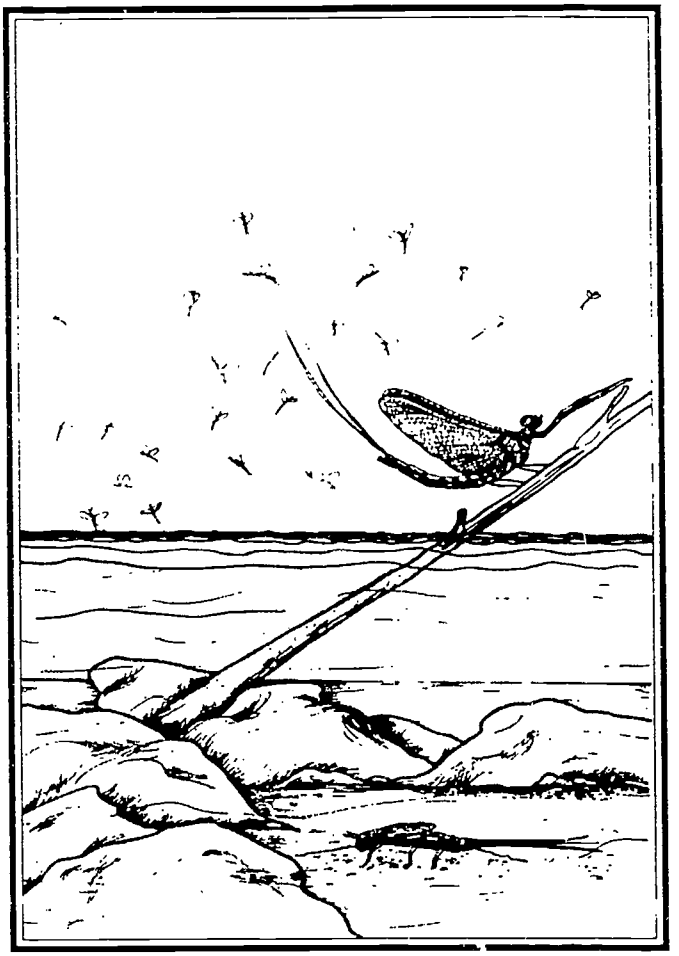
ABSTRACT

This learning packet, one in a series of eight, was developed by the Eno River State Park in North Carolina for Grades 5-6 to teach about various aspects of water life on the Eno River. Loose-leaf pages are presented in nine sections that contain: (1) introductions to the North Carolina State Park System, the Eno River State Park, and to the park's activity packet; (2) a summary of the activities that includes major concepts and objectives covered; (3) pre-visit activities on map trivia and dichotomous classification keys; (4) on-site activities on river flow, pH values, water bugs and river sediment; (5) post-visit activities on water pollution; (6) a list of 69 related vocabulary words; (7) park and parental permission forms for the visit; and (8) blank pages for taking notes. Contains 24 references and includes a separate educator's guide. (MDH)

LIVING WATER



Eno River State Park

An Environmental Education Learning Experience

Designed for the Middle Grades

"Without life, there would still be water. Without water no life."

- David Quammen, Natural Acts, A Sidelong View of Science and Nature.

This Environmental Education Learning Experience
was developed by

Scott Hartley and Martha Woods
Lead Interpretation and Education Ranger and Ranger I
Eno River State Park

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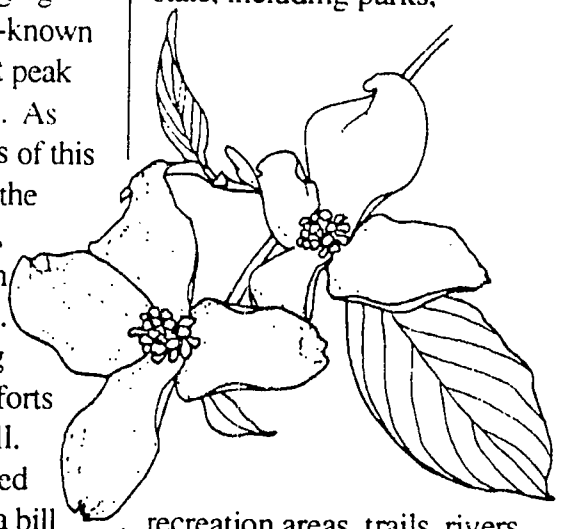
Table of Contents

Introduction to the North Carolina State Parks System

Preserving and protecting North Carolina's natural resources is actually a relatively new idea. The seeds of the conservation movement were planted early in the 20th century when citizens were alerted to the devastation of Mount Mitchell. Logging was destroying a well-known landmark - the highest peak east of the Mississippi. As the magnificent forests of this mile-high peak fell to the axe of the lumbermen, alarmed citizens began to voice their opinions. Governor Locke Craig joined them in their efforts to save Mount Mitchell. Together they convinced the legislature to pass a bill establishing Mount Mitchell as the first state park.

That was in 1915. The North Carolina State Parks System has now been established for more than three-quarters of a century. What started out as one small plot of public land has grown into 59 properties across the state, including parks,



recreation areas, trails, rivers, lakes and natural areas. This vast network of land boasts some of the most beautiful scenery in the world and offers endless recreation opportunities. But our state parks system offers much more than scenery and recreation. Our lands and waters contain unique and valuable archaeological, geological and biological resources which are an important part of our natural heritage.

As one of North Carolina's principal conservation agencies, the Division of Parks and Recreation is responsible for the more than 125,000 acres that make up our state parks system. The Division manages these resources for the safe enjoyment of the public, and protects and preserves them as a part of the heritage we will pass on to generations to come. An important component of our stewardship of these lands is education. Through our interpretation and environmental education services, the Division of Parks and Recreation strives to offer enlightening programs which lead to an understanding and appreciation of our natural resources. The goal of our environmental education program is to generate an awareness in all individuals which cultivates responsible stewardship of the earth.

For more information contact:

N.C. Division of Parks and Recreation
P.O. Box 27687
Raleigh, N.C. 27611-7687
919/ 733-PARK

Introduction to Eno River State Park

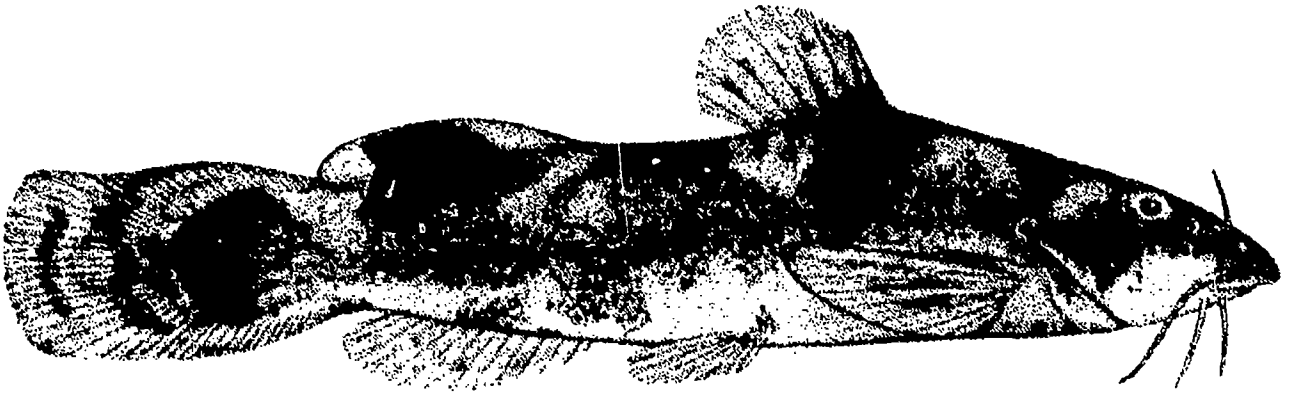
Efforts to establish Eno River State Park began in 1965 when the city of Durham proposed building a reservoir on the Eno. In response, a group of concerned citizens formed the Association for the Preservation of the Eno River Valley. The Association was successful in gaining community support for its proposal that a state park be established along the river. In May of 1972, the state of North Carolina approved the idea, and the city of Durham withdrew its plans to construct the reservoir. By 1975, 1,100 acres of land had been acquired with the help of the Association, the Nature Conservancy and the Division of Parks and Recreation. Today the park protects 11 miles of river and over 2,100 acres of associated land in Orange and Durham counties.

Life In and Along the Eno River

Eno River State Park provides important habitat for a host of animals and plants. A mixture of steep rocky ridges and bottomlands creates several distinct plant communities. Many of the wildflowers and shrubs found in the park are normally found in the mountains and foothills of North Carolina. Shrubs, including mountain laurel and Catawba rhododendron, and wildflowers, such as yellow lady's slipper, showy orchis and wild geranium, find suitable habitat in the river valley. The river hosts 56 species of fish. Two are unique to the Neuse (of which the Eno is a part) and Tar river basins - the Roanoke bass and the Carolina madtom (a catfish).

Freshwater mussels, including the endangered green floater, and numerous aquatic macroinvertebrates, are found in the river. These wonderfully-adapted creatures can be used as indicator species to monitor water quality.

Water quality in the river is presently good. The river is classified as a public water supply and is also suitable for swimming, fishing and wading. Continuing development and water withdrawals upstream give cause for concern about the river's quality. Only through sustained vigilance and protection efforts can the river's water quality be preserved.



Carolina madtom

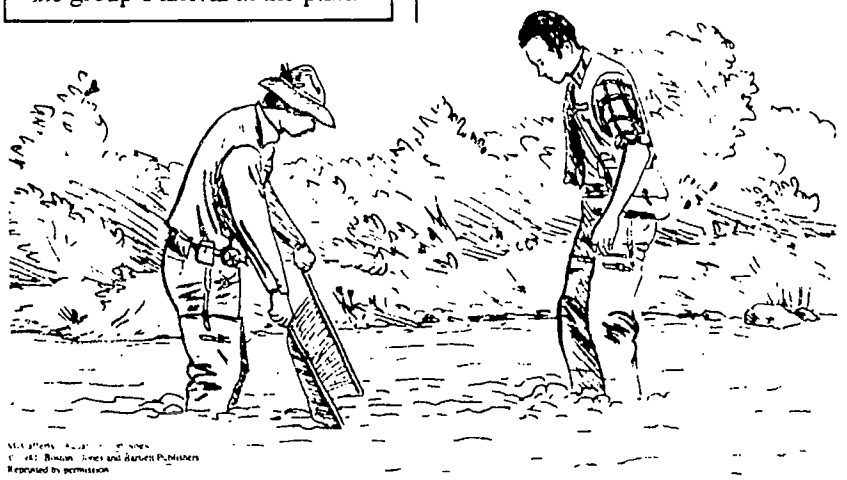
Introduction to the Activity Packet for Eno River State Park

NOTE: On-site activities, weather and river conditions permitting, will be held on the banks of the river and in the river. Students will wade in shallow rocky areas. They should dress appropriately (long pants and tennis shoes) and bring a change of clothing. The students may encounter ticks, poison ivy and snakes, though this is not likely as long as students stay in appropriate areas. Chemical reagents are used in water quality testing. Because misuse of these chemicals can be hazardous, standard chemical protection procedures will be required. Goggles and rubber gloves will be provided for all students handling testing kits. These must be worn at all times during test procedures. The educator will assist in seeing that all safety precautions are followed. It is also the responsibility of the educator to be aware of special considerations, medical needs, etc. of participants and be prepared to take appropriate precautionary measures. Park staff should be informed of any special considerations prior to the group's arrival at the park.

The environmental education learning experience, Living Water, was developed to provide hands-on environmental education activities for the classroom and the outdoor setting of Eno River State Park. This educator's activity packet, designed to be implemented in grades 5 and 6, meets established curriculum objectives of the North Carolina Department of Public Instruction. Three types of activities are included:

1) pre-visit activities
2) on-site activities
3) post-visit activities

On-site activities will be conducted at the park, while pre-visit and post-visit activities are designed for the classroom environment. Pre-visit activities should be introduced prior to the park visit so that students will have the necessary background and vocabulary for the on-site activities. We encourage you to use the post-visit activities to reinforce concepts, skills and vocabulary learned in the pre-visit and on-site activities. These activities may be performed independently or in a series to build upon the students' newly gained knowledge and experiences.



The environmental education learning experience, Living Water, will expose the student to the following major concepts:

- **Water Quality**
- **Indicator Species**
- **Water Testing**
- **Watersheds**
- **Aquatic Sampling**
- **Aquatic Insect Populations**
- **Natural Resource Management**
- **Stewardship of Natural Resources**

The first occurrence of a vocabulary word used in these activities is indicated in **bold type**. Their definitions are listed in the back of the activity packet. A list of the reference materials used in developing the activities follows the vocabulary list.

Activity Summary

The following outline provides a brief summary of each activity, the major concepts introduced and the objectives met by completion of the activity.

I. Pre-Visit Activities

#1 Map Trivia (page 3.1.1)

Using a North Carolina state transportation map, students will be introduced to the concept that the Eno River watershed is part of a larger river system. They will be asked to trace the river from its headwaters to the ocean and to identify key geographic locations.

Major concepts:

- Map use
- Watersheds
- Group participation

Objectives:

- Interpret and use the legends on the North Carolina state transportation map to answer five questions.
- Locate five geographic locations within the Neuse River watershed.
- Participate effectively in groups while answering questions on the worksheet.

#2 Keys Made Easy: Introduction to the Use of a Dichotomous Key Parts 1 & 2 (page 3.2.1)

Introduce your students to the use of dichotomous keys through a series of fun activities. In Part 1, students will use a simple key to identify unknown tree leaves. In Part 2, the students will use a more complex key to identify macroinvertebrates found in the Eno River.

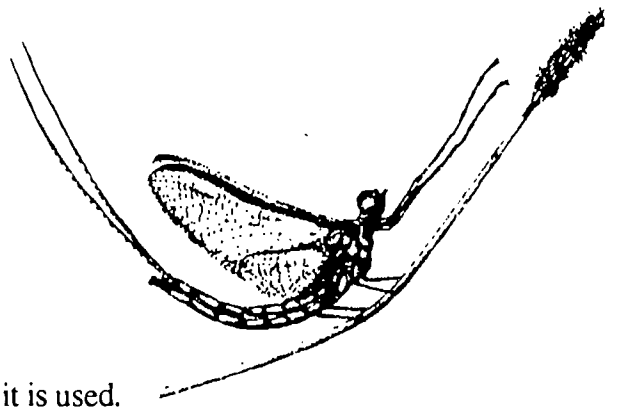
Major Concepts:

(Part 1)

- Dichotomous key
- How to use a key
- Importance of keys for identification

(Part 2)

- Basic taxonomy



Objectives:

(Part 1)

- Define dichotomous key and explain why it is used.
- Use a simple key to identify five unknown tree leaves.

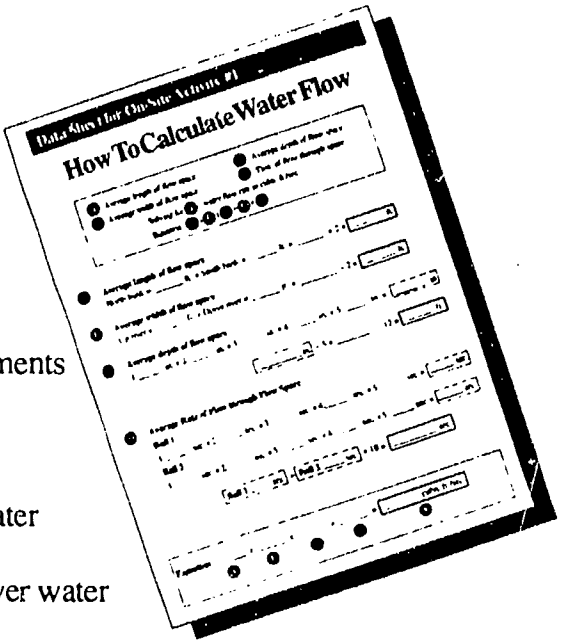
(Part 2)

- Define taxonomy.
- List the five kingdoms.
- Key out at least one macroinvertebrate using a simple dichotomous key.

II. On-Site Activities

#1 Go with the Flow (page 4.1.1)

Get wet while taking physical measurements of the river. Students will use their measurements to calculate water flow in the Eno River.



Major Concepts:

- Measurement of water flow
- Human influence on water flow
- Natural influences on water flow
- How natural and human influences affect aquatic life

Objectives:

- Calculate the rate of water flow using measurements and a mathematical formula.
- List three human actions that affect water flow.
- List three natural influences on water flow.
- Describe the important relationship between water quantity and quality.
- Describe three problems that can result from river water quantity extremes.
- Describe three problems that can result from river water quality changes.
- Discuss at least two things people can do to help protect rivers and water quality.

#2 Mind Your p's and H's - The Power of Hydrogen (page 4.2.1)

Learn to measure pH by using hands-on methods to determine the pH values of several different liquids including water from the Eno River.

Major Concepts:

- Water quality
- pH testing
- pH range (acid-neutral-base)
- pH range that supports aquatic life

Objectives:

- Demonstrate the use of litmus paper and the LaMotte test kit for determining pH.
- Analyze samples to demonstrate pH range.
- List three natural influences which can affect the pH rating of a river.
- List three human influences which can affect the pH ratings of a river.
- Know the North Carolina Environmental Management Commission pH range for aquatic macroinvertebrates.

#3 Sediment: The "S" Word (page 4.3.1)

Through a simple experiment, students will learn one method of measuring sediment. Using what they observe, students will discuss where sediment comes from, how it affects water quality and ways to control sediment.

Major Concept:

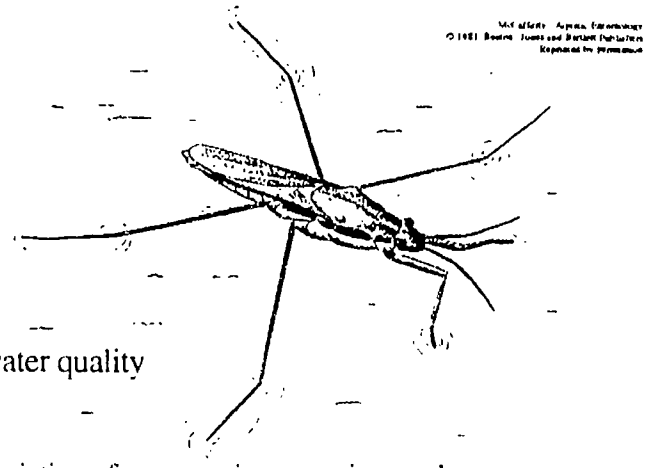
- Water quality
- Observation skills
- Measurements of sediment
- Effects of sediment on aquatic life

Objectives:

- Demonstrate how to measure sediment levels using the Imhoff cones.
- Describe three ways sediment affects aquatic life.
- List three origins of sediment and three possible ways to control the level of sediment in the river.
- List the most important causes of stream degradation in North Carolina today.

#4 Water Bugs (page 4.4.1)

Get wet, have fun, and learn while doing it. Students will use different methods to collect and identify aquatic organisms.

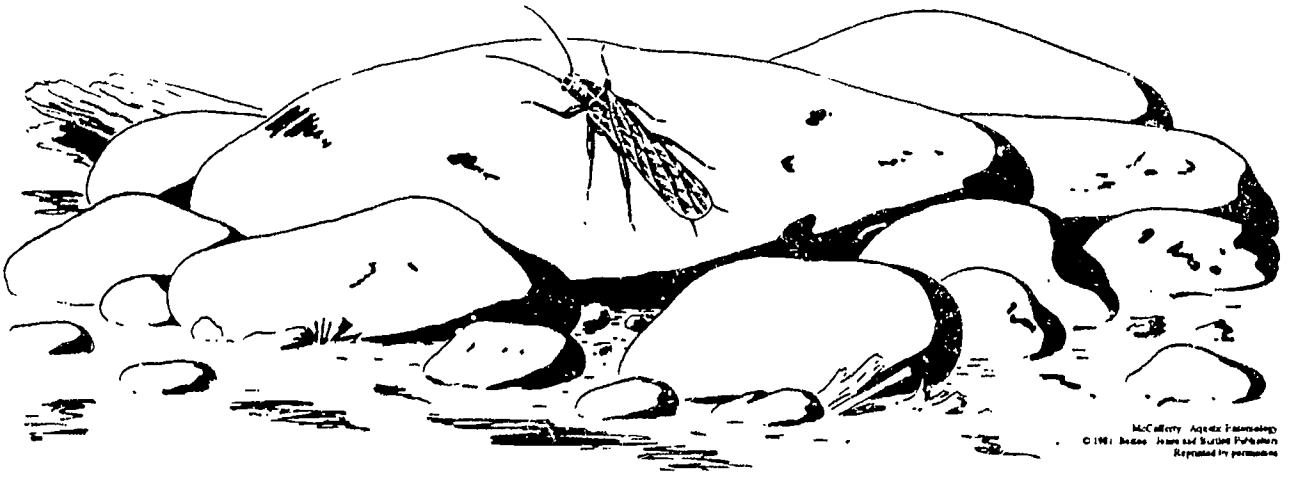


Major Concepts:

- Water quality
- Aquatic sampling
- Indicator species
- Aquatic habitats
- Basic anatomy
- Adaptations
- Species identification
- Human influence on water quality

Objectives:

- Describe three characteristics of an aquatic macroinvertebrate.
- Identify three macroinvertebrates.
- Define indicator species.
- Name three indicator species and explain how they are used to determine water quality.
- Use keys and field guides to identify unknown aquatic specimens.
- Use a dissecting microscope.
- List three or more ways humans affect aquatic life.
- Describe the differences between nymph and larva.



III. Post-Visit Activities

#1 Fragile Waters (page 5.1.1)

Using a topographic map and land use cutouts, students will make decisions about the development of a portion of the Eno River's watershed.

Major Concepts:

- Human impact on the Eno River watershed
- Water quality
- Land use planning and its effect on the Eno and areas further downstream
- Resource management

Objectives:

- Evaluate the effects of different imaginary land uses on the Eno River watershed.
- Discuss and list five ways to minimize damaging effects in the Eno watershed.
- List two animal species endemic to the Neuse River and Tar River watersheds.

#2 Troubled Waters (page 5.2.1)

After reading a story about the discovery made by two young river enthusiasts, students will create their own ending. Optionally, the class can develop an action plan to correct an aquatic pollution problem in their community.

Major Concepts:

- Water pollution
- Problem solving
- Creative writing
- Cause and effect relationships

Objectives:

- Identify two potential cause and effect relationships involving aquatic pollution.
- List and evaluate two alternative solutions to aquatic pollution.
- Create an action plan to reduce aquatic pollution.

Pre-Visit Activity #1 — Map Trivia

Curriculum objectives:

Grade 5 -

- Communication Skills: listening and visual comprehension, study skills.
- Guidance: competency and skill for interacting with others.
- Math: measurement
- Social Science: organize, analyze information, draw conclusions; use maps, participate effectively in groups.

Grade 6 -

- Communication Skills: listening and visual comprehension, study skills.
- Math: measurement
- Social Science: organize and analyze information, draw conclusions; use maps, participate effectively in groups.

Location: Classroom
Group size:
30 students, class size
Estimated time:
30-40 minutes
Appropriate season: Any
Materials:
Provided by educator:
Map Trivia Worksheet (1 copy per group of 4 students), current North Carolina transportation maps (1 map per group of 4 students). Maps are available through your local tourism office or the:

N.C. Dept. of Economic and Community Development
Travel & Tourism Division
430 N. Salisbury St.
Raleigh, N.C. 27603
1-800-VISITNC
or 919/733-4171

Educator's Information:

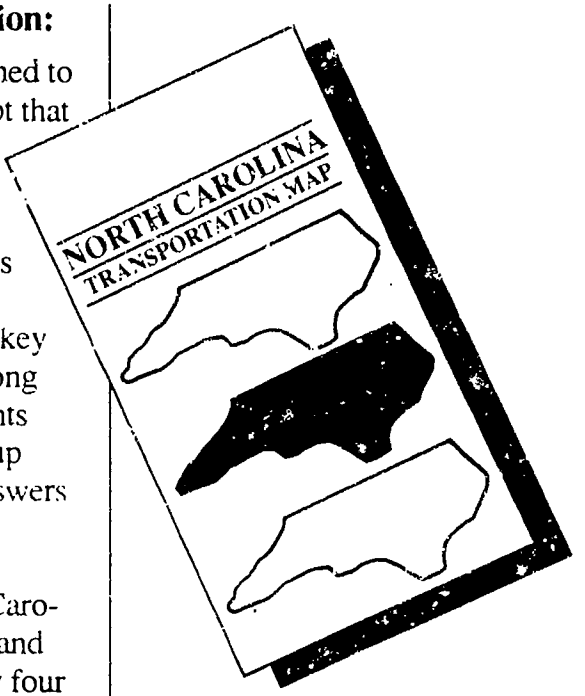
This activity is designed to illustrate the concept that the Eno River is part of a larger river system. Students will trace the river from its headwaters to the ocean, using map legends and identifying key geographic locations along the water course. Students will participate in a group activity to obtain the answers for the worksheets.

Provide one North Carolina transportation map and one worksheet for every four students.

Note: If your students use the 1992/93 North Carolina Transportation Map (golf course on cover), please have the students use the scale on their worksheet. The scale on the 1992/93 map is incorrect.

Have each group of students answer questions on the worksheet, using the map as a reference.

After the groups have finished answering the questions, have each group answer one of the questions and explain how they got the answer. Continue with each group reporting their answer until all questions have been answered and discussed.



Major Concepts:

- Map use
- Watersheds
- Group participation

Objectives:

- Interpret and use the legends on the North Carolina transportation map to answer five questions.
- Locate five geographic locations within the Neuse River **watershed**.
- Participate effectively in groups while answering questions on the worksheet.

Worksheet for Pre-Visit Activity #1

Map Trivia

Instructions: Using the North Carolina transportation map, answer the following questions.

1. What is the name of the county where the Enc River begins?

_____

2. Name the counties surrounding Orange County.

_____

_____

_____

3. What is the name of the **tributary** that joins the Eno near Camp Butner?

_____

4. List the counties the Eno River flows through before becoming the Neuse River near Camp Butner?_____

_____

_____

_____

5. Approximately how long is the Eno River?
in miles _____
in kilometers _____

6. What is the name of the reservoir into which the Eno River flows?

_____

7. What is the name of the river which eventually carries the water from the Eno to the ocean?

_____

8. What is the first town with a population over 2,000 through which the Eno River flows?_____

_____

9. What is the name of the sound into which the water from the Eno River flows?

_____

_____

10. Approximately how many miles are there between Durham and New Bern in a straight line?

_____

kilometers ? _____

11. List the state parks and recreation areas located along the path that the Eno River takes to the ocean?

_____

_____

_____

_____

_____

_____

12. What is the approximate distance from Ranger, NC to Whalebone, NC?
in miles_____
in kilometers _____

13. What is the map symbol for park campsites?

_____

14. List the towns or cities with a population over 10,000 that water from the Eno River flows past on its way to the ocean?

_____

_____

_____

_____

_____

_____

15. What is the closest **latitude** and **longitude** to Eno River State Park?

_____

_____

16. New Bern is closest to what latitude and longitude?

_____

_____

17. Name the points of interest (see map symbols) within three miles of the Eno and Neuse Rivers from Eno River State Park to New Bern.

_____

_____

_____

_____

_____

_____

_____

18. Name the national forest found along the Neuse River.

_____

19. Name the river located west and south of the Eno River near Burlington.

_____

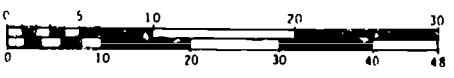
20. Near what large city does the river from question 19 reach the ocean?

_____

21. Name the river located north and east of Falls Lake.

_____

22. Near what city does the river from question 21 reach the ocean?_____



SCALE OF MILES ONE INCH EQUALS APPROX 13 MILES
SCALE OF KILOMETERS ONE INCH EQUALS APPROX 21 KILOMETERS
1 MILE IS EQUAL TO 1.609 KILOMETERS

Answers for Pre-Visit Activity #1

Map Trivia

1. Orange County
2. Caswell, Person, Durham, Alamance, Chatham
3. Flat River
4. Two - Orange and Durham
5. Approximately 33 miles
   Approximately 53 kilometers
6. Falls Lake
7. Neuse River
8. Hillsborough
9. Pamlico Sound
10. Approximately 120 miles
    Approximately 193 kilometers
11. Eno River State Park, Falls Lake State Recreation Area, Waynesboro State Park (on 92/93 or later maps), Cliffs of the Neuse State Park
12. Approximately 500 miles
    Approximately 805 kilometers
13. A tent
14. Durham, Raleigh, Goldsboro, Kinston, New Bern
15. 79 degrees latitude, 36 degrees longitude
16. 77 degrees latitude, 35 degrees longitude
17. Bennett Place, Stagville Center, Clemmons Educational State Forest, Waynesboro State Park (on 92/93 or later maps), Cliffs of the Neuse State Park, Caswell Memorial & CSS Neuse, Tryon Palace
18. Croatan National Forest
19. Haw River
20. Wilmington, NC
21. Tar River
22. Washington, NC

Pre-Visit Activity #2 Keys Made Easy

Curriculum objectives:
Grade 5 -
- Communication Skills: listening and visual comprehension, study skills
- Science: earth science, environment
- Math: measurement

Grade 6 -
- Communication Skills: listening and visual comprehension, study skills
- Science: earth science, environment
- Math: measurement

Location: Classroom

Group size:
30 students, class size

Estimated time:
Part 1 - 20 to 30 minutes.
Part 2 - 30 to 50 minutes.

Appropriate season: any

Materials:
Provided by educator:
copies of the activity sheets and a ruler (1 per student): "Key to 10 Common Leaves", "10 Common Leaves", "Key To Common Macroinvertebrates Found at Fews Ford, Eno River State Park", "Aquatic Life Illustrations"

Major Concepts:
Part 1:
- **Dichotomous key**
- How to use a **key**
- Importance of keys for identification

Part 2:
- Basic **taxonomy**

Objectives:
Part 1:
- Define dichotomous key and explain why it is used.
- Use a simple key to identify five unknown leaves.

Part 2:
- Define taxonomy.
- List the five kingdoms.
- Key out at least one **macroinvertebrate** using a simple dichotomous key.

An Introduction to the Use of a Dichotomous Key

Educator's Information:

This two-part activity introduces students to a simple dichotomous key. Students will learn what a dichotomous key is, why keys are useful and how to use a simple identification key.

Part 1 will give the student an introduction to the use of a simple key and why keys are useful. In Part 2, the students will key out several macroinvertebrates, using the same key that they will use at the park in On-Site Activity #4 - Water Bugs.

Instructions for Part 1:

Have the students read the Student's Information. Discuss taxonomy and how organisms are grouped into naturally related groups. Define a key and discuss why keys are useful. Explain how a key works. Separate the students into groups of four or five. Hand out copies of the "Key to 10 Common Leaves." Next hand out copies of "10 Common Leaves." Have each group work through the key to identify each of the 10 leaves. As a class, go over the answers and discuss any difficulties encountered.

Instructions for Part 2:

Split the students into groups of four or five. Hand each group a copy of "Aquatic Life Illustrations" and a copy of "Key To Common Macroinvertebrates." As a class, work through the key to identify animal number 1 then have the students work within their groups to identify the rest of the macroinvertebrates. When each group is done, have each group share how they identified one of their macroinvertebrates. Discuss the difficulties encountered and reinforce the importance of keys.

Student's Information:

Taxonomy is the branch of **biology** that deals with the **classification** of **organisms** into established categories. The word, taxonomy, comes from the Greek words meaning arrangement and law. Through taxonomy, organisms are arranged into related groups based on similarities in morphology, anatomy, physiology, genetics, ecology and distribution.

All organisms are first divided into large groups known as kingdoms. There are five kingdoms – Monera, Protista, Fungi, Plantae and Animalia. Each kingdom is then split several more times into more closely related groups until we finally get to a specific organism.

Keys:

A key is an essential tool in the science of taxonomy. It is defined as an ordered list of significant characteristics of a group of organisms used to identify unknown organisms. Simply put, a key is a list of characteristics that describe an organism. Keys are used by scientists and students to identify unknown organisms. They often contain a combination of pictures, drawings and written descriptions.

Dichotomous Keys:

Most keys are dichotomous, meaning dividing or branching into two parts. A dichotomous key, therefore, is a key that divides the characteristics that describe an organism into two choices. At each level of the key, you pick the choice that best describes the organism you are trying to identify.

How a Key Works:

Here's how a dichotomous key works. A list of characteristics is arranged as a series of either/or statements. For each pair of statements, only one will be a correct description of the unknown organism. For example, if you were handed a leaf from a pine tree to identify, you would start at the top of the key with these two choices:

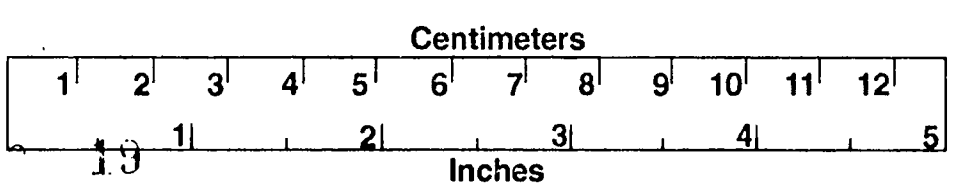
1. Leaf long and needle-like or
2. Leaf not needle-like.

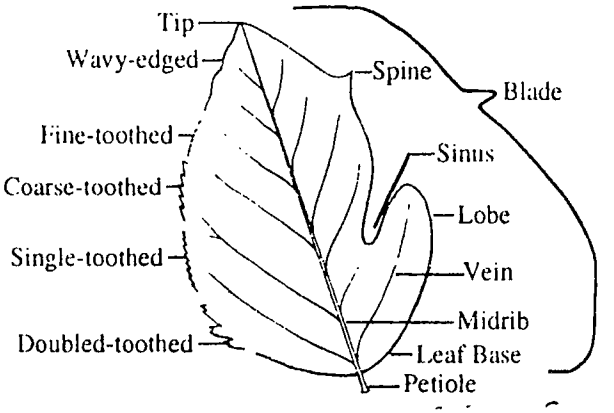
A pine needle is long and needle-like so you would choose statement 2 and continue to the next choice under that side of the dichotomous key.

Key to 10 Common Leaves

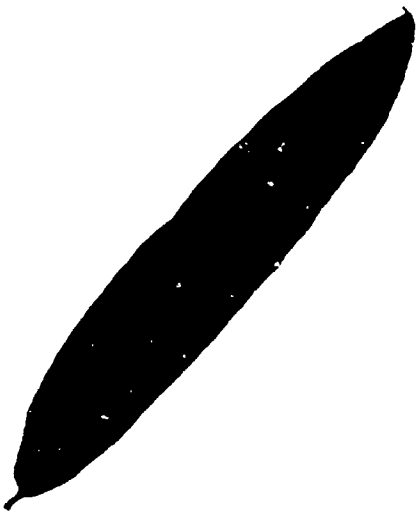
(Tree Leaves)

- Leaf long & needle-like
  - Leaves in group of 2; less than 10 cm long — *Shortleaf pine*
  - Leaves in group of 3; more than 10 cm long — *Loblolly pine*
- Leaf not needle-like
  - Leaf with lobes
    - Edge of leaf without teeth
      - Petiole of leaf 1 cm or longer
        - Leaf petiole less than 2 cm — *Sassafras*
        - Leaf petiole longer than 2 cm — *Tulip poplar*
      - Petiole of leaf less than 1 cm — *White oak*
    - Edge of leaf with teeth
      - Leaf with 5 lobes; petiole 3.5 cm or longer — *Sweet gum*
      - Leaf with 3 lobes; petiole shorter than 3.5 cm — *Red maple*
  - Leaf without lobes
    - Leaf edge with teeth
      - Each tooth with spine — *American holly*
      - Teeth without spines — *River birch*
    - Leaf without teeth — *Willow oak*



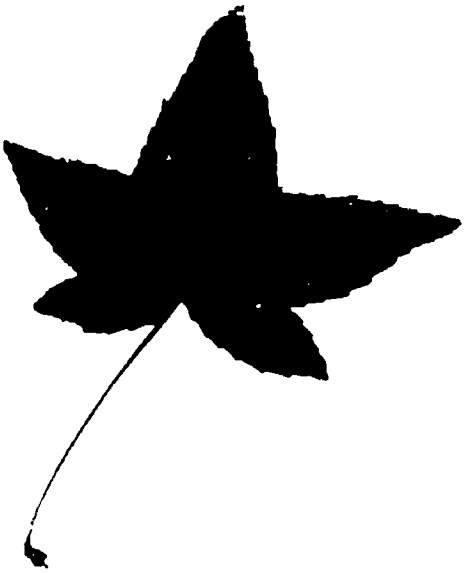


10 Common Leaves

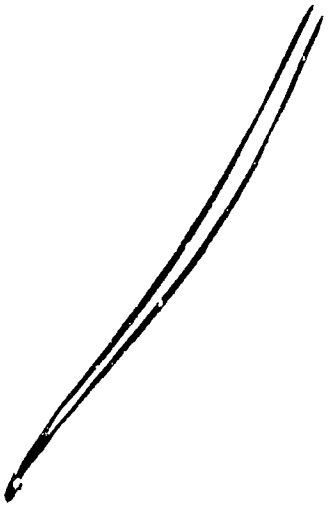


1. _____

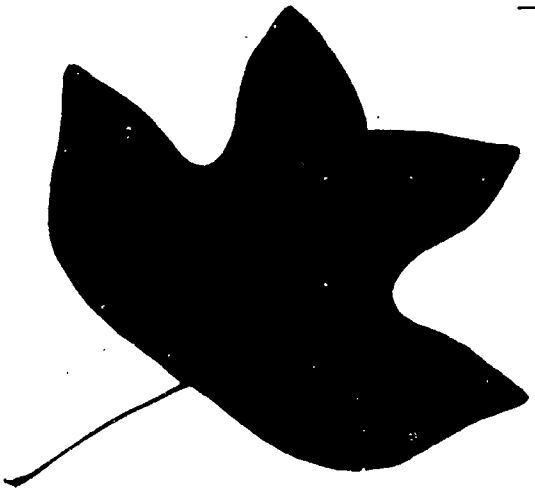
2. _____



3. _____

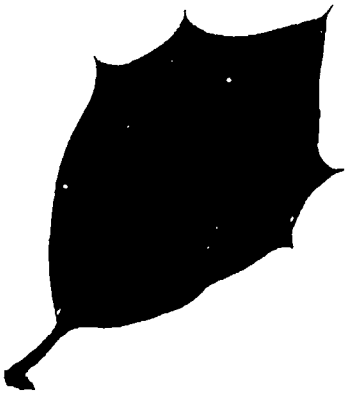


4. _____

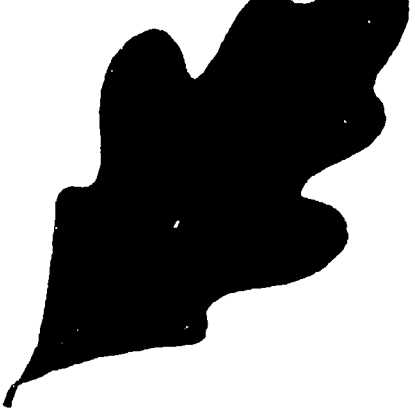


5. _____

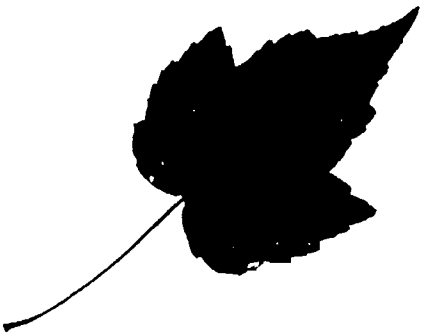
6. _____



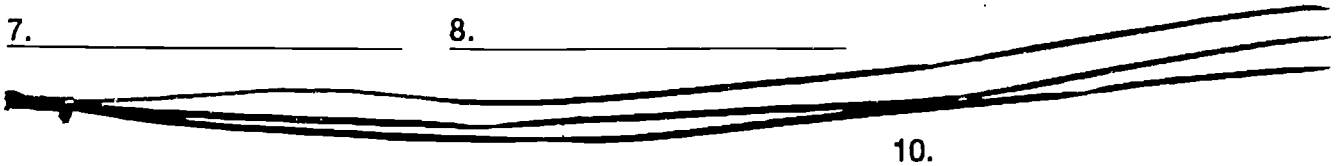
7. _____



8. _____



9. _____



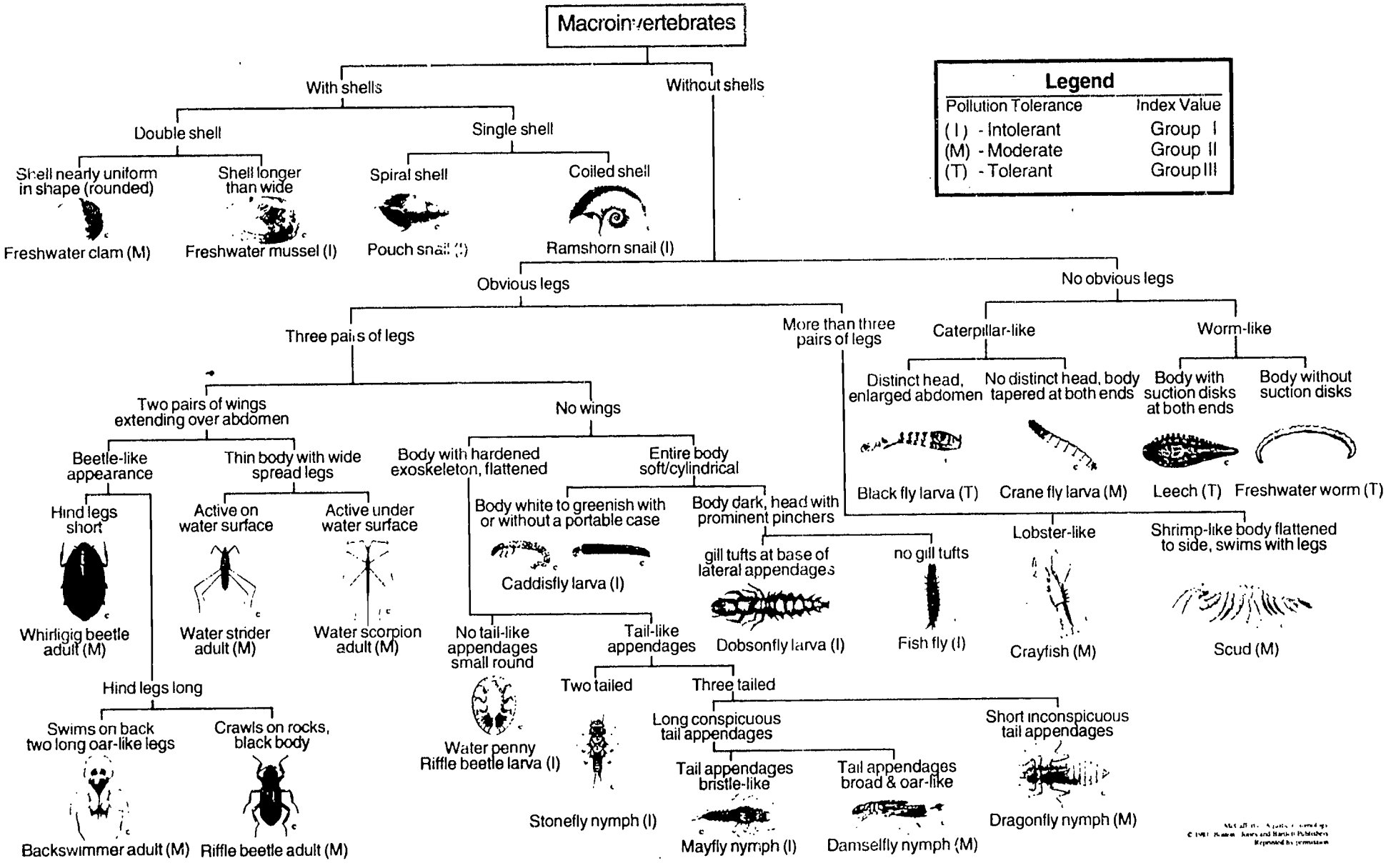
10. _____

Key To Common Macroinvertebrates
Found at Fews Ford, Eno River State Park

Eno River State Park, NC

3.2.5

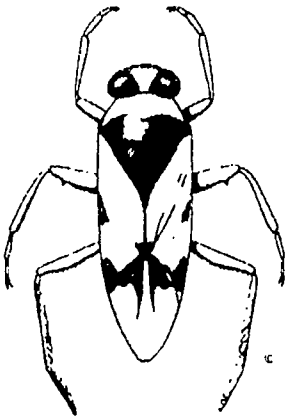
October 1992



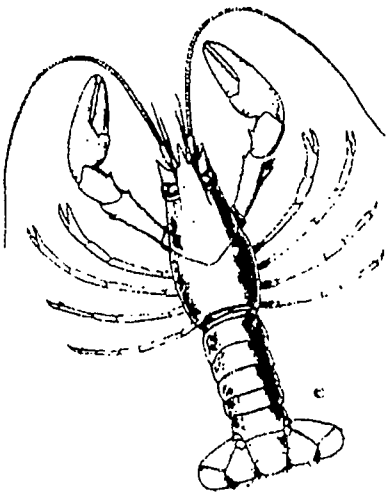
Legend

Pollution Tolerance	Index Value
(I) - Intolerant	Group I
(M) - Moderate	Group II
(T) - Tolerant	Group III

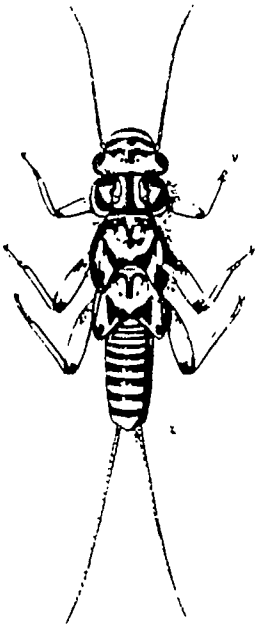
Aquatic Life Illustrations



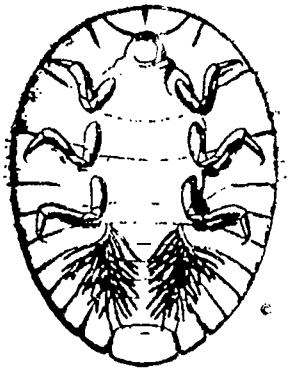
1. _____



2. _____



4. _____

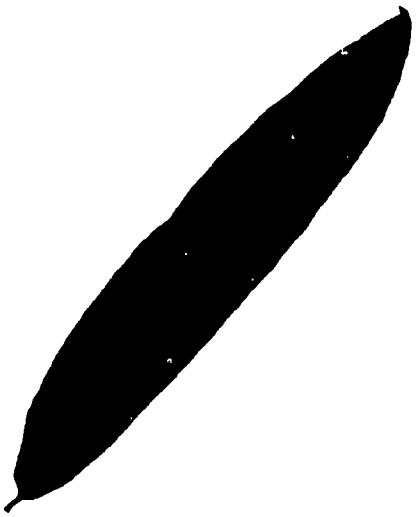


3. _____

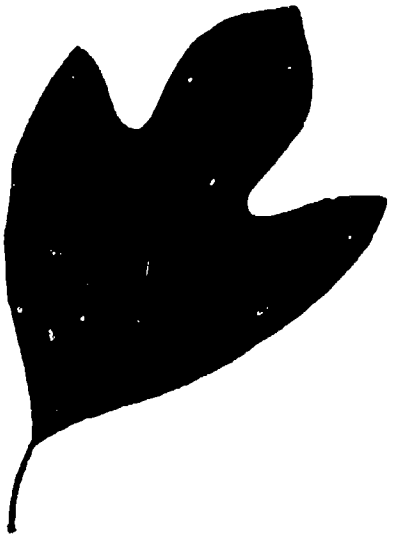
5. _____

6. _____

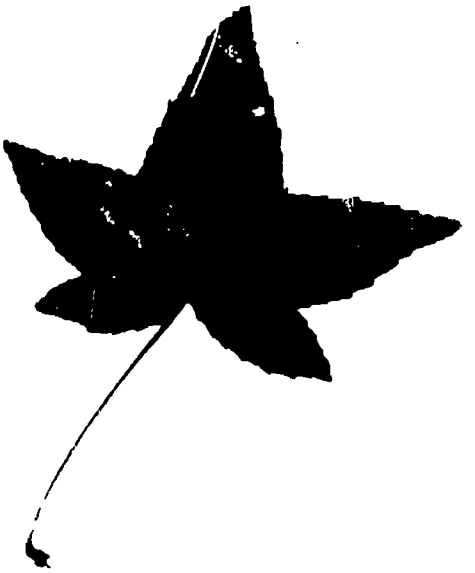
Answer Sheet to 10 Common Leaves



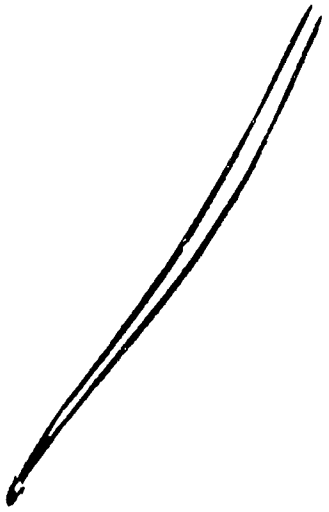
1. *Willow oak*



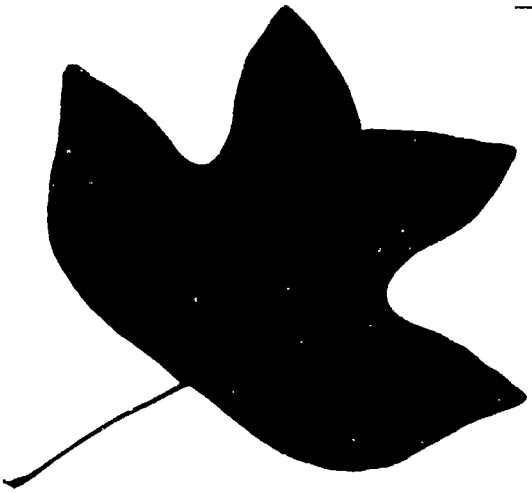
2. *Sassafras*



3. *Sweet gum*

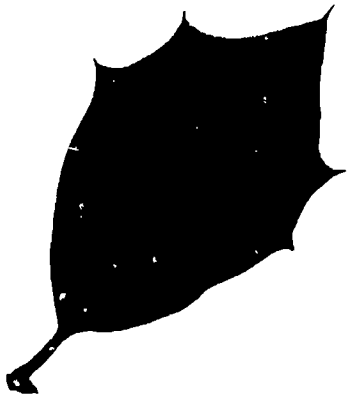


4. *Shortleaf pine*

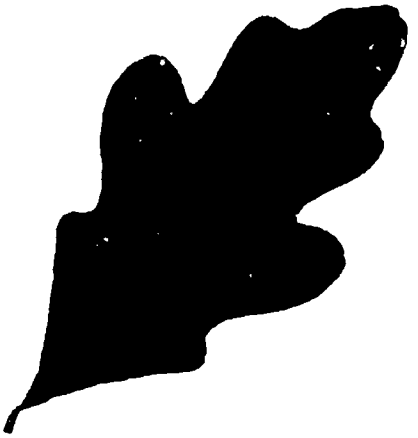


5. *Tulip poplar*

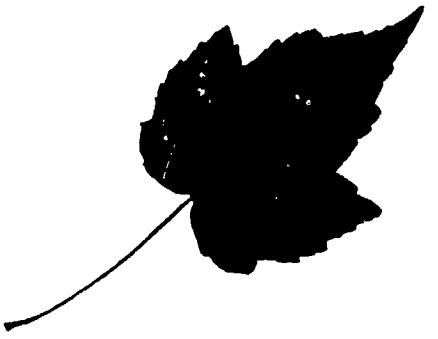
6. *River birch*



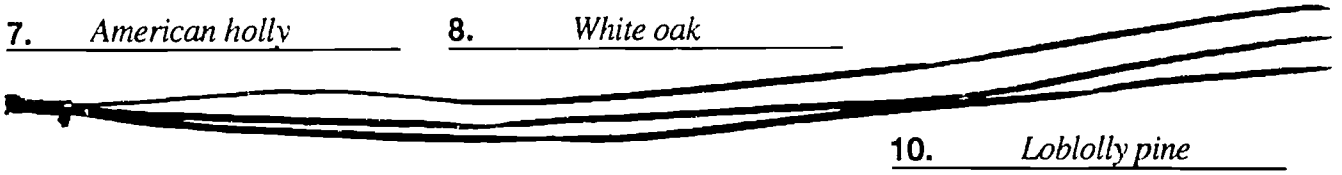
7. *American holly*



8. *White oak*

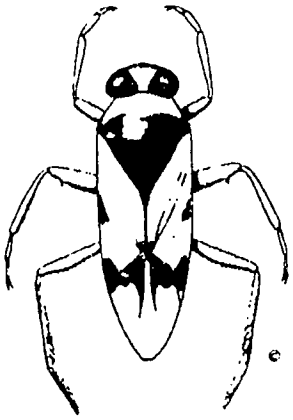


9. *Red maple*

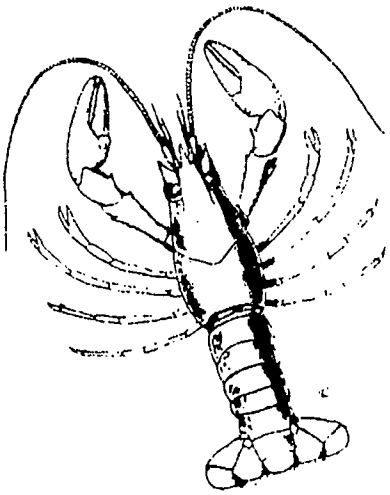


10. *Loblolly pine*

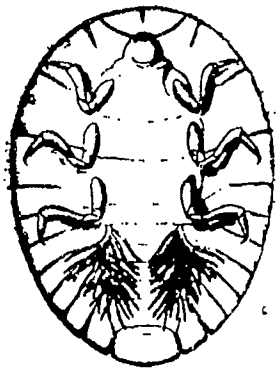
Answer Sheet to Aquatic Life Illustrations



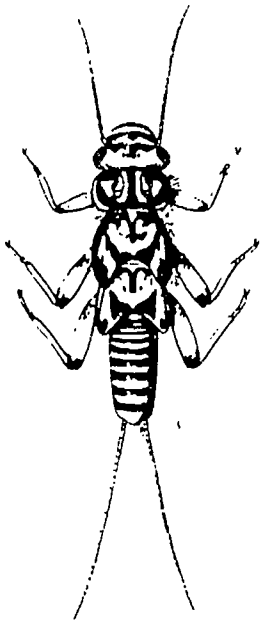
1. *backswimmer adult*



2. *crayfish*



3. *water penny*



4. *stonefly nymph*

5. *freshwater mussel*

6. *leech*

On-Site Activity #1 — Go With The Flow

Curriculum objectives:

Grade 5 -
- Communication Skills: listening and visual comprehension.
- Guidance: competency and skill for interacting with others.
- Healthful Living: recreational safety.
- Math: measurement, probability and statistics.
- Science: earth science, environment.
- Social Science: organize and analyze information, draw conclusions; participate effectively in groups.

Grade 6 -
- Communication Skills: listening and visual comprehension.
- Guidance: competency and skill for interacting with others.
- Healthful Living: environmental health, recreational safety.
- Math: measurement, probability and statistics.
- Science: ecology.
- Social Science: organize and analyze information, draw conclusions; participate effectively in groups.

Location:
Fews Ford Access Area

Group size: 8 students

Estimated time: 20 minutes

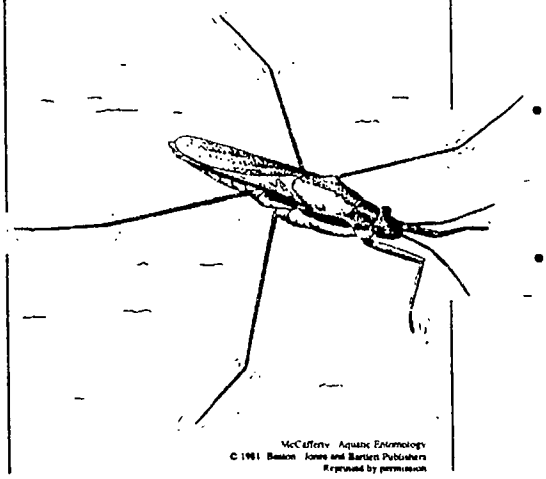
Appropriate season:
April through October

Materials:

Provided by park:
life jackets, throw ropes, 100 ft. tape measure, metal yardstick, stopwatches, tennis balls, boundary ropes, charts, activity sheets, clipboards, pencils

Provided by educator:
worksheets (one per student), pencils

Special considerations:
See the safety message on introduction page 1.3.



McCafferty Aquatic Entomology
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Calculating Water Flow in the Eno River

Major Concepts:

- Measurement of water flow
- Human influences on water flow
- Natural influences on water flow
- How human and natural influences affect **aquatic life**

Objectives:

- Calculate the rate of water flow using measurements and a mathematical formula.
- List three human actions that affect water flow.
- List three natural influences on water flow.
- Describe the important relationship between water quantity and quality.
  - Describe three problems that can result from river water quantity extremes.
  - Describe three problems that can result from river water quality changes.
  - Discuss at least two things people can do to help protect rivers and water quality.

Educator's Information: Water Flow

In this activity, the students will learn a simple method for determining water flow. They will then use this information to explore the ways that water flow and water quality are affected by human and natural factors. They will also be asked to think of ways they can influence local government to protect water quality.

To prepare your students for their visit we recommend the pre-visit activity, Map Trivia.

Have students read Student's Information. Discuss this information in class prior to your visit.

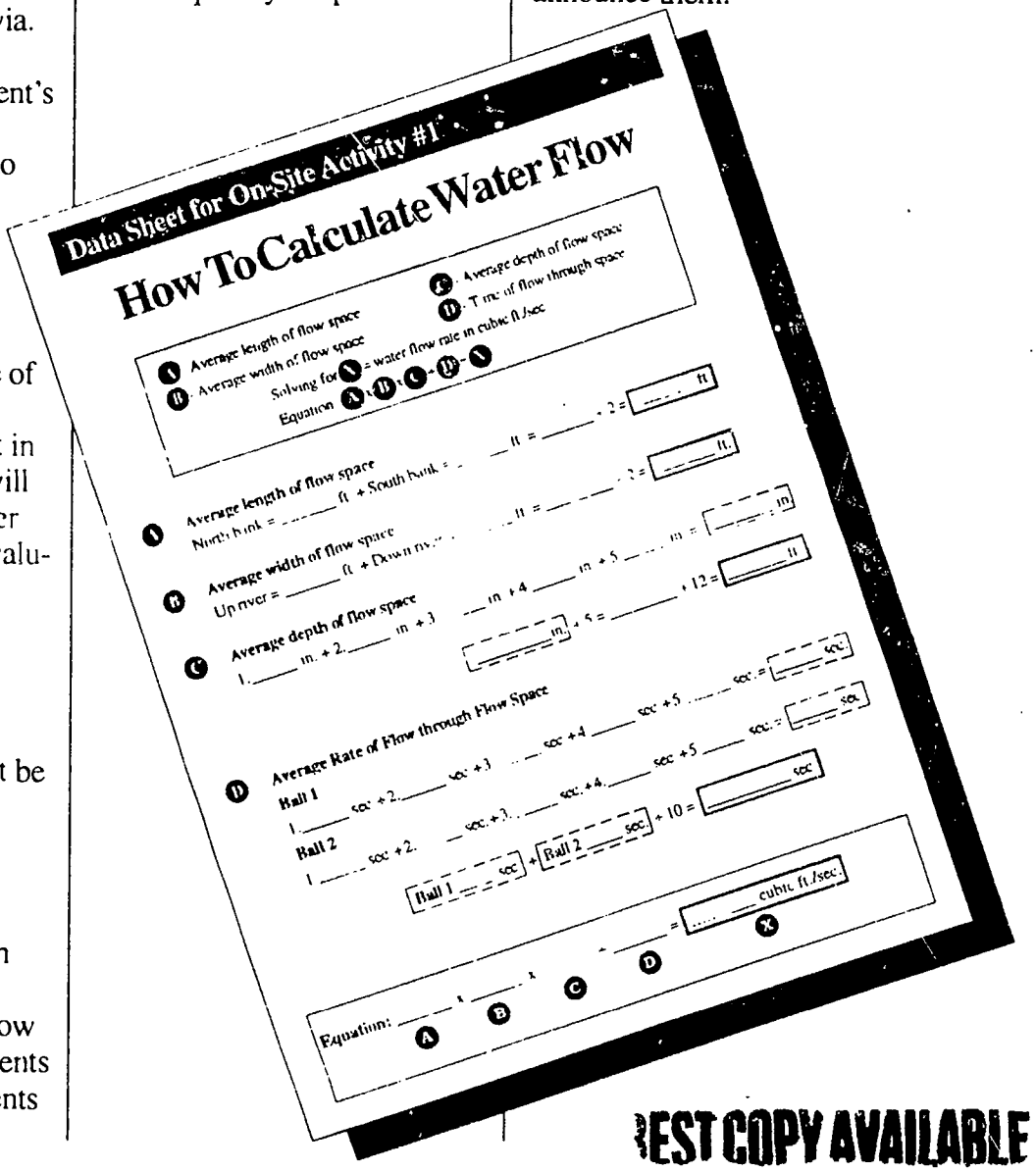
Instructions:

1. Lead a brief discussion concerning the importance of water flow in maintaining water quality. Explain that in this activity, the students will learn how to calculate water flow and thus be able to evaluate this aspect of the Eno River's water quality.

2. Explain the method for measuring water flow and safety procedures that must be followed.

3. Select three students to get in the water. Have two students measure the length and width, and one student measure the depth of the flow space. Have the other students write down the measurements on their worksheets.

4. Select four students to measure the rate of flow. Have two students, each with a ball, go to the upstream end of the flow space. Have two other students, each with a stopwatch, go to the downstream end of the flow space. The student with ball #1 should place it in the river upstream from the beginning of the flow space and hold his/her hand in the air. As the ball passes the beginning of the flow space, he/she quickly drops his/her hand. This is the signal for the student with stopwatch #1 to start the stopwatch. The stopwatch is stopped the moment the ball passes out of the flow space. He or she will then retrieve the ball, and they will repeat this four more times. The students with ball #2 and stopwatch #2 will follow the same procedure. The other students will record the flow rates on their worksheets as the students with the stopwatches announce them.



5. Have all the students determine the four averages and then calculate the water flow rate in cubic feet/second. Discuss these results and what they might mean to the Eno River's water quality.

6. Lead a discussion of factors that affect water flow (natural and human), and how these factors in turn affect aquatic life. (Natural factors affecting water flow include drought, flooding and natural stream obstruction, i.e., beaver dams or log jams. Human activities include dams, **irrigation**, and industrial use. These natural and unnatural water controls can adversely impact aquatic organisms by reducing water flow and decreasing water quality.)

7. Ask the students how they can influence the government to protect our water resources. Be sure to emphasize the importance of everyone being involved in caring for our resources (**stewardship**). The Eno River Association is an organization that exemplifies stewardship. If time allows, the leader will briefly explain how the park was created with the help of the Eno River Association.

Student's Information: Water Flow

Water flow refers to the amount of **water** moving in a river or stream. Some of the ways that we express the rate of flow are gallons per second, cubic feet per second or acre feet per second (an acre foot is equal to one acre of water one foot deep or 325,850 gallons of water). The following exercise will show you how to estimate water flow in cubic feet per second. Why is this important? Read the following story and discover why water flow is such an important concept.

The river is the Colorado. It begins in the Colorado Rockies and empties 1,450 miles later into Mexico's Gulf of California. The Colorado provides water for seven western states. This includes water for human consumption as well as irrigation for farms and domestic livestock. The Colorado is one of the most controlled rivers in the world; it has scores of dams, hundreds of miles of aqueducts and tunnels, dozens of pumping stations, thousands of miles of canals, and more than 30 hydroelectric plants. Water is pumped from the Colorado to cities like San Diego, California; Las Vegas, Nevada; Denver, Colorado and Phoenix, Arizona. Each year 16.5 million acre feet of water are diverted from the Colorado (multiply 16.5 million times 325,850 to see how many gallons are taken from the river each year). Sometimes the water level is so low that rafters can not run certain rapids in the Grand Canyon.

Dams above the canyon control how much water moves through the canyon. This has had a big impact on aquatic life. For example, before the Colorado was dammed, the river flowed cold and carried lots of mud and silt during the spring floods and slowed to a warm clear trickle in the fall. Native aquatic species were well adapted to these specific conditions. Now dams trap sediment in huge reservoirs and constantly release clear cold water from the bottom of the lake. This creates excellent habitat for introduced species, like trout, but is contributing to the near extinction of several native species of fish that do not tolerate the cold water.

By the time the Colorado River reaches the Gulf of California there is barely a trickle, and at times the river dries up before it reaches the gulf. Even if there is water flowing, **evaporation** has caused it to become so saline (at this point the salt content averages 700 parts per million) that it is much too salty to use for irrigation.

A huge delta and estuary at the mouth of the Colorado used to be one of the most productive in the Southwest, but a decrease in water flow has caused that to change. In 1922 ecologist Aldo Leopold explored the delta. He described it "as a milk and honey wilderness where egrets gathered like a premature snow storm, jaguars roamed, and wild melons grew." Since that time two marine animals have become endangered, one a porpoise and one a large fish called a totoaba. The totoaba spawned in the estuary, and the tide carried their eggs up into the natural nursery of the delta. According to saltwater agronomist Nicholas Yensen, "the river was like the Nile in its importance to the delta, unknown species may have disappeared" as a result of the decrease in water flow.

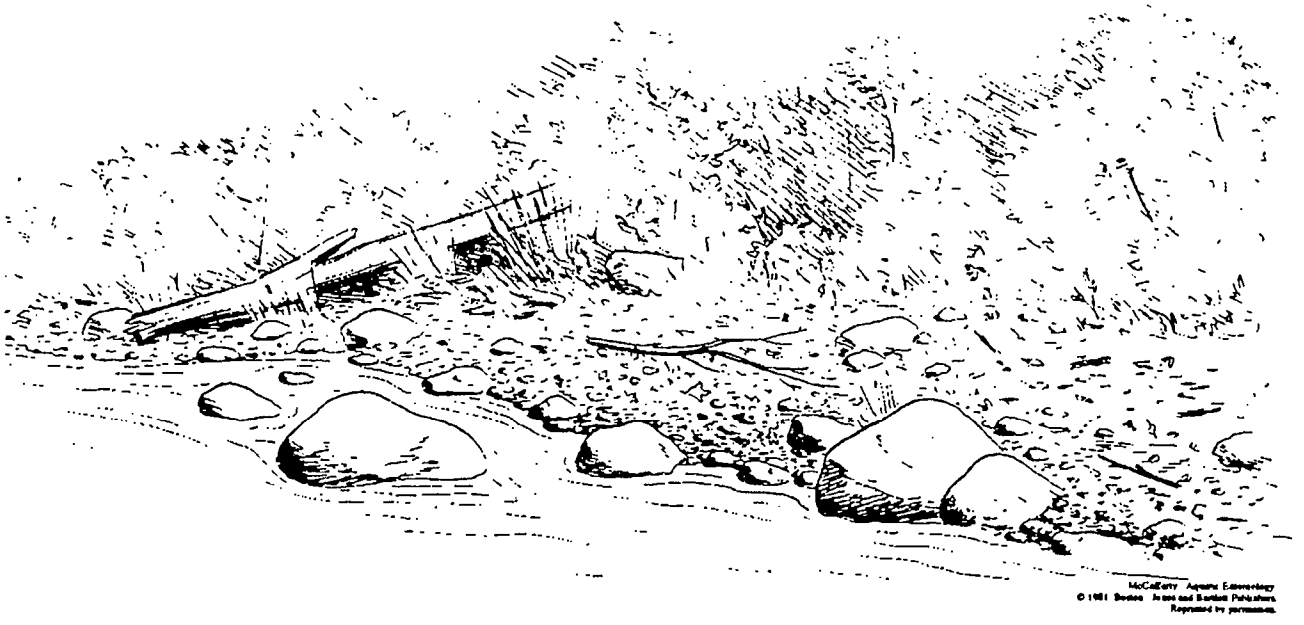
Water Flow Basics

You might be surprised to learn that even the Eno is affected by low water flow. Such conditions can have adverse effects on the entire aquatic **community**.

- When water levels are low, the water temperature can increase and result in less **dissolved oxygen** being available. This can be dangerous to macroinvertebrates and fish.
- **Algae** can spread rapidly during low water flow, and it uses tremendous amounts of oxygen as it decays. Fish kills can occur because of insufficient dissolved oxygen.
- During low water levels there is less **habitat** for river animals, and they become more vulnerable to predators.
- Last but not least, you might be forced to conserve water during low flow periods to make sure you have enough to drink and bathe.

We have talked a lot about low water levels but high flow levels affect us also. Heavy rains wash exposed soil into the river. This sediment can suffocate macroinvertebrates, kill fish eggs, and alter habitat. A lot of towns and cities divert rain water into storm drains that empty into rivers. This storm water brings all kinds of nasty things into the river: vehicle oil and gas from pavement; chemicals used in farming and lawn care; overflow from **waste water treatment plants;** and trash from dumps and other sources.

As you can see, water flow is very important to us. Using water wisely and protecting our river's watershed from unwise use are two ways we can help maintain a healthy and more natural water flow.



Worksheet for On-Site Activity #1

How To Calculate Water Flow

A - Average length of flow space
B - Average width of flow space
C - Average depth of flow space
D - Time of flow through space

Solving for X = water flow rate in cubic ft./sec.

Equation: A x B x C ÷ D = X

A **Average length of flow space**

North bank _____ ft. + South bank _____ ft. = _____ ÷ 2 = [_____ ft.]

B **Average width of flow space**

Up river _____ ft. + Down river _____ ft. = _____ ÷ 2 = [_____ ft.]

C **Average depth of flow space**

1._____ in. + 2._____ in. + 3._____ in. + 4._____ in. + 5._____ in. = [_____ in.]

[_____ in.] ÷ 5 = _____ in. ÷ 12 in. = [_____ ft.]

D **Average rate of flow through flow space**

Ball 1

1._____ sec. + 2._____ sec. + 3._____ sec. + 4._____ sec. + 5._____ sec. = [_____ sec.]

Ball 2

1._____ sec. + 2._____ sec. + 3._____ sec. + 4._____ sec. + 5._____ sec. = [_____ sec.]

[**Ball 1** _____ sec.] + [**Ball 2** _____ sec.] ÷ 10 = [_____ sec.]

Equation: _____ ft. x _____ ft. x _____ ft. ÷ _____ sec. = [_____ cubic ft./sec.]

A B C D X

Answer Sheet for On-Site Activity #1 (An Example)

How To Calculate Water Flow

A - Average length of flow space
B - Average width of flow space
C - Average depth of flow space
D - Time of flow through space

Solving for X = water flow rate in cubic ft./sec.

Equation: A x B x C ÷ D = X

A **Average length of flow space**

North bank 80 ft. + South bank 95 ft. = 175 ÷ 2 = 87.5 ft.

B **Average width of flow space**

Up river 75 ft. + Down river 83 ft. = 158 ÷ 2 = 79 ft.

C **Average depth of flow space**

1. 10 in. + 2. 18 in. + 3. 24 in. + 4. 12 in. + 5. 6 in. = 70 in.

70 in. ÷ 5 = 14 in. ÷ 12 in. = 1.17 ft.

D **Average rate of flow through flow space**

Ball 1

1. 20 sec. + 2. 22 sec. + 3. 18 sec. + 4. 23 sec. + 5. 21 sec. = 104 sec.

Ball 2

1. 21 sec. + 2. 26 sec. + 3. 24 sec. + 4. 21 sec. + 5. 22 sec. = 114 sec.

Ball 1 104 sec. + Ball 2 114 sec. ÷ 10 = 21.8 sec.

Equation: 87.5 ft. (A) x 79 ft. (B) x 1.16 ft. (C) ÷ 21.8 sec. (D) = 367.82 cubic ft./sec. (X)

On-Site Activity #2 — Mind Your p's and H's

Curriculum objectives:

Grade 5 -
- Communication Skills: listening and visual comprehension
- Healthful Living: school safety
- Math: measurement
- Science: earth science, environment
- Social Science: organize, analyze information, draw conclusions

Grade 6 -
- Communication Skills: listening and visual comprehension
- Healthful Living: environmental health, home safety
- Math: measurement
- Science: ecology
- Social Science: organize, analyze information, draw conclusions

Location:
Fews Ford Access Area
Group size: 8 students
Estimated time: 20 minutes
Appropriate season:
April to October

Materials:
Provided by the educator:
pencils, student worksheet (one copy per student)
Provided by the park:
test paper, LaMotte Test Kit, "pH Ranges That Support Aquatic Life" poster, "Sample pH Range" poster, sample items (distilled water, Eno River water , vinegar, lemon juice, Liquid Plumber™, Rolaids™, Coca-Cola™, soap, Formula 409™, baking soda)

Major Concepts:

- Water quality
- **pH** testing
- pH range (**acid**-neutral-**base**)
- pH range that supports aquatic life

Objectives:

- Demonstrate the use of litmus paper and the LaMotte test kit for determining pH.
- Analyze samples to demonstrate pH range.
- List three natural influences which can affect the pH rating of a river.
- List three human influences which can affect pH ratings of a river.
- Know the North Carolina Environmental Management Commission pH range for aquatic macroinvertebrates.

Special considerations:
Chemical reagents are used in water quality testing. Because misuse of these chemicals can be hazardous, standard chemical protection procedures will be required. Goggles and rubber gloves will be provided for all students handling testing kits. These must be worn at all times during test procedures. The educator will assist in seeing that all safety precautions are followed.

The Power of Hydrogen

Educator's Information:

In this activity, students will test the pH of several household products, as well as river water. Park staff will lead a discussion focusing on how the **pH scale** works, what pH ranges aquatic life will tolerate, and natural and human influences which can change pH. The students will use litmus paper to test the pH of several items and record their results on the "Sample pH Range" worksheet. They will also use a LaMotte test kit to test the pH of distilled water and Eno River water and record their results on the "Sample pH Range" worksheet. Park staff and students will discuss their results and compare them to the "pH Ranges That Support Aquatic Life" poster. They will note the extreme ranges of the samples and be able to determine which animals might be able to live in water with those pH's.

Have the students read the Student's Information prior to the park visit.

Instructions:

1. Review the pH information provided in the Student's Information. Discuss what the term pH means and how it is measured. Be sure to use an example, such as if there was a change in a river's pH from 6 to 5, it would mean that the river is now 10 times more acidic; from 6 to 4 would mean it is 100 times more acidic.

2. Have two students test the pH of the Eno River water using the LaMotte Test Kit. Have one student read how it is done from the instructions with the test kit while the other student does the test. Have the students then test the pH of the distilled water and the pH of the rain water using the LaMotte Test Kit.

3. Discuss the results, reinforcing the Student's Information. (The Eno River water should fall between 6.0-9.0 to meet the North Carolina standards for freshwater. Generally, the pH falls between 6.5-7.5, the best range for macroinvertebrates).

Review how aquatic life is affected by pH. Be sure to cover the concept of tolerance ranges for different organisms. Use an example such as the one on mayfly nymphs. Also, discuss the range of pH tolerance found on the "pH Ranges That Support Aquatic Life" poster.

4. Discuss with the students that the rain water, collected in a park rain gauge, will have a varying pH. (Results for the park have been from 5.4 to 6.5.) Review the **acid precipitation** section of the Student's Information. Emphasize that rain is naturally acidic, with a pH around 5.5. Rain is buffered by the soil, resulting in stream water with a pH between 6 and 8. Note that there are naturally acidic bodies of water, particularly in the eastern part of the state. Finally discuss what acid precipitation is, where it comes from, and what types of changes it can cause to the pH of the stream water.

5. Discuss other ways the pH of streams is changed, reinforcing the Student's Information, particularly:

- pH increases with increases in **effluent** from **sewage** treatment plants (effluent is high in ammonia which neutralizes acids)
- pH increases with **photosynthesis** in plants (photosynthesis removes carbon dioxide, CO_2)
- pH increases with **aeration** by **riffles** and rapids (aeration adds oxygen, O_2)
- pH decreases with an increase in rainfall (rain water is typically more acidic)
- pH decreases with **decomposition** of plants (decomposition removes O_2)
- pH decreases with **respiration** (animal breathing releases CO_2)

6. Discuss the pH of household products (the pH of many products used for cleaning is basic, while the pH of items that taste sour is acidic). Explain the test procedure using litmus paper. Note that litmus paper can test a broad range of pH and that each litmus paper type covers a specific range within the pH scale.

7. Have one student come forward and pick a product to test. Prior to testing, have the student decide if the product will be basic, acidic or neutral. Have the student select a strip of litmus paper from within the range they think appropriate and place it in the product. Match the color on the litmus paper chart. Discuss the results and have the student mark the class poster. All students should mark their own worksheet.

8. Continue this process until all products are tested.

To test Rolaids™, soap and baking soda, dissolve the products with an equal amount of distilled water. Remind the students that pure, deionized water contains equal numbers of H^+ and OH^- ions and is considered neutral, pH of 7. Note that this will slightly buffer the true pH of these products, but the products will still provide examples of basic pH's. Point out that Rolaids™ and baking soda are both basic (pH of 9) and that baking soda could be used for acid indigestion just as well as Rolaids™. Discuss some of the foods that give us acid indigestion. [Pizza (tomatoes), chili (tomatoes), orange juice (citric acid), etc.] We, too, are living organisms and can not tolerate drastic changes in pH! To test "you," have a student place the tip of a strip of paper on his or her tongue. Have the class decide if the student is acidic, basic, or neutral prior to the test.

9. Sum up the activity by emphasizing that aquatic life is affected when the pH varies a great deal from neutral.

A change in the pH of a river can be one of the first indicators of water quality problems and can quickly affect the aquatic life in the stream. The Eno River is tested each month for pH, dissolved oxygen, temperature, water flow and macroinvertebrate population and diversity. These tests are done by the Riffle and Pool Naturalists, a Streamwatch group that has adopted the Eno River. This vigilant testing of the river identified a chemical spill which put the pH over 12 for a period of time. It has also provided data to help establish water flow regulations controlling the amount of water that can be removed from the river. The Eno River is fortunate to have so many good stewards!

Student's Information: Mind Your p's and H's

The term pH means (p)ower of (H)ydrogen ion activity. Scientists use the pH scale to define the degrees of acidity/basicity in soil and water. On one end of the scale, a pH of 0 is extremely acidic (many hydrogen ions, H^+), whereas at the other end of the scale, a pH of 14 is extremely basic (many hydroxide ions, OH^-). A pH of 7 is neutral (equal numbers of H^+ and OH^- ions), being neither acidic nor basic. pH is measured on a logarithmic scale with each number representing a factor of ten. Thus, a change in a river's pH from 6 to 5 means that the river is now 10 times more acidic; from 6 to 4 means it is 100 times more acidic.

North Carolina has established water quality standards. For all freshwaters, except swamps, the acceptable pH range is 6.0 - 9.0 (swamps can have a pH as low as 4.3).

Aquatic life is affected when the pH varies a great deal from neutral. Different organisms tolerate varying ranges of pH, and the population of aquatic organisms will change if the pH changes favor certain species. For example, mayfly nymphs do best when the pH is around 6.5, but they usually can not survive if the pH drops below 5.0. Most macroinvertebrates do best if the pH is between 6.5 and 7.5.

The pH of rainfall is naturally acidic, usually registering from 5 to 5.5. However, many soils are somewhat basic and "buffer" the rainwater by raising its pH, making it less acidic. As a result, despite the pH of non-polluted rain being around 5.5, the pH of most stream water is between 6 and 8. However, you can find naturally acidic water in swamplands, bogs and blackwater rivers in the eastern part of the state. There, the soils contain large amounts of peat (partially decayed plant material) which is acidic.

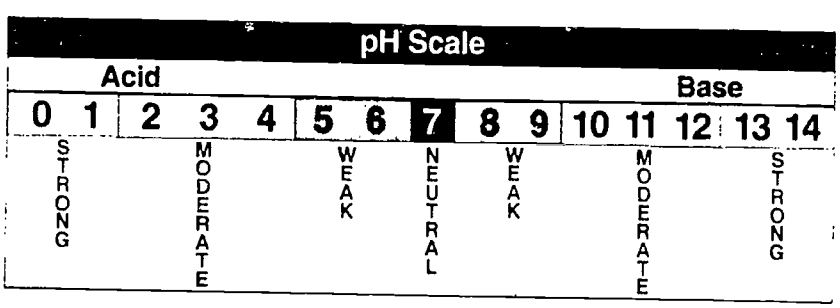
Some acidic waters are not natural, but the result of **acid precipitation**. Acid precipitation falls in the form of rain, snow, fog, sleet and hail. The acidity results primarily from the mixing of water vapor with sulphur dioxide (from coal burning power plants) and nitrous oxides (from cars and trucks) in the atmosphere. Acid precipitation can cause changes in the pH of our waterways.

The pH of water increases (becomes more **alkaline** or basic) with increases in the following: effluents from sewage treatment plants (the effluent is high in **ammonia**), photosynthesis in plants (photosynthesis removes carbon dioxide, CO_2), and aeration by riffles and rapids (aeration adds oxygen, O_2).

The pH of water decreases (becomes more acidic) with each of the following: increases in rainfall (allowing little or no buffering from the soil), decomposition of plants (decomposition removes O_2) and respiration (animal breathing releases CO_2).

Changes in pH can give valuable clues to water quality changes. A pH change, either an increase or decrease, may be an indication of biological processes such as decomposition of organic matter, photosynthetic activity or an increase/decrease in pollutant levels.

Monitoring the pH of our streams and rivers is of great importance. It is one of the methods we use to determine the health of our waters. Through monitoring, we can detect extremely high or low pH's that would kill most aquatic organisms. It can alert us to changes in our water quality and help us to protect our waters by giving us clues to the source of the changes.

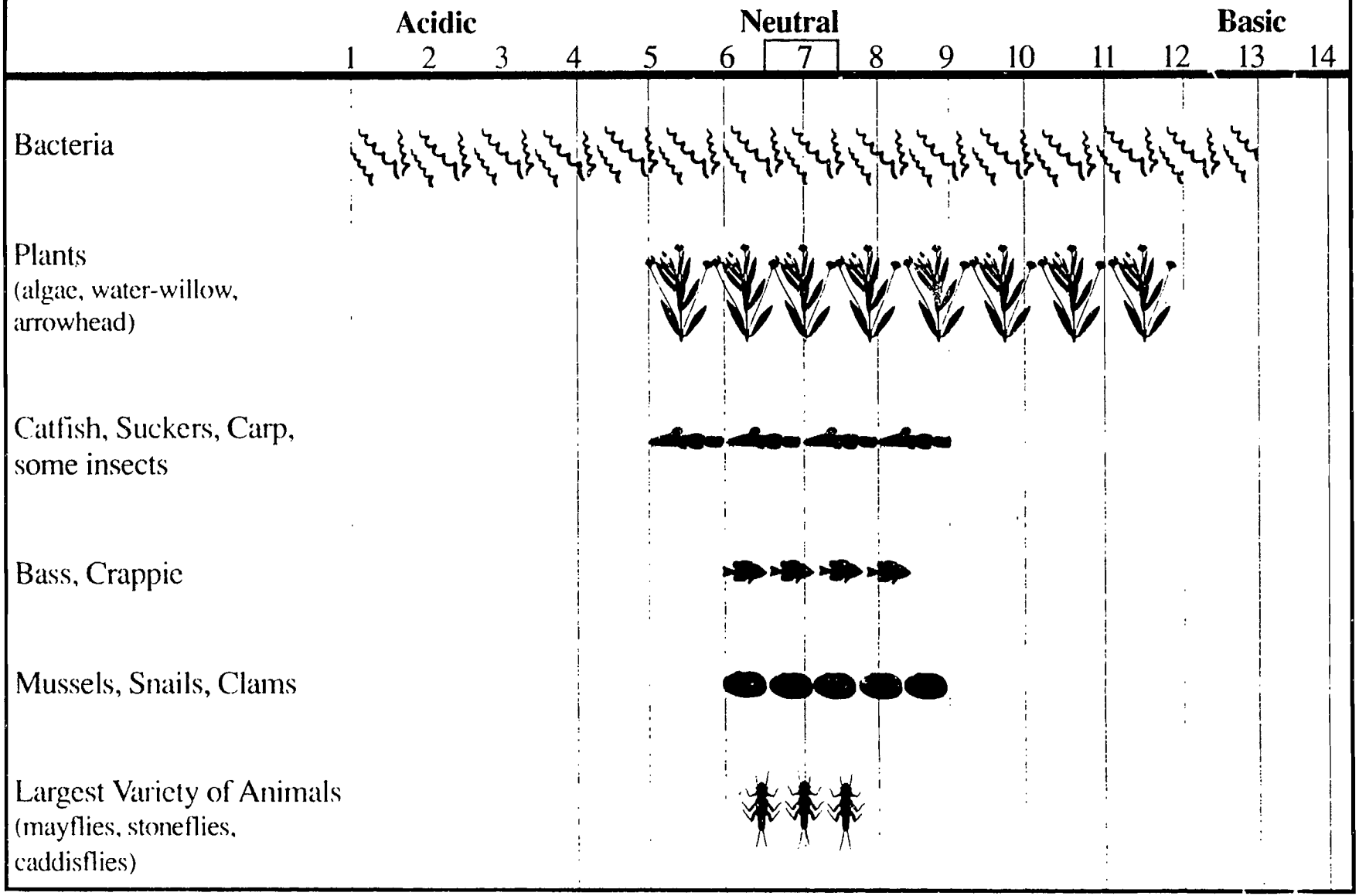


Worksheet for On-Site Activity #2

Sample pH Range

	Acid						Neutral					Base		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
H_2O (Distilled)														
H_2O (Eno River)														
H_2O (Rain)														
Vinegar														
Lemon Juice														
Liquid Plumber™														
Yourself														
Rolaids™														
Coca-Cola™														
Baking Soda														
Formula 409™														
Soap														

pH Ranges That Support Aquatic Life



On-Site Activity #3 Sediment: The "S" Word

Curriculum objectives:

Grade 5 -
- Communication Skills: listening and visual comprehension
- Math: measurement
- Science: earth science, environment
- Social Science: organize and analyze information, draw conclusions

Grade 6 -
- Communication Skills: listening and visual comprehension
- Healthful Living: environmental health
- Math: measurement
- Science: ecology
- Social Science: organize and analyze information, draw conclusions

Location:
Fews Ford Access Area
Group size: 8 students
Estimated time: 20 minutes
Appropriate season:
April to October
Materials provided by park:
Imhoff Cones (2), 2000 ml of water with high suspended solids level

Major Concepts:

- Water quality
- Observation skills
- Measurements of sediment
- Effects of sediment on aquatic life

Objectives:

- Demonstrate how to measure sediment levels using the Imhoff cones.
- Describe three ways sediment affects aquatic life.
- List three origins of sediment and three possible ways to control the level of sediment in the river.
- List the most important causes of stream degradation in North Carolina today.

Educator's Information:

In this activity, students will observe and determine the amount of sediment in the test cones. They will discuss the origin of sediment, how sediment is tested in streams and lakes, and the effect of **sedimentation** and **turbidity** on aquatic life.

Instructions:

1. Park staff will prepare a 1,000 ml sample of sediment-laden water in an Imhoff cone prior to the arrival of the students.

2. When the students arrive the group leader will discuss sediment and turbidity. At this point, the leader will pour another 1,000 ml of sediment-laden water into a second Imhoff cone.

3. Have the students compare the two samples and observe that the second cone contains more suspended sediment; the larger particles are settling to the bottom, and the water near the surface of the cone is clearing. The first cone contains layers of sediment on the bottom; the water appears uniform in clarity from the surface to the first layer of sediment. Ask the students to explain why the water in the first cone is less turbid. (The water in the first cone is less turbid because it had time to settle and has not been disturbed - like a quiet **pool**.)

4. Ask the students where sediment comes from, its effect on aquatic life, and ways to control sediment in a watershed. Go over the key points from the Student's Information, stressing that some sediment is natural, but that most of the heavy sediment we see in our streams is due to human activities. Have the students list several animals or plants which might be disturbed or killed due to heavy sediment loads. Then have them list ways that sediment could be controlled. Encourage them to suggest any personal actions they could take to decrease the sediment runoff into our waters.

Student's Information: Sediment: The "S" Word

Sedimentation and turbidity are the major causes of stream degradation in North Carolina today. Sediment clogs fish gills, destroys habitat needed for egg-laying, blocks sunlight, carries pollutants and buries plant life.

Sediments are solid materials, usually **soil** particles, that settle to the bottom of a river, stream or lake. As a rule, particles of silt, clay and organic materials settle to the river bottom, especially in impounded or slow-moving stretches of river. These settled particles (sedimentation) can accumulate and smother the eggs of fish and aquatic insects that were laid on the river bottom. Sediment settles into spaces between rocks making these microhabitats unsuitable for mayfly nymphs, stonefly nymphs, caddisfly larvae and other aquatic insects which require such spaces.

Turbidity results from solids remaining suspended in the water. The water is no longer clear, but cloudy or muddy. Suspended solids vary, ranging from clay, silt and **plankton** to industrial wastes and sewage. They may come from soil **erosion**, waste discharge, and urban runoff from streets and parking lots. They also may be the result of excess nutrients, for when too much phosphorous and nitrogen get into the water, an over abundance of algae may grow. Depending on the source(s) of the solids, turbid water may be almost any color: white, red-brown, green, gray, purple, etc.

At higher levels of turbidity, water loses its ability to support a diversity of aquatic organisms. Waters become warmer as suspended particles absorb heat from sunlight. The higher the concentration of particles, the higher the water temperature rises, which means there is less oxygen available. Also, turbidity reduces the amount of light penetrating into the water which decreases photosynthesis; that in turn further reduces oxygen concentrations. Thus, fish and other aquatic creatures may die of suffocation.

Additionally, suspended solids may clog fish gills, reduce growth rates and decrease resistance to disease, as well as prevent egg and larval development.

Sediment: Where It Comes From

Sediment is the result of rain or other precipitation falling on exposed surfaces and carrying materials from them into streams and lakes. Sediment occurs naturally in small amounts in any body of water. Natural erosion of river banks or shorelines is one example. However, humans add significantly to sediment loads in a number of ways. Road construction, timber harvesting, allowing livestock to over graze (so that the soil is bared), clearing land for buildings, and farming all can contribute to sediment problems in our water unless sediment control methods are used.

Sediment: Stop It From the Start

With appropriate control methods sediment can be stopped before it becomes a problem. Here are several ways:

1. Planning - anytime a project is planned near a body of water, appropriate sediment control methods should be included before the project starts.

2. Buffer areas - leaving wide undisturbed strips of vegetation between a project and a body of water is essential in helping stop excessive sediment from reaching the water.

3. "Silt fence" - string a fine mesh net between the project and the body of water. When this fence is erected properly it can trap a lot of sediment.

4. Ground cover - after initial clearing for a project, all exposed areas should be seeded with grass or planted with some other ground cover and covered with straw to prevent the soil from being washed away.

5. Contour farming - farmers can plow with the contour of the land and leave buffer areas along the edges of their fields. They can also try to keep cover crops on exposed soil to minimize erosion.

6. Overgrazing - livestock should be moved at the first sign of erosion. The number of animals should not be more than an area can handle. Buffer areas along water should be fenced. Watering areas should be located where the banks are not steep. These watering areas should be fenced off and new areas should be used when erosion becomes a problem.

On-Site Activity #4 Water Bugs

Curriculum objectives:
Grade 5 -
- Communication Skills: listening and visual comprehension
- Guidance: competency and skill for interacting with others
- Healthful Living: recreational safety
- Math: measurement
- Science: earth science, environment
- Social Science: organize and analyze information; draw conclusions; participate effectively in groups

Grade 6 -
- Communication Skills: listening and visual comprehension
- Guidance: competency and skill for interacting with others
- Healthful Living: environmental health, recreational safety
- Math: measurement
- Science: ecology
- Social Science: organize and analyze information; draw conclusions; participate effectively in groups

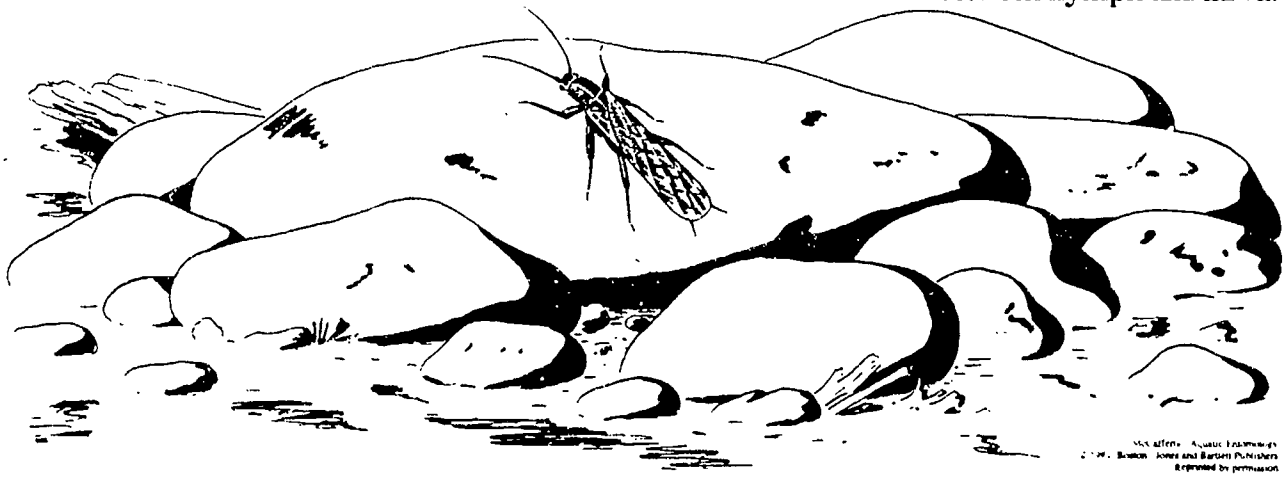
Special considerations: See the safety message on introduction page 1.3.
Location: Fews Ford
Group size: 16 students, 2 adults
Estimated time: 1 hour
Appropriate season:
April to October

Materials:
Provided by park:
kick net, seine net, dip net, wide mouth plastic jars, aquariums, plastic tubs, dissecting scopes, clipboards, remarkable board, field guides, laminated fish keys, laminated invertebrate key, aquarium nets, plastic spoons, glass dishes, table, life jackets, extra activity sheets, examples of adult macroinvertebrates

Provided by the educator:
worksheets, pencil (one per student)
Make sure participants bring a complete change of clothes and wear clothes and shoes that they don't mind getting wet and/or dirty.

Major Concepts:
- Water quality
- Aquatic sampling
- **Indicator species**
- Aquatic habitats
- Basic **anatomy**
- **Adaptations**
- **Species** identification
- Human influence on water quality

Objectives:
- Describe three characteristics of an aquatic **macroinvertebrate.**
- Identify three macroinvertebrates.
- Define indicator species.
- Name three indicator species and explain how they are used to determine water quality.
- Use keys and field guides to identify unknown aquatic specimens.
- Use a dissecting scope.
- List three or more ways humans affect **aquatic life.**
- Describe the differences between **nymph** and **larva.**



Educator's Information:

To prepare your students for their visit, we recommend the pre-visit activities: Map Trivia and Keys Made Easy.

The purpose of this activity is to introduce students to macroinvertebrates and aquatic organisms and how they can be used as indicator species to determine the health of the river.

The students will be involved in collecting macroinvertebrates in the river and must be dressed appropriately. Park staff will rope off the area where sampling will occur. Life jackets and a first aid kit will be available. Park staff will discuss safety considerations and the educator will assist in seeing that all safety precautions are followed. The students will work in groups of four or five, with one person recording the data. After completing the worksheet, students will gather and discuss their results with the park staff.

Have the students read the Student's Information and complete Pre-Visit Activity #2 - Keys Made Easy. Discuss these topics as a class prior to your visit.

Instructions:

1. Park staff will lead a brief discussion focusing on: **macroinvertebrates (macros)**, what they are and why they are important; **metamorphosis**, what it is and how it is accomplished; and indicator species, what they are and how they are used to determine the health of a river. Park staff will also cover how to use sampling equipment and safety precautions that must be followed when using the equipment.

2. Separate the students into groups of four or five and have them collect aquatic samples following all safety procedures.

3. After collecting samples, each group should identify the aquatic macroinvertebrates using the "Key to Common Macroinvertebrates." They should also use field guides and dissecting scopes to aid in identification. Have them record their answers on the "Aquatic Sampling Data Sheet" and use their results to determine the **Stream Index Value** (relative health) of the river.

The Stream Index Value groups macros into three groups based upon how tolerant or sensitive they are to changes in water quality.

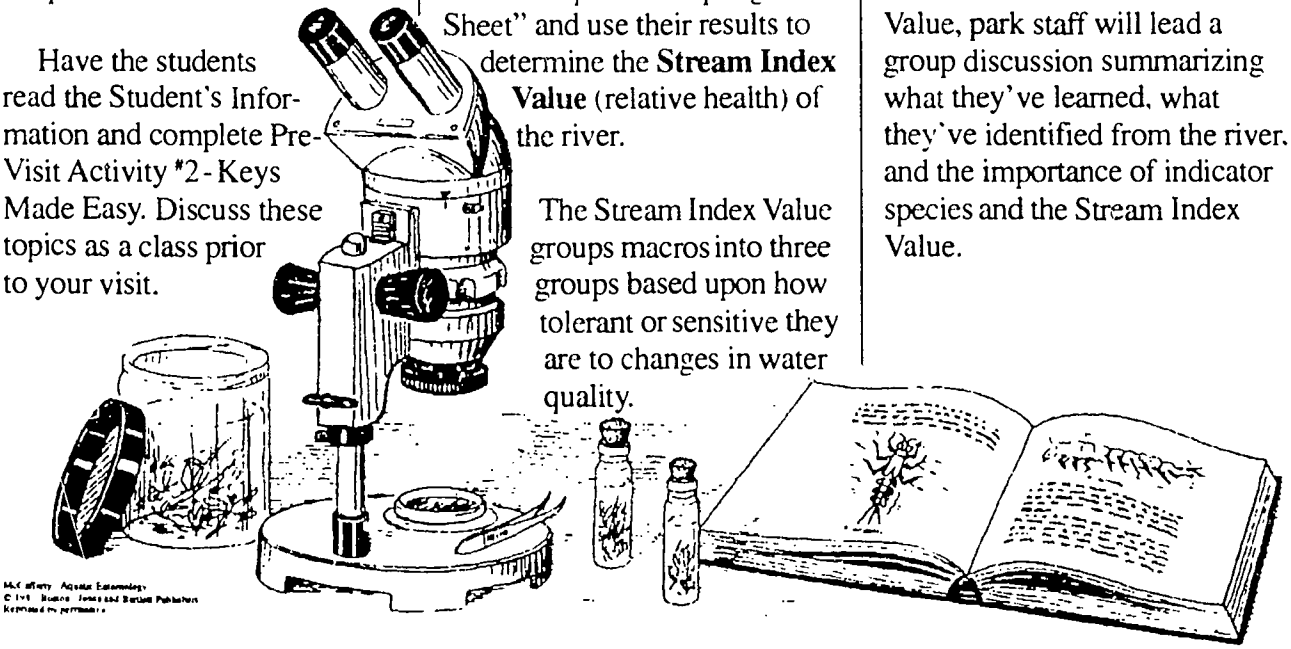
Group I includes macros that are very intolerant to water pollution. The dominant presence of Group I species is an indication of good water quality. Group I is given an index value of 3.

Group II includes macros that are moderately tolerant to a reduction in water quality. They are given an index value of 2.

Group III represents macros that are tolerant to pollution. Their dominance indicates poor water quality. They are given an index value of 1. The students will learn how to calculate the Stream Index Value by using a simple formula:

(3 x number of Group I)
(2 x number of Group II)
+ (1 x number of Group III)
= **Stream Index Value**

4. After the students have identified their specimens and determined the Stream Index Value, park staff will lead a group discussion summarizing what they've learned, what they've identified from the river, and the importance of indicator species and the Stream Index Value.



Student's Information: Water Bugs

"Water, Water everywhere nor any drop to drink." So says the sailor in Samuel Taylor Coleridge's "Rime of the Ancient Mariner" as their boat is becalmed at sea. Fortunately, in our area water is everywhere and there seems to be plenty to drink. But that may be changing. Let's take a closer look at water and discover what a fragile and sensitive resource it is.

What is water? The dictionary defines water as a colorless, odorless transparent liquid occurring on earth as rivers, lakes, oceans, etc., and falling from the clouds as rain, snow, ice, etc. Water occupies more than 70 percent of the earth's surface, and it makes up approximately 60 percent of the human body. You may have heard the saying "Water is life." Think about it for a minute. Can you think of any living organism that does not depend on water?

David Quammen, in his book, Natural Acts, A Sidelong View of Science and Nature says, "Without life, there would still be water. Without water no life."

Recipe for a River

Water comes in many forms. To really appreciate it you need to pick out one of its many forms and get to know it personally. For your visit to Eno River State Park you need to know more about water in the form of a river.

What is a river? A river is defined as a natural flow of water which empties into an ocean, a lake, or another river. It is the result of springs, streams and creeks joining together to produce a larger **volume** of flow. These smaller bodies of water are called **tributaries**. The land that a river and its tributaries flow through is called a **watershed**. A healthy river must have a well protected watershed because any kind of disturbance to the watershed has an effect on the river.

Life in a River

The various forms of life found in a river can be compared to a fine stew or soup. Just like a river, a fine stew or soup needs lots of different ingredients. Usually the more you add, the better the stew. A stew also needs small amounts of spices to make it taste just right. If you try to make a stew with just one ingredient, or if you leave out an important spice, your stew is not going to be good.

Here then is a recipe for a fine healthy river.

Some sunlight - just enough for **algae**, moss, diatoms and aquatic plants to photosynthesize. (Too much sun heats up the water and robs it of dissolved oxygen.)

Fallen leaves - they provide the main source of energy for a river system. In the fall, leaves drift down from the trees into the water where they soon sink to the bottom or get caught in logjams or wedged between rocks. At this point, bacteria and fungi climb aboard the leaves and begin to "munch out," causing the leaves to decompose and break down into smaller pieces. The half-eaten leaves, bacteria and fungi are eventually swept downstream where they provide food for munchers, grazers and filter feeders - the wonderfully adapted macroinvertebrates (macros), such as stonefly nymphs, mayfly nymphs, and caddisfly larvae. These organisms further break down the leaves into a very fine mulch called **detritus**. In addition to the munchers, grazers and filter feeders, there are other types of macroinvertebrates that prey on other macroinvertebrates. Lots of different kinds of macros are a sign of a healthy river.

Dissolved oxygen and carbon dioxide - all the animals in the river need dissolved oxygen to breathe. These same animals breathe out carbon dioxide which is essential for algae and other aquatic plants. These plants in turn take in the carbon dioxide and give off oxygen.

Aquatic plants and animals - aquatic plants like riverweed and water willow provide cover for macros and small minnows. All the aquatic animals in the river provide food for each other and non-aquatic animals in a complex **food web**. When all these various plants and animals die or excrete waste, they return essential nutrients that were borrowed so that they could live.

Various minerals - the fine spices of a river include calcium bicarbonate, potassium, nitrates and phosphates. These ingredients help balance a river's pH, provide building material for the shells of snails, **mussels**, clams and crayfish, help fish breathe more efficiently and act as natural fertilizers essential for aquatic plants.

These are just the minimum ingredients needed for a healthy river. Now mind you, a river needs only natural ingredients, unnatural ingredients can have a bad affect on a river. David Quammen sums up what makes a healthy river when he talks about a trout stream. "A good trout stream must first be an excellent insect stream, a superior haven for algae and fungi and bacteria, a prime dumping ground for dead leaves, a surpassing reservoir of oxygen and calcium. It will then also, and thereby, be a good osprey stream, a favorite among otters, a salvation to dippers and kingfishers and bank swallows and heron, mergansers and Canada geese and water shrews, mink and muskrat and beaver. Not to mention the occasional grizzly bear. And who knows but that, sometime, a human might want to drink."

If there are plentiful numbers of many different species of plants and animals in a river, then we have a healthy river. Taking samples of these aquatic plants and animals is a means to monitor the quality of a river's waters.

Key To Common Macroinvertebrates
Found at Fews Ford, Eno River State Park

Eno River State Park, NC

4.4.5

October 1992

Legend

Pollution Tolerance	Index Value
(I) - Intolerant	Group I
(M) - Moderate	Group II
(T) - Tolerant	Group III

- **Macroinvertebrates**
  - **With shells**
    - **Double shell**
      - Shell nearly uniform in shape (rounded) → Freshwater clam (M)
      - Shell longer than wide → Freshwater mussel (I)
    - **Single shell**
      - Spiral shell → Pouch snail (I)
      - Coiled shell → Ramshorn snail (I)
  - **Without shells**
    - **Obvious legs**
      - **Three pairs of legs**
        - **Two pairs of wings extending over abdomen**
          - Beetle-like appearance
            - Hind legs short → Whirligig beetle adult (M)
            - Hind legs long
              - Swims on back two long oar-like legs → Backswimmer adult (M)
              - Crawls on rocks, black body → Riffle beetle adult (M)
          - Thin body with wide spread legs
            - Active on water surface → Water strider adult (M)
            - Active under water surface → Water scorpion adult (M)
        - **No wings**
          - Body with hardened exoskeleton, flattened
            - No tail-like appendages small round → Water penny Riffle beetle larva (I)
            - Tail-like appendages
              - Two tailed → Stonefly nymph (I)
              - Three tailed
                - Long conspicuous tail appendages
                  - Tail appendages bristle-like → Mayfly nymph (I)
                  - Tail appendages broad & oar-like → Damselfly nymph (M)
                - Short inconspicuous tail appendages → Dragonfly nymph (M)
          - Entire body soft/cylindrical
            - Body white to greenish with or without a portable case → Caddisfly larva (I)
            - Body dark, head with prominent pinchers → Dobsonfly larva (I)
      - **More than three pairs of legs**
        - gill tufts at base of lateral appendages → Dobsonfly larva (I)
        - no gill tufts → Fish fly (I)
        - Lobster-like → Crayfish (M)
        - Shrimp-like body flattened to side, swims with legs → Scud (M)
    - **No obvious legs**
      - Caterpillar-like
        - Distinct head, enlarged abdomen → Black fly larva (T)
        - No distinct head, body tapered at both ends → Crane fly larva (M)
      - Worm-like
        - Body with suction disks at both ends → Leech (T)
        - Body without suction disks → Freshwater worm (T)

Worksheet for On-Site Activity #4

Aquatic Sampling

Name: _____ Date: _____

Location: _____ Temperature: Air _____ Water _____

Methods used to sample: _____ Stream Index Value: _____

Instructions:
Use the "Key to Common Macroinvertebrates" or "Pollution Tolerance of Macroinvertebrates" chart to identify organisms. Record the species of organisms found in the space below, using the chart to classify them by their tolerance levels. (See example below.)

Group I	Group II	Group III
1.	1.	1.
2.	2.	2.
3.	3.	3.
4.	4.	4.
5	5.	5.
6.	6.	6.
7.	7.	7.
Total =	Total =	Total =

Calculate the Stream Index Value by multiplying the number of species of organisms in each group by the index value for that group. Then, add the resulting three numbers to obtain the Stream Index Value (see example below.)

(3 x no. of species - Group I)
(2 x no. of species - Group II)
+ (1 x no. of species - Group III)
= **Stream Index Value**

Cumulative Index Values	Stream Index Rating
23 and above	Excellent
17 to 22	Good
11 to 16	Fair
10 to less	Poor

EXAMPLE:

Group I	Group II	Group III
1. stonefly *4. riffle beetle*	*1. dragonfly*	*1. black fly*
2. mayfly *5. caddisfly*	*2. crayfish*	*2. freshwater worm*
3. mussels *6.*	*3.*	*3.*

(3 x **5**) + (2 x **2**) + (1 x **2**) = **21**

[**21** is the stream index value, which is a good rating according to the chart above]

Adapted from A Field Manual for Water Quality Monitoring, An Environmental Education Program for Schools by Mark K. Mitchell and William B. Stapp.

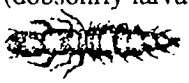
Pollution Tolerance of Macroinvertebrates

Group I - Index Value = 3

These macroinvertebrates can not tolerate pollution or changes in water quality. Their presence or dominance generally indicates good water quality.

mayfly nymph

Hellgrammite
(dobsonfly larva)



freshwater mussel

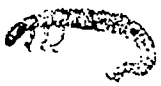
stonefly nymph

riffle beetle adult

right-handed pouch snail

water penny
(riffle beetle larva)

caddisfly larva



Group II - Index Value = 2

These macroinvertebrates can exist in a wide variety of water quality conditions.

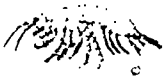
dragonfly nymph

damselfly nymph

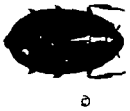
crayfish

freshwater clam

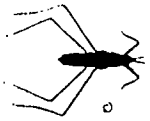
scud



whirligig beetle



water strider



Group III - Index Value = 1

These macroinvertebrates can exist in polluted water. Their dominance indicates poor water quality.

black fly larva

leech

freshwater worm

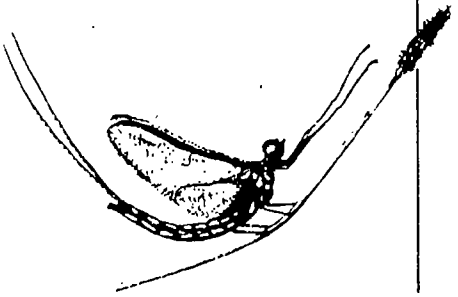
Post-Visit Activity #1 — Fragile Waters

Curriculum objectives:

Grade 5 -
- Communication Skills: listening and visual comprehension, study skills
- Guidance: competency and skill for interacting with others
- Science: earth science, environment
- Social Science: organize and analyze information, draw conclusions; use maps, participate effectively in groups

Grade 6 -
- Communication Skills: listening and visual comprehension, study skills
- Guidance: competency and skill for interacting with others
- Healthful Living: environmental health
- Science: ecology
- Social Science: organize and analyze information, draw conclusions; use maps, participate effectively in groups

Location: classroom
Estimated time: one to three 45 minute periods
Appropriate season: any
Credits: This activity was adapted from the Aquatic Project WILD activity, Dragonfly Pond.



Materials:
Provided by educator:
for each student: one copy of Student's Information, and "Special Species Fact Sheet," for each three students: scissors, masking tape, paste or glue, paper, one copy of each of the following: "Legend and Land Use Cutouts," "Topo Map of the Upper Eno River Basin," "Eno River to the Pamlico Sound"

Major Concepts:
- Human impact on the Eno River watershed
- Water quality
- Land use planning and its effect on the Eno and areas further downstream
- Resource management

Objectives:
- Evaluate the effects of different imaginary land uses on the Eno River watershed.
- Discuss and list five ways to minimize damaging effects in the Eno watershed.
- List two animal species endemic to the Neuse and Tar River watersheds.

Educator's Information:

Every human use of land in the Eno River watershed has a positive or negative effect not only on the Eno River, but on the water, wildlife and people from here to the Pamlico Sound. What we do with land is a reflection of our priorities and lifestyles. The search for a modern day "good life" and all of its conveniences produces mixed results for plants, animals, water quality and people in the Eno watershed. Some people see our natural resources as little more than raw material for human use. Others believe that the natural environment is to be preserved without regard for human needs. Still others yearn for a balance between development and protecting our resources. Very real differences of opinion regarding these issues exist between well meaning people.

At the core of land use issues is the concept of growth. Growth in natural systems has inherent limits, imposed by a dynamic balance of energy between all parts of the system. Energy in natural systems is translated into food, water, shelter, space and continued survival. This means that the vitality of natural systems is expressed by their ability to be self-regulating. This capacity for self-regulation makes it

possible for all natural members of an **ecosystem** to live in harmony. All life forms of any ecosystem must be considered. The macroinvertebrates in the water are just as necessary to a habitat as the plants and fish. It is this natural dynamic balance, with all its inherent and essential parts, that much of human land use has tended to disturb. Human activities often go beyond the natural limits of a setting. Humans have the ability to import energy sources that allow a system to exceed its natural limits - or to remove energy sources that are necessary for a system to stay in balance. For example, people can dam rivers to provide power, drinking water and irrigation. Water from the river can be used in factories, mills, sewage treatment and other industries that need large amounts of water to produce certain products. All of these activities could affect life in the Eno River watershed.

The purpose of this activity is to encourage students to wrestle with development, local economy and resource management issues. The students will use the Eno River watershed as a microcosm of environmental concerns in making management decisions. They will contend with the arrangement of overlapping and conflicting land uses in an effort to preserve the Eno River watershed. When the students reach some kind of agreement about local issues, they will discuss how what they have done affects the river downstream. The activity ends with the idea that the planet is, in fact, a single river watershed.

Instructions:

1. Prepare copies of the land use cutout sheet, the "Topo Map of the Upper Eno River Basin," the Student's Information and "Special Species Fact Sheet" ahead of time. Explain the activity. Tell the students that they will be responsible for arranging the pattern of land use around the Eno River in such a way as to minimize the impact on the river. Remind them that some of these land uses might be conflicting and therefore they will have to make some very tough management decisions. Pass out the Student's Information and "Special Species Fact Sheet" and have the students read them.

2. Divide the class into groups of three to five, with each group representing one of the interest groups or taking on the role of the town commissioners.

Students will stay in these groups until the end of the activity. Each group must decide where to place all the land uses.

Possible interest groups:

- Residents - people who want to live there.
- Farmers - want to use the land to raise food.
- Businesses - want to use land for commerce and growth.
- State park - wants to preserve and protect watershed for plants and wildlife, recreation, drinking water and historic sites.
- Highway department - wants to build a bypass road to ease traffic congestion in town.
- Textile factory - wants to construct a huge factory that would provide 500 jobs and boost local economy.
- School representatives - want to build a new school to accommodate more students due to rapid growth of the town.
- Hospital representatives - propose building a new hospital to service the community in the future because of expected growth and development in the area.
- County and state representatives - believe it is essential to have a bigger landfill and a newer, more efficient wastewater treatment plant.

3. Pass out the "Topo Map of the Upper Eno River Basin." Read the following text to the students:

You will be using an enlargement of an actual **topographic** map of the upper Eno River basin. Topographic is derived from Greek words *topos*, meaning place, and *graphein*, meaning to write or draw. Thus, a topographic (topo) map is a drawing or picture of a place. One feature on a topo map is **contour lines**. Contour lines are thin lines that indicate the contour of the land and its elevation. The distance between contour lines on your map is 10 feet. Where the lines are very close together there is steep terrain. Level terrain appears where contour lines are further apart. Knowing how steep or flat the terrain is in this activity will dictate where certain land uses can occur. For example, you would not want to put a landfill on a steep ridge. A legend explaining other map symbols is included on the "Legend and Land Use Cutouts" page.

Spend some time discussing features and symbols on the topo map. Practice locating ridges, summits, rivers, highways, etc.

Then read the following text aloud:

Notice that there are two species of plants and three species of animals on the map where they might naturally occur. These species are either state protected or have special habitat requirements. The purpose of placing these on the topo is to make the decisions more realistic. Information on these species is on the "Special Species Fact Sheet."

4. Pass out the "Land Use Cutouts" sheet and the "Topo Map." Have the students cut out the land use pieces. When they fasten the cutouts to their "Topo Map," suggest that they use small loops of tape. This will allow them to change their minds before they paste them down.

5. Place the following rules on the chalkboard:

- all land use cutouts must be used; the cutouts may be cut smaller
- cutouts may touch, but may not overlap
- no cutout, except for the state park, can touch or cover a "Special Species" circle
- except for the state park and the vegetable farm, all cutouts must touch a new or existing road
- vegetable farm and landfill must be on relatively level land
- both textile factory and waste water treatment plant must touch the river
- no cutout can touch or cover an existing building

6. Once the students have cut out the necessary materials and are ready to make land use decisions, have them create a list of pros and cons for each land use. Guide the class discussion so the consequences of each land use are considered. Record these on the chalkboard.

7. Have the students work in their groups long enough to begin to seriously grapple with the challenge.

8. Invite each group to display and describe their work in progress. Encourage discussion of their choices. In the discussions emphasize that:

- no land use can be excluded
- wildlife habitat must be preserved
- everyone within their small group must agree

Discuss how their plans will impact the various interest groups.

Look for the consequences of their proposed land use plans. Be firm about this being a very difficult set of choices. Remind them that for certain habitats this is a "no-win" situation in many ways. The best that can be hoped for is that the land use plans will minimize the threats to the river and the special plants and animals.

9. Display all the final land use plans for everyone to see and discuss. Analyze and discuss the merits of each of the approaches. Point out that although their solutions may not be perfect, they can minimize the damage to the Eno River.

10. Pass out the "Eno River to the Pamlico Sound" sheet. Choose one of the groups' land use plans and connect their topo to the "Eno River to the Pamlico Sound."

11. Ask the students to brainstorm possible effects that their land use plans could have on the water quality and people downstream. For example, you could emphasize the **effluent** from the textile factory. How will it be treated? Where? By whom? Where will it go? What effect will it have on water quality?

12. Ask the students to look again at all of the land uses in this activity. What could the people who are actually in charge of these various land uses do in their practices to minimize the damage to Eno River and the special species? End the activity with a discussion of solutions, rather than of problems. For example, some industries have developed new technology that allows them to remove harmful waste using a scrubbing filter. Maybe such a filter could be used on their textile factory. Some communities have used new technology to collect methane gas (a common gas generated by decomposing garbage) from landfills and use it as a source of energy.

13. Ask the students to create a list of things they, personally, can do to begin to reduce the potentially damaging effects of their own lifestyles on the downstream habitats. If possible invite them to report periodically, throughout the school year, on their progress in carrying out these new practices. Discuss with them the concept that all the waters of the planet are, in fact, part of a single Eno River.

Extensions:

1. Trace the Eno River from its origin to the Pamlico Sound. List all the sites that might lower the quality of the waters in their journey to the sound and suggest how to reverse the process of lowering water quality.

2. Take a field trip to Cliffs of the Neuse State Park near Goldsboro to collect similar data on the river the Eno feeds into, the Neuse. For more information contact:

Cliffs of the Neuse State Park
Route 2 Box 50
Seven Springs, N.C. 28578
(919) 778-6234

3. Collect newspaper articles for local water and land related issues as a current events activity.

4. Learn more about environmental impact statements. Try to obtain actual statements concerning land use in your area. See what concerns are addressed in these documents.

5. Find out about zoning laws and land use regulations in your area. Would the plans the student groups proposed for the upper Eno River be allowed in your community?

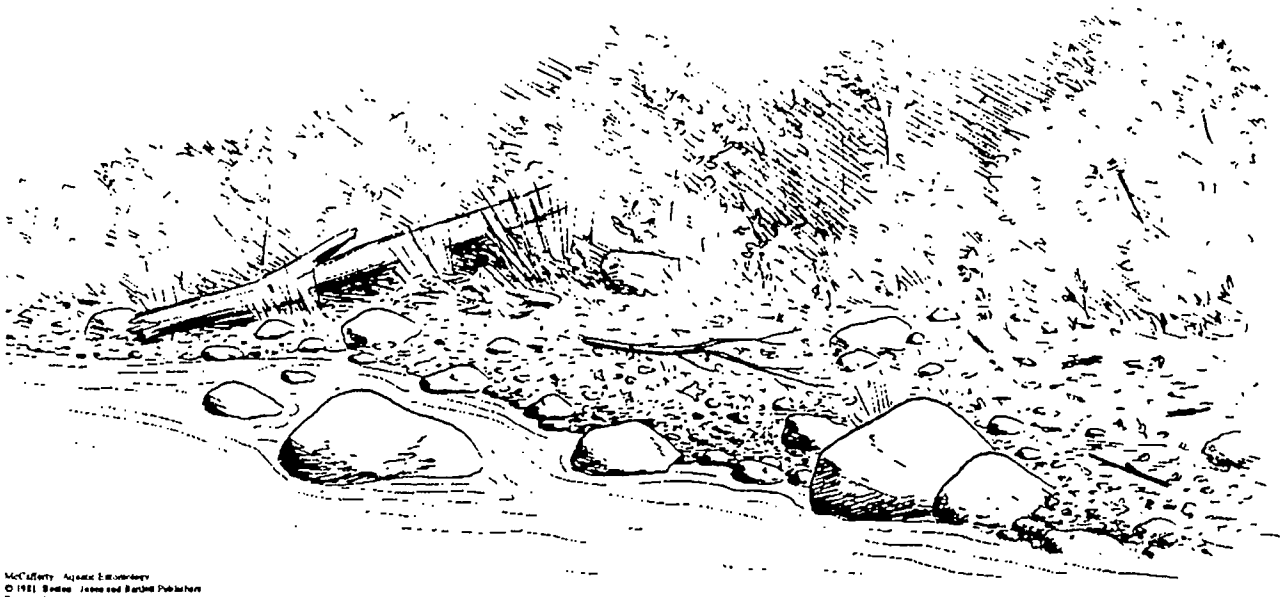
6. Send a representative sample of the students' land use plans to the park. (We would appreciate the feedback.)

Student's Information: Fragile Waters

The Eno River watershed is located in an area that is growing rapidly. Homeowners and industry are spreading out from our cities into the country. They seek undeveloped land to use and help our local economy by creating new jobs. This is good but sometimes development conflicts with protecting the river and the special species that live in the watershed. This is where different people have different ideas about how to best use the land and water from the Eno River and still insure that the Eno is clean.

Think back to your visit to the Eno River. We know that the Eno provides drinking water for Hillsborough and Raleigh. We know that water is taken from the Eno for sewage treatment, irrigation and use in industry. Many different forms of recreation are enjoyed in the Eno River watershed. The Eno River and its watershed provide crucial habitat for many plant and animal species. The Roanoke bass and Neuse River waterdog are two animals that are **endemic** to the Neuse and Tar river watersheds, of which the Eno is part. Endemic means they are found in these watersheds and nowhere else on earth!

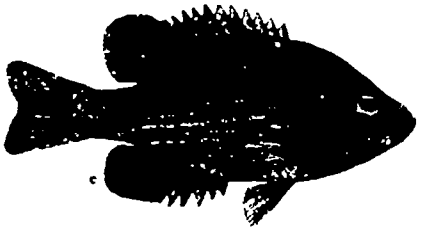
So how do we make land use decisions that will benefit the local economy and still protect our natural resources? The following activity is designed to give you a taste for how difficult the decision making process can be.



Special Species Fact Sheet

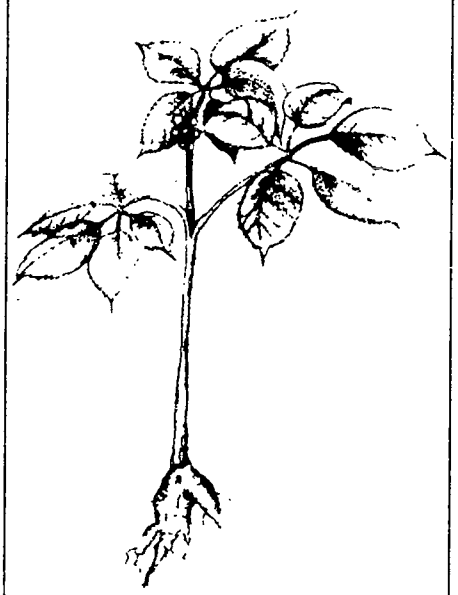
Yellow lady's-slipper orchid

A rare wildflower in this area. It requires soils that are close to a neutral pH (most soils in our region are acidic) and a mature tree canopy to give partial shade. It takes a minimum of 15 years for this orchid to grow from seed to a flowering plant.



Roanoke bass

An endemic fish that requires clean swift flowing rivers with rock and gravel bottoms. The Roanoke bass is a favorite game fish in this area.

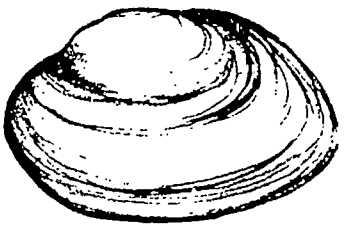


American ginseng

A medicinal plant that has been over-collected to sell in this country and overseas. Ginseng is very rare in this area and is becoming rare in the mountains where it was once plentiful. This plant has been used for centuries for its reported medicinal powers.

Thorey's grayback drag(nfly

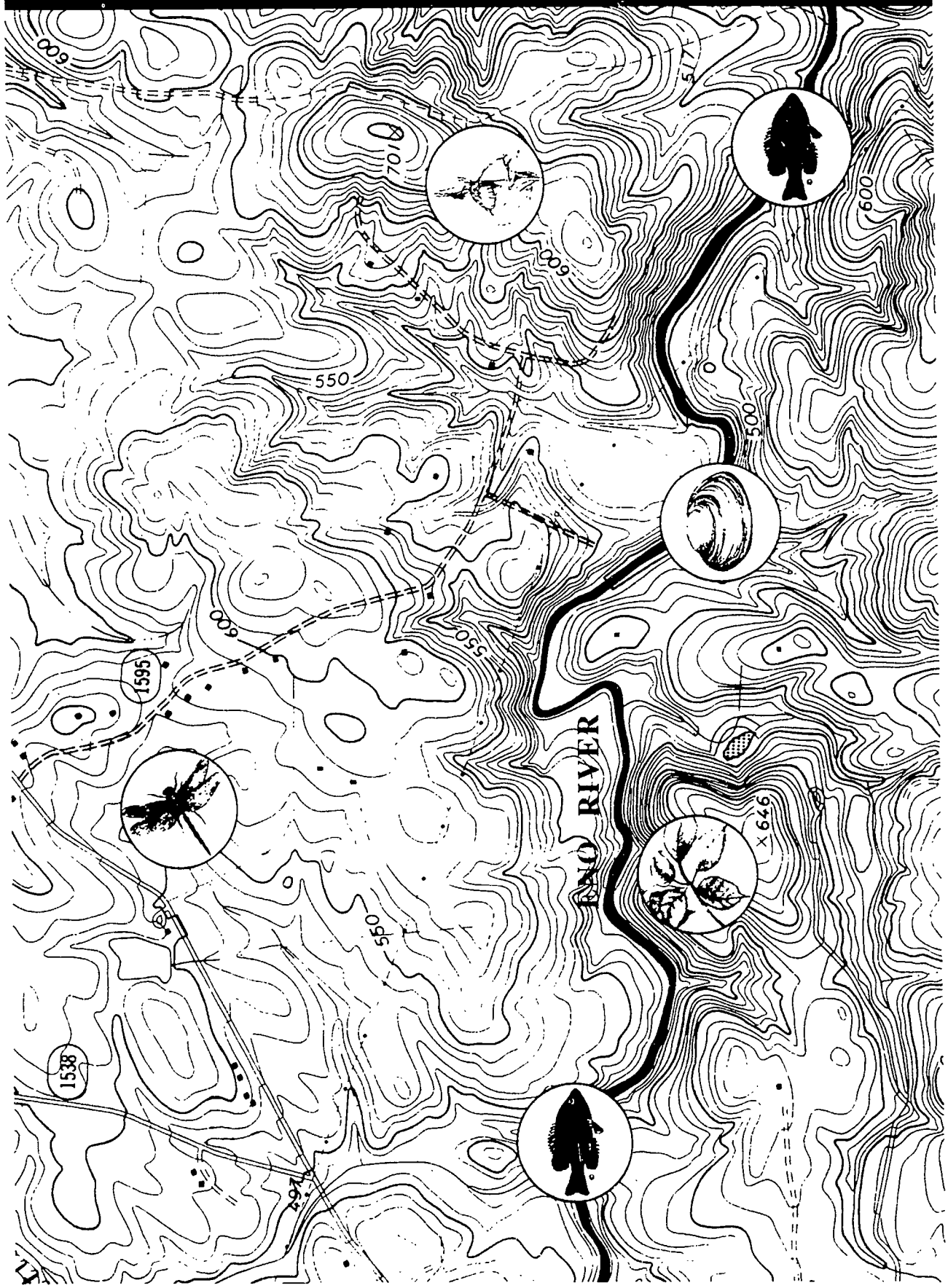
A type of dragonfly that : .s very special habitat requirements. It needs wet seeps or marshy areas near springs to raise its young. This dragonfly is also interesting because it hunts mainly in the forest instead of over water like most dragonflies.



Yellow lampmussel

Almost all mussels require clean water to live in. Since the lampmussel is a filter-feeder, it passes large volumes of water through its system to strain out its food. If the water in which it lives is polluted, the pollutants can become concentrated in the mussel's tissue and kill it or impair its ability to reproduce. The yellow lampmussel's presence in a river is an indicator of good water quality.

Topo Map of the Upper Eno River Basin



Legend and Land Use Cutouts

LEGEND FOR TOPO MAP

Building	■		
Light-duty road	═══	**Elevation heights**	—550—
Unimproved road	= = = = =	**Summit symbol**	X
Power line	--•----•--	**Topo lines** (10 ft. intervals)	

ROAD

DRY CLEANERS

GAS STATION

SHOPPING MALL

OFFICE COMPLEX

GROCERY

WASTE WATER TREATMENT PLANT

FIRE STATION

VEGETABLE FARM

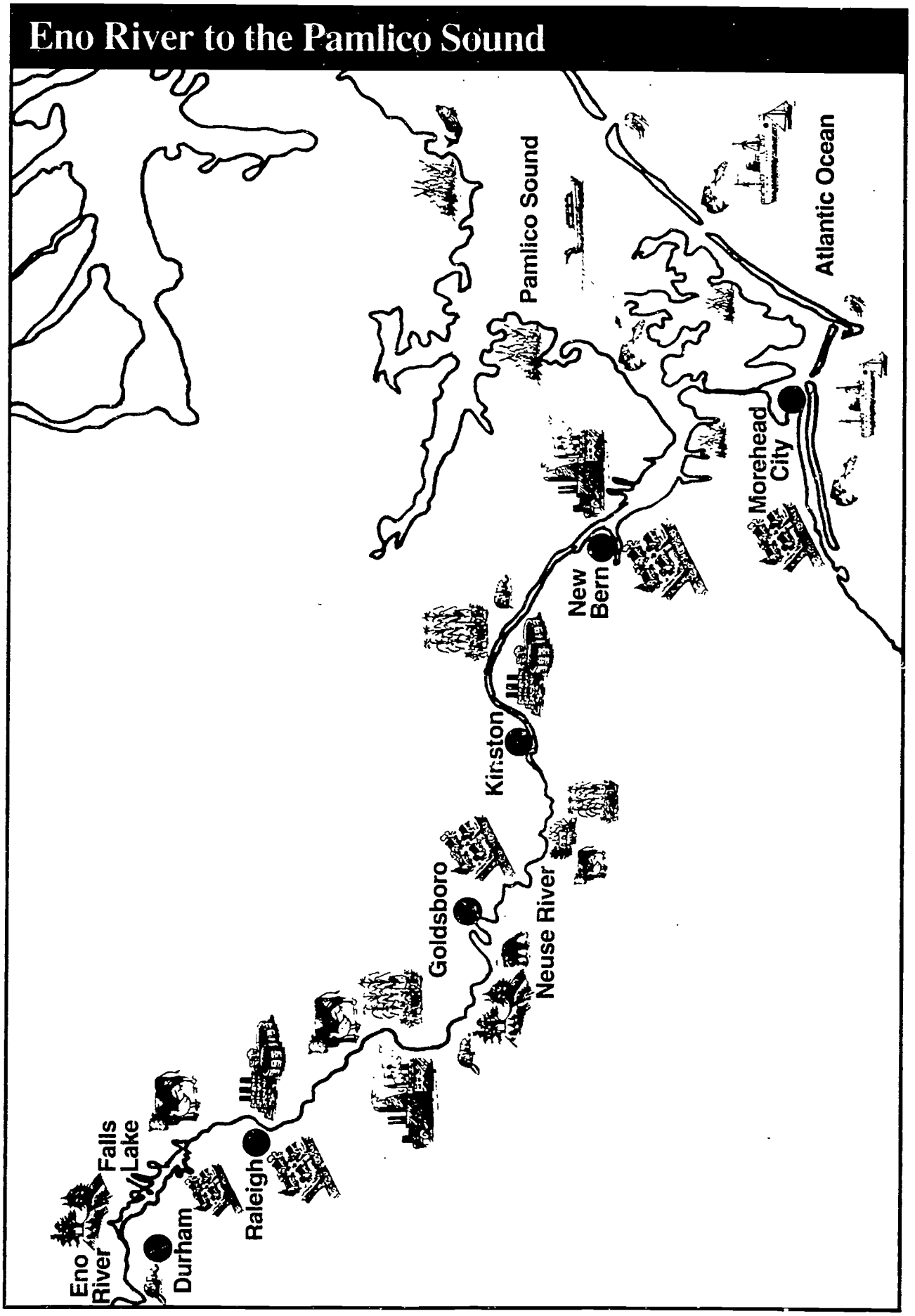
SCHOOL

TEXTILE FACTORY

STATE PARK

LANDFILL

HOSPITAL


Eno River to the Pamlico Sound
Eno River
Durham
Falls Lake
Raleigh
Goldsboro
Neuse River
Kinston
New Bern
Pamlico Sound
Morehead City
Atlantic Ocean

Post-Visit Activity #2 — Troubled Waters

Curriculum objectives:

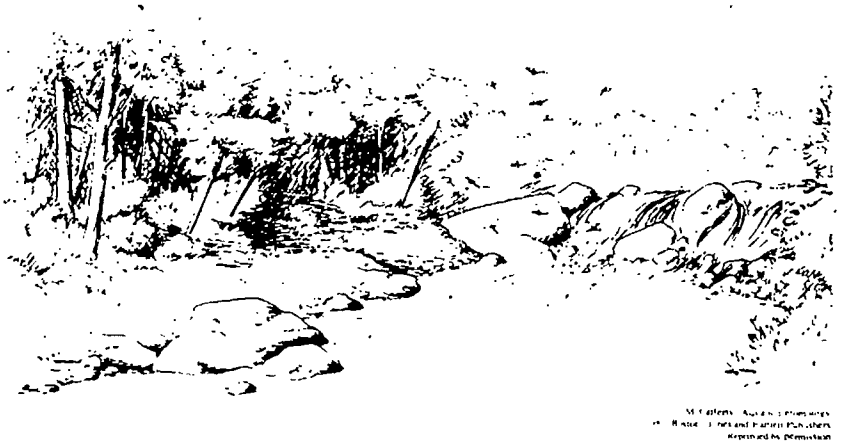
Grade 5 -
- Communication Skills: listening and visual comprehension, writing, study skills
- Guidance: competency and skill for interacting with others
- Science: earth science, environment
- Social Science: organize and analyze information, draw conclusions; use maps, participate effectively in groups

Grade 6 -
- Communication Skills: listening and visual comprehension, writing, study skills
- Guidance: competency and skill for interacting with others
- Healthful Living: environmental health
- Science: ecology
- Social Science: organize and analyze information, draw conclusions; use maps, participate effectively in groups

Location: classroom
Estimated time: two or more 45 minute class periods.
Appropriate season: any

Credits: This activity was adapted from the Aquatic, Project WILD activity, Something's Fishy Here!

Materials:
Provided by educator:
Student's Information and "Troubled Waters" story (one per student)



Major Concepts:

- Water pollution
- Problem solving
- Creative writing
- Cause and effect relationships

Objectives:

- Identify two potential cause and effect relationships involving aquatic pollution.
- List and evaluate two alternative solutions to problems with aquatic pollution.
- Create an action plan to reduce aquatic pollution.

Instructions:

1. Have the students read the Student's Information.

2. Have each student read the story.

3. After the students have finished reading, discuss the story with them. Ask the students to think about as many different endings to the story as possible. Ask each student to write an ending to the story.

4. Divide the class into small groups. Have each group discuss how they think the story should end, sharing the ending they wrote.

5. Have each group present one or more of their endings to the rest of the class. List the essential points of each ending on the chalkboard.

6. Discuss the various endings with the entire class. Identify cause and effect relationships. Look for possible relationships between the story and problems regarding water use in the Eno River watershed or an aquatic habitat in your community.

7. Next, have the students generate a list of possible aquatic problems that they believe exist in their community. Then go through the list, noting which problems they might be able to solve. For example, pollution in a nearby brook is far more realistic for them to address than an entire watershed. It is important that the students be able to experience some success in developing a plan to tackle the problem. Have them form groups that have a common interest in one or more of the "solvable" problems and develop an outline listing steps on how to find out more about the problem. Once they have developed this outline, have each group report back to the class. Or, decide on one problem and work on it as a class.

8. If several groups outlined separate problems, ask the class to select the problem they would most like to address. Assure them that choosing one does not make the others less important. To be most effective in solving a problem, it helps for everyone to get behind one effort. Remind the students to develop an attitude for a clean environment. Have them seek solutions rather than only place blame.

9. Once a specific issue is chosen, have the class list 10 things that can be done to make that problem less damaging to aquatic habitats.

10. Act as facilitator to the class by helping them develop an action plan. Establish a time line and specific assignments.

11. Once the students have implemented their action plan, or have completed a project, please send a brief summary report to the park so we can share your efforts to clean up local aquatic areas with other groups.

Student's Information: Troubled Waters

Environmental pollution is an issue everywhere on the planet. Often individuals feel overwhelmed, helpless and unable to do anything to help. Yet successful action to reduce environmental problems often starts through the actions of an individual. School children have initiated projects that improved the safety of neighborhoods, created parkland, and preserved major habitats for wildlife. When a group of individuals join together the chances of solving these problems increases. For example, Eno River State Park owes its creation to an individual who formed a group called the Association for the Preservation of the Eno River Valley.

The city of Durham wanted to build a reservoir that would have flooded the entire Eno River valley. By working together, the group was able to acquire some land and sell the idea of a park to the state of North Carolina. As a result, Eno River State Park was born and the reservoir project was abandoned. All of this work originated from one person's decision to take action.

There is still much to be done to protect aquatic habitats in the Eno River watershed. Reducing or eliminating pollution is one area where individuals can make a difference. Significant aesthetic improvements can result from reducing two common forms of water pollution - litter and sedimentation. Other forms of pollution are harder to detect and control. Much work needs to be done to identify and eliminate sources of pollution in lakes, rivers, groundwater and oceans.

Pollution is a term that is, at times, difficult to define. Even in nature, pure water cannot be found. When precipitation falls from the sky it picks up carbon dioxide and other gases and becomes more acid and capable of dissolving some rocks. Water is known as the "universal solvent." This means that it can dissolve many kinds of substances. Water can also carry suspended particles such as soil and plant material. These particles reduce the penetration of light into water which affects the plants living below the water's surface. Water temperature and the amount of dissolved gases also change over time and affect the aquatic life.

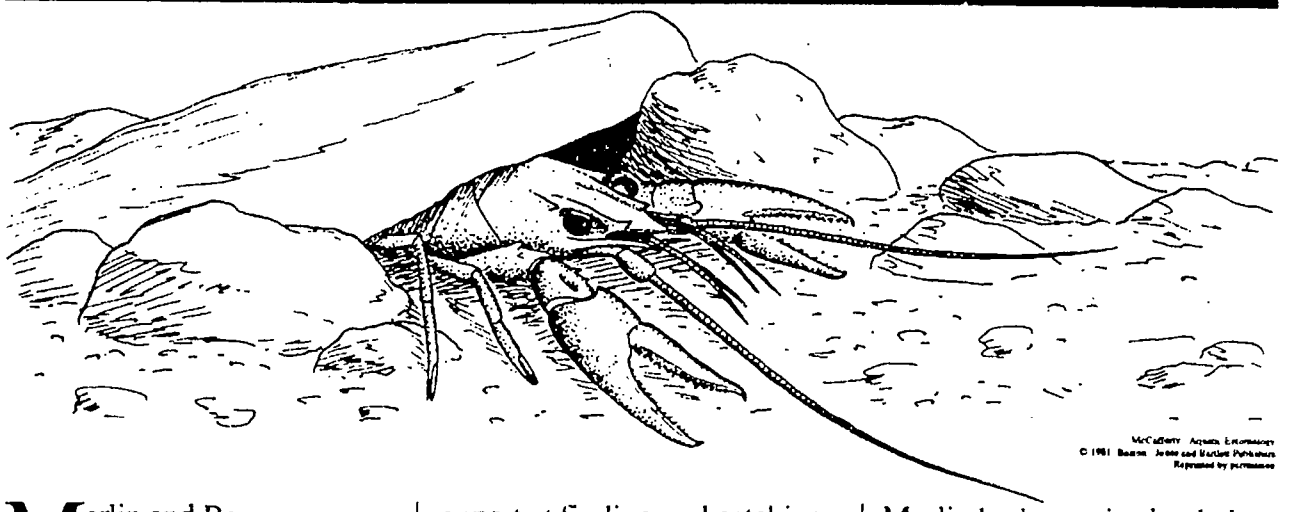
We tend to think of pollution as something that is damaging and unnatural. Additionally, water pollution is usually described in relation to the use humans make of the water in which the pollutant is found. For example, if conditions in the Eno River reach the point where Roanoke bass, a sought after gamefish, start to die, the river would

definitely be labeled polluted. It is quite possible that the river could have been called polluted much earlier, since macroinvertebrates were dying but no one had done any sampling. Moreover, it might also still support other types of fish that can tolerate more pollution than a Roanoke bass. In other words, water could be described as polluted for some organisms and not for others.

The presence of chemicals in water affects certain organisms depending upon the chemicals' concentration. Some chemicals can be toxic to some organisms even at very low concentrations. Scientists usually measure the concentration of materials in ratios, comparing the parts of the chemical substance to the parts of water containing it. When concentrations of materials reach critical levels, certain organisms die. For example, living things need the oxygen that is dissolved in water.When oxygen levels fall below certain points, organisms die. The warmer the water, the less oxygen it can hold. Some animals need more oxygen than others, therefore warm water can be described as polluted for some kinds of organisms and not for others.

The purpose of this activity is to recognize our potential for making a contribution to the environmental quality of life in our own community and our responsibilities for actions affecting life in the Eno River watershed.

Troubled Waters



Merlin and Barre were brother and sister. They lived in an old wooden house right beside the Eno River, just a little ways downstream from Hillsborough. Merlin was in the sixth grade and his sister Barre in the fifth.

Ever since they were able to walk, their parents had taken them down to the riverside to play. As they grew older, they discovered many wonderful things living in the river. With homemade nets and aquariums they would spend hours catching and watching crayfish, water striders, stonefly nymphs, minnows, frogs and turtles. They learned how to handle and release these creatures without harming them or themselves.

Often in the spring and summer, the entire family would spend a day picnicking and fishing. Merlin liked to catch feisty Roanoke bass because they fought so hard. After admiring them, he would release them. Barre was the expert at finding and catching the biggest crayfish. She would also spend more time looking at the aquatic **insects** than Merlin. These bizarre animals were fascinating to her and she already knew the names of most of the common ones. The river provided endless opportunities for adventure. There was always something new waiting to be discovered.

Springtime was eagerly anticipated by Barre and Merlin. Spring meant warmer weather, fresh air, wildflowers and lots of new life in the river. This spring was especially important to Barre. Every year the fifth grade class had an environmental science fair. Students would choose a topic and develop a display to be judged at the fair. This year the theme for the fair was water quality. Barre had decided to learn more about aquatic insects and the kind of water quality they needed to survive. She also planned to catch some aquatic insects to display alive in her aquarium at the fair. Merlin had promised to help her. With his help, she would have a good chance of winning the "Most Unusual Animal Display." Barre could hardly wait to go to the river and collect the aquatic insects for her display.

Finally, the day before the science fair arrived. Merlin and Barre walked down the short trail to the Eno River. Signs of spring were everywhere. Trout lilies, violets, and crested-dwarf iris were in bloom. Fresh new green leaves were unfurling on every tree and shrub. Butterflies and bees floated and buzzed in the clean warm air. Their hopes ran high, what a great day! They were sure to catch lots of neat aquatic insects. Merlin and Barre made their way down the slippery bank of the Eno and out onto a gravel bar that stuck out into the river. The water was shallow here and moved swiftly over small rocks and gravel. Here they planned to pick up rocks and gently scrape the clinging

insects off them. Merlin had a dip net to catch some minnows and water striders.

Barre eagerly started picking up rocks while Merlin tried to catch the minnows. The first rock she picked up had no insects on it, neither did the second or third rock. Merlin had not caught any minnows or even seen any water striders. Where were all the insects? They both looked around puzzled. Merlin then noticed some dead aquatic insects floating on the surface in a pool behind the gravel bar. Barre and Merlin looked around carefully and found hundreds of dead insects floating on the surface and washed up on the bank. There were even some dead minnows. It took a few moments to register. Barre forgot all about what this would mean for her science display. They both felt genuine concern. These fascinating animals that had provided them with hours of enjoyment were all dead! What could have happened? They soon realized that there was a mystery to be solved!

What would Sherlock Holmes have done under similar circumstances? Right! Look for clues. Hundreds of aquatic insects don't keel over from fear of being exposed in public at a science fair! There had to be a really good reason. Barre and Merlin were determined to discover the answer.

A quick glance over the surrounding area revealed little evidence of foul play. Merlin did note that there was a condition common to all of the dead aquatic insects. They were slippery to the touch and seemed to be coated with a soapy substance. Barre saw the foamy suds first. The suds were clinging to the rocks and collecting in the still waters of the deeper pool upstream. They started upstream searching for more clues. Beyond the deep pool the suds were scarce. Carefully they moved further upstream until they came to where the river flowed through town. Beyond this, a new black-topped parking lot sporting a brand new mini-shopping mall, signaled the edge of the town. There they discovered something new. Under fresh packed soil, tucked beside the fence, storm drains were partially buried. They were opened to allow flow of water into the Eno.

That night at dinner Barre and Merlin talked with their parents. They decided to map the area of the new shopping center and identify the stores that might have soap in their waste water.

Merlin and Barre sat down and compiled a list of the shopping center's stores. They produced several possibilities - Floyd's Cleaners, Davis' Wash and Dry Laundromat, Geiger's Car Wash, and Tillotson's Auto Body. They decided to record observations on a daily basis for a week. They agreed to take turns looking for evidence. (Good detectives keep records, note patterns and follow trails before they draw conclusions or make accusations.)

One evening when it was Barre's turn to observe, her mother drove her to the shopping center. What she found made her very excited. When she got home she rushed into Merlin's room and cried, "We've got them! When Mom drove me to the shopping center we drove over a big bump in the parking lot near the car wash. They have a big black hose running into the drain pipe. They connect it after dark! I saw it - I know it! They let it flow into the storm drains from their storage tanks. That's where the soap is coming from! We gotta do something Merlin! Where do we go? What do we do?"

VOCABULARY

Acid - having a pH less than 7; the chemical state of water or other substance in which the hydrogen (H^+) ions exceed the hydroxyl (OH^-) ions. For example, a car's battery acid has a pH of 1. See pH scale.

Acid Precipitation (including acid rain) - any form of precipitation that is acidic as a result of mixing with sulphur or nitrogen compounds in the atmosphere. Sulphur and nitrogen compounds can come from coal burning power plants and car emissions.

Adaptation - a change in the structure or activity of an organism that produces a better adjustment to its environment, thus enhancing its ability to survive and reproduce. For example, the flattened, oval shape of the larva of the riffle beetle (called a water penny) is an adaptation that helps it cling to the surface of rocks in swift flowing waters.

Aeration - The process of exposing to the air or to causing air to circulate through.

Algae - primitive one-celled or multi-cellular plants that contain chlorophyll, but has no true root, stem, or leaf. Normally found in water or damp places.

Alkaline - see Base.

Ammonia - a colorless, strong smelling gas composed of nitrogen and hydrogen. It has a pH of 12.

Anatomy - the branch of biology that deals with the structure of plants and animals.

Aquatic life - A plant or animal growing or living in or upon water.

Average - the numerical result obtained by dividing the sum of two or more quantities by the total number of quantities; for example, 2 + 4 + 6 + 8 = 20 and 20/4 = 5 therefore, 5 is the average of the four numbers.

Base - having a pH greater than 7; the chemical state of water or other substance in which the hydroxyl (OH^-) ions exceed the hydrogen (H^+) ions. For example, soap has a pH of 10. See pH scale.

Biochemistry - the branch of chemistry that deals with the life processes of plants and animals.

Biology- the science that deals with the origin, history, physical characteristics, life processes and habits of plants and animals.

Classification - The grouping of organisms into categories based on shared characteristics or traits. For example, any animal that has feathers is considered a bird and placed in the Class Aves. Furthermore, if the bird has its eyes in front rather than on the side of its head, it is a member of the Order Strigiformes (the owls).

Community - a group of plants and animals living in a specific region under similar conditions, and interacting with each other through food webs and other relationships.

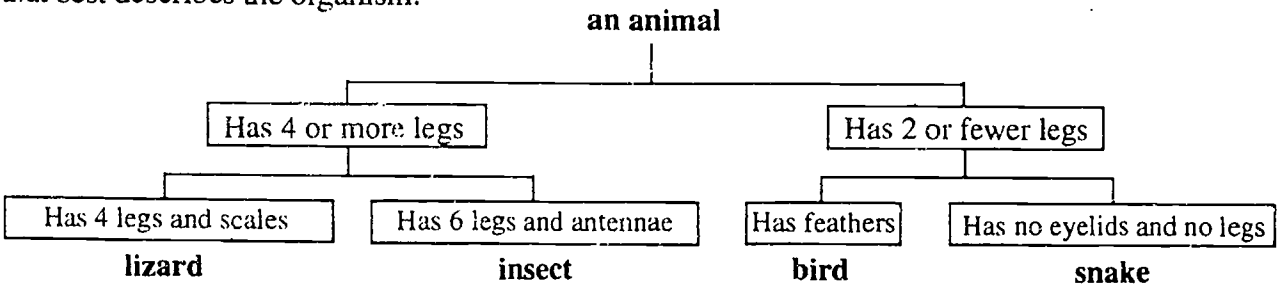
Contour Lines - thin lines found on a topographical map that indicate elevation. They show the contour of the land.

Decomposer - an organism whose feeding action results in decay, rotting or decomposition. The primary decomposers are bacteria and fungi. They are very important parts of a healthy ecosystem.

Decomposition - to rot or to break apart into basic components. Decomposition makes nutrients, such as nitrogen and phosphorous, available for use by other organisms.

Detritus - dead organic matter, such as fallen leaves, twigs, and other plant and animal material which exist in any ecosystem.

Dichotomous - divided into two parts, groups or classes, such as a dichotomous key. Using a dichotomous key, one can identify an unknown organism by following the one branch of each pair that best describes the organism.



Distribution - the act of scattering or spreading out; the geographic range of an organism.

Dissolved Oxygen (DO) - the amount of oxygen gas molecules dissolved in water. Fish and other aquatic animals depend on DO for respiration.

Ecosystem - plants, animals and their physical surroundings which interact with environmental conditions, such as temperature and rainfall, forming an interdependent system.

Effluent - a liquid flowing out. The outflow of a sewer, septic tank, etc.

Endangered Species - a species that verges on extinction in all or a significant part of its range.

Endemic - found only in a particular region or area. For example, the Carolina madtom is a species of catfish found only in the Tar and Neuse rivers. Thus, it is endemic to the Tar and Neuse rivers.

Erosion - the process by which soil particles are carried away by wind, water, freezing and thawing, or a combination of these factors.

Evaporation - the natural process by which water changes into vapor.

Food Chain - the transfer of energy and material through a series of organisms as each one is fed upon by the next. For example:

Detritus —> caddisfly larvae —> sunfish —> otter

Food Web - the interlocking pattern of food chains which exist in an ecosystem.

Habitat - the environmental conditions of the area where a plant or animal naturally grows or lives; its environment.

Indicator Species - an organism whose presence or absence in a particular environment can be used to determine the health of that particular environment.

Insect - any animal in the Class Insecta. Has a head, thorax, abdomen, and three pairs of legs on the thorax. As adults they usually have one or two pairs of wings attached to the thorax.

Irrigation - the pumping of water from ponds, lakes, or rivers through pipes or canals to supply crops with water during dry periods.

Key - an ordered list of significant characteristics of a group of organisms used to identify unknown species.

Larva - (larvae, plural) the immature form of an animal that changes structurally when it becomes an adult, usually by complex metamorphosis.

Latitude - measured in degrees, the distance north or south from the equator. For example, Durham is at 36° N latitude.

Longitude - the distance measured in degrees east or west of the prime meridian (0° longitude) at Greenwich, England. Durham is at 79° W longitude.

Macroinvertebrate - *macro* means large, *invertebrate* means without a backbone. An invertebrate usually large enough to be seen without the aid of magnification.

Metamorphosis - *meta* means change, *morphe* means form. A change in form, structure or function as a result of development. A physical transformation undergone by various animals during development from the larval stage to the adult form. For example, through metamorphosis, a hellgrammite (larval form) becomes a Dobsonfly (adult form). The change from tadpole (larval form) to frog (adult form) is another example of metamorphosis.

Molecular Biology- the branch of biology that deals with the chemical and physical composition, and the activities of the molecules of living matter.

Mussel - any of the various freshwater or saltwater bivalves (meaning the two shells), held together by a strong muscle.

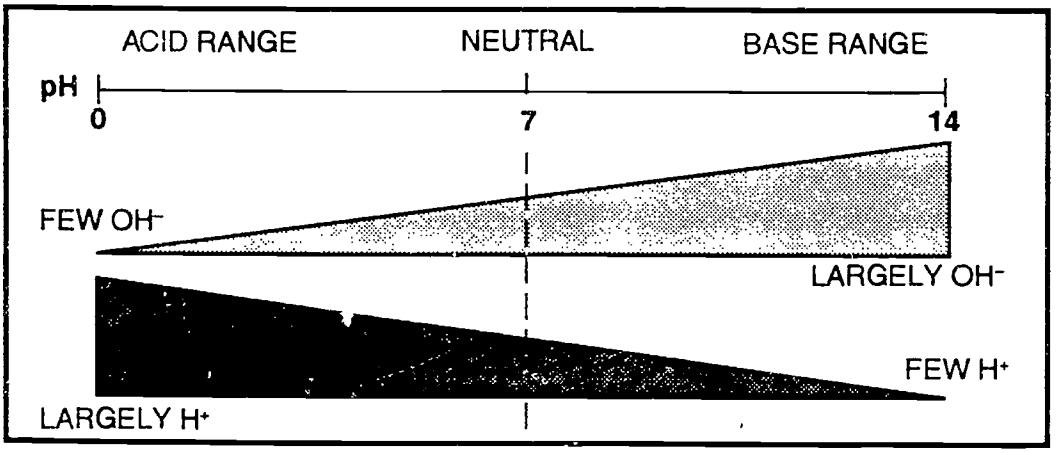
Non-permeable - not open to passage or penetration, especially by fluids.

Nymph - the young of an insect that undergoes incomplete metamorphosis, differing from the adult primarily in size and structural proportions.

Organism - a plant or animal; any living thing.

pH - a measure of the power of the hydrogen ion (H^+) activity in a substance.

pH Scale - a range of 0 to 14 used to measure the degree of acidity or basicity of a substance. A pH of 7 is neutral. See Acid and Base.



Photosynthesis - the chemical process carried on by green plants in which the cells that contain chlorophyll use light energy to produce glucose (a plant food) from carbon dioxide and water; oxygen is released as a by-product. See Respiration.

Plankton - collective term for the mostly microscopic plants (phytoplankton) and animals (zooplankton) that float or drift in oceans and freshwaters. These plants and animals are a very important food source in aquatic environments.

Pool - a deep still spot in a river, creek or stream.

Precipitation - a general term for all forms of falling moisture including rain, snow, hail or sleet.

Respiration - the process by which an organism takes in oxygen and releases carbon dioxide; breathing. See Photosynthesis.

Riffle - a shoal or gravel bar in a shallow part of a stream that produces a stretch of choppy ruffled water surface.

Sedimentation - the deposition or accumulation of soil particles in water.

Sewage - liquid and solid waste mixed with water.

Soil - a collection of organic and inorganic particles, mainly composed of clay, silt, sand, and gravel.

clay - less than 1/256 of a millimeter (mm) in diameter
silt - between 1/256 and 1/16 of a mm in diameter
sand - between 1/16 and 2 mm in diameter
gravel - over 2 mm in diameter

Species - A biological classification of organisms. All organisms of a single distinct kind that have a high degree of similarity, and can mate and produce fertile offspring.

Stewardship - the act of people taking responsibility to maintain and protect a clean and healthy environment.

Stream Index Value - the relative health of a water body. It is based on the tolerance or sensitivity of a macroinvertebrate to changes in water quality and calculated using a simple formula.

Taxonomy - a system of arranging animals and plants into natural, related groups based on some factor common to each, such as structure, embryology, biochemistry, etc.

Threatened Species - a species that could become endangered in the future if it is not given some kind of protection.

Topographic - an accurate and detailed drawing of surface features of a particular region. These surface features include mountains, valleys, rivers, lakes, highways, bridges, etc.

Tributary - a stream or river flowing into a larger stream or river. The Eno River is a tributary of the Neuse River.

Turbidity - cloudiness caused by particles suspended in water.

Volume - a quantity, bulk, mass, or amount. The amount of space occupied in three dimensions.

Waste Water Treatment Plant - a facility where household, business and industrial sewage are treated to remove harmful bacteria and chemicals.

Water - a colorless, transparent liquid occurring on the earth's surface as rivers, lakes, oceans, etc. A chemical compound of hydrogen and oxygen, H_2O.

Water Treatment Plant - A facility where water is treated with chemicals, processed and distributed to homes, businesses and industries for drinking and other clean water uses.

Watershed - The total land area that drains directly or indirectly into a particular stream, river or lake.

References

Borror, J. Donald and E. Richard White. 1990. A Field Guide to Insects of America North of Mexico. Houghton Miffilin Co. Boston, MA.

Coker, Robert E. 1954. Streams, Lakes, Ponds. University of North Carolina Press, Chapel Hill, NC.

Hall, Stephen and Dawson Sather. 1988. *Inventory of the Natural Areas and Wildlife Habitats of Orange County, North Carolina*. Sponsored by the Triangle Land Conservancy in coordination with the North Carolina Natural Heritage Program. For information, contact the Natural Heritage Program, Division of Parks & Recreation, 512 North Salisbury Street, Raleigh, NC. 27604-1148. Phone 919-733-7701.

North Carolina Department of Transportation. 1992-1993. North Carolina Transportation Map. North Carolina Dept. of Transportation. Maps can be obtained from: Travel & Tourism Division, 430 N. Salisbury St., Raleigh, NC. 27603. Phone 1-800-VISITNC or 919-733-4171.

Kejellstrom, Bjorn. 1975. Be Expert With Map & Compass, The "Orienteering" Handbook/New Revised Edition. Charles Scribner's Sons, New York, NY.

Linnsennanier, Walter. 1972. Insects Of The World. McGraw Hill Co. New York, NY.

McCafferty, Patrick W. 1981. Aquatic Entomology, The Fisherman's And Ecologist's Illustrated Guide to Insects and Their Relatives. Illustrations by Arwin V. Provonsha. Jones and Bartlett Inc., Boston, MA.

Mitchell, Mark and William Stapp. 1990. Field Manual for Water Quality Monitoring. An Environmental Education Program for Schools. Thomson-Shore Printers, Dexter, MI.

Nebel, Bernard and Edward Komondy. 1981. Environmental Science, The Way The World Works. Prentice-Hall Inc., Englewood Cliffs, NJ.

Needham, James and Paul Needham. 1962. A Guide to The Study of Freshwater Biology. Holden-Day Inc. Oakland, CA.

O'toole, Christopher, ed. 1986. The Encyclopedia of Insects. Facts on File Inc., New York, NY.

Penak, W. Robert. 1989. Freshwater Invertebrates of The U.S. The Ronald Press Co., New York, NY.

Pfeiffer, C. Boyd and Mark Sosin. 1987. Aquatic Resources Education Curriculum. Kendall/Hunt Publishing Co., Dubuque, IA.

Quammen, David. 1985. Natural Acts, A Sidelong View of Science and Nature. Nick Lyons Books, New York, NY.

Reid, K. George and Herbert Zim. 1967. Golden Guide, Pond Life. Golden Press Inc., New York, NY.

Division of Water Resources. *Stream Watch News*, "pH What Does it Mean." Feb. 1991. Division of Water Resources, Department of Environment, Health, and Natural Resources, 512 North Salisbury Street, Raleigh, NC. 27604-1148. Phone 919-733-4064.

Taylor, Mark. 1989. *Streamwatching With Kids, An Outing Leader's Guide.* Reprinted by North Carolina Wildlife Resource Commission, Department of Environment, Health, and Natural Resources, 512 North Salisbury Street, Raleigh, NC. 27604-1148. Phone 919-733-7123.

United States Dept. of Agriculture. July 1986. Teaching Soil and Water Conservation, A Classroom and Field Guide. Soil Conservation Service, United States Department of Agriculture, 4405 Bland Road, Raleigh, NC. 27609. Phone 919-790-2887.

United States Department of Agriculture. 1989. Key to The Major Invertebrate Species of Stream Zones. Soil Conservation Service Publication SCS-TP-161 Water Quality Indicators Guide, United States Department of Agriculture, 4405 Bland Road, Raleigh, NC. 27609. Phone 919-790-2887.

Western Regional Environmental Education Council. 1987. Aquatic Project Wild. For information contact the Wildlife Resources Commission, 512 North Salisbury St., Raleigh, NC. 27604-1148. Phone 919-733-7123.

Wiessinger, John. 1990. *Right Before Your Eyes,* "All Eyes." #9009. Box 453, Ethna, NY. 13602.

Wiessinger, John. 1990. *Right Before Your Eyes,* "Flying Dragons." #9020. Box 453, Ethna, NY. 13062.

Wildlife Resources Commission. March 1991. *Wildlife in North Carolina.* "Special Issue, Endangered Species." Wildlife Resource Commission, Department of Environment, Health, and Natural Resources, 512 North Salisbury Street, Raleigh, NC. 27604-1148. Phone 919-733-7123.

Winborne, Ferne B. 1989. *A Guide to Streamwalking.* Division of Water Resources, Department of Environment, Health & Natural Resources, 512 North Salisbury Street, Raleigh, NC. 27604-1148. Phone 919-733-4064.

SCHEDULING WORKSHEET

Date request received_____ Request received by_____

1) Name of group (school) _____

2) Contact person _____ _____
name phone (work) (home)

_____
address

3) Day/date/time of requested program _____

4) Program desired and program length _____

5) Meeting place _____

6) Time of arrival at park _____ Time of departure from park _____

7) Number of students _____ Age range (grade) _____

8) Number of chaperones _____

9) Areas of special emphasis _____

10) Special considerations of group (e.g. allergies, health concerns, physical limitations)_____
_____

11) Have you or your group participated in park programs before? If yes, please indicate previous programs attended: _____ _____
_____

If no, mail the contact person an Educator's Guide.

12) Are parental permission forms required? _____ If yes do they have these forms? _____
If they do not, mail contact person a Parental Permission form.

I, _____, have read the entire Educator's Guide and understand and agree to all the conditions within it.

Return to: Eno River State Park
Route 2 Box 436-C
Durham, North Carolina 27705

PARENTAL PERMISSION FORM

Dear Parent:

Your child will soon be involved in an exciting learning adventure - an environmental education experience at _____ _____. Studies have shown that such "hands-on" learning programs improve children's attitudes and performance in a broad range of school subjects.

In order to make your child's visit to "nature's classroom" as safe as possible we ask that you provide the following information and sign at the bottom. Please note that insects, poison ivy and other potential risks are a natural part of any outdoor setting. We advise that children bring appropriate clothing (long pants, rain gear, sturdy shoes) for their planned activities.

Child's name _____

Does your child:

- Have an allergy to bee stings or insect bites?_____
  If so, please have them bring their medication and stress that they, or the group leader, be able to administer it.

- Have other allergies? _____

- Have any other health problems we should be aware of?_____
  _____

- In case of an emergency, I give permission for my child to be treated by the attending physician. I understand that I would be notified as soon as possible.

  _____ _____
  Parent's signature date

Parent's name _____ Home phone _____
(please print) Work phone _____

Family Physician's name _____ __ phone _____

Alternate Emergency Contact

Name_____ phone _____

NORTH CAROLINA PARKS & RECREATION
PROGRAM EVALUATION

Please take a few moments to evaluate the program(s) you received. This will help us improve our service to you in the future.

1. Program title(s) _____ Date _____
   Program leader(s) _____

2. What part of the program(s) did you find the most interesting and useful? _____
   _____

3. What part(s) did you find the least interesting and useful? _____
   _____

4. What can we do to improve the program(s)? _____
   _____
   _____

5. General comments _____
   _____
   _____
   _____

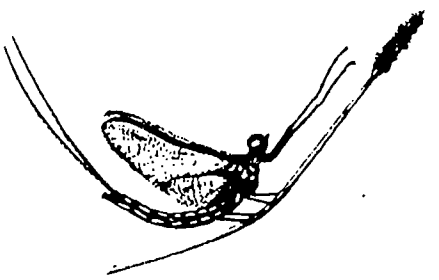
LEADERS OF SCHOOL GROUPS AND OTHER ORGANIZED YOUTH GROUPS PLEASE ANSWER THESE ADDITIONAL QUESTIONS:

6. Group (school) name _____

7. Did the program(s) meet the stated objectives or curriculum needs? _____
   If not, why? _____
   _____

Please return the completed form to park staff. Thank you.

Notes



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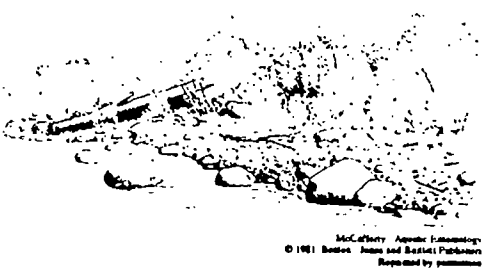

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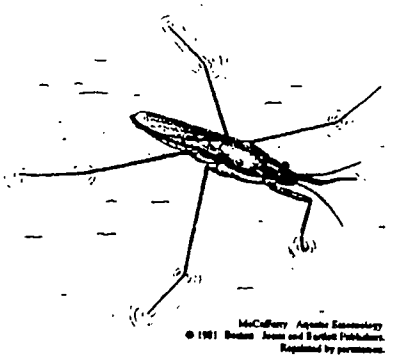

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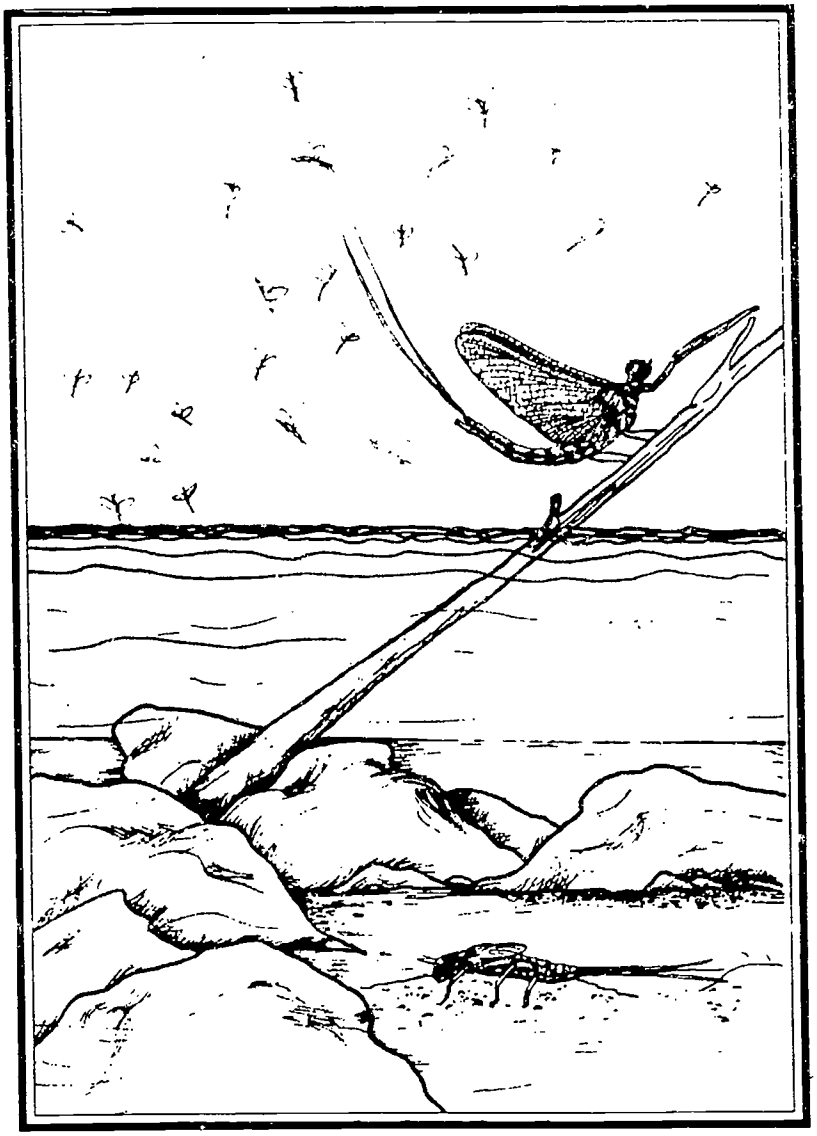
EDUCATOR'S GUIDE



Eno River State Park

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10-92

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Secretary

Introduction to the North Carolina State Parks System

Since its creation in 1916, the North Carolina State Parks System has provided its visitors with opportunities for educational experiences and programs. Through the years, we have continued to revise and update our programming to make it more informative and more tailored to the needs of our state's school system.

Our state parks system provides a wonderful outdoor classroom for learning about our North Carolina heritage. Each of our unique state parks offers a variety of environmental education opportunities which highlight our state's natural and cultural resources. All of our environmental education programs are designed to meet curriculum requirements of the North Carolina Department of Public Instruction. Subject areas covered include science, social studies, art, mathematics and communication skills.

The goal of our environmental education program is to generate an awareness in all individuals which cultivates responsible stewardship of the earth.

Introduction to **Eno River State Park**

Efforts to establish Eno River State Park began in 1965 in response to the city of Durham's proposal to build a reservoir on the Eno. A group of concerned citizens formed the Association for the Preservation of the Eno River Valley. The Association was successful in gaining support from the community, and it proposed that a state park be established along the river. In May 1972 the state of North Carolina approved the idea and the city Durham withdrew its plans to construct the reservoir. By 1975, 1,100 acres of land had been acquired with the help of the Association, the Nature Conservancy and the Division of Parks and Recreation. Today the park, located just north of Durham, protects 11 miles of river and over 2,100 acres of associated land in Orange and Durham counties. Four access areas along the river provide access to 20 miles of hiking trails.

Combine easy access, 2,100 acres of land along a major river, and unique animal and plant life and you have the recipe for a rewarding educational experience.

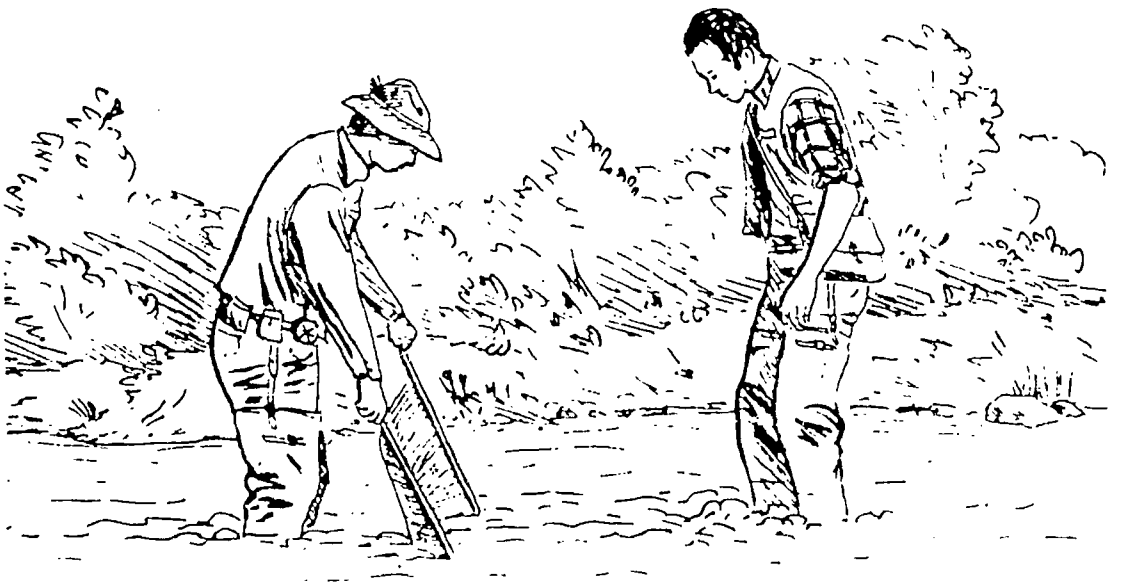
Program Options

Environmental Education

Our specially developed, curriculum-based Environmental Education Learning Experiences are available by reservation only (see section on how to schedule a program). These programs are supplemented by an activity packet which includes suggested activities for before and after your visit.

Programs are geared to different grade levels and provide a fun and exciting way to learn about different topics. Some of these topics include: birds, mammals, fish, macroinvertebrates, astronomy and plant identification. Many of our programs can be adapted to meet special requests.

Groups are welcome to visit the park for self-guided expeditions.



Life in the Eno River

Eno River State Park's most valuable natural resource is the Eno River and the aquatic life that lives there. The river and river corridor provide critical habitat for both aquatic and terrestrial species. Nine species of freshwater mussels, four of them on the state threatened and endangered list, are known to occur in the river. The Roanoke bass and Neuse River waterdog (an aquatic salamander) are found only in the Neuse, of which the Eno is a part, and Tar River basins in North Carolina. The 56 species of fish recorded for the river represent 25 percent of the species known for the state.

The river is presently classified WS-III and Class C which means it is suitable for fish and wildlife use, boating, fishing and drinking water. Only through continued vigilance and protection efforts can the river's water quality be preserved.

Life along the Eno River

The park provides important habitat for a host of animals and plants. A mixture of steep rocky ridges and bottomlands create several distinct plant communities. Many of the wildflowers and shrubs found in the park are normally found in our state's mountains and foothills. Some of the park's most outstanding flowers include mountain laurel, Catawba rhododendron, yellow lady's slipper, showy orchis, and wild geranium to name just a few.

Somewhat harder to observe is the animal life in the park. More than 150 species of birds have been observed in the park. Deer are common and can be seen along all hiking trails if you are quiet and patient! Signs of animal feeding and tracks give away the presence of beaver, fox, raccoon, mink, muskrat, gray squirrel, and if you're very observant and lucky, bobcat and river otter. Butterflies and a wide variety of insects can readily be observed in the fields near the picnic area at Fews Ford.

Trail Descriptions

Eno Trace Trail: This is a self-guided nature trail. Brochures in a box at the beginning of the trail interpret sites from numbered posts along the trail. The easy .5-mile trail follows the river and loops back along a small ridge offering a view of the river below. During the spring, wildflowers blanket the ground along the trail. The Trace trail is accessed from the picnic area. Use caution when descending the short steep rocky section from the picnic area.

Fanny's Ford Trail: This easy 1-mile loop trail is accessed by crossing the suspension bridge over the Eno and following an old mill road 1-mile to the Fanny's Ford Trail. The trail takes you to Fanny's Ford, then back down the river past an old grist mill site. Several forest types can be observed along the trail. Small springs and vernal pools near the trail provide breeding habitat for frogs, toads and salamanders. Along the river look for basking turtles, water snakes on logs and beaver signs. Total length of trail from picnic area is 3 miles.

Buckquarter Creek Trail: Access this moderate 1.5-mile loop trail from the Fews Ford parking area. The trail follows the river upstream across a rocky ridge and then back to its beginning. On the ridge, the steep rock outcrop on the right side of the trail gives way to the wide bottomlands of Buckquarter Creek. Enjoy the view and use caution here. Look for wildflowers, birds and animal signs. Listen for owls calling in the afternoon at Buckquarter Creek bridge.

Eight additional hiking trails are located in the park. Contact park staff for additional information.

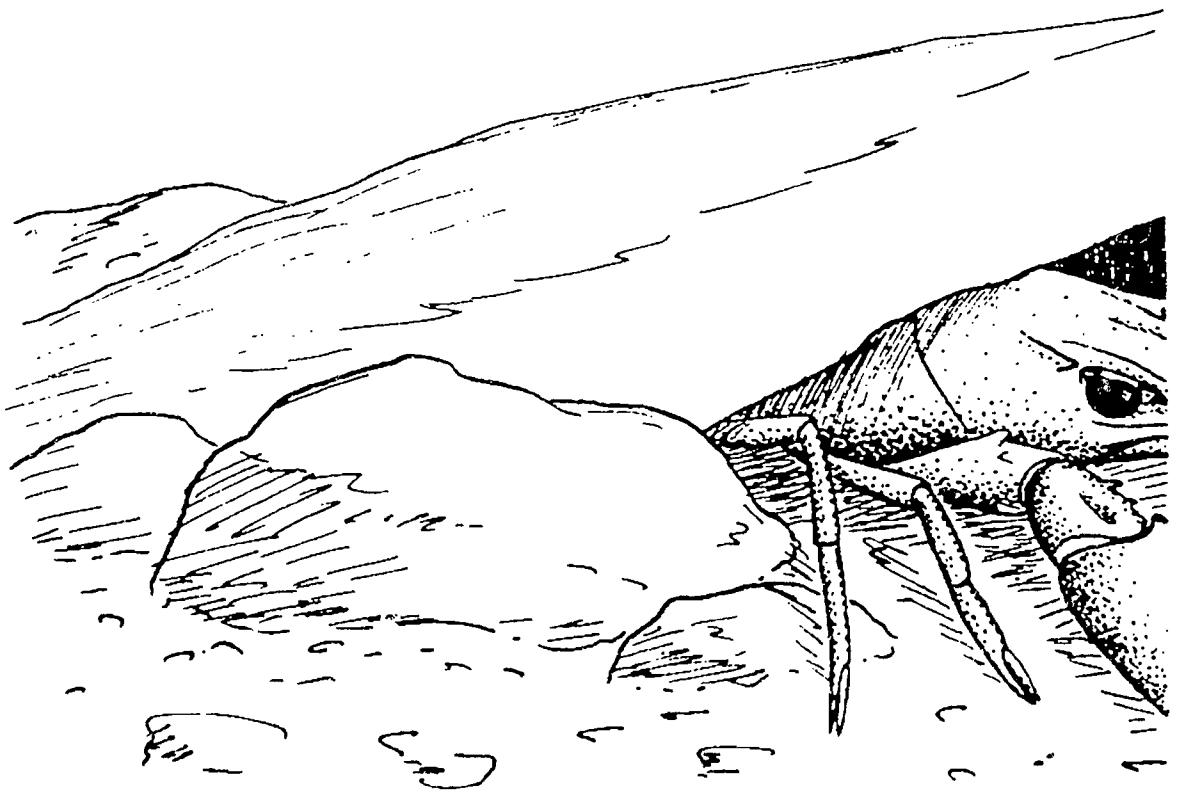
Scheduling a Trip to Eno River State Park

Groups are encouraged to visit the park during all seasons of the year for hikes, exploration, environmental education programs and activities. Leaders may choose to conduct their own activities or enlist the help of park staff.

To Make a Reservation

Because our Environmental Education Learning Experiences involve all park staff and several volunteers, it is necessary to contact the park one month in advance.

For other types of programs including special requests, please contact the park at least two weeks in advance.

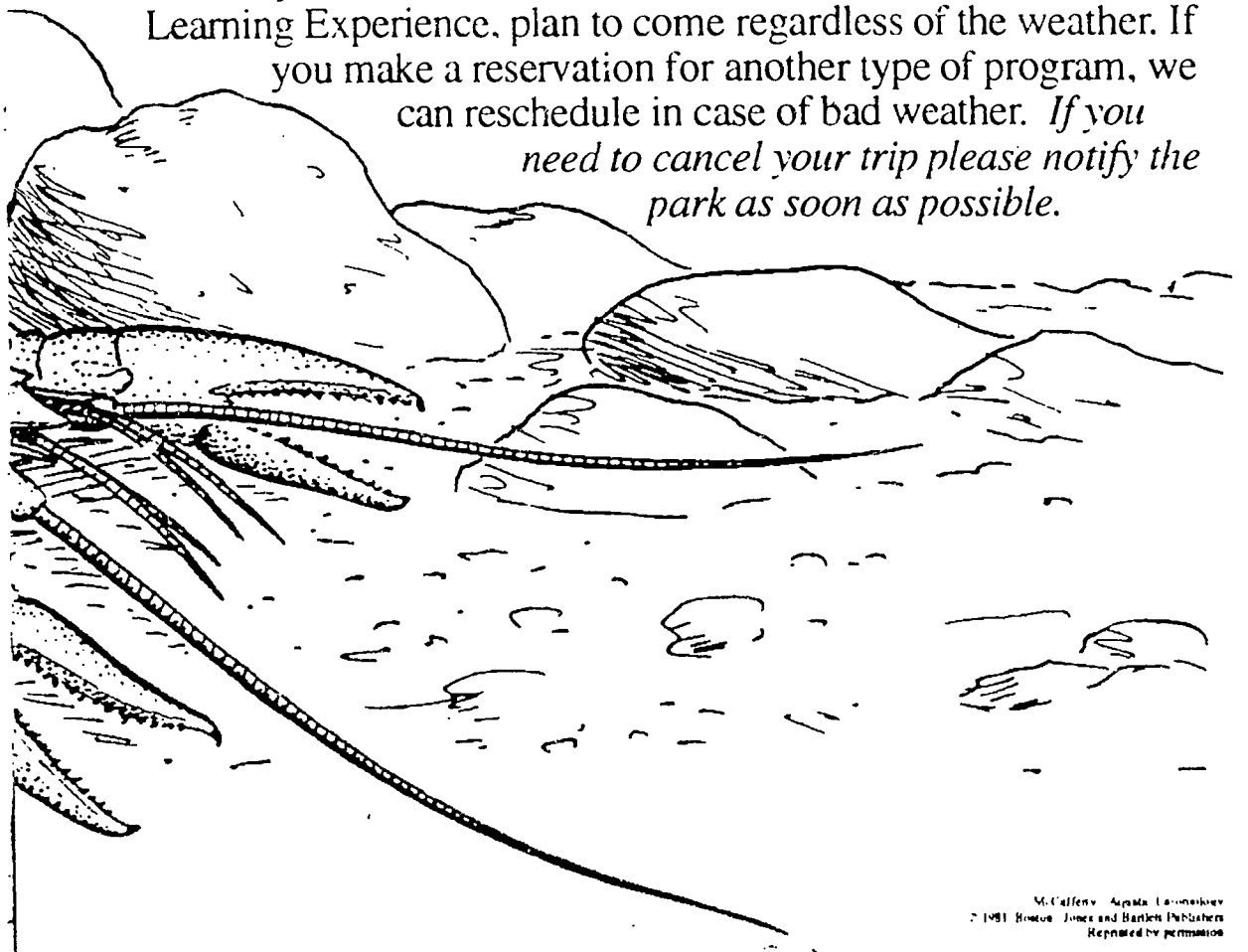


Please provide the following information:

- Name of group (school).
- Name, address, work and home telephone numbers of the group contact person.
- Date, time of arrival and meeting place at the park.
- Departure time from the park.
- Number of participants and adult leaders.
  A maximum of 30 participants is recommended. Please have one adult leader per 8 students. Adult leaders are responsible for maintaining control of the group.
- Age range and/or special needs of participants.
- Desired activities, assistance needed by park.

Bad Weather Policy and Cancellations

Our Environmental Education Learning Experiences are held outside. If weather conditions prohibit us from holding the program outside, we will provide a modified version at the park office. If you make a reservation for a Environmental Education Learning Experience, plan to come regardless of the weather. If you make a reservation for another type of program, we can reschedule in case of bad weather. *If you need to cancel your trip please notify the park as soon as possible.*



Before You Make the Trip

1. Complete any appropriate pre-visit activities.

2. Visit the park without the participants prior to the scheduled group trip. This will give you a chance to become familiar with facilities and park staff, and provide you with an opportunity to identify potential problems.

3. Discuss behavior expectations with adult leaders and participants when planning the trip. Discuss the park rules listed. Emphasize safety.

4. Inform the group about poison ivy, ticks and snakes. Discuss the need to use insect repellant in the spring and early summer.

5. Inform your group of the need to dress appropriately for the season. Shoes suitable for wading and walking on slippery trails, clothes that students don't mind getting wet or dirty, a towel and a complete change of clothes are recommended for the Environmental Education Learning Experience, Living Water.

6. Have everyone wear a name tag. For safety, please color-code them for groups. Establish a buddy system for younger students.

7. *Group leaders are responsible for obtaining a consent form from each participant including a list of any health considerations and medical needs.* These forms are available at the park and in the Environmental Education Learning Experience packet.

8. If your group plans to collect any plant, animal or mineral within the park, a Research Activity Permit is required. Contact the park to obtain a permit application at least 30 days in advance.

9. Assign jobs to students and/or leaders. Leaders could be responsible for lunches, moving groups from one place to another and enforcing rules. If students are working in small groups they could each be assigned a task to accomplish.

While at the Park

Please obey the following rules:

1. To help you get the most out of the experience and increase the chance of observing wildlife, be as quiet as possible while in the park.

2. On hikes, walk behind the leader at all times. Stay on the trails. Running is not permitted.

3. All plants and animals within the park are protected. Breaking plants and harming animals is prohibited in all state parks. This allows future visitors the same opportunity to enjoy our natural resources.

4. Picnic only in designated picnic areas. Help keep the park clean and natural; do not litter.

5. Always wear shoes or waders when wading in the river. No bare feet.

6. Avoid the river during high water. Riverside trails can be very slick and are sometimes completely underwater after a heavy rain.

7. In case of accident or emergency, contact park staff immediately.

Following The Trip

1. Complete post-visit activities in the Environmental Education Learning Experience packet.

2. Build upon the field experience and encourage participants to seek answers to questions and problems encountered at the park.

3. Relate the experience to classroom activities and curriculum through reports, projects, demonstrations, displays and presentations.

4. Give tests or evaluations, if appropriate, to determine if students have gained the desired information from the experience.

5. File a written evaluation of the experience with the park. Evaluation forms are available from park staff and in the Enivironmental Education Learning Experience activity packet.

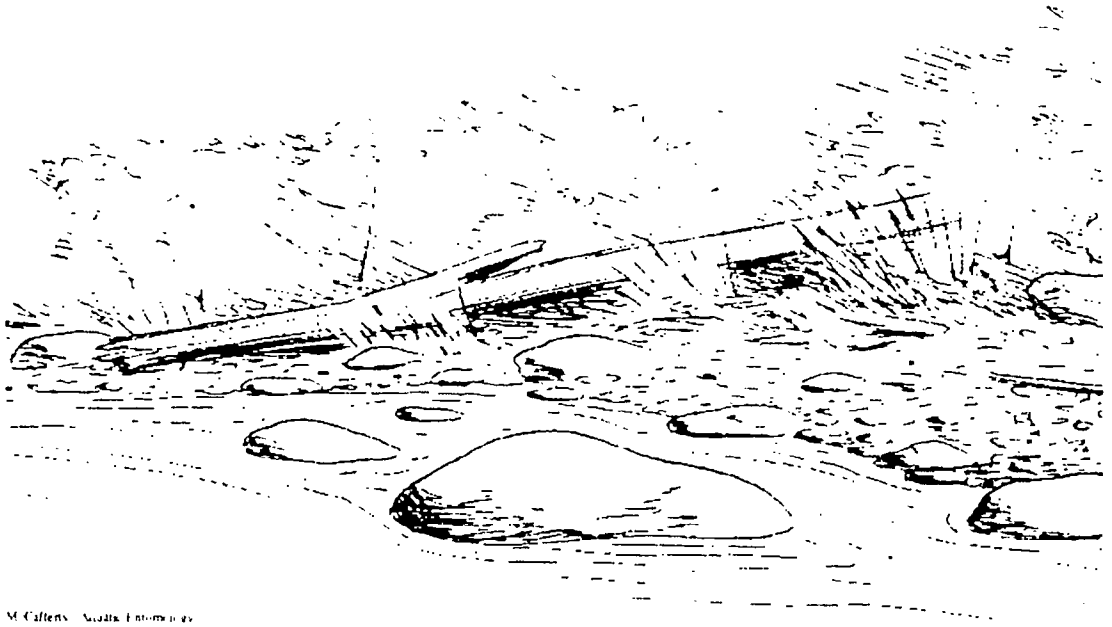
Facilities at Fews Ford

Restrooms: *Restrooms are available only at the Park Office.*

Picnic Area: Picnic tables and grills, available on a first-come basis, are located adjacent to the trail to the suspension bridge. Water is available from March to November.

Primitive Group Camping: One area with five large level tent pads is available for organized groups. A small fee is charged for the use of this area, which is available by reservation only. Facilities include one fire ring (bring your own firewood since collecting live or dead wood is not allowed), one picnic table, three benches and a pit toilet. Drinking water is not available. There is no vehicular access to the group camping area. Campers must carry their gear .5 mile to the site.

Primitive Backpack Camping: Five sites are available on a first-come basis. A pit toilet is available. Campers must carry everything they need 1 mile to the sites. Fires are not allowed at this area. A modest fee is charged.



Park Information

Location:

The park office is located at Fews Ford Access Area, six miles north of Durham at the end of Cole Mill Road. Do not confuse us with West Point on the Eno, located on Roxboro Road.

Address:

Eno River State Park
Route 2 Box 436-C
Durham, North Carolina 27705

Telephone:

(919) 383-1686

Office Hours:

Monday-Friday 8 a.m. to noon and most weekend afternoons.

Hours of Operation for Fews Ford Access Area:

November - February	8 a.m. - 6 p.m.
March and October	8 a.m. - 7 p.m.
April, May and September	8 a.m. - 8 p.m.
June-August	8 a.m. - 9 p.m.

Hours of Operation for Cole Mill Access:

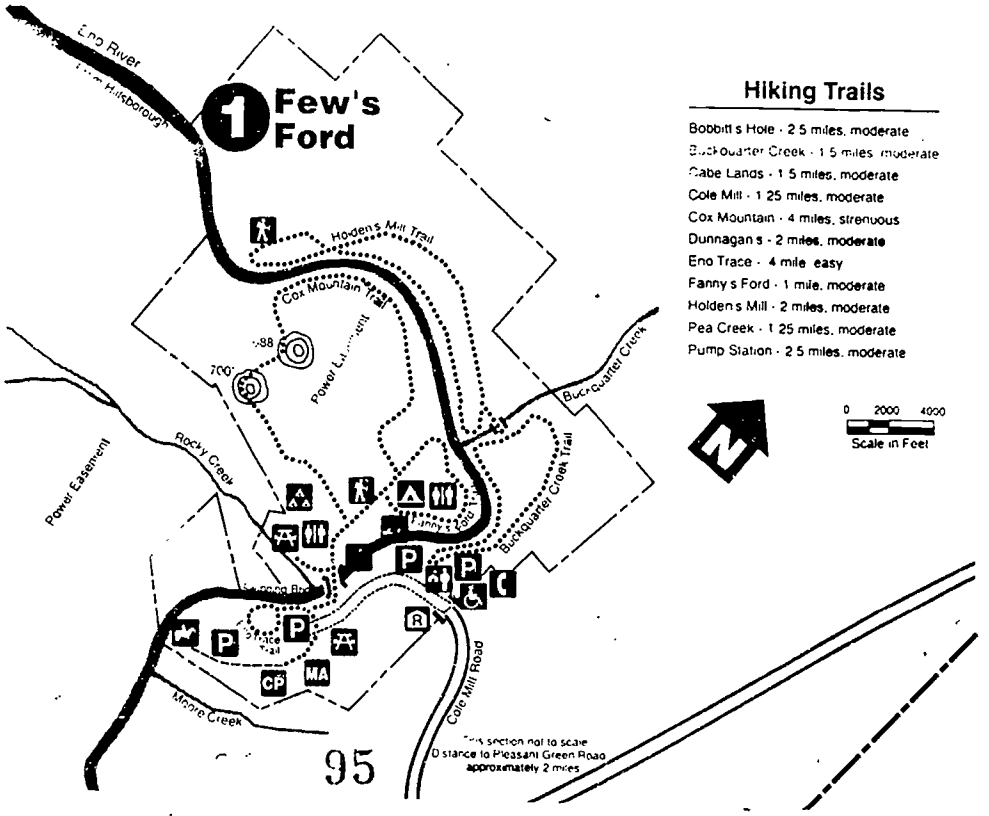
Open 9 a.m. and close one-half hour earlier than the above times.

Hours of Operation for Pleasant Green Access:

Open 8:30 a.m. and close one-half hour earlier than the above times.

Eno River State Park

- Bridle Trail
- Camper Parking
- Canoe Access
- Elevation
- Group Camp
- Gravel Road
- Handicapped Accessibility
- Hospital Durham County General 470 5345
- Hiking Trail
- Maintenance Area
- Park Boundary
- Park Entrance
- Park Office
- Parking Lot
- Paved Road
- Picnic Area
- Primitive Camping
- Point of Interest
- Power Easement
- Ranger Residence
- Rest Room (Pit Privies)
- Water

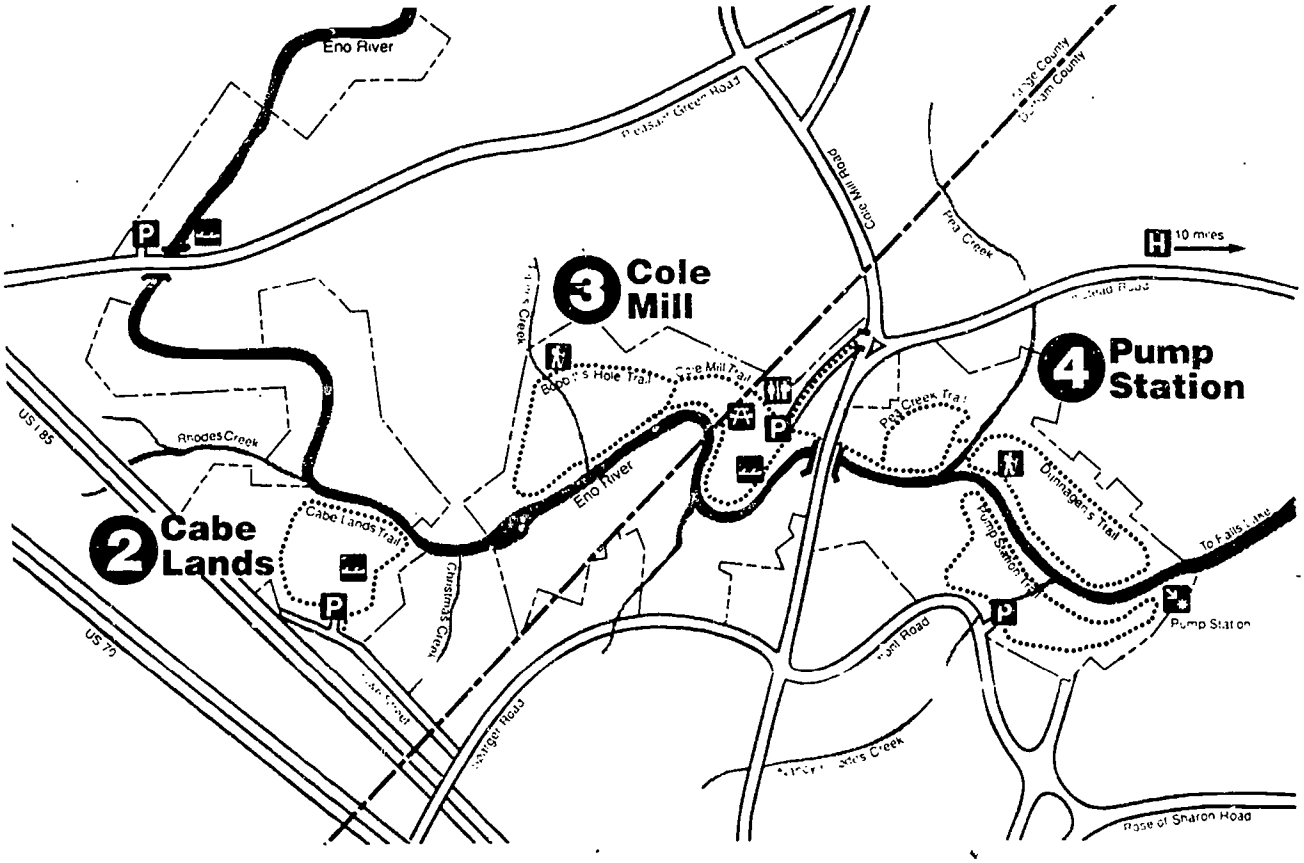


Hiking Trails

Bobbitt's Hole - 2.5 miles, moderate
Buckquarter Creek - 1.5 miles, moderate
Cabe Lands - 1.5 miles, moderate
Cole Mill - 1.25 miles, moderate
Cox Mountain - 4 miles, strenuous
Dunnagan's - 2 miles, moderate
Eno Trace - 4 mile easy
Fanny's Ford - 1 mile, moderate
Holden's Mill - 2 miles, moderate
Pea Creek - 1.25 miles, moderate
Pump Station - 2.5 miles, moderate

N

0 2000 4000
Scale in Feet



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