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ABSTRACT

The Long Island Pine Barrens is Long Island's premier ecosystem. It overlies the greatest quantity of the purest drinking water remaining on Long Island and boasts the greatest diversity of plants and animals in New York State. This curriculum guide provides background and suggested inquiry-based in-class and field trip experiences to use with students in grades 3-8 when teaching environmental science. The environmental significance of the ecological system is discussed and suggested classroom and out-of-classroom activities are also presented to assist in developing hands-on environmental science lessons for students. These suggested activities are presented as lesson plans and are designed to be easily adaptable to the Frameworks for Mathematics, Science, and Technology program currently being promulgated by the New York State Education Department. They can also serve as the starting point for student-produced work presented in portfolios or incorporated into performance-based/authentic assessment activities. (Contains approximately 75 resources.) (CCM)

The Long Island Pine Barrens: A Curriculum & Resource Guide

Prepared by The Long Island Pine Barrens Society
Manorville, NY 11949

This Curriculum Guide was made in cooperation with:

Western Suffolk BOCES
Outdoor/Environmental Education Program

The New York State
Legislative Commission on Water Resource Needs of
New York and Long Island

To the Teacher:

The Long Island Pine Barrens is Long Island's premier ecosystem. It overlies the greatest quantity of the purest drinking water remaining on Long Island and boasts the greatest diversity of plants and animals in New York State. This curriculum guide provides background and suggested inquiry-based in-class and field trip experiences to use with students in grades 3-8 when teaching environmental science. The environmental significance of the ecological system is covered; suggested classroom and out-of-classroom activities are also presented to assist you in developing hands-on environmental science lessons for your students. These suggested activities are presented as lesson plans and are designed to be easily correlated to the standards for mathematics, science and technology currently being promulgated by the New York State Education Department. They can also serve as the starting point for student-produced work presented in portfolios or incorporated into performance-based/ authentic assessment activities.

In addition, the history of the unique grassroots beginnings of the Pine Barrens preservation efforts and the use of the legislative process to secure the Comprehensive Management Plan and establish the Pine Barrens Commission as an oversight body is covered here. This information can provide extensions in government and reading following science lessons. Also, it can provide an interesting context in which to demonstrate the integration of disciplines: science, government, sociology, economics, etc. You may wish to include a unit on the Pine Barrens when covering Long Island and/or New York State history.

Finally, a Resource Guide is included as an appendix. Print, video and electronic resources are listed, along with suggested sites to visit in the Pine Barrens. It is our hope that the learning that results from this guide will enrich your classes and impart an appreciation for the environment in which you and your students live and work.

Specifically, participating students will:

1) understand the Long Island aquifer system and its importance to the region;
2) understand the role of the Pine Barrens in protecting the drinking water that resides in the aquifer;
3) understand the science of groundwater flow, permeability and porosity;
4) understand those substances that can contaminate the aquifer, the paths to contamination, the dangers to the ecosystem and the means to protect it;
5) appreciate the Pine Barrens as an ecosystem;
6) appreciate the diversity of species residing in this ecosystem;
7) appreciate the role of citizen action groups and government in protecting the Pine Barrens; and
8) be familiar with interesting sites on Long Island where individuals can appreciate and study the environment.

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The Long Island Pine Barrens Society

Contents

Background Information - Environmental Science

The Long Island Pine Barrens

Today, the region commonly known as the Long Island Pine Barrens totals about 100,000 acres and is located in middle and eastern Suffolk County - generally stretching from mid-Brookhaven Town through parts of Riverhead Town and into Southampton Town. In addition, there are isolated Pine Barrens stands in Setauket , Brentwood and on the South Fork. Before the development of Long Island, the Pine Barrens **ecosystem** encompassed about 1/4 of a million acres throughout the interior of Suffolk County and extreme eastern Nassau County stretched into the center of Nassau County. The **ecological** forces of this region including periodic wildfires and dry, sandy, nutrient poor soil are interesting and unique.

The term "Pine Barrens" is derived from Dutch settlers' reference to pine dominated areas not suitable for farming -- therefore, these were barren areas. Pitch pine thrives in the sandy soil that, even today, does not support much agriculture. An unusual form of pitch pine, the "dwarf" pine, grows in the Dwarf Pine Plains community of Westhampton. The sandy parent material is a remnant of the time when the last great glacier extended southward and deposited rocks, pebbles, silt and mostly sand which formed most of what we know today as Long Island.

The Significance of the Pine Barrens Today

The Pine Barrens, essentially a huge groundwater **watershed**, sits atop an aquifer system that is important to all Long Islanders. In addition, the Pine Barrens is home to diverse and unusual species, many of which are endangered or threatened. Among other species these include the eastern tiger salamander, the northern harrier, the hognose snake and the buck moth.

A particularly rare community in the Pine Barrens is the Dwarf Pine Plains, an area dominated by a dwarf pitch pine ecotype. It is has been ranked by ecologists as globally rare. Encompassing about 2,500 acres, it is located in Westhampton surrounding the crossroads of Sunrise Highway and County Road 31. It also is one of the major forest areas that burned during the summer of 1995. The Dwarf Pine Plains also is the region of the Pine Barrens with the greatest concentration of buck moths, due to the great availability of its host plant, the scrub or bear oak.

The eastern tiger salamander, an endangered species in the northeast, can be found near several of the lakes and ponds in the Pine Barrens. It is but one example of scores of wetland species that are found in the Long Island Pine Barrens.

The sandy Pine Barrens soils that discouraged early settlers on Long Island was, and still is, the basis for the replenishment of our **groundwater**, stored in an **aquifer** system. Precipitation in the form of rain, snow, sleet, freezing rain and hail falls to the ground. In an ideal environment, this precipitation is "caught" by the vegetation and the **porous** soil. It permeates downward through the soil layers, being cleansed by particles in the soil as it passes through. This downward **percolation** continues until it reaches the upper most level of the underground water stored in the aquifer system - this level is referred to as the **water table**.

Without porous soils, such as those found in the Pine Barrens, to serve as **recharge areas** to provide catchment of the precipitation and to promote **absorption** so that the water can percolate through the

permeable underground layers of soil and aquifer, much of this water would become **runoff**. It would then be less available to replenish our underground water supply. Runoff becomes contaminated by oils, animal feces, garbage, etc. as it passes over less permeable land and road surfaces before it finally enters the Long Island Sound, Great South Bay, Peconic Bay or Atlantic Ocean -- lost to the drinking water supply.

Obviously, if the Pine Barrens is replaced by residential, commercial and industrial development water quality in this regionally significant watershed will decline and an enormously important groundwater supply will be threatened.

Also, the thousands of species that collectively make the Pine Barrens an ecological treasure trove depend upon the maintenance of the natural conditions, features and habitats that now exist on it. It is a delicate, fire-dependent ecosystem.

The Pine Barrens and Precipitation

The **hydrologic cycle** traces the path of precipitation from the atmosphere to the earth and back again. Through evaporation from the bodies of water that surround the Island and its various lakes and streams, along with the evapotranspiration from trees and plants, water vapor returns to the atmosphere where it forms clouds, which in turn result in precipitation. This precipitation then percolates through soil and underlaying parent material, where it eventually flows into the groundwater system and follows a **groundwater flow** pattern. Water that percolates along the coasts moves horizontally, however, and eventually flows into the salt water bodies that surround Long Island.

The Geology of Long Island and Its Aquifer System

Long Island is, in great part, a remnant of the advance and retreat of the last Wisconsin glacier. Melting at the glacial terminus created the Ronkonkoma **moraine**, which roughly follows the path of the Long Island Expressway and then extends on the northern edge of the south fork to Montauk Point. Simultaneously, the melting of the retreating glacier deposited sand and gravel to the south of this moraine. This produced the **outwash plain** south of the Ronkonkoma moraine. Following glacial retreat caused by a warming trend, the glacier made a brief advance once again to form the Harbor Hills Moraine, which became the Island's north shore and north fork, extending to Orient Point.

The deposits of sand left by the glacier provide the physical capacity of Long Island's aquifer system. The aquifer system is an underground geologic formation that holds water; it is the only source of fresh drinking water for Long Island. All fresh water provided to Long Islanders through private or public wells comes from the aquifer system. Therefore, whether water is provided from the Suffolk County Water Authority, the Plainview Water District, or a private well, the source is the same -- the aquifer system.

The Long Island aquifer system is composed of three main "layers": Upper Glacial, Magothy and Lloyd. The Upper Glacial aquifer is closest to the surface. It is composed of sand and gravel that is highly permeable. It also contains some clay-like deposits of low permeability, and in isolated areas, ice-shoved deposits of ancient origin.

The Magothy aquifer is much larger and is located directly beneath the Upper Glacial aquifer. It contains coarse and fine sand and gravel, making it highly permeable. There also are areas of silt and clay, which are of low permeability.

Below the Magothy aquifer is the Raritan clay layer, which does not hold water. Its composition is mainly low permeability clay, with some barely permeable silt and fine sand. Hydrologists refer to this type of layer as an aquiclude.

The very narrow Lloyd aquifer represents the deepest aquifer. It sits atop the Island's bedrock and is moderately permeable. State law restricts water from this aquifer for use to Long Island's coastal communities.

The top and thickness of each layer varies with its location. In general, each begins closer to the surface and is thinnest on the north shore. Similarly, each begins at a greater depth and is a thicker layer on the south shore. The top of the Upper Glacial can be at sea level. The Magothy begins at a depth of about 200 feet on the north shore; the Lloyd at 400 feet.

The Upper Glacial aquifer, which has been the source of drinking water since the Island was first settled, is no longer potable in many areas. The Magothy aquifer is now being used increasingly.

Contamination from cesspools, landfills, pesticides, fertilizers and careless dumping of chemicals has overburdened the ability of the soil to cleanse water entering the system. Development in the Pine Barrens can and does have an adverse impact on water quality. Water continues to be withdrawn, however, at an increasing rate as population and commercial/industrial development continues. In coastal areas, when withdrawal increases and recharge cannot keep up with it, **salt water intrusion** results. The surrounding salt water in the bays, the sound and the ocean diffuse into the Upper Glacial and Magothy aquifers, further threatening their viability as drinking water sources.

The Importance of Open Space: Habitats

In addition to protecting the fragile drinking water supply for Long Islanders, the Pine Barrens supports a wide diversity of rare and interesting natural communities and species. Some of the more well-known communities include the Dwarf Pine Plains, Pitch Pine-Oak forests, Atlantic White Cedar swamps and coastal plain pondshores. These communities provide habitat to a host of rare and endangered species. In wetland areas tiger salamander, spotted and eastern mud turtle and several fish species occur. Wetland loving orchids such as rose pogonia and calopogon thrive in abandoned cranberry bogs as do several unique carnivorous plants such as pitcher plants, sundews and bladderworts.

Dry upland communties also provide necessary habitat to a host of plants and animals. The buck moth, feeding on its host plant scrub oak as a caterpillar, is common in the Dwarf Pine Plains. An array of migratory songbirds such as wood thrush, scarlet tanager, and rufous-sided towhee breed in Pine Barrens forests. Uncommon butterfly species also occur here including numerous hairstreaks and elfins.

The Importance of Open Space: The Role of Fire

A large undeveloped area also is needed so that the various natural forces which have shaped the Pine Barrens, such as wildfire, can continue to exert their influence. Long Islanders witnessed the intensity of such fires during the summer of 1995, when large areas of the Pine Barrens in Rocky Point and Westhampton burned, sometimes perilously close to homes and businesses.

Wildfire has played a vital role in shaping and maintaining the Pine Barrens ecosystem. Because of this, ecologists define the Pine Barrens as a fire climax system. Many of the plants and animal species have evolved various adaptations enabling them to survive wildfire. In contrast, invading non-fire adapted species such as black locust and black cherry are killed. Pitch Pine has several adaptations enabling it to survive wildfire. These include thick bark; special buds, known as epicormic buds, located along the bark of the tree that elongate to become branches after a fire; basal crook buds located at the base of the tree that elongate after a fire in response to the aboveground portion of the tree being killed; and serotinous or closed cones.

As with all **conifers**, the cones of the pitch pine contain its seeds. Pitch pines exhibit two kinds of cones: "normal" cones and serotinous or closed cones, although only one type is found on an individual tree. Serotinous cones are tightly sealed with **serotin**, a waxy resin. The pines of the Dwarf Pine Plains have a much higher ratio of serotinous cones to normal ones. Normal cones open yearly to release seeds. Serotinous cones open only when the intense heat of fire melts the resin, thereby allowing the cones to open so that the seeds can be released. It is these seeds that result in reproduction and regrowth of the dwarf pine forest. Seeds germinate and grow in an ash-enriched soil that receives plenty of sunlight since few trees remain.

Background Information - Legislative Protection of the Long Island Pine Barrens

The Long Island Pine Barrens Society

The Long Island Pine Barrens Society (LIPBS) is well known for its political campaign to protect this environmentally sensitive area. Formed in 1978 by three environmental science students, it initially was organized to raise educational awareness about the importance and uniqueness of the Pine Barrens, its species, ecosystems, landscapes and resources.

In the late 1980s, the LIPBS recognized that this region was threatened by encroaching development that was threatening to disrupt the ecological balance required for the survival of the Pine Barrens ecosystem. The focus of the group shifted from an educational awareness to designing an active preservation campaign. This section of this guide outlines the major legal and legislative steps that ultimately have led to the protection and preservation of the Pine Barrens. The LIPBS once again can focus on its educational mandate; this guide is an outcome of this refocusing effort.

Early Efforts

During the 1970s and '80s, various environmental agencies and organizations worked to protect the Pine Barrens. It was understood that establishing a "greenbelt" was crucial for the preservation of this vital resource. In 1971, 2,300 acres that had been part of Brookhaven National Laboratory was ceded by the federal government to New York State creating Brookhaven State Park. Also, in 1978, the RCA property (Rocky Point and Riverhead) totaling more than 7,200 acres was transferred to the state for $1.

Although a greenbelt was being established, threats to the region persisted. In 1977 and 1978, new threats emerged. A major portion of the Dwarf Pine Plains was threatened by a Free Trade Zone proposal while along the Peconic River several dozen acres of cranberry bogs were threatened to be filled for a golf course.

Many positive actions occurred through 1987. In 1984, the Pine Barrens Review Commission was established. This commission's major function was to review development proposals in an effort to protect the ecosystem and underlying water supply. In 1986, the Suffolk County Open Space Program, was enacted. This initiative resulted in the purchase of 28 new park sites encompassing about 4,600 acres of land. In 1987 and 1988, Suffolk County voters overwhelmingly approved (83-17%) the extension of the 0.25% sales tax to purchase critical watershed areas.

However, as voters were approving the use of sales tax revenues to protect the Pine Barrens, several hundred development projects were being proposed in the central Pine Barrens. If these projects were successfully culminated, the ecological integrity of the Long Island Pine Barrens would be severely compromised.

The Long Island Pine Barrens Society Pine Barrens Preservation Initiative (1989)

In November, 1989, when many new developments were proposed in the Central Pine Barrens, the LIPBS with the support of several dozen civic and environmental organizations filed suit against the Suffolk County Department of Health and the Brookhaven, Riverhead and Southampton Town Boards, as well as their Planning Boards and their Zoning Board of Appeals. This suit demanded that the environmental impact of development be ascertained prior to the start of any construction. The LIPBS called this effort the Pine Barrens Preservation Initiative; it was New York State's largest environmental lawsuit involving several billion dollars worth of real estate.

A Grassroots Campaign

Once the lawsuit was filed, the LIPBS began a remarkable campaign to enhance the environmental awareness and knowledge of Long Islanders. The public and government leaders of Long Island, in general, and of Suffolk County, in particular, had supported many environmental initiatives in the past: the banning of phosphate-laden detergents, farmlands preservation, and a portion of sales tax revenues to protect drinking water supplies. However, the notion of preservation of an entire ecosystem was not a consideration for most. Housing developments, shopping malls and other commercial projects were being proposed and approved in a piecemeal process, with little regard for the cumulative environmental impact of such projects.

Through community meetings, informational mailings and extensive media attention, the LIPBS informed Long Islanders about their drinking water supply, habitats and the Pine Barrens. The role of the Pine Barrens in maintaining the drinking water supply and the diversity of species that reside there drew interest from the public.

In but a few short years, the membership of the LIPBS increased from 50-80 to over 5,000! What was more astounding was that many of these members volunteered their time and effort to lead meetings, prepare print materials and help to effect political change. Along with members of other local environmental groups, they attended Town Board and County Legislative meetings, gathered signatures on petitions, contributed funds to support the numerous legal proceedings required and wrote and phoned their local and state representatives. A true grassroots effort!

The Long Island Pine Barrens Protection Act (1993) and The Comprehensive Management Plan (1995)

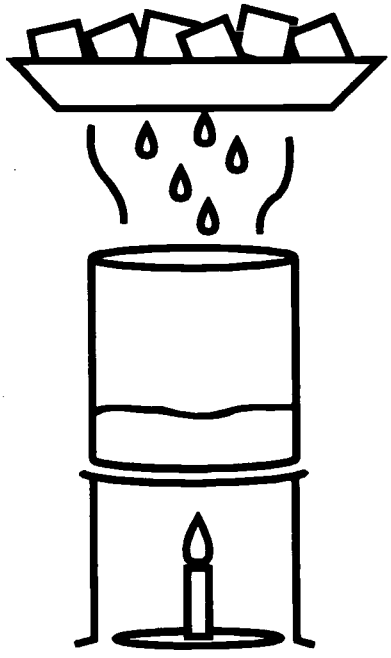
Although the LIPBS eventually lost the suit in the Court of Appeals, New York State's highest court, after winning at the Appellate level, citizens continued to press for action. Ultimately, this led to an unprecedented convergence of environmentalists, business leaders and government representatives to produce the Long Island Pine Barrens Protection Act. This Act, initiated in and passed by the New York State Legislature and signed into law by the governor, protects the Pine Barrens forever.

The Legislation has several important components. First it established a five member Central Pine Barrens Commission to oversee the development and implementations of a Comprehensive Management Plan (CMP); it also delineated two major regions within the 100,000 acre area - a 52,000 acre core preservation area where no new development is permitted and a 48,000 acre compatible growth area where limited, environmentally compatible development is allowed. The Plan also recommends that 75% of the core preservation area be preserved through public acquisition. The CMP was adopted by the Pine Barrens Commission in 1995.

To make the plan a reality the core area must be acquired. Funds approved by voters for the preservation of drinking water were, and continue to be, used to purchase core acreage. An interesting feature of this plan, and one needed to make this plan a reality, is the concept of transfer of development rights (TDR). This provision makes it possible for landowner/developers who own land in the core preservation area to acquire the rights to build in another location by transferring ownership of the core lands to a government entity for perpetual preservation.

CLASSROOM ACTIVITIES

THE HYDROLOGIC CYCLE



Grade Level:
3-8

Activity Level:
Interactive

Seasonality:
Fall, Winter, Spring, Summer

Time:
30 Min.

Group Size:
1 Class in Small Groups

Habitat:
Classroom

OVERVIEW

Students will create their own working model of the hydrologic cycle.

OBJECTIVE

After completing this activity, students will be able to:

1. name the four steps in the hydrologic cycle
2. know the three physical states of matter
3. describe the path water takes through the hydrologic cycle

MATERIALS

For each group:

- Portable electric burner
- Aluminum pie plate
- 1 Pound of ice
- Pot or beaker for boiling water
- Copies of the "Long Island Aquifer System" diagram

PROCEDURE

Distribute the "Long Island Aquifer System" diagram and discuss the hydrologic cycle.

STANDARDS MET

Science Inq. - 1
Physical Setting - 1,2,3,4
Systems Thinking - 1
Models - 2
Equilib. & Stability - 4
Connections - 1
Strategies - 2

Remind students of the dangers involved with using burners and boiling water. Then have the students plug in the burners and set the heat to medium high.

Next, students should place a half full pot of water on the burner and fill their pie plate with ice.

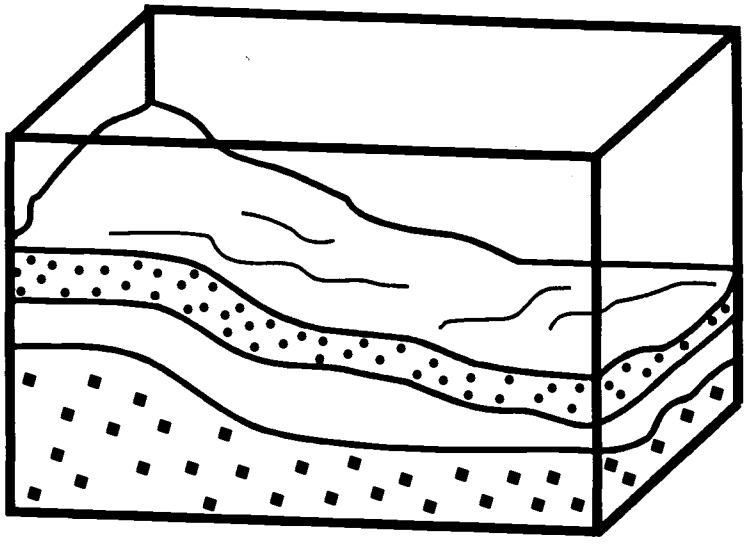
When the water boils, and steam can be seen rising from the pot, have students hold the pie plate with ice about 12 inches above the pot. They will need to hold it there for a few minutes.

After a few minutes, the students will see the water cycle at work. The steam will condense on the pie plate, and as the drops of water enlarge they will fall back into the pot.

FOLLOW-UP and EVALUATION

Discuss the concepts of recharge, infiltration and groundwater as they relate to the water cycle.

GROUNDWATER MODELING



Grade Level:
4-12

Activity Level:
Interactive

Seasonality:
Fall, Winter, Spring, Summer

Time:
1 hour

Group Size:
1 class in small groups

OVERVIEW

Students will construct a groundwater model in order to bring concrete meaning to the otherwise abstract concepts of groundwater geology.

OBJECTIVE

Students will:

1. understand the value of modeling
2. construct a simple groundwater model
3. discuss the variables that affect groundwater flow
4. appreciate the importance of groundwater to Long Island
5. discuss the Long Island Aquifer System

MATERIALS

Large translucent, rectangular tubs/containers
(Fish tanks are ideal)
An assortment of rocks, soils, gravel, organic material
The "Long Island Aquifer System" diagram

PROCEDURE

Introduce the concept of groundwater/aquifers using the "Long Island Aquifer System" diagram. Discuss the concept of modeling.

STANDARDS MET

Science Inq. - 1,2,3
Physical Setting - 2,3
Systems Thinking - 1
Models - 2
Connections - 1
Strategies - 2

Make the above materials available to students. Explain that using these materials, they need to make a model of Long Island's groundwater system.

Be sure that students demonstrate the following concepts: bedrock, aquifer, water table and groundwater.

Let Students fill in their tanks with an assortment of rocks, soil and gravel. Then have them pour water in so it comes within 6 to 8 centimeters of the surface of the soil. They should then label and define the features of their model.

FOLLOW-UP and EVALUATION

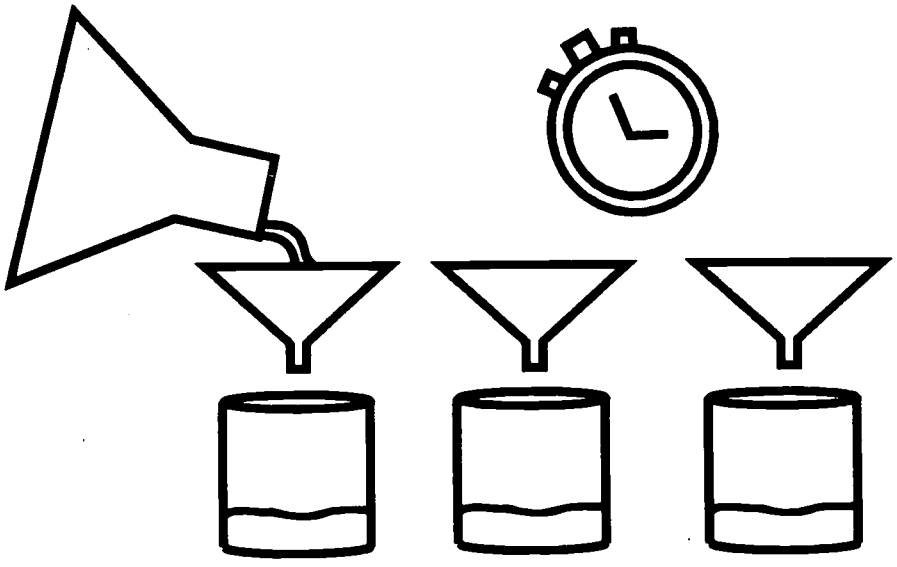
Have students modify their model to include a pond (clay works well for a pond bottom), model buildings and people.

Students can further demonstrate the water cycle by adding moss, a clear plastic top and a light source (a heat lamp or natural sunlight).

To simulate how a leaking underground storage tank may contaminate groundwater, students might bury a bottle with small holes and then fill it with colored water.

Invite a representative from Brookhaven National Lab, Suffolk County Department of Health Services or contact the New York State Water Resource Commission for a copy of a video on Long Island's groundwater system, entitled "The Long Island Water Story" geared towards middle/high school students.

SOIL PERMEABILITY



Grade Level:
6-12

Activity Level:
Interactive

Seasonality:
Fall, Winter, Spring, Summer

Time:
45 Min.

Group Size:
1 Class in Small Groups

Habitat:
Classroom

OVERVIEW

Students will determine the permeability of various soil samples.

OBJECTIVE

Students will:

1. understand permeability
2. measure the permeability of various soils
3. describe the role of permeability as related to precipitation and groundwater

MATERIALS

Various soil samples
3 Funnels
Water
Cotton balls
Stopwatch
3 Beakers
3 Graduated cylinders

STANDARDS MET

Science Inq. - 1
Model/Multi Rep. - 4
Measurement - 5
Physical Setting - 2,3
Models - 2
Magnitude & Scale - 3
Patterns of Change - 5
Connections - 1
Strategies - 2

PROCEDURE

If this activity is done in conjunction with "Separating Soil Particles", the particles should then be taken from the second sieve (fine gravel), the third sieve (coarse sand) and from the bottom container (silt and clay). The particles in the first and fourth sieves are not used in this investigation. Three funnels should be placed side by side with loose wadding of cotton in the neck of each. They should be tested before hand, to see if water effectively drains through each. Each funnel should be nested in a beaker to hold it upright.

Have students place equal amounts of the fine gravel in the first funnel, the coarse sand in the second funnel and the silt and clay particles in the third funnel.

Three separate graduated cylinders should be filled with 50 milliliters of water, which will be poured into the three funnels.

The length of time it takes for the water to drain through each funnel should be recorded using a stopwatch. The speed with which water moves through material is termed permeability.

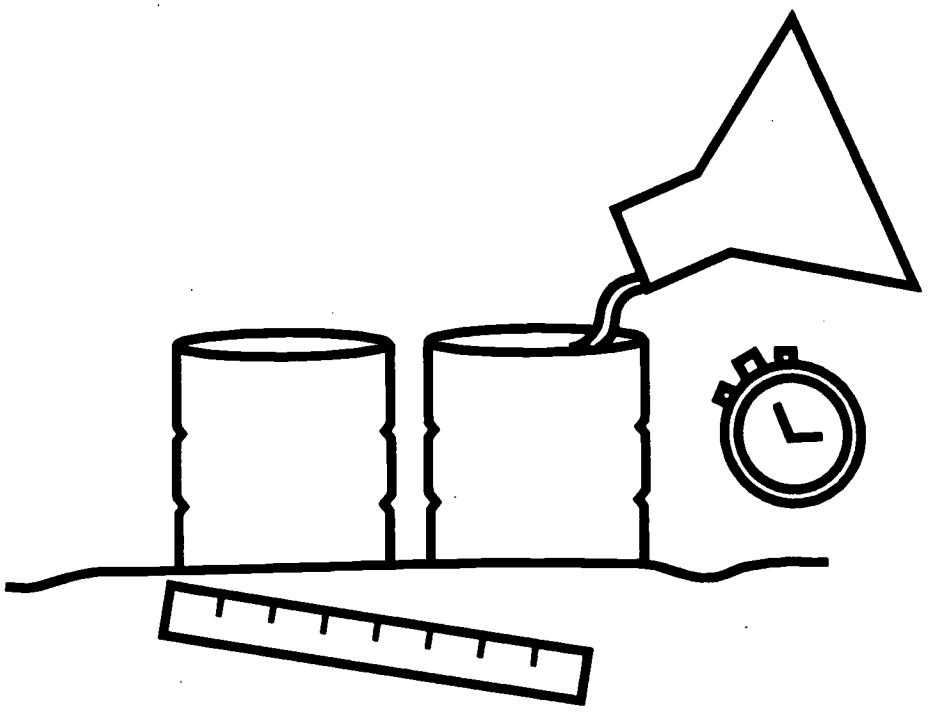
Students can also measure the amount of water that travels through the funnel and into the beaker below. Subtracting the amount left in each beaker from the original 50 milliliters will reveal the amount of water trapped between the particles as capillary water (soil water).

FOLLOW-UP and EVALUATION

Results can be organized into a chart or graph.

Ask students to explain how soil permeability is related to precipitation and groundwater.

SOIL POROSITY



Grade Level:
3-8

Activity Level:
Interactive

Seasonality:
Fall, Spring, Summer

Time:
20 Min.

Group Size:
1 Class in Small Groups

Habitat:
Field, Woodlands

OVERVIEW

Students will compare the rate at which soils from different areas absorb water.

OBJECTIVE

Students will:

1. understand porosity
2. measure porosity of different soils
3. describe the role of porosity as related to precipitation and groundwater

MATERIALS

Coffee can with both ends open
Ruler or meter stick
Water
Stopwatch or watch
Worksheet
Pencils

PROCEDURE

Students should place the coffee can into the ground, so that just one inch is below the surface. The can should be in a vertical position so that the hole at one end is in the ground and the hole at the other end is facing up.

STANDARDS MET

Science Inq. - 1,3
Model/Multi Rep. - 4
Measurement - 5
Uncertainty - 6
Patterns/Functions - 7
Physical Setting - 2,3
Living Env't. - 3,7
Systems Thinking - 1
Magnitude & Scale - 3
Equilib. & Stability - 4
Patterns of Change - 5
Connections - 1
Strategies - 2

The students should now fill the can with water; making sure that none flows out from the sides.

After three minutes the students should measure how many inches or centimeters of water have percolated into the ground and record the results on the data sheet.

Record the total porosity time - how long it takes for all the water to percolate into the soil.

Repeat the procedure in a different area.

FOLLOW-UP and EVALUATION

Have students complete the questions on the chart for soil porosity.

CHART FOR SOIL POROSITY

	After 3 Minutes	Total Porosity Time
Area 1		
Area 2		

1. Which area had the fastest percolation?_____

2. What were the ground covers?_____

_____

3. What does this tell you about the 2 areas of soil tested?_____

_____

4. What happens to water after it is absorbed by the soil?_____

_____

FOOD WEB GAME

Grade Level:
1-8

Activity Level:
Interactive

Seasonality:
Fall, Winter, Spring, Summer

Time:
30 Min.

Group Size:
8-10 Children or 1 Class

Habitat:
Classroom

OVERVIEW

Students will create a life sized web with string to show the inter-relationships between the organisms in a Pine Barrens community.

OBJECTIVE

Students will:

1. understand that all living things are important in the balance of nature
2. develop an awareness of the fragility and complexity of nature
3. recognize the necessity of conservation and preservation of our resources

STANDARDS MET

Living Env't. - 5,6,7
Systems Thinking - 1
Models - 2
Equilib. & Stability - 4
Connections - 1
Strategies - 2

MATERIALS

5 X 7 Index cards
String
Crayons
Hole puncher
Field guides or other resources

PROCEDURE

Punch holes in the index cards (one per student) and tie string in each hole so that it makes a loop big (long) enough to hang around the neck. Have students research a plant or animal in the Pine

Barrens and label an index card with its name and a few facts such as what it eats. Be sure your community includes: the source of energy (sun), producers of food (plants), primary consumers (animals that eat plants directly), and secondary consumers (animals that eat animals). A variety of organisms makes the game more enjoyable and interesting.

Suggested Pine Barrens Organisms:

Eastern Bluebird
Lichens
High Bush Blueberry
Pink Lady Slipper
Pitch Pine
Scrub Oak
Tiger Beetle
Buck Moth
Black Capped Chickadee
Rufous Sided Towhee
Tiger Salamander
Spring Peeper
Black Racer
Spotted Turtle
Eastern Chipmunk
White Footed Mouse
Red Fox
White Tailed Deer
Screech Owl
Red Tailed Hawk
Pitcher Plant
Midges

Once the cards have been made, have the students sit in a circle wearing their cards. Starting with the sun use a piece of string to connect each organism to the one which gets energy from/eats it. The idea is to make a food web by interconnecting all of the organisms.

It is suggested that groups be no more than six or eight children, otherwise the strings tend to become tangled. To do this activity with an entire class, choose eight students to make a small circle and have the remaining students sit in a larger circle around them. The small circle will become the web, and the outer circle can participate by naming the connections to be made.

FOLLOW-UP and EVALUATION

Once a web is completed, the group can play with their stable food web (their stable community). You can throw in various scenarios to see how they affect the community. If some plant or animal dies, the organism which feeds on it must drop their connecting rope and dies.

Examples of situations which can affect the web:

a. The introduction of DDT, a pesticide, into the community.
b. Human activity in the area.
c. Another animal from a foreign area moves in to the ecosystem.
d. A natural disaster, such as a fire, or a flood or an invasion of locusts...

TOWN MEETING

Grade Level:
5-12

Activity Level:
Interactive

Seasonality:
Fall, Winter, Spring, Summer

Time:
1 to 1 1/2 hours

Group Size:
1 or 2 classes

OVERVIEW

Students will participate in a mock town meeting to decide if a portion of the Pine Barrens should be developed.

OBJECTIVE

Students will:

1. participate in a debate
2. understand the influence public opinion can play in government decision making

STANDARDS MET

Living Env't - 6,7
Systems Thinking - 1
Models - 2
Optimization - 6
Connections - 1
Strategies - 2

MATERIALS

Watch or stopwatch
Paper
Pencils
Area maps

PROCEDURE

Divide the students into small groups. Each group will represent and role play the opinions of an interest group. For example, students may represent the views of a conservation organization, a "Mom and Pop" business, a large corporation, etc. (There should be relatively equal numbers of interest groups potentially for and against the proposal.) One group will be the town council.

Two adults are needed to assume the roles of the moderator and the developer.

The moderator will begin the town meeting by introducing the developer. The developer now has a few minutes to present his/her plans to develop a Pine Barrens area into a shopping mall, amusement park, etc. It is suggested that the developer use area maps and diagrams to make his/her point.

Once the developer has presented, the groups have 10 - 15 minutes to choose a spokesperson, and to think of any questions and/or points they would like to present to the developer.

Next, the moderator will allow each group's spokesperson a predetermined amount of time (three to five minutes) to ask the developer their questions and make their case to the town council why they are for or against the project.

Once all groups have had a turn, the town council will have five minutes to talk among themselves and vote for or against the proposal.

FOLLOW-UP and EVALUATION

Review the Town Meeting Procedure. Discuss how the students feel it went and how a similar event might play out in real life.

Discuss some of the legislative history involved with preserving the Pine Barrens.

OUTDOOR ACTIVITIES

QUADRAT STUDY

Grade Level:
4-8

Activity Level:
Interactive

Seasonality:
Fall, Spring, Summer

Time:
1 hr. w/follow up 2 hrs.

Group Size:
1 class in small groups

Habitat:
Field, Woodlands

OVERVIEW

This activity allows students to focus in on and study a small field or woodland area using investigative skills.

OBJECTIVE

Students will:

1. establish quadrats
2. identify and count species within a quadrat
3. make generalizations about an area

MATERIALS

4 Stakes
1 Length of string (20m)
1 Tape measure
Field guides
Compass
Pencils
Crayons
Clipboards
2 Thermometers
1 Trowel
Graph paper

PROCEDURE

To make the quadrat, have students use a compass to lay the first side of the quadrat facing due north (with younger students you may wish to forgo the compasses). Then use a right-angled object (i.e. a clipboard) to finish marking off a 5m X 5m square.

STANDARDS MET

Science Inq. - 1,2
Num & Numeration - 2
Operations - 3
Mode/Multi Rep. - 4
Measurement - 5
Uncertainty - 6
Patterns/Functions - 7
Physical Setting - 2
Living Env't. - 3,6
Systems Thinking - 1
Models - 2
Magnitude & Scale - 3
Patterns of Change - 5
Connections - 1

Each student will use their graph paper to map their quadrat. They should include all trees, logs, shrubs, grass, saplings, etc. Anything over 10 feet tall with one trunk should be counted as a tree. Everything mapped in the quadrat should also be identified by a key. For example, a pine tree might have the symbol "P" or an arrow, grass might be a "V" or "G".

Within the quadrat, students will locate the highest and lowest temperatures and indicate them on the map, for the following areas:

- at the land surface
- 4 ft. above ground
- 2 inches into the soil
    a) Explain why?
    b) Will it always be that way? How can it change seasonally or daily?

Signs of animal activity within the quadrat should also be mapped on the graph paper. Describing each sign and naming the animal that may have produced the sign can be recorded as well. Turning over leaves, logs or using a sweep net in grass may expose insects.

Within the study area, students should find and mark the least and most common plants.

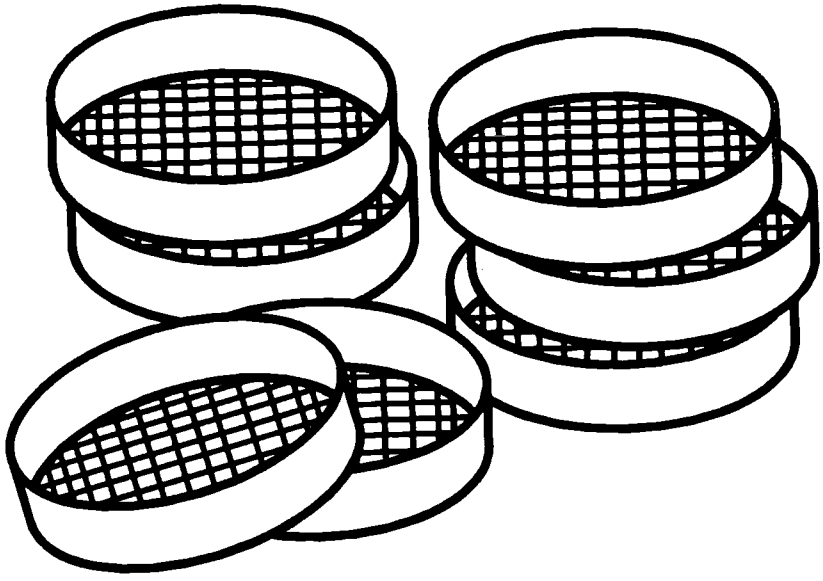
FOLLOW-UP and EVALUATION

Discuss and compile class data.

Have students generalize about the locale based on the data collected.

Discuss other areas where quadrat studies might be useful.

SEPARATING SOIL PARTICLES



Grade Level:
3-8

Activity Level:
Interactive

Seasonality:
Fall, Spring, Summer

Time:
20 Min.

Group Size:
1 Class in Small Groups

OVERVIEW

Students will use soil sifters to observe the different sizes of soil particles.

OBJECTIVE

Students will:

1. closely examine a soil sample
2. understand that soil is composed of many different sized particles

MATERIALS

White paper
Magnifying lens
Soil sifters
Work sheet
Pencils

PROCEDURE

Have students place a small amount of soil on a sheet of white paper. Using a magnifying lens, they should examine individual soil particles.

Next students should arrange the sifters in a colum with the largest screened chamber at the top and the smallest at the botttom.

STANDARDS MET

Science Inq. - 1
Num & Numeration - 2
Measurement - 5
Uncertainty - 6
Patterns/Functions - 7
Physical Setting - 3
Magnitude & Scale - 3
Patterns of Change - 5
Connections - 1
Strategies - 2

Instruct the students to place a handful of soil in the top chamber of the sifter and place the cover on. They should then shake the sifter in a back and forth motion for a minute or so. Students may then look inside each chamber and record their observations.

SEPARATING SOIL PARTICLES

PROCEDURE:

1. Place some soil on a sheet of white paper.

2. Use magnifying glass and try to identify individual particles.

   A. Do they differ in size?_____

   B. Shape?_____

   C. Texture?_____

3. Arrange sifters in column.

   A. What size sifter should you put on top?_____

   _____

   B. On the botton?_____

4. Place a sample of soil in the top sifter and shake the entire column. After a few minutes of shaking, look inside at the various levels of the sifter.

   A. What do you see happening?_____

   B. Are there different sizes of particles in each sample?_____

   _____

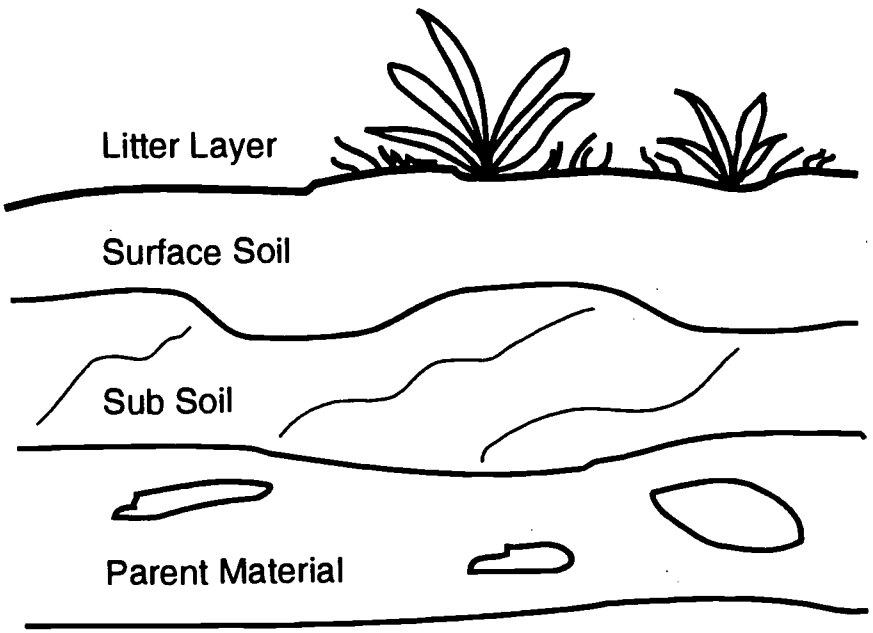
   C. Does particle size change from sample to sample?_____

   _____

   D. Explain._____

   _____

SOIL PROFILE



Grade Level:
3-8

Activity Level:
Interactive

Seasonality:
Fall, Spring, Summer

Time:
20 Min.

Group Size:
1 Class in Small Groups

OVERVIEW

Students will examine soil to gain an understanding that it is more than "lifeless dirt".

OBJECTIVE

Students will become familiar with the horizontal layers of soil by collecting a sample and making their own soil profile.

MATERIALS

Data sheets
Pencils
Soil augers
Glue
5 X 8 Index cards

PROCEDURE

Select a woodland area that does not appear to have been disturbed by digging or plowing.

Students should push a soil auger straight down into the ground. Occasionally, the auger is obstructed by a stone or root. If this happens, simply remove the auger and try again. Carefully move auger back and forth once or twice to loosen the soil, and slowy remove from the ground.

STANDARDS MET

Science Inq. - 1,3
Physical Setting - 2,3
Living Env't - 5,6
Systems Thinking - 1
Models - 2
Equilib. & Stability - 4
Patterns of Change - 5
Connections - 1
Strategies - 2

Next, have the students put a thin line of glue down the center of an index card long ways. The glue should be spread so that it makes a thin coating about one inch wide. This step must not be done until a soil sample has been taken with the auger, otherwise, the glue will dry before the soil is applied.

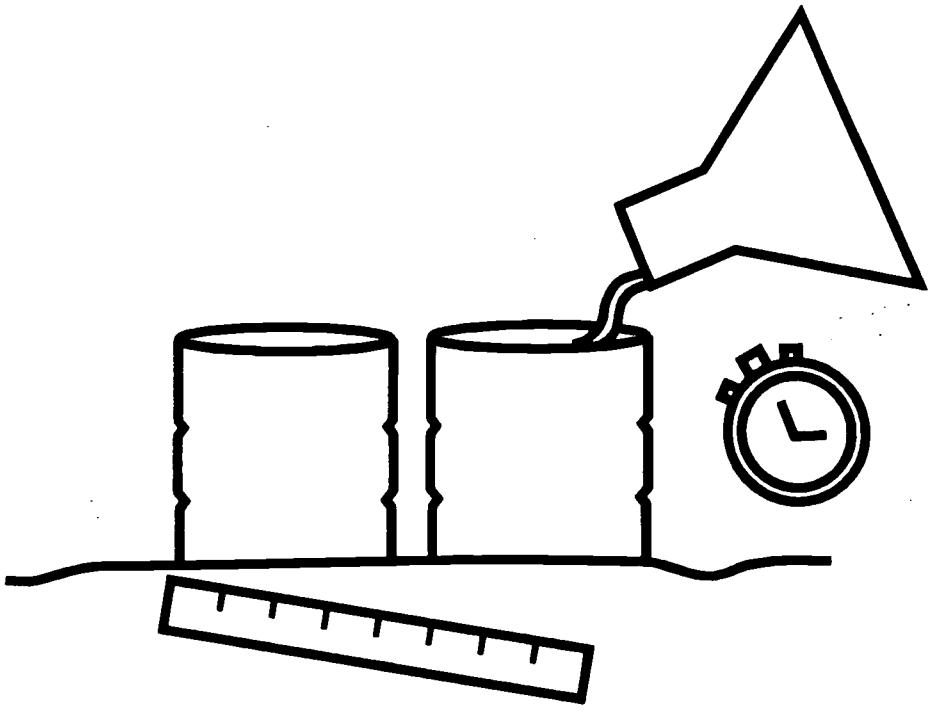
Using their fingers, have students carefully transfer the soil, section by section, from the auger to the index card, then shake off any excess soil. Be careful not to allow any glue to get on the auger.

Students may then label their soil profile according to the Soil Profile diagram.

EVALUATION

Have students complete the soil profile data sheet.

SOIL POROSITY



Grade Level:
3-8

Activity Level:
Interactive

Seasonality:
Fall, Spring, Summer

Time:
20 Min.

Group Size:
1 Class in Small Groups

Habitat:
Field, Woodlands

OVERVIEW

Students will compare the rate at which soils from different areas absorb water.

OBJECTIVE

Students will:

1. understand porosity
2. measure porosity of different soils
3. describe the role of porosity as related to precipitation and groundwater

MATERIALS

Coffee can with both ends open
Ruler or meter stick
Water
Stopwatch or watch
Worksheet
Pencils

PROCEDURE

Students should place the coffee can into the ground, so that just one inch is below the surface. The can should be in a vertical position so that the hole at one end is in the ground and the hole at the other end is facing up.

STANDARDS MET

Science Inq. - 1,3
Model/Multi Rep. - 4
Measurement - 5
Uncertainty - 6
Patterns/Functions - 7
Physical Setting - 2,3
Living Env't. - 3,7
Systems Thinking - 1
Magnitude & Scale - 3
Equilib. & Stability - 4
Patterns of Change - 5
Connections - 1
Strategies - 2

The students should now fill the can with water; making sure that none flows out from the sides.

After three minutes the students should measure how many inches or centimeters of water have percolated into the ground and record the results on the data sheet.

Record the total porosity time - how long it takes for all the water to percolate into the soil.

Repeat the procedure in a different area.

FOLLOW-UP and EVALUATION

Have students complete the questions on the chart for soil porosity.

CHART FOR SOIL POROSITY

	After 3 Minutes	Total Porosity Time
Area 1		
Area 2		

1. Which area had the fastest percolation?_____

2. What were the ground covers?_____

_____

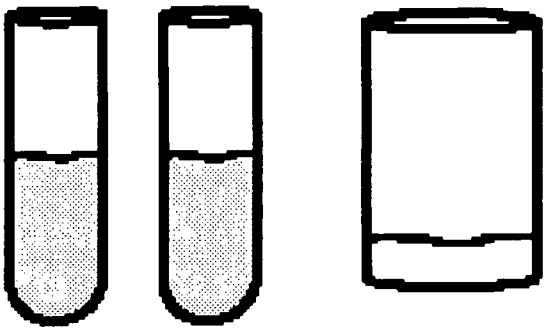
3. What does this tell you about the 2 areas of soil tested?_____

_____

4. What happens to water after it is absorbed by the soil?_____

_____

TEST FOR ORGANIC MATERIAL



Grade Level:
3-8

Activity Level:
Interactive

Seasonality:
Fall, Spring, Summer

Time:
20 Min.

Group Size:
1 Class in Small Groups

Habitat:
Field, Woodlands

OVERVIEW

Students will use a simple chemical reaction to test and compare the organic content of different soil.

OBJECTIVE

Students will:

1. understand what organic material is
2. use a simple chemical reaction to test soil for organic content

MATERIALS

Test tube
Soil sample
Hydrogen peroxide
Work sheet
Pencils

STANDARDS MET

Science Inq. - 1
Physical Setting - 2,3
Living Env't. - 6
Systems Thinking - 1
Equilib. & Stability - 4
Patterns of Change - 5
Connections - 1
Strategies - 2

PROCEDURE

Explain to the students that in order for something to be considered organic, it must have carbon in its makeup.

Fill test tubes about 1/3 full with samples of the different soil types you would like to test. Pour a small amount, about one capful, of hydrogen peroxide into each test tube and cap with rubber top. Wait for the reaction and record the time until the cap pops off.

If the soil begins to fizz or bubble, the soil has organic material in it. This means some of its substance is living or it contains the remains of living things (carbon). In general, the soil with the greatest organic content will pop the top the soonest. If the soil does not fizz or bubble there are no organic particles in it.

SOIL TESTED (Woods, Beach, Etc.) or different horizons	TEST RESULTS	ORGANIC OR NON-ORGANIC

FIELD TRIPS

PECONIC RIVER CANOE TRIP

Grade Level:
5-12

Activity Level:
Active

Seasonality:
Fall, Spring, Summer

Time:
2 to 6 hours

Group Size:
1 or 2 classes

Habitat:
River

OVERVIEW
Students will explore the Peconic River ecosystem as they canoe.

OBJECTIVE
Students will:

1. recognize the diverse flora and fauna of a river
2. learn the proper techniques for safely navigating a canoe

STANDARDS MET

Physical Setting - 2
Living Env't - 1,6,7
Systems Thinking - 1
Connections - 1
Strategies - 2

MATERIALS
Small note pads
Pencils
Area and river maps
Field guides
Appropriate dress

PROCEDURE
Canoes may be rented from any number of canoe rental companies in Suffolk County.

Introduce the trip in the classroom by distributing maps and discussing the location of the Peconic River. Explain that the Peconic is New York State's largest groundwater fed, Pine Barrens Stream.

Have the students predict what they will observe along the Peconic River.

Discuss proper canoe safety and paddling techniques.

Along the river, students should record their observations of flora, fauna, bogs, possible sources of pollution, etc...

FOLLOW-UP and EVALUATION

After returning to the classroom, compare the students' observations to their predictions. Ask the students to account for any difference between their predictions and actual observations.

Compile and discuss student data. Discuss the diversity of species noted.

CENTRAL PINE BARRENS HIKE

Grade Level:
4-12

Activity Level:
Active

Seasonality:
Fall, Spring, Summer

Time:
2 to 4 hours

Group Size:
1 or 2 classes

Habitat:
Central Pine Barrens

OVERVIEW

Students will hike through the Central Pine Barrens discovering its geology, flora and fauna.

OBJECTIVE

Students will:

1. describe the flora and fauna of the area
2. appreciate the glacial features that comprise Long Island
3. understand the importance of open space for maintaining a clean groundwater supply
4. measure and understand the importance of soil permeability and porosity

MATERIALS

Small notebooks and pencils
Area maps
Appropriate dress
Materials for any soil or quadrat activities that may be done

PROCEDURE

Prior to the hike, discuss Long Island geology. Be sure to discuss the concepts of moraines, outwash plains and watersheds.

STANDARDS MET

Physical setting - 1,2,3
Living Env't - 1,2,3,4,5,6,7
Systems Thinking - 1
Equilib. & Stability - 4
Patterns of Change - 5
Optimization - 6
Connections - 1
Strategies - 2

Have the students predict what they will observe in the Central Pine Barrens.

While hiking through the area, have students note any observations, including glacial features, flora and fauna, and record them in their notebooks.

Let the students select sites for soil and quadrat studies. Once they have provided the rationale as to why they selected a particular area, the students should conduct their studies, making sure to record their data.

FOLLOW-UP and EVALUATION

After returning to the classroom, compare the student's observations to their predictions. Ask students to account for any differences between their predictions and actual observations.

Compile and compare student data. Have the students make generalizations about the study area based on their findings.

QUOGUE WILDLIFE REFUGE

Grade Level:
4 -12

Activity Level:
Active

Seasonality:
Fall, Spring, Summer

Time:
2 hours

Group Size:
1 class in small groups

Habitat:
Wildlife Refuge

OBJECTIVE

Students will take a self-directed hike through the Quogue Wildlife refuge, a New York State wildlife protection area, using a trail guide and a compass.

STUDENT SKILLS NEEDED

Students will:

1. navigate using a compass
2. appreciate the diversity of flora and fauna at the refuge
3. compare the flora and fauna of the refuge with those of the Pine Barrens

MATERIALS

Small notebook
Pencil
Compass
Appropriate dress

PROCEDURE

Prior to the trip, determine the location of the refuge on area maps. Have students predict what flora and fauna they expect to find at the refuge.

STANDARDS MET

Science Inq. - 2
Measurement - 5
Physical setting - 2
Systems thinking - 1
Patterns of change - 5
Connections - 1

Be sure the students understand how to use a compass. Review basic compass parts, units of measurement and usage procedures.

At the refuge, have students use the self-directed course through the Quogue Wildlife refuge. Students should note their observations.

Upon returning to the classroom, students should compare the observed flora and fauna with their predictions.

Ask students for possible explanations of the differences.

FOLLOW-UP and EVALUATION

Have students design an activity that requires use of the compass as a navigational tool.

A Self-Directed Course through the Quogue Wildlife Refuge

Standing in front of the main gate, take the trail leading in a direction of 200°. Soon you will reach a boardwalk. Proceed along the boardwalk, noticing the plant life. After a short distance you will come to a platform. Step up onto the dirt embankment and continue in a 280° direction.

On your right is Old Ice Pond. Why do you suppose it was given this name?
A clue: the embankment you are walking on is man-made.

At the end of the embankment, proceed on the trail that heads off in a direction of 360°.

What direction is this?

As you make the turn onto this trail, notice the low green ground cover. It is a Pine Barrens plant called Bearberry. It grows in sandy, open areas. List other plants you see but do not pick any!

As you continue ahead, you will come to two red benches. Rest if you wish and then continue in a 10° direction.

As you walk, what do you notice about the forest? Has it been subjected to fire recently? How do you know? Have plants been affected?

At the fork seek a bearing of 20° and continue. Proceed to a second fork and continue at 90°.

What direction is this commonly called?

You will come to a cleared area. Continue through it and at the next fork take a bearing of 70° and proceed ahead. As you continue, notice the height of the pitch pine trees. You may also notice an evergreen shrub with black berries. This is an ink berry, a member of the holly family. The trail continues, so relax and enjoy the scenery!

What does this area smell like?

At the next intersection, take the trail heading off in a 90° direction. Ahead you will come to a bog. Proceed back down the trail and take a 180° bearing at the intersection.

As you proceed, do you notice any signs of a bog?

At the fork, take a bearing of 190° to another boardwalk. Stop briefly and notice the plants growing here. This is a second bog. At the brown post with the #30 on it, you can observe a large amount of pitcher plant. You can also see sphagnum moss growing. Another plant to look for is cranberry. Notice the stumps in the stream.

After you leave the boardwalk, proceed ahead to the end of the trail. Your final heading is 170°.

DWARF PINE PLAINS

Grade Level:
4-12

Activity Level:
Active

Seasonality:
Fall, Spring, Summer

Time:
2 to 4 hours

Group Size:
1 or 2 classes

Habitat:
Dwarf Pine Plains

OVERVIEW

Students will hike through the Dwarf Pine Plains which is characterized by a form of pitch pine that grows to three to five feet.

OBJECTIVE

Students will:

1. discuss the ecological factors that created this environment
2. identify the floral species of the area
3. determine the soil porosity and permeability
4. appreciate the need for fire in the Dwarf Pine Plains

MATERIALS

Small notebooks and pencils
Area maps
Plastic bags
Materials for quadrat, porosity, permeability studies, etc. as desired

PROCEDURE

Prior to the hike, locate the Dwarf Pine Plains on area maps.
Ask students what they expect to see.

STANDARDS MET

Physical Setting - 1,2,3
Living Env't - 1,2,3,4,5,6,7
Systems Thinking - 1
Equilib. & Stability - 4
Patterns of Change - 5
Optimization - 6
Connections - 1
Strategies - 2

While at the Dwarf Pine Plains have students examine the area noting the flora such as the dwarf pitch pine, black huckleberry, bearberry and several species of ground loving lichens.

This area has the greatest concentration of buck moths in the world, so have students look for moths, especially the brightly colored, poisonous male.

Ask students to identify signs that indicate the area has recently sustained fire. Ask for the rationale. Look for signs of new growth.

Instruct each group to collect an unopened dwarf pine cone and some soil for further study in the classroom.

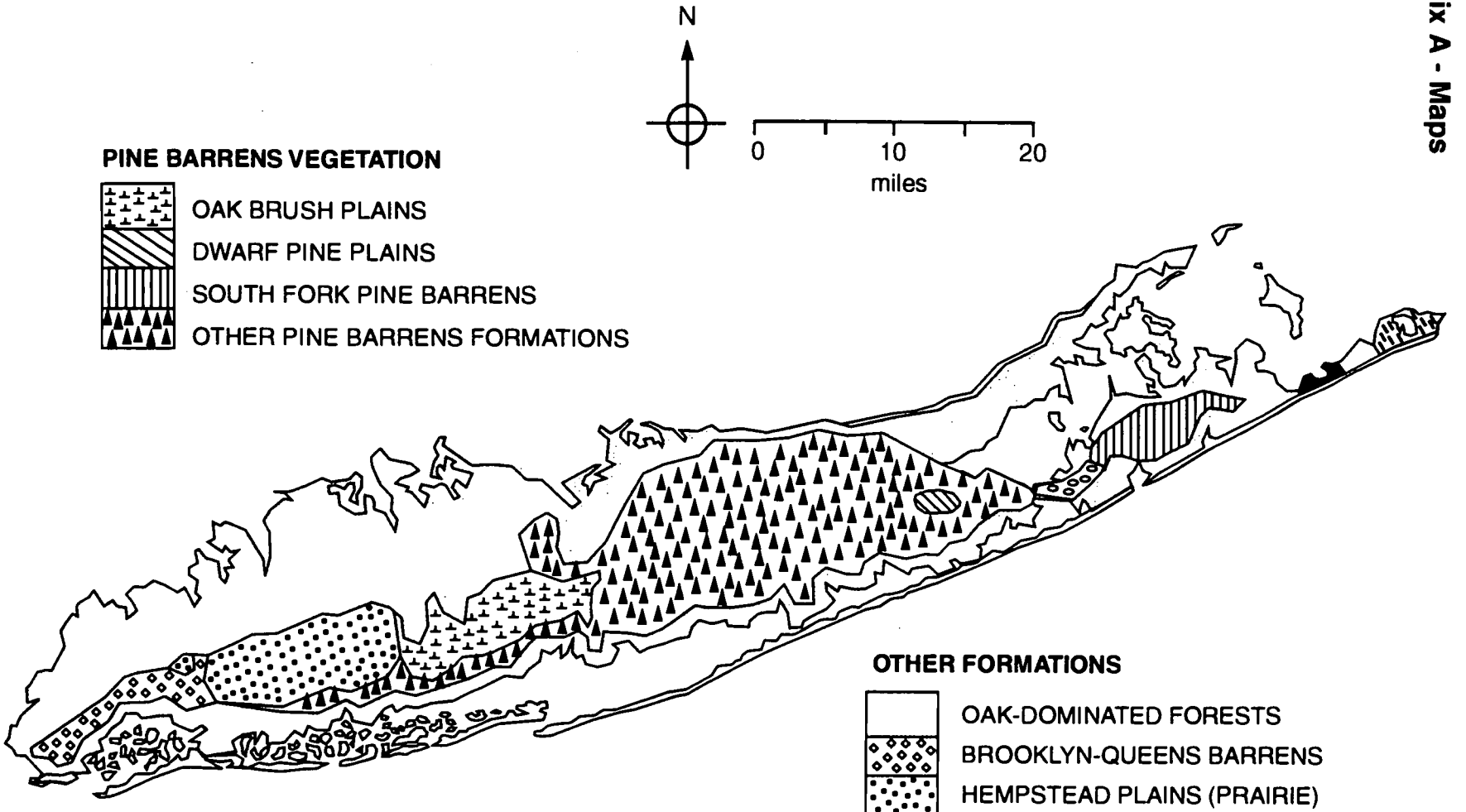
FOLLOW-UP and EVALUATION

Compile and discuss the data collected in the Dwarf Pine Plains. Compare results to any previous studies in other areas.

Have students use a heat source (a hot plate) to cause the dwarf pine cones to open. (Be sure to remove the cones from the heat as soon as it starts to open to avoid killing the seeds.)

Germinate dwarf pine seeds in the soil sample collected.

MAJOR VEGETATION OF LONG ISLAND



Map No. 1: Major Vegetation of Long Island, shows relationship of Oak Brush Plains to rest of Long Island Pine Barrens.

THE LONG ISLAND AQUIFER SYSTEM

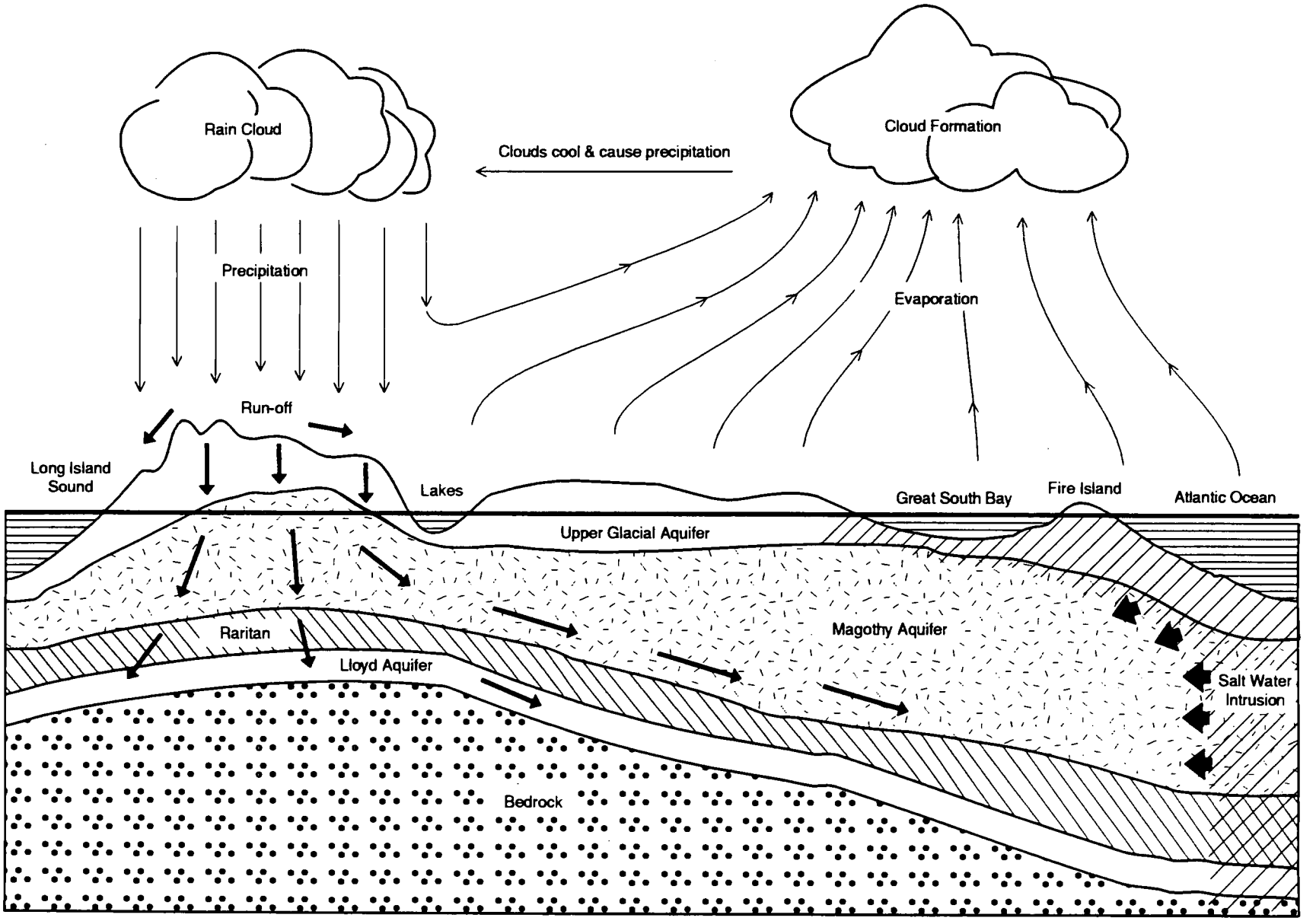
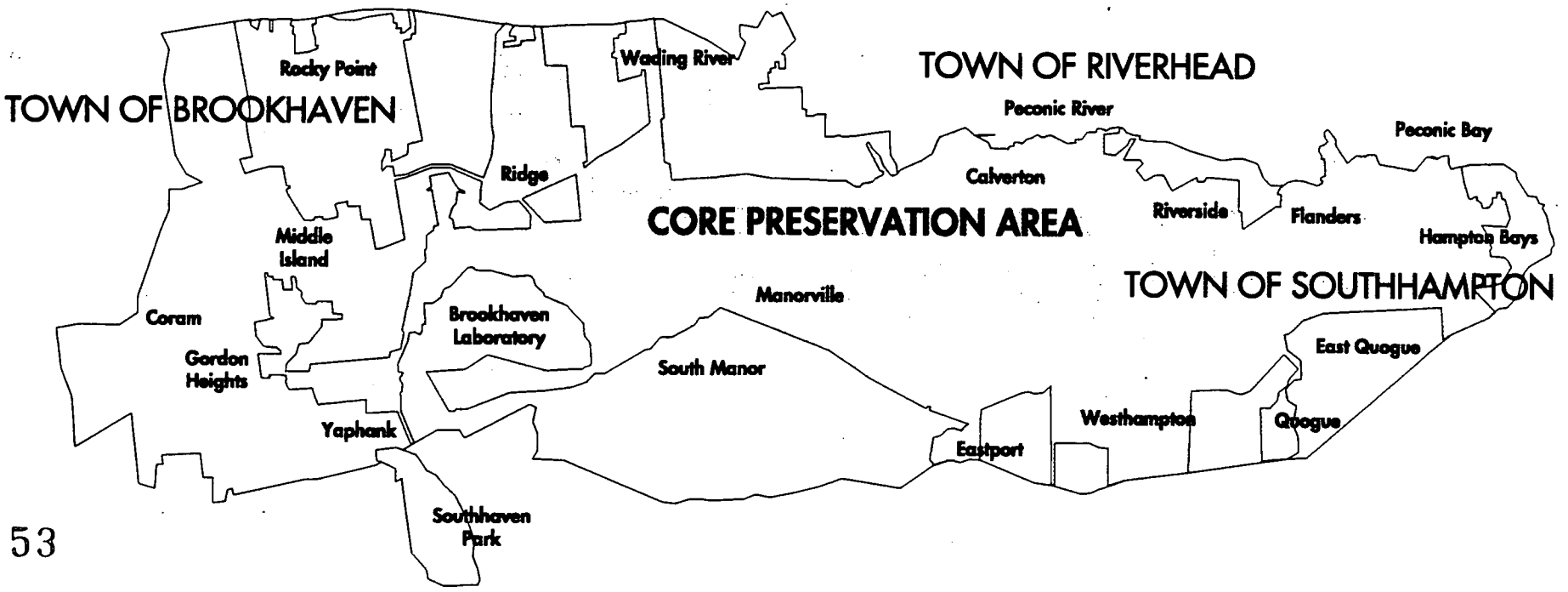


Diagram by Rose Design

CENTRAL PINE BARRENS, SUFFOLK COUNTY, NEW YORK



Appendix B - Glossary

For your convenience, those terms that are highlighted in the background section are defined here.

Absorption - process by which a liquid, e.g., water, is taken up and distributed throughout a substance. In the Pine Barrens, precipitation is absorbed by the soil.

Aquifer - geologic formation that holds and transmits water beneath the earth's surface. All of Long Island's drinking water is drawn from an aquifer system.

Conifer - trees with seed contained in cones, e.g., pine cones.

Diffusion - the movement of gases or liquids, e.g., water, from areas of high concentration to those of low concentration. In the Pine Barrens, precipitation may collect on the soil's surface or in its upper layers and diffuse downward and outward to areas not yet saturated. Also, salt water intrusion is a diffusion process.

Ecology - the study of the relationships between and among organisms and their environment.

Ecosystem - an area in which living organisms interact with each other and the nonliving components of their environment to process energy and cycle nutrients. The plants, animals, soils, insects, streams and underground water are part of the Pine Barrens ecosystem.

Groundwater - fresh water that resides and is trapped beneath the earth's surface in geologic formations such as the aquifers.

Groundwater flow - the direction(s) in which the groundwater naturally moves, as dictated by gravitational and hydraulic forces. On Long Island, the regional flow is south to the Great South Bay/Atlantic Ocean, north to the Long Island Sound or east toward the Peconic Bay. The determinant as to which direction the flow will take is the groundwater divide, typically located north of the Ronkonkoma Moraine. South of the groundwater divide, the flow is toward the ocean/bay; in those areas north of the groundwater divide, the flow is toward the Sound. The regional flow is altered on a local level by streams and wells, which draw water toward them, and local geological conditions, such as peninsulas.

Habitat - the area where an organism occurs, including its environment, and encompassing such factors as climate which affect its environment.

Hydrologic cycle - the distribution and movement of water in the atmosphere and of the earth's surface, changing form as it moves This includes the evaporation of water from surface waters and the soil. Water is moved by plants and is added to the atmosphere as water vapor in a process called evapotranspiration. Atmospheric water moves as water vapor, water droplets, or ice in clouds. When the water vapor condenses precipitation falls as rain, sleet or snow. This water falls to the ground surface where it may retum to the oceans as it passes over land. The time required to complete the cycle varies from place to place and for different parts of the cycle.

Indigenous species - species natural to an area.

Minimum range - the smallest size of home range needed to maintain a species. The home range is the area in which an animal normally lives.

Moraine - a mass of rocks, gravel, sand and other particles deposited by a glacier at its lower end (terminal) or along its side (lateral). The Ronkonkoma Moraine runs through the center of Long Island, roughly following the path of the Long Island Expressway, and continues across the north shore of the south fork to Montauk Point. The Harbor Hills Moraine forms the north shore of Long Island, roughly following Route 25A, and continuing to Orient Point.

Outwash plain - a plain composed of sand and gravel deposited by melting water beyond the lower end of a glacier. The area south of the Ronkonkoma Moraine, basically the mid-south shore of Long Island, is an outwash plain.

Percolation - the passing and filtering of a liquid, e.g., water, through the small spaces in a porous substance, e.g., sandy soil.

Permeability - a measure of the ability of a gas or liquid, e.g., water, to pass through a substance, e.g., soil or aquifer, as determined by the surface area.

Porosity - a measure of the ability of a liquid, e.g., water, to pass through a substance, e.g., soil, as determined by the air space available in that substance.

Recharge area - a porous and permeable ground area that allows for the natural collection, absorption, diffusion and percolation of precipitation and collected runoff which eventually replenishes the groundwater reserves in the aquifers.

Runoff - water that flows over the land surface toward areas of lower elevation, e.g., the ocean, rather than entering the underground water supply.

Salt water intrusion - in coastal areas, as water is drawn from the aquifer, salt water from the ocean, bays and sound may infiltrate an aquifer. This renders the groundwater brackish and not suitable for drinking.

Serotin - the resin that seals dwarf pine tree cones, preventing the release of seeds. In the natural state, fire occurs intermittently. The sealed cones protect the seeds. Once the resin melts the seeds are released and fall to the ground to regrow the forest.

Watershed - a region where all precipitation is directed to the lowest elevation. The water is "shed" by the land to a common area.

Wetlands - ecosystems with soils which are inundated or water-saturated for all or part of a year and are home to water-loving or water-tolerant plants (hydrophytes).

Wildfire - in a Pine Barrens ecosystem, a naturally occurring fire that serves to allow the cones of the serotinous conifers to open to disperse its seeds, thereby reproducing. This occurs if the fire remains a ground fire; if it becomes a crown fire (reaches tree tops), the seeds are likely to be destroyed.

Appendix C - A Pine Barrens Resource Guide

This resource guide lists locations, print materials, videos, environmental organizations and electronic resources to enrich environmental education for both teachers and students. While the primary focus is the Long Island Pine Barrens, additional environmental sites and readings of interest are included for your convenience.

LOCATIONS

Hiking areas

Blueberry Loop (Manorville)
Berry-laden vegetation, Pine Barrens
Begin at the Pine Barrens Trails
Information Center at Exit 70, L.I.E.

Dwarf Pine Plains (Westhampton)
Dwarf pines, buck moths
Sunrise Highway & County Road 31

Long Island Trail (Heckscher State Park - Sunken Meadow State Park)
Diverse settings

Manorville Hills (Manorville)
Pine Barrens
Halsey Manor Road & L.I.E.

Nassau-Suffolk Trail (Massapequa - Cold Spring Harbor)
Diverse settings - swamp maples, Pine Barrens,
hardwoods, Ronkonkoma and Harbor Hills Moraines
Park at northeast corner, Merrick Road and Ocean Avenue.

Pine Trail Preserve and Peconic Ponds (Rocky Point - Ridge - Manorville)
Pine Barrens, Peconic River headwaters
Park on Route 25, east of William Floyd Parkway

Rocky Point Preserve (Rocky Point)
Hardwood forest, Harbor Hill Moraine, kettlehole, Pine Barrens
Parking off Route 25A. Permit needed (NYSDEC, 444-0273)

Wildlife Preserves

Barcelona Neck (Sag Harbor)
Hardwoods, swamp, marsh
Permit needed (NYSDEC, 444-0273)

Connetquot River State Park and Preserve (Oakdale)
Fish hatchery, ospreys, egrets
Sunrise Highway

Cranberry Bog County Preserve (Riverhead)
Pine Barrens, wetlands
Riverhead - Moriches Road

David Sarnoff Pine Barrens Preserve (Riverhead)
Pine Barrens
Route 104

Edgewood Oak Brush Plain Preserve (Brentwood)
Pine Barrens, hawks
Commack Road

Quogue Wildlife Refuge (Quogue)
Self-guided Pine Barrens trails
Old Country Road

Robert Cushman Murphy County Park (Manorville)
Cranberries, bladderworts
River Road & Swan Pond

Wertheim Refuge (Shirley)
Hardwoods, pine barrens, wetlands
Smith Road

Reading List

Citations are arranged by category in reverse chronological order. Asterisked entries are suitable for children.

Technical Documents

Central Pine Barrens Joint Planning and Policy Commission. *Proposed Final Central Pine Barrens Plan and Supplemental Draft Environmental Impact Statement.* Great River, New York. 1995.

Central Pine Barrens Joint Planning and Policy Commission. *Draft Comprehensive Land Use Plan.* Great River, New York. 1995.

Pitt, Jo-Ann. A Compilation of Long Island Water Resources: *A Bibliography of Cooperative Water Resources Reports*. U.S. Geological Survey-New York District, Long Island Subdistrict. 1994.

Corwin, R. Central Pine Barrens Handbook: *A Working Guide to the Long Island Pine Barrens Maritime Reserve Act of 1990*, as amended by the Long Island Pine Barrens Protection Act of 1993. Central Pine Barrens Joint Planning and Policy Commission. Great River, New York.1994.

United States Geological Survey. *Evaluation of Statistical Models to Predict Chemical Quality in Shallow Groundwater in the Pine Barrens of Suffolk County, Long Island, New York. 1993.*

Buxton, H.T. and Modica, E. "Patterns and Rates of Groundwater Flow on Long Island, New York." *Groundwater*. November-December, 1992.

Long Island Regional Planning Board. Koppelman, L.E., Kunz, A., Tannenbaum, E. and Davies, D. *The Long Island Comprehensive Special Groundwater Protection Area Plan*. Plan Division of Environmental Quality. Hauppauge, New York. 1992.

Buxton, H.T. et al. "Particle Tracking Analysis of Recharge Areas on Long Island, New York." *Groundwater*. January-February, 1991.

**Raymond, Lyle S. Jr. *Aquifers*. New York State Water Resources Institute Center for Environmental Research, Bulletin No. 3. Cornell University. Ithaca, New York. November, 1990.

**Raymond, Lyle S. Jr. *Groundwater Contamination*. New York State Water Resources Institute Center for Environmental Research, Bulletin No. 2. Cornell University. Ithaca, New York. November, 1988.

**Raymond, Lyle S. Jr. *What is Groundwater?*. New York State Water Resources Institute Center for Environmental Research, Bulletin No. 1. Cornell University. Ithaca, New York. July, 1988.

New York State Department of Environmental Conservation. *Watershed Strategy for Long Island*. 1988.

Collins, Beryl Robichaud and Emily W.B. Russell, ed. *Protecting the New Jersey Pine Barrens - A New Direction in Land-Use Management*. Rutgers University Press, New Jersey. 1988.

Suffolk County Department of Health Services. *Suffolk County Comprehensive Water Resource Management Plan*. Division of Environmental Quality. 1987.

New York State Department of Environmental Conservation. *Long Island Groundwater Protection Area Plan*. 1986.

Long Island Regional Planning Board. *Special Groundwater Protection Area Project*. 1986.

United States Geological Survey. *Hydrogeologic Appraisal of the New York Pine Barrens*. 1986.

Nagle-Kelly, Nancy. *Land Use and Groundwater Quality in the Pine Barrens of Southampton*. Comell University. Ithaca, New York. 1983.

McGrath, Robert T., The Long Island Pine Barrens Task Force. *The Heath Hen*. June, 1982.

Greenberg, E., Meyland, S., and Tripp, J. T. B.,Eds. *Watershed Planning for the Protection of Long Island's Groundwater*. Coalition for the Protection of Long Island's Groundwater. 1982.

Long Island Regional Planning Board. *Long Island Comprehensive Waste Management Plan*. 1978.

General Information

Turner, John L. *Exploring the Other Island: A Seasonal Guide to Nature on Long Island*. Waterline Books. Great Fall, Virginia, 1994.

Turner, John L. "Preserving the Plains at Edgewood." *The Conservationist*. New York Department of Environmental Conservation. May-June, 1990.

Cryan, J.F. "Retreat in the Barrens." *Defenders*. January-February, 1985.

Cryan, J.F. and Turner, J.L. "The Peconic: Pine Barrens River." *The Heath Hen*. 1985.

Cryan, J.F. "An Introduction to the Long Island Dwarf Pine Plains." *The Heath Hen*. 1982.

Cryan, J.F. and Turner, J.L. "A Landscape Imperiled: The Long Island Oak Brush Plains." *The Heath Hen*. 1981.

Eggington, Joyce. "The Long Island Lesson." *Audubon 83*. July, 1981.

Englebright, Steven. "Long Island's Secret Wilderness." *The Conservationist*. January-February, 1980.

Glenn, R.A. *The Long Island Pine Barrens..Our Fragile Wilderness*. The Museum of Long Island Natural Sciences, Occasional Pub. No. 3. SUNY at Stony Brook, New York. 1979.

Forman, Richard T.T., ed. *Pine Barrens-Ecosystem and Landscape*. Academic Press, New York. 1979.

Many of these documents and articles may be found at the Central Pine Barrens Joint Planning and Policy Commission Library located at 3525 Sunrise Highway, Great River. Please call (516) 224-2604 or (516) 563-0385 to schedule an appointment.

Research Papers

Chase, Christine. *Conflict and Accommodations: The Long Island Pine* Barrens. Master's Thesis, 1995.

McDougal, James. *Conservation of Biodiversity in the Central Pine Barrens Protection Area of Suffolk County, New York: Ecological Considerations for Planning and Management*. Master's Thesis, 1994.

Meek, Carrie. *Sustainable Development in the Midst of Suburban Sprawl: The Central Pine Barrens Land Use Plan.* Master's Thesis, 1997.

Print Press

The collection of print and video press that details the Long Island Pine Barrens saga is enormous. Both Newsday and The New York Times have covered the story in detail since the 1989 suit filing. Newsday covered the issue since its inception, with groundwater issues covered as early as the late '70's. Both publications maintain electronic archives at www.newsday.com and www.nytimes.com. In addition, various public libraries maintain up-to-date vertical files; the collections in Patchogue and Smithtown are particularly noteworthy. The Long Island Pine Barrens Society maintains the most comprehensive vertical file and may be viewed upon request.

For our purposes here, we cite a few articles that highlight some of the most significant developments in the fight to preserve to preserve the Long Island Pine Barrens. They are listed in reverse chronological order.

"The Pine Barrens Saved." *Newsday.* June 29, 1995.

"Senate Oks Bill on Pine Barrens." *Newsday.* July 23, 1993.

'The War of the Woods is Over." *Newsday.* July 15, 1993.

"The Art of the Deal." *Newsday.* June 27, 1993.

"Only $$$ Stands in the Way." *Newsday.* June 10, 1993.

"Pine Barrens Deal Nears Finish Line." *Newsday.* June 4, 1993.

"The Final Frontier: The Pine Barrens Development Clash." *Newsday.* May 25, 1993.

"Dispute Over the Pine Barrens Still Persists." *Newsday.* May 16, 1993.

"Pine Barrens Ruling: A Boost for the Builders." *Newsday.* November 25, 1992.

"Pine Barrens Ruling: Appeals Court Reinstates Environmentalists' Lawsuit." *Newsday.* March 12, 1993.

"Suit: Halt Building in the Barrens." *Newsday.* November 22, 1989.

The following articles highlight the wildfires that occurred in the Rocky Point and Westhampton Pine Barrens during the summer of 1995.

"The Pine Barrens' Rebirth." *Newsday.* October 30, 1995.

"Sowing the Seeds of Life." *Newsday.* August 31, 1995.

"Contained-Firefighters Finish Barrier Around Westhampton Blaze." *Newsday.* August 28, 1995.

"The Fire." *Newsday*. August 26, 1995.

"East End Wildfire Ablaze!" *Newsday*. August 25, 1995.

"Line of Fire-Hundreds Battle Giant Rocky Point Blaze." *Newsday*. August 23, 1995.

Video

"Long Island's Wilderness...The Pine Barrens"

Electronic Resources

Listed below are some interesting World Wide Web sites that hold a wealth of environmental information, including lesson plans.

National Science Teachers Association
www.nsta.org/online resources/

Gatewest
www.gatewest.net/~green/

Forests Forever
www.forestsforever.org/

EnviroLink
www.envirolink.org/EnviroLink_Library/
www.enn.com/

The Globe Project
www.globe.gov/

Web Directory of Environmental Resources
www.webdirectory.com/Education/
www.webdirectory.com/Water_Resources/Groundwater/

The Audubon Society
www.audubon.org/aububon

Long Island Nature Conservancy
www.cyberdata.com/litnc/

The Long Island Pine Barrens Society web address is **www.pinebarrens.org**

Local Environmental Agencies and Organizations

You may contact the **Long Island Pine Barrens Society** at
P.O. Box 429
Manorville, NY 11949
(516)369-3300

BOCES Outdoor/Environmental Education, 810 Meadow Road, P.O. Box 604, Smithtown, NY 11787 (516) 360-3652

Cornell Cooperative Extension of Suffolk County, 248 Griffing Avenue, Riverhead, NY 11901 (516) 454-0900

Environmental Centers of Setauket-Smithtown, Inc., 62 Eckerkamp Drive, P.O. Box 257, Smithtown, NY 11787 (516) 979-6344

Group for the South Fork, P.O. Box 569, Bridgehampton, NY 11931 (516) 537-1400

Long Island Botanical Society, P.O. Box 905, Levittown, NY 11756

Long Island Greenbelt Trail Conference, 23 Deer Path Road, Central Islip, NY 11722 (516) 360-0753

Long Island State Park Region, P.O. Box 247, Babylon, NY 11702 (516) 669-1000

Museum of Long Island Natural Sciences, Earth and Space Sciences Bldg., SUNY at Stony Brook, Stony Brook, NY 11794 (516) 632-8230

Nassau BOCES - Outdoor & Environmental Education, Valentines and The Plains Roads, Westbury, NY 11590 (516) 997-8700

The Nature Conservancy, Long Island Chapter, 250 Lawrence Hill Road, Cold Spring Harbor, NY 11724 (516) 367-3225

The Nature Conservancy, South Fork-Shelter Island Chapter, P.O. Box 5125, East Hampton, NY 11937 (516) 329-7689

New York State Department of Environmental Conservation, Bldg. #40, SUNY at Stony Brook, NY 11790 (516) 444-0273

Open Space Council, P.O. Box 275, Brookhaven, NY 11719

Sierra Club, Long Island Chapter, P.O. Box 210, Syosset, NY 11791

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