Water

Water is one of the key defining elements of the Pine Barrens ecosystem. While everything you need to know about the Pine Barrens starts with the acidic, low-nutrient soil, it is the water through which the soil exerts much of its influence on the plants and animals that thrive in this environment. The water shapes the life of the Pine Barrens in several ways:

- The Kirkwood-Cohansey aquifer system sustains the terrestrial plants that live in the region’s droughty upland soils.

**Why are Pine Barrens streams “teacolored”?

This is one of the most frequently-asked questions among visitors to the Pine Barrens. The answer is that the tannins and other organic molecules are leached out of dead leaves and cedar and pine needles by the acidic waters. Iron molecules, which are abundant in the soils, attach to these compounds and color the water reddish brown. Some of the iron also precipitates out of the water and is deposited on stream bottoms, eventually forming thick mats of “bog iron.”

- The Kirkwood-Cohansey aquifer system also supplies virtually all of the water that feeds the Pine Barrens extensive streams and wetlands, which cover about 1/3 of the Pinelands’ surface area.
- All the aquifers underlying the outer coastal plain provide virtually all the drinking water for the large and growing human population of the region.
- The acidic, low-nutrient chemistry of Pine Barrens surface and ground waters determines the plant and animal species that can flourish here, and those that cannot.

**The Kirkwood-Cohsansey Aquifer System:**

To understand the ecology of the Pine Barrens, and how the Pine Barrens links to the coastal estuaries, one must examine the Kirkwood-Cohansey aquifer system. An aquifer is a body of water embedded in the earth. The Kirkwood-Cohansey aquifer system is the vast body of water embedded in the sands of New Jersey’s coastal plain.

Picture in your mind pouring water into a bucket of sand, filling it until the water comes up to just below the surface of the sand. Then draw your finger through the sand to create a depression deep enough to expose the water. You now have a good idea of the Kirkwood-Cohansey aquifer system. It is a surficial aquifer, meaning it is exposed to the surface of the earth, rather than being confined underground in some deep layer of soils or rock. But where there are depressions in the surface, such as in streams and wetlands, the water is actually visible. In one respect, this static thought experiment is not accurate, for the water that makes up the Kirkwood-Cohansey aquifer system is always on the move. The whole body of underground water is generally flowing slowly to the east, towards the seacoast. A portion of the underground water is drawn into rivers and streams and flows gently downhill into the estuaries along the Atlantic seaboard or the Delaware River.

The simplified drawing in Figure 1 [Aquifer Chart] shows how the Kirkwood-Cohansey aquifer occupies the top of the enormous wedge of sand that makes up most of South Jersey, and how it is related to the other partially confined aquifers (especially the Atlantic City 800-foot Sands) and fully confined aquifers (such as the Potomac-Raritan-Magothy aquifer) that lie beneath the Kirkwood-Cohansey. An aquifer is considered confined if it is confined within a geologic formation that has impermeable formations (“confining layers” of clay or rock) above and below it; an aquifer is unconfined if, like the Kirkwood-Cohansey, there is no confining layer between the aquifer and the surface; and it is deemed semi-confined if there is a partially permeable geologic layer between the deeper aquifer and the aquifer or the surface above.

We call the Kirkwood-Cohansey an “aquifer system” because it is contained within two connected
geologic formations, the Kirkwood and the Cohansey sands, and has many local variations caused by variations in the soils in which it is embedded. For example, in some places, the aquifer may be partially confined because of a local layer of impermeable clay beneath the surface. These variations can affect the influence the aquifer has on the biology of the surface, the flow of pollutants in the water through the ground, and the impacts that pumping the water for human use will have on nearby streams and wetlands.

The Kirkwood-Cohansey is the life blood of the Pine Barrens. Ninety percent of the water in the streams and wetlands of the Pine Barrens is supplied by the aquifer system, rather than direct runoff from rain or melting snow. If the water table - the highest surface of the aquifer - were to fall far enough, the streams and wetlands and all their inhabitants would become severely stressed for lack of water, and would eventually die.

The Kirkwood-Cohansey aquifer is fed, or “recharged,” by rainfall and melting snow. On average, the Pinelands receives about 45 inches of precipitation annually, which translates to about 1.3 trillion gallons. About half of this water is transpired by vegetation or evaporates. A small amount enters streams as storm runoff, mostly from low-lying and developed areas. The remainder enters the ground and enters the aquifer as recharge.

At the same time, the aquifer is losing water due to both natural and human causes. As water flows out of the ground into streams, it flows out of the system and into the coastal bays and estuaries. And when humans pump water out of the aquifer for home use and irrigation, most of that water is also lost to the system. Much of it is ultimately flushed out to sea in sewer discharge. A great deal of the water used for irrigation is actually lost to evaporation.

In June of 1960, an ambitious aquifer test was conducted in what is now Wharton State Forest to evaluate the feasibility of developing a major water supply there. This was during a different era, in which the “Wharton Tract,” as it was known then, was regarded primarily as a water reserve intended to meet water-supply needs of southern New Jersey. A shallow well located northwest of Batsto near the Mullica River was pumped at a high rate, while a small army of observers measured water levels around the clock in dozens of nearby observation wells.
wells. A total of 17 million gallons of water was extracted from the shallow Kirkwood-Cohansey aquifer over 12 days. As a result, the water table was lowered to the extent that wetlands on both sides of the stream temporarily dried up. The test illustrates the intimate connection between the aquifer system and wetland habitats, and points to a broad range of ecological issues relating to ground-water withdrawals, such as changes in wetlands habitat, the severity of wildfires, and the maintenance of adequate freshwater flows to coastal bays.

The United States Geological Survey estimates that the shallow Kirkwood-Cohansey aquifer system contains as much as 17 trillion gallons of water. This estimate however, can be deceiving since recently there have been cases where water companies and farming operations have reduced water levels in wetlands and lakes from over pumping the shallow aquifer. On a regional scale the water resources of the Pinelands are indeed vast, but on a local level they are not inexhaustible.

In its natural state, the aquifer gains through recharge what it loses through discharge. The key question is whether the aquifer is still in equilibrium after we take into account the consumptive uses we human are making of the water.

Scientific studies have shown that pumping water out of the Kirkwood-Cohansey has in fact begun to lower the water table in some areas, such as in the Toms River basin. That means human consumption is reducing the amount of water in nearby rivers, streams and wetlands. Salt water from the ocean is beginning to enter the aquifers along the coast, a phenomenon called “salt water intrusion.” As fresh water is drawn out of the aquifers, the boundary between fresh and salt water in the sands along the coast moves inland. At the bottom of the Cape May Peninsula, this boundary has moved far enough inland that public drinking water wells are now drawing up salty, undrinkable water. Scientists are now trying to understand what impacts these changes are having on the natural systems, plants and animals living on the surface. These impacts are discussed in the introductory article to the section on Human Impact and Conservation.

**Water Chemistry and Quality**

The Kirkwood-Cohansey is critical to the natural landscape not only in the volume of water it
provides for streams and wetlands. It is also critical for the quality of the water it supplies. Being exposed to the surface of the earth where we humans live and play, the Kirkwood-Cohansey aquifer system is especially vulnerable to contamination by pollutants that humans put on the surface and allow to be washed into the aquifer. The health of Pine Barrens natural communities depends on keeping toxic chemicals out of the aquifers, streams and wetlands, but also on maintaining the distinctive, acidic and low-nutrient chemistry of these waters.

As noted in the introductory article on soils, sandy soils are made up of mineral particles that are much larger than those in silt and clay soils. The large gaps between sand particles make sand very porous. As rainwater and melting snow drain rapidly through these porous Pine Barrens soils, the water carries away organic matter - the particles of decomposed pine needles, leaves and animal bodies - that have the nutrients plants need. Nutrients are not retained in the upper layers of soil, but flow down into the water table and are diluted in the aquifer. When this same water emerges into streams and wetlands, it is very low in nutrients.

The sandiness of Pine Barrens soils also makes the water that flows through this soil highly acidic. This is so for two reasons. First, even unpolluted rainwater is somewhat acidic, and "acid rain" can be very acidic. Most soils have the ability to buffer, or neutralize, this acidity. Pine Barrens' sandy soils do not have this ability, because they do not hold the minerals and organic matter that does this buffering in richer soils. Second, Pine Barrens soils have relatively high proportions of aluminum, which tends to break down water molecules (H2O) into an H+ and an OH⁻ ion, keep hold of the OH⁻ ion and release the H+ ion into its surroundings, thus lowering pH and increasing acidity.

Many species of plants cannot adjust to the low-nutrient, acidic conditions in the Pine Barrens. Only those species that are either specifically adapted to acid conditions, or those flexible enough to thrive across a broad range of acidity, can prosper in the Pine Barrens.

A number of distinctive Pine Barrens plants are found here as "disjunct" populations. This means the Pine Barrens populations are isolated from the other places these species are found, in some cases far to the north and in some cases far to the south of New Jersey. These plants arrived in the Pine Barrens during the advance and retreat of glaciers in prior epochs, and they have persisted here because of the special soil and water conditions of the Pine Barrens. Why do they thrive in the Pine Barrens and not, say, in North Jersey or Pennsylvania?

There are at least three reasons this happens:

- The plant requires acidic, low nutrient soils because it is specially adapted to these conditions. A prime example are the sphagnum mosses, which require acidic water and even release chemicals into their surroundings that help keep the conditions very acidic. There are about 30 different species of sphagnum mosses in the Pine Barrens.
- The plant can grow in a variety of conditions, but it is out-competed in other places by plant species that prosper in non-Pine Barrens environments. An example is the rare white wildflower, Pine Barrens Boneset.
- The plant has lost its natural habitats outside the Pine Barrens due to human destruction or alteration of its habitats elsewhere. The Bog Asphodel, a very beautiful wildflower discussed below, is an example.

The peculiar chemical conditions that make the Pine Barrens distinctive - the droughty, highly acidic and relatively nutrient-poor soil and water - also create a natural barrier against invasive species that cannot tolerate this environment. As a result, the Pine Barrens is one of the few places in North America that has not suffered significant ecological disruption from non-native, invasive species. At least, that's true where the ecosystem that has not suffered chemical changes to soil and water from fertilizer runoff, liming of soils and other contaminants from suburban lawns and farm fields.

The distinctive communities of plants and animals inhabiting intact Pine Barrens habitats tell us about the special geology and history of this ecosystem. They also provide a test or a standard for judging how well the Pine Barrens ecosystem is faring amidst human alteration of the landscape. As we discuss more fully in the introductory article on Human Impact and Conservation, scientists have been studying whether suburban, urban and agricultural development are altering the Pine Barrens ecosystem. They have found that the chemical features of stream water (such as pH and dissolved nutrients), the plants in and along the streams, and the fishes and frogs inhabiting the streams and wetlands are very accurate indicators of human impacts on the ecosystem. And where human activities have altered water chemistry by raising its pH and level of nutrients, the distinctive character of Pine Barrens natural communities is lost. Non-Pine Barrens species move into these areas, often displacing native species. In essence, these areas cease to be Pine Barrens because human beings have altered the chemistry of the water and soil.
Objectives

Students will be able to…

• Work in cooperative groups to gather/or to interpret topographical information about specific Pine Barrens watershed region(s).
• Create a cardboard relief map of their assigned Pine Barrens watershed(s) from topographic maps.
• Appreciate the effects of the contour of the land on recharging an area in the watershed.

Overview

A watershed is a specific geographic or land area that drains into a river system or other body of water. A topographical map represents how the surface of a specific geographic or land area is arranged in regards to elevation. By combining topography with an area drained by a particular aquatic system, the boundaries of a watershed can be determined. Areas of “runoff” or storm water draining can be simulated and students can obtain a better understanding of how water moves in a particular watershed. Students may even be able to predict the effect of human activity in that watershed based upon their relief maps.

Procedure

Pre-activity A: Students simulate a watershed

- Take a piece of paper and crumple it in your hands.
- Tape the edges of the paper down on another sheet of paper that acts as a support so that the shape of a “mountain” is formed.
- Use a water-soluble marker to highlight the edges of the “mountain.”
- Spray a mist of water on the soluble markings to simulate rain on the “mountain.”
- Observe the movement of the rivulets of water as this “storm water” runs from the higher elevation to the lower elevation. The use of color makes the movement of the water quite apparent.

Or

Pre-activity B: Students simulate a watershed

(adapted from Penn State Sustainable Forestry Teacher Resource Center. See References)

- Place a large piece of aluminum foil over crumpled newspapers to simulate an area with mountains and valleys. Make sure all parts of the foil drain into a single low valley. To contain the “rain” in this lowland area, turn the edges of the foil up to form a “pan.”
- Take one half of a cup of water in a sprayer to make it “rain on the watershed” till all of the water is utilized in the sprayer.
- Observe the flow of the water and be careful to catch all the runoff in the “pan.”
- Measure how much water moved through this watershed.
- Run the same raining simulation again but this time place pieces of paper towel on the highest parts of the model watershed to imitate the effect of the ground storing some of the water.
- Take one half of a cup of water in a sprayer to make it “rain on the watershed” till all of the water in the sprayer is again utilized.
- Observe the flow of the water and be careful to catch all the runoff in the “pan” and measure how much water moved through this watershed simulation.
- Compare the water levels that were measured in both simulations.
Activity

- Have students work in groups.
- Have students explore this site before proceeding with this activity: [http://imnh.isu.edu/digitalatlas/geog/basics/topo.htm](http://imnh.isu.edu/digitalatlas/geog/basics/topo.htm)
- Give each student a copy of the student activity sheet.
- Give each group two topographic maps of the local area in the Pine Barrens that you would like them to explore.
- Review with students how the map represents an area.
  - The closer the lines, the steeper the land.
  - Dotted lines represent streams.
  - Numbers indicate the elevation of the area.
  - Comparing numbers indicates if the land is getting higher or lower.
  - Identify any other attributes of the map that you deem important for your particular area and group of students.
- Have students shade in the waterways with blue for easy identification.
- Distribute supplies (foam core or corrugated cardboard).
- Have students glue each topographic map onto a flat surface (cardboard/styrofoam).
- Notice that the contour lines on the topographic maps are of different thickness; these are the ones to be cut along.
- Have the students mark one map as map A and the other as map B.
- Cut along the even numbered contour lines on map A and the odd numbered contour lines on map B.
- Now assemble the pieces together. The pieces are stacked on top of each other with the cuts aligned on the topographic line on the piece below.
- Upon completion the students will have converted their flat topographical map into a three dimensional map.
- Students can “customize” their maps with the additional of color for vegetation for example.
- Have students present their map and discuss the types of landforms that can be identified.

Optional Activity

- Students find their watershed on an aerial photograph.
- Students personalize their watershed map with information collected from interviewing residents and asking them about past water uses and watershed events.
- Students then use this information to make predictions about future land development in their Pine Barrens area that will protect water quality.

Materials

- Maps of particular Pine Barrens Watershed Regions
- Corrugated cardboard or thin Styrofoam sheets
- Scissors
- Markers/colored Pencils
- Glue

New Jersey Core Curriculum Standards

5.1, 5.3, 5.4, 5.5, 5.8 & 5.10
**Glossary**

**Map Symbols**: See the USGS for a multitude of official symbols for surface features, mines and caves, vegetation, glaciers and permanent snowfields, water features, building and related features, roads, railroads and others.

**Map Key**: student designed feature of this activity based upon the Map Symbols chosen for the Relief Map.

**Map Scale**: is the relationship between distance on a map and the distance on the earth’s surface. See http://geography.about.com/cs/maps/a/mapscale.htm

**Compass Rose**: A design on a map that shows directions as in north, east, south and west.

**Longitude and Latitude**: Refer to the two numbers that describe any location on Earth. They are actually angles measured in degrees. See http://www-istp.gsfc.nasa.gov/stargaze/Slatlong.htm

**Physical Map**: A map of the locations of identifiable landmarks such as country borders, major cities and significant bodies of water.

**Topographic Map**: A map that shows a surface by contour lines that join points of equal elevation on the surface of the land above or below a reference surface along with symbols that represent features such as streams, buildings, streams and woods.

**Political Map**: A map that shows governmental boundaries of countries, states, and counties, along with major cities. They usually include significant bodies of water.

**Relief Map**: A map that shows the hills, valleys and mountains of a particular area.

**Natural Resource Map**: A map that identifies natural resources that are useful to humans found in a particular area. These resources include food, energy sources, plants and animals for example.

**Contour Lines**: A line drawn on a map connecting points of equal height.

**Terrain**: A piece of ground having specific physical characteristics.

**Watershed**: An area of land that drains down-slope to the lowest point. These drainage pathways converge into streams and rivers becoming progressively larger as the water moves downstream. May be used interchangeably with drainage basin or catchment basin.

**Elevation**: Height.

**Absolute Location**: The location of a point on the earth that can be expressed by a latitude and longitude.

**Relative Location**: A location estimated by comparison to something else.

*This lab activity is based upon Lesson 5-Topographical Map Making from the Educators Toolbox http://www.stormwatercoalition.org/html/et/et_lp_2html along with assorted other sources.*

**References**


http://erg.usgs.gov/isb/pubs/booklets/symbols/ Topographic Map Symbols

http://water.usgs.gov/wsc/glossary.html (Science in Your Watershed-General Introduction and Hydrologic Definitions

http://sfrtc.cas.psu.edu/LessonPlans/EarthSciences/IdentifyingWatersheds.html Sustainable Forestry Teacher Resource Center Earth Sciences Lesson Plans

http://plasma.nationalgeographic.com/mapmachine Find nearly any place on Earth, and view it by population, climate, and more. Plus, browse antique maps, find country facts, or plan your next outdoor adventure with trail maps.

1. How does water flow in this watershed?
2. How does the geography of a watershed change over time?
3. How does erosion affect this watershed?
4. How would fire affect this watershed?
5. Who uses the water that flows in this watershed?
6. How do animals, plants, and macroinvertebrates positively and negatively impact the watershed?
7. Would agricultural activities affect any part of this watershed?
8. What would happen if pollution increased in this watershed?
9. What would be the effect of a housing development in this watershed?
10. How would you advise government officials on being the good stewards of this watershed?
Objectives

Students will be able to:

• Define and describe aquifer formation and use in the Pinelands.
• Investigate the permeability and water holding capacity of various substrate materials.
• Construct an aquifer using various substrate materials (rock, sand, silt and clay).
• Model ground water use and contamination.

Overview

The construction of a model aquifer allows students to understand the movement of water through various substrates. Pumping mechanisms provide the means for assessing aquifer depletion and ground water pollution is modeled by food color soaked small sponges.

Procedure

Ο Students evaluate the water holding capacity and permeability of clay, sand and rock substrate.
Ο Students look up the aquifers underlying the NJ Pinelands and review the formation, depth and historical use of the water resources found within.
Ο Using an aquarium or other transparent container, an aquifer is constructed using various substrate types (sand, clay and rock).
Ο As substrate layers are laid down, soap or bottle pumps are inserted at desired levels so that water can be removed from various layers.
Ο Sponges soaked in food coloring can be used to mimic underground pollution sources – substrate layers are placed over top.
Ο Once the aquifer is complete – layered to desired depth, water can be added (precipitation) or removed (ground water access). Levels can be observed through the sides of the container. Colored water plumes may be observed and pollution may be withdrawn with water supply.

Extensions

• Students compare rates of infiltration and permeability among the substrate types.
• Students provide a written description and diagrams of New Jersey Aquifers.
• Students produce labels and diagrams for their model aquifer.
• Students determine the ratio of removal and infiltration that may be sustainable in terms of human use.

Materials

• 5 Gallon terrarium/aquarium or other large transparent container
• Various substrate materials (rock, sand, clay)
• Plastic bottle dispenser pumps
• Sponge (2 inch square)
• Food coloring

NJ Core Curriculum Standards

5.1B, 5.3A, 5.8A, 5.8C, 5.8D, 5.10A, 5.10B

Glossary

Aquifer: An underground bed or layer of earth, gravel, or porous stone that yields water.
Recharge: To replenish.
Depletion: The use or consumption of a resource, especially a natural resource, faster than it is replenished.
Unconfined aquifer: A layer of water below the surface of the earth found below porous layers. Rainwater can seep unimpeded into unconfined aquifers, which make them more subject to groundwater pollution than confined aquifers.
Confined aquifer: The ground water only partially fills the aquifer and the upper surface of the ground water (the water table) is free to rise and decline.
Substrate: An underlying layer; a substratum.
Objectives
Students will be able to...
• Make predictions about the water quality and characteristics of Pine Barrens streams.
• Explain why Pine Barrens streams are so unique in their fauna and flora.
• Identify ways in which humans can impact water quality.
• Identify causes of changes and pollution in the water of a stream.

Overview
The abundance and quality of water is an important feature of the Pine Barrens of New Jersey. There are many methods available to obtain the condition of waterways. Water quality testing includes collecting data on the physical characteristics of a stream, water chemistry and the organisms living in or near the water. Many of the plant and animal species are good indicators of water quality because they differ in their sensitivity to stress in the waterway. This activity will introduce students to these means of collecting data by having them analyze fictitious but representative data collected from Oyster Creek in the Pine Barrens of New Jersey.

In this activity, the class will be divided into three groups. Each group will be given a different data set taken from a fictitious water quality assessment of a Pine Barrens stream, Oyster Creek. The three data sets will have information on the characteristics of the stream to include: water chemistry, macro invertebrates and fishes collection and a visual survey of the stream including plant species identified. After analyzing the data sheet that the group received, each group is asked to make predictions of what the other sets of data might look like. There is an optional protocol of how to complete water testing and actual macro invertebrate sampling. It will also introduce the students to the fact that New Jersey water testing data that labels some Pine Barrens water as distressed or damage even though they are not.

Procedure
○ Divide the class into three groups. Give each group one of the following sets of data: Data Sheet #1: Chemical Analysis Data, Data Sheet #2: Macro Invertebrate and Fish Data and Data Sheet #3: Stream Habitat Characteristics and Plant Species.
○ Using the data set provided to them, students are to analyze their data and predict the characteristics of the stream to include the information that the other data sets contain in order to get an accurate picture of a particular stream in the Pine Barrens.
○ Students should then share their predictions on each of the other data sets to the respective group. The group with that data set will then confirm their data with the other group.
○ As a class, discuss the overall health of the stream and answer the analysis questions.

Optional Activity
○ Water Quality Survey
○ Macro Invertebrate Sampling
Materials

- Copies of Data Sheets

New Jersey Core Curriculum Standards


Glossary

pH: A measure of the acidity or alkalinity of a solution, numerically equal to 7 for neutral solutions, increasing with increasing alkalinity and decreasing with increasing acidity. The pH scale commonly in use ranges from 0 to 14.

Dissolved Oxygen: Dissolved oxygen analysis measures the amount of gaseous oxygen (O2) dissolved in an aqueous solution. Oxygen gets into water by diffusion from the surrounding air, by aeration (rapid movement), and as a waste product of photosynthesis.

Turbidity: Having sediment or foreign particles stirred up or suspended; muddy: turbid water.

Nitrate: The univalent radical NO3 or a compound containing it, as a salt or an ester of nitric acid.

Phosphorous: Of, relating to, or containing phosphorus, especially with valence 3 or a valence lower than that of a comparable phosphoric compound.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>4.4</td>
</tr>
<tr>
<td>Dissolved Oxygen</td>
<td>7.8 mg/L</td>
</tr>
<tr>
<td>Biological Oxygen Demand (5 day)</td>
<td>1.1 m/L</td>
</tr>
<tr>
<td>Color</td>
<td>Brownish</td>
</tr>
<tr>
<td>Temperature</td>
<td>17.5°C</td>
</tr>
<tr>
<td>Turbidity</td>
<td>2 JTU</td>
</tr>
<tr>
<td>Total Nitrate</td>
<td>.03 mg/L</td>
</tr>
<tr>
<td>Total Phosphorous</td>
<td>.04 mg/L</td>
</tr>
</tbody>
</table>
Data Sheet #2  
Macro invertebrates Collection Data from Oyster Creek

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Taxa</th>
<th>Number of Individuals Found</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mayflies</td>
<td>Order Ephemeroptera</td>
<td>23</td>
</tr>
<tr>
<td>Stoneflies</td>
<td>Order Tricoptera</td>
<td>17</td>
</tr>
<tr>
<td>Damselflies</td>
<td>Suborder Zygoptera</td>
<td>12</td>
</tr>
<tr>
<td>Dragonflies</td>
<td>Suborder Anisoptera</td>
<td>11</td>
</tr>
<tr>
<td>Crayfish</td>
<td>Order Decapoda</td>
<td>7</td>
</tr>
<tr>
<td>Scuds</td>
<td>Order Amphipoda</td>
<td>46</td>
</tr>
<tr>
<td>Aquatic Worms</td>
<td>Class Oligochaeta</td>
<td>22</td>
</tr>
<tr>
<td>Crane Flies</td>
<td>Suborder Nematocera</td>
<td>26</td>
</tr>
<tr>
<td>Midge Fly Larva</td>
<td>Suborder Nematocera</td>
<td>5</td>
</tr>
</tbody>
</table>

• Biotic Index Cards can be found at the following websites:
  - [http://sftrc.cas.psu.edu/LessonPlans/Water/PDFs/BioticIndexCard.pdf](http://sftrc.cas.psu.edu/LessonPlans/Water/PDFs/BioticIndexCard.pdf)

Fish Species Caught in Net Trap

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>mud sunfish</td>
<td>Acantharchus pomotis</td>
</tr>
<tr>
<td>banded sunfish</td>
<td>Enneacanthus obesus</td>
</tr>
<tr>
<td>chain pickerel</td>
<td>Esox niger</td>
</tr>
<tr>
<td>redfin pickerel</td>
<td>Esox americanus</td>
</tr>
<tr>
<td>yellow perch</td>
<td>Perca flavescens</td>
</tr>
<tr>
<td>black crappie</td>
<td>Pomoxis nigromaculatus</td>
</tr>
</tbody>
</table>
Data Sheet #3
Stream Habitat Characteristics and Plant Species

Site Conditions-March 2005

• Sandy Bottom
• Water near the banks is relatively still (pool)
• Water at the middle of the stream is moderately flowing (riffle)
• There is a fallen tree that runs parallel with the bank of the stream
• The banks of the stream are shallow
• The stream is approximately .25 meters deep and 5.5 m wide
• Weather Conditions: Partly Cloudy

Plant Species Identified on the Stream's Bank

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arrow-leaved Tearthumb</td>
<td>Polygonum sagittatum</td>
</tr>
<tr>
<td>Cardinal Flower</td>
<td>Lobelia cardinalis</td>
</tr>
<tr>
<td>Common Wild Yam</td>
<td>Dioscorea villosa</td>
</tr>
<tr>
<td>Deertongue Grass</td>
<td>Panicum clandestinum</td>
</tr>
<tr>
<td>Japanese Stiltgrass</td>
<td>Microstegium vimineum</td>
</tr>
<tr>
<td>False Nettle</td>
<td>Boehmeria cylindrica</td>
</tr>
<tr>
<td>Marsh Fern</td>
<td>Thelypteris palustris</td>
</tr>
<tr>
<td>Sallow Sedge</td>
<td>Carex lurida</td>
</tr>
<tr>
<td>Swamp Milksweed</td>
<td>Asclepias incarnate</td>
</tr>
<tr>
<td>Wood-reed</td>
<td>Cinna arundinacea</td>
</tr>
</tbody>
</table>
1. Is this a typical Pine Barrens stream? Why or why not?
2. How would the addition of fertilizer runoff alter the characteristics of this stream?
3. How would the plants and animals that live at this site be affected by the addition of fertilizer?
4. How can human activities affect the test results that were performed?
5. What types of remedial activities could be done to help improve stream quality?
6. How would the data collected change during the year?
7. How does the water quality values for Pine Barrens streams compare to values for streams located outside of the Pine Barrens?
Objectives

Students will be able to…

• Measure the pH of a water body using a digital pH meter or simple field test kit.
• Measure the nitrate concentration of a water body using either a digital colorimeter or simple field test kit.
• Net and identify fish from a water body.
• Locate the survey sites on a map, determine which watershed each site is in, and place the site within a context of the natural landscapes and human land uses.
• Analyze the results of their survey work in light of features of the natural and built environment of the relevant watersheds.

Overview

This suggested field trip itinerary is focused on surveying two contrasting streams, lakes or ponds – one with typical Pine Barrens water quality of low pH and nutrients, and one with altered water quality from human activities. This itinerary takes you to Skit Branch in Wharton State Forest, a pristine Pine Barrens location, and Indian Mills Pond, a pond with water quality degraded by nonpoint source contamination due to agricultural and suburban development. The field trip should take about 4 hours from the time you reach the first survey site at Indian Mills Pond.

The two sites are shown on the attached map and are about 20 minutes drive apart. Mapping the watersheds in which the survey sites are located, including land uses and land covers, is an important part of the lesson. This information can be obtained from the New Jersey Department of Environmental Protection web site at www.state.nj.us/dep/gis/. At this site, land use and land covers can either be downloaded (for use with ArcReader or ArcView mapping software) or mapped online using the iMap site.

Digital pH meters and colorimeters provide exact measures of pH and nitrate, but are expensive, and the colorimeter is somewhat complex. Simple field test kits provide a less accurate but sufficient qualitative measure of these key parameters.

You will need nets to catch fish. We recommend using dips nets with a sturdy metal frame and a long handle, which can be used by one person. We also have success with a small (about 4-5 foot wide) seine net fixed to two strong poles, dowels or branches. The easiest way to catch fish in Pine Barrens settings is to stand just off the shoreline in shallow water and push or pull your net along the bottom right up into the vegetation on the shore, then pull your net up quickly. Fish are often hidden in the muck you pull up, so it is important to sift through the muck with your fingers to find fish and other organisms. To make it easier to find creatures in the muck, it is useful to lay down a white plastic painters’ cloth on the ground and dump the contents of the net onto the cloth.

It is generally easier to catch fish in ponds than it is in streams. Pine Barrens streams and ponds often have unpredictable bottoms which may fall off quickly to deeper water, have areas of deep muck, or have many branches that create an uneven bottom. The stream or pond edge may also change greatly depending on water level, which varies with rainfall. It is a good idea to check out the specific spot in which you want to survey ahead of time in order to determine the footing and find the best point of access. We also recommend that no one step into the water without wearing sneakers or water shoes, as sunken branches can be sharp and there is a small but real possibility of encountering an old fish hook or other piece of trash on the bottom.
**Procedure**

**A. Classroom Preparation**

- Create a map of the watersheds in which field trip destinations are located, including basic land uses and covers (urban or suburban development, farmland, forest and wetlands). If possible, print or draw a large format map and have it laminated to take into the field. Small format maps for each student will also work.

- Have students study the land use and land cover map and summarize what they believe are the relevant features that may affect water quality at the survey sites.

- Review the meaning and significant of the pH scale and the nitrogen cycle.

- Have students create a simple “field guide” to the fishes you are likely to find. A list of the Pine Barrens native and nonnative fish species is attached. Students can either make drawings from published field guides or copy public-use images from the internet to create the images. They should also record information about the fish from their sources. If this project is not practicable, use a standard published field guide to freshwater fishes of the northeast.

**Optional**

- Have students research and summarize the history of human settlement and exploitation of natural resources in the area of the study site.

- Instruct students on proper attire for the field trip: sneakers that can get wet; shorts, bathing suits or pants that can get wet; dry clothes, shoes and socks to change into if they want; sunscreen and bug repellent; a hat. Students should be told they will not be able to participate in the best parts of the field trip if they are not wearing sneakers.

**B. Field Trip Itinerary**

- Travel to Indian Mills Pond. Park at the public parking lot for the boat ramp.

- Examine the setting for topography, vegetation and signs of past and present human activities.

- Find the sub watershed in which the site is located using the land use/land cover map.

- Discuss the history of human habitation and exploitation of the landscape for the site.

- Measure the pH and nitrate of the water following the instructions for whatever instruments or test kits you have. Record results on data sheets.

- Wade in at the boat ramp and net fish, temporarily placing them in small aquariums or buckets. Identify fish with the “field guide” before returning them to the water. Record results on data sheets. Examine other creatures you happen to net.

- Move to the Skit Branch site and repeat the process.

**Extensions**

Analyze any differences in results achieved in terms of natural and manmade differences between the sites that may affect water quality. Have students formulate and test hypotheses about the reasons for the results, particularly the contrasting results, they find at each study site.

**Materials**

- Maps showing key geographic features and land use and land cover of watersheds in which surveys sites are located.

- Digital meters or simple field test kits for measuring pH and nitrate.

- Small plastic aquarium, clear container or bucket for examining fish.

- Nets, either dip nets with sturdy metal frames and long handles, or short seine nets attached to poles, strong dowels or sturdy branches.

- Field guide that includes the fish species listed below.

- Data sheets, such as the sample below.
**New Jersey Core Curriculum Standards**


**Glossary**

**pH:** A measure of the acidity or alkalinity of a solution, numerically equal to 7 for neutral solutions, increasing with increasing alkalinity and decreasing with increasing acidity. The pH scale commonly in use ranges from 0 to 14.

**Dissolved Oxygen:** Dissolved oxygen analysis measures the amount of gaseous oxygen (O2) dissolved in an aqueous solution. Oxygen gets into water by diffusion from the surrounding air, by aeration (rapid movement), and as a waste product of photosynthesis.

**Turbidity:** Having sediment or foreign particles stirred up or suspended; muddy: turbid water.

**Nitrate:** The univalent radical NO3 or a compound containing it, as a salt or an ester of nitric acid.

**Phosphorous:** Of, relating to, or containing phosphorus, especially with valence 3 or a valence lower than that of a comparable phosphoric compound.

**Fish Species**

Fish Species you are likely to encounter in Pinelands streams and ponds. Non-native species are those that are not characteristic of unimpaired, low pH and low nutrient Pine Barrens waters, but are found in waters that have been altered and have higher pH and nutrients.

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
<th>Pine Barrens Native or Non-native</th>
</tr>
</thead>
<tbody>
<tr>
<td>mud sunfish</td>
<td>Acantharchus pomotis</td>
<td>Native</td>
</tr>
<tr>
<td>yellow bullhead</td>
<td>Ameiurus natalis</td>
<td>Native</td>
</tr>
<tr>
<td>American eel</td>
<td>Anguilla rostrata</td>
<td>Native</td>
</tr>
<tr>
<td>pirate perch</td>
<td>Aphredoderus sayanus</td>
<td>Native</td>
</tr>
<tr>
<td>blackbanded sunfish</td>
<td>Enneacanthus chaetodon</td>
<td>Native</td>
</tr>
<tr>
<td>bluespotted sunfish</td>
<td>Enneacanthus gloriosus</td>
<td>Native</td>
</tr>
<tr>
<td>banded sunfish</td>
<td>Enneacanthus obesus</td>
<td>Native</td>
</tr>
<tr>
<td>creek chubsucker</td>
<td>Erimyzon oblongus</td>
<td>Native</td>
</tr>
<tr>
<td>chain pickerel</td>
<td>Esox niger</td>
<td>Native</td>
</tr>
<tr>
<td>redfin pickerel</td>
<td>Esox americanus</td>
<td>Native</td>
</tr>
<tr>
<td>swamp darter</td>
<td>Etheostoma fusiforme</td>
<td>Native</td>
</tr>
<tr>
<td>tesselated darter</td>
<td>Etheostoma olmstedi</td>
<td>Non-native</td>
</tr>
<tr>
<td>pumpkinseed</td>
<td>Lepomis gibbosus</td>
<td>Non-native</td>
</tr>
<tr>
<td>bluegill</td>
<td>Lepomis macrochirus</td>
<td>Non-native</td>
</tr>
<tr>
<td>largemouth bass</td>
<td>Micropterus salmoides</td>
<td>Non-native</td>
</tr>
<tr>
<td>tadpole madtom</td>
<td>Noturus gyrinus</td>
<td>Native</td>
</tr>
<tr>
<td>yellow perch</td>
<td>Perca flavescens</td>
<td>Non-native</td>
</tr>
<tr>
<td>black crappie</td>
<td>Pomoxis nigromaculatus</td>
<td>Non-native</td>
</tr>
<tr>
<td>eastern mudminnow</td>
<td>Umbra pygmaea</td>
<td>Native</td>
</tr>
</tbody>
</table>
# Pine Barrens Water Quality Survey Data Sheet

**Survey Team:**

**Date & Time:**

---

**Site 1**

Location: _________________________________________________________________

Latitude & Longitude: ______________________________________________________

Weather Conditions: _______________________________________________________

**Samples:**

<table>
<thead>
<tr>
<th></th>
<th>pH</th>
<th>Nitrates</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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</tr>
<tr>
<td>2</td>
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<tr>
<td>10</td>
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<td></td>
</tr>
</tbody>
</table>

**Site 2**

Location: _________________________________________________________________

Latitude & Longitude: ______________________________________________________

Weather Conditions: _______________________________________________________

**Samples:**

<table>
<thead>
<tr>
<th></th>
<th>pH</th>
<th>Nitrates</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<tr>
<td>2</td>
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<tr>
<td>10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Objectives

Students will be able to...

• Consider and discuss a variety of issues that surround zoning change.
• Play the role of one of the stakeholders in a town meeting.
• Consider of the stakeholders points of view in developing a resolution to the issue.

Overview

This public meeting has been called to decide how a large tract of land in the New Jersey Pinelands will be developed or preserved by the Pinelands Commission and the two municipal government councils of Hamilton and Burr Townships. The tract of land is 4,000 acres in size, with 2,500 acres in Hamilton and 1,500 acres in Burr. The towns’ zoning ordinances currently allow the land to be developed for houses, but not for stores, malls or industry.

Procedure

❖ Read and review “The Pinelands Commission Overview” Case Study background information together as a class.
❖ Review “Zoning Area Map Features” and “Zoning Area Map”
❖ Divide the students into different groups and assign each group one of the roles listed on the “Stakeholder Roles”.
❖ Students will be given time to research and develop arguments that best support the point of view of the role that they were assigned.
❖ All groups, agencies and individuals involved in the discussion should think about questions such as the following in forming your positions:
  • What do we need to know about this area in order to make a well-founded decision about future development and conservation here?
  • What do we value most about the area? What do we think is the best use that can be made of this land? Best for whom?
  • What rights do existing landowners have to do with the land what they wish? Are there any valid limits on landowners’ freedoms?
  • What uses of the land are compatible with one another? Which are definitely incompatible? Can any that seem incompatible be made compatible with smart planning and design?
  • What natural resources found in this area do people need to live well? Does everyone need them, or need them equally?
  • Is there a moral, or perhaps a religious, obligation to protect any of the natural resources found in this area, even if people do not value or need them?
  • How do you speak to someone with a different set of interests and concerns in a way that may persuade him or her to accept your point of view on the issues?
❖ A “town meeting” will be called and each group will be given the opportunity to present their arguments surrounding the case and ideas for resolution.
❖ The groups will collectively come to a resolution that best satisfies each point of view.
**Materials**

- Copies of:
  - “The Pinelands Commission Overview”
  - “Zoning Area Map Features”
  - “Zoning Area Map”
  - “Stakeholder Roles”

**New Jersey Core Curriculum Standards**


**Glossary**

**Aquifer:** A body of permeable sand, gravel or other rocks and soil that holds large quantities of water underground. An unconfined or surficial aquifer is one which rises to the surface of the ground or to the water table. A confined aquifer is one which is confined between two impermeable layers of rock or clay.

**Cluster development:** A style of housing or commercial development in which structures and roads are clustered on a small portion of a large piece of land, and the rest of the land is left undeveloped. The undeveloped land is usually placed under a permanent, legal restriction (called a “deed restriction”) so it can never be developed. Cluster development contrasts with a development which consumes an entire piece of land with houses or other structures.

**Ground water:** Water found below the earth's surface, such as the water which is held within and flows through an aquifer.

**Landfill:** An area where trash and waste have been deposited, usually in a hollow dug out of the ground or formed by hills. When rainfall or ground water moves through the landfilled wastes, it leaches chemicals out of the solid waste, or releases chemicals stored in containers that leak or decompose. If the landfill is not fully sealed, this chemical leachate flows out of the landfill into the surrounding ground and/or surface waters.

**Pinelands Commission:** The government agency that oversees development and land use in the Pinelands. The Commission created, and sometimes changes, the Comprehensive Management Plan. The Commission also implements the Plan by reviewing development plans for consistency with the Plan.

**Pinelands Comprehensive Management Plan (CMP):** The government regulations that control development and other land uses in the Pinelands. The CMP divides the Pinelands into eight “management areas,” and each management area has different rules for what a property owner can and cannot do in the way of development. The CMP also has rules for protecting threatened and endangered species, water quality and other natural resources.

**Plume (of contamination):** The body of contaminated water that spreads out in ground water from a chemical spill, unsealed landfill or other source of contamination.

**Surface water:** Water found at the surface of the earth, as in rivers, streams, lakes, swamps and bogs. In the Pine Barrens, surface waters are just the Kirkwood-Cohansey aquifer made visible in shallow depressions of the land such as stream corridors or isolated ponds.

**Threatened and endangered species:** Those species of plants and animals designated by a state or the federal government as threatened with extinction, either on a global, national or state level. Threatened species are those facing possible extinction due to gradual reduction in population or significant changes to their environment; without assistance, these species will probably become endangered. Endangered species are those in immediate danger of extinction; without immediate assistance, these species will probably become extinct.
**Pinelands Commission Overview**

The Pinelands Commission is a regional government agency that oversees development for the whole Pinelands through the Pinelands Comprehensive Management Plan. The Commission has asked the two towns and other interested persons to discuss whether the existing rules for this area should be changed in any way. Use your imaginations, but some possible changes might be:

- Change the zoning to prevent housing developments in all or part of this area. (Zoning rules tell landowners what they can and cannot build on different land areas in a town. Sometimes zoning rules will allow houses in one area, shopping centers in another, and industrial buildings in yet another area. Zoning rules also often set maximum and minimum densities of development, such as saying houses in this area have to each have at least 1 acre, or 10 acres, or ? acre of land.)
- Change the zoning to allow commercial development like shopping malls or industry in all or part of this area.
- Create new rules for development in this area, such as:
  - lower density of houses (fewer big houses on very big lots, rather than more houses on smaller lots);
  - clustering development (bunch up the development one part of a property and protect the rest of the property from development);
  - impose larger or smaller “buffers” of land between development and the streams and wetlands in the area;
  - impose other regulations on buildings or homeowners to reduce the impact of development on natural resources like streams, wetlands and forests.
- Come up with creative ways to pay for cleaning up the old landfill, or to pay for protecting more open space, possibly as part of a development plan for other lands.

The Pinelands Commission has to decide whether to make any changes in the rules that control land use and development in this area. The Commission’s decision will be based on the facts, opinions, needs and arguments put forward by the other participants in the discussion.

**Zoning Area Map Features**

*The map shows some important features of the area:*

- About half the land is owned by one development company, Shady Pines Development Corporation. This land is today completely undeveloped, with intact forests, streams, wetlands and ponds.
- Another large property of 400 acres in the area is owned by a couple of wealthy retired Wall Street stock brokers and amateur naturalists named Howe and Ida Greene. This property is also undeveloped, except for the Greens’ large house, tennis courts, and indoor and outdoor pools.
- About 400 acres of the land has already been developed into a housing community of 1,500 homes named Pine Grove Estates.
- Another piece of land of about 25 acres is an abandoned industrial landfill, fenced off and used only by illegal off-road vehicles riders who sometimes break in. The landfill has been slowly leaching toxic chemicals into the ground and the fresh water aquifer for years. At this point, no one really knows how far these chemicals have reached – that is, how big the “plume” of chemical contamination of the aquifer is.
- There is one 400-acre cranberry farm in the area, owned and operated by the Berry family for the last 100 years.
- The rest of the land is owned by smaller property owners.
- There are no public parks in this area.
- There are several streams, wetlands and ponds.
Stakeholder Roles

Note that only two of the organizations and people in this exercise are real: the Pinelands Preservation Alliance and the Pinelands Commission. The rest, including the towns of Hamilton and Burr, are fictitious.

You are assigned one of the following as your identity in this discussion. The fact that you have a certain role, however, does not mean you have to take a single-minded or selfish position in the debate. For example, some developers also love the outdoors, and all environmental activists want a nice home to live in. Try to step into the shoes of a real person who might have one of these identities in the real world, and remember that most real people are more complicated than our stereotypes might lead us to assume!

- **Burr Township Council**: You are an elected member of the town council and represent the council in this discussion. The Burr council has several goals for the discussion, including development of a new town center with housing, shops and new government offices; creating open space for recreation of various kinds; and cleaning up and making some beneficial use of the old landfill. The Burr council is not particularly worried about its drinking water supply because it gets water most of its residents from a company that takes water from the Delaware River; but some of Burr’s residents do rely on their own shallow wells for drinking water.

- **Hamilton Township Council**: You are an elected member of the town council and represent the council in this discussion. The Hamilton council has several goals, including having fewer new homes built (new houses mean more children and more school costs), creating public parks for recreation and nature, and protecting water supply (the town’s drinking water comes from a set of wells in the Kirkwood-Cohansey aquifer system).

- **Shady Grove Development Corporation**: You own and run this company, which has been building houses and shopping centers in Southern New Jersey for 50 years. You live in Burr yourself, in one of the fancier developments your company built. Your father created the company, and when you took over you have continued to build it into one of the most successful developers in the region. You employ around 2,000 people, ranging from carpenters and bricklayers, to surveyors, to architects, lawyers and engineers. You have close ties to the communities in which you work, supporting youth sports, emergency services and other charities. You take pride in the quality of the homes you build.

- **Pinelands Preservation Alliance (PPA)**: You work for PPA, a nonprofit environmental organization devoted to protecting the Pinelands’ plants and animal communities, water resources, forests, streams and wetlands. PPA tries to persuade government agencies to make the Pinelands Comprehensive Management Plan stronger from the point of view of protecting natural resources. PPA wants to see forests, streams and wetlands protected, and is worried that toxic chemicals from the old landfill are slowly poisoning the ground and surface waters that plants, animals and many people rely upon for life.

- **South Jersey Affordable Housing Alliance**: You work for this nonprofit organization, which is dedicated to the creation of quality, affordable housing for people of modest means. There are many thousands of families in New Jersey who cannot afford decent housing in most parts of the state. Many of these families live in substandard and excessively crowded conditions. The lack of enough affordable housing fosters segregated housing patterns, with most poorer families living in distressed urban areas and wealthier families choosing suburbs and rural towns like Hamilton and Burr. You dream of a day when the wealthy and the not-so-wealthy of all races and ethnicities live together in integrated communities.
• **Howe and Ida Greene**: As well-healed retired stock brokers and amateur naturalists, you are interested in preserving the 500 acres of land on which you live, and as much land around your own property as possible, for nature. In your retirement you have documented several threatened and endangered species on your property, including Barred Owl, Bobcat, Timber Rattlesnakes, Swamp Pink and Pine Barrens Gentian wildflowers, and three species of rare orchids. In fact, you are drawing up plans to donate your land to create a nature preserve, but you feel this would only be worthwhile if additional land around your own is also protected in order to make sure the streams flowing through your property stay clean and healthy and that there is enough connected forest to be a good habitat for the birds, snakes and bobcat that you value so highly. If your piece of land became an isolated island surrounded by houses, you fear it would not succeed in protecting the biodiversity it currently supports.

• **The Berry Family**: You are life-long cranberry growers, and your farm has been operating for over 100 years. Your cranberry bogs cover about 80 acres, and the rest of your 500-acre property is forested (except for your homestead, where you live.) The forest provides clean water for your bogs, because the land absorbs rain and snow into the aquifer, which in turn feeds the stream running through your property, which in its turn feeds bogs where the cranberries grow, as well as a reservoir of water you also need for cranberry farming. You worry that development upstream of your farm could pollute the stream on which you rely. You also love the broader landscape in which you live and want it to stay as it is. On the other hand, cranberry growing is a tough and unpredictable business, so you also want to have as many options as possible for your property in the future.

• **Hamilton/Burr Landowners Association**: You have been chosen to represent this loose association of the smaller landowners in Hamilton and Burr whose property might be affected by any changes to the rules governing development in the area. Some members of the Association are definitely interested in selling their land to a developer (or anyone else who will pay a good price) in order to fund their own retirement. Others are interested in keeping their land just the way it is, or even one day donating or selling it for conservation. But all members of the Association want to keep their freedom of choice about what they do with their land, and they are worried that dramatic changes in the regulations might deprive them of options.

• **Pine Grove Estates Homeowners Association**: You are the elected President of the Pine Grove Estates Homeowners Association, which represents all the residents of the Pine Grove Estates development. The Homeowners Association likes things just the way they are. The community is surrounded by nature, there are clean streams and ponds for recreation (even if some of them are on other people’s property), there is wildlife all around, and there is no traffic problem at all in the area. The people who moved into this development value the natural setting and the natural resources around them. While the Homeowners Association recognizes it cannot prevent anything from changing in the area, it has a strong interest in maintaining the scenery and large natural areas.

• **Local Residents**: You are residents of the towns but at the beginning of this process, you really don’t know what you think about whether development should be restricted, encouraged or managed in any particular way. You come to the meeting to learn, to ask questions, and to decide what you think is the right answer at the end of the process.

• **Pinelands Commission**: You work for the Pinelands Commission and are charged with making a recommendation to the Commission about what changes, if any, should be made to the Comprehensive Management Plan for this area. You agency is charged by statute with:
  • preserving the natural resources of the Pinelands, including forests, wetlands, water, threatened and endangered species and their habitats; and encouraging development that is compatible with achieving the preservation of the Pinelands’ natural resources, while preventing development that is incompatible with goal.