

Changing of the Green

Students investigate differences in the abundance of woody and herbaceous plants growing in areas with different mowing regimes to explore the tendency for forests to succeed field **habitats** that are left undisturbed.

Background

When Captain John Smith first reached Virginia in the early 1600s he noted, “Virginia dothe afford many excellent vegetables and living creatures, yet grass there is little or none, but what groweth in low marshes; for all the country is overgrown with trees.” Such would still be the case today were it not for the steady influence of saws, plows, mowers and livestock, since there is a natural tendency for land in this state to revert to forest after being disturbed.

Signs of this **succession** can be easily found on almost any patch of open ground left undisturbed for a few years. The evidence is young, **woody plants**—vines, shrubs, and trees—sprouting among the grasses and other **herbaceous** species that preceded them. Among the most obvious and abundant pioneer trees in the Piedmont region of Virginia are pines and red cedar. However, several other woody plants might be among the first to grow in a given area, including Japanese honeysuckle, poison ivy, staghorn or winged sumac, blackberries, green briar, wild rose, sassafras, tulip polar or red maple.

Most woody species cannot tolerate being cropped off by mowers or

grazing animals and are thus absent or scarce on lawns and pastures. But if left undisturbed, woody plants rapidly appear. At first they are scattered and somewhat hidden among the grasses, goldenrod, Queen Anne’s lace and other **annuals** and **perennials**. With each successive year, more woody plants appear. Many sprout from seeds, and others—particularly the vines and brambles—grow as vegetative shoots from the original pioneer plants. Woody plants will appear in small patches of ground, such as the corner of a lawn, along the edge of a fence or in an untended flowerbed, or will take over entire fields if left to grow.

During the early stages of succession, the combined woody and herbaceous plant growth can be very dense and lush, providing valuable cover and food for many animal species such as bobwhite, cottontail rabbits, box turtles, snakes, grasshoppers, praying mantises and garden spiders. Some state parks keep sections of old fields in the early stages of succession using grazing or by mowing them on a two- to four-year cycle. This maintains habitat **diversity** which is valuable to wildlife.

Procedure

Before the Trip:

1. Visit the site to locate at least two study locations. One should be an area that is grazed or mowed at least twice a year. The other should be a place that has not been mowed or grazed for at least two years. If possible, locate several

Grade Levels: 6–12

Objectives

Students will *investigate* change in plant composition of quadrats of earlier and later succession stages by:

- *predicting* relative abundance of plants;
- *distinguishing* between herbaceous and woody plants;
- *quantifying* plants within a given space; and,
- *comparing* actual ratios of plants.

Materials

- insect repellent (ticks and chiggers can be a nuisance in tall grass)

Per team:

- quadrat markers (1 hula-hoop or other circle OR four meter sticks, bolts and wing nuts)
- bean bags or other tools for random point selection
- clipboard, paper, pencil

Credits

Illustrations of poison ivy used with permission from *The Manual of the Vascular Flora of the Carolinas*. 1969©. C. Richie Bell et. al. University of North Carolina Press.

When

Late spring through fall is best, but can be done in winter.

Where

All parks.

Changing of the Green

areas at various stages of succession (e.g. 0 years, 2-3 years, 5-6 years, greater than 10 years). Park staff should be able to help identify these locations and give some indication of the last mowing date.

- Review with the class the concept of **species abundance**, in which abundance (A) is calculated by dividing the number of individuals of one species (or group of species) (N) by the total number of individuals of all species found in an area (T). Thus: $A = N/T$. For example, there may be 400 pine seedlings growing on a plot with 1,600 other plants. Thus: $A = 400/(1,600 + 400) = 400/2,000 = 0.20$
- Divide the class into teams of three.
- Have each team list two or three ways to estimate the abundance of plants in a large area without counting each plant. Write their ideas on the board and discuss the pros and cons of each. Lead the class to the concept of using quadrats (samples of small sections of the area) to make population estimates about the whole area.
- Have each team make a quadrat marker by one of the following methods:
 - Square marker: Join the ends of four meter sticks with wing nuts and bolts to make a square. (Any other meter long pieces of thin, sturdy material will do.) The wing nuts can be loosened or removed to fold down the marker for storage or transport.
 - Hoop-style marker: Hula-hoops work well, but be prepared to cut them in one place to fit them around large plants. Otherwise, a circle of sturdy rubber tubing the same diameter as a hula-hoop can be used.
- Ask the class to think of ways that

- sampling with quadrats could be biased (e.g., the sampler is allergic to poison ivy so doesn't take any samples near poison ivy plants). Lead them to the concept of taking random samples and have each team think of two or three ways to choose random quadrat samples. Write their ideas on the board and settle on a simple method that can be used during the field trip. (A bean bag tossed randomly into the study site is sufficient for this activity.)
- On the school grounds, practice selecting random samples, using the quadrat markers, and calculating the abundance of some type of plant, such as grasses or broad-leaved plants.
 - Explain to the class that they will be investigating the abundance of woody plants in various locations at the site. Provide the recent history of each location: Has it been mowed, plowed, burned? If so, when? Have each team rank the sites on paper and predict which ones will have the greatest abundance of woody plants.
 - Review ways to distinguish woody from herbaceous plants:
 - Woody plants usually have solid, tough, flexible stems. The main stems on herbaceous plants are often hollow and usually easy to break.
 - Woody plants stay alive through the winter. Even though they may lose their leaves, the stems remain flexible and the bark, when scraped a little, has a greenish tint and is moist and supple. Many herbaceous plants stay green through the winter, but these are usually low to the ground and lack a live, central stem.
 - Make sure everyone can recognize poison ivy, which can cause a terrible rash. It may appear as a woody vine or look more like a low shrub.

Time Required

At the Site: Allow 45 minutes per study location.

Extensions

- Ask students to search for successional changes by finding old photographs of familiar places and comparing them with the locations today.
- Fence off a one square meter plot on the school grounds and keep a monthly record of the species growing there for a period of several years.

Variations

- Do a quadrat study with areas along a different gradient such as the transition from lighter to darker areas at the edge of a forest, or various levels of moisture in a ravine or on a ridgetop.
- Consider doing this activity along different power line easements. Power companies generally keep records of mowing regimes for easements. Be sure to get permission from the power company and property owner.

Younger Students:

- Encourage the students to categorize the woody stems in their own different ways. Map the site area and label each study location prior to the trip. Students draw or color types of vegetation, shading drawings to represent the predicted abundance of woody plants.
- Estimate species abundance in the quadrats together as a group.

Resources

Andrews, W.A. 1974. *Terrestrial Ecology*. Prentice-Hall, n NJ.



Poison Ivy

Changing of the Green

The leaves are usually smooth and shiny above, and are divided into three distinct leaflets. The main stem of mature vines is often covered with brown “hair.”

At the Site:

At each study location, set the boundaries for the area being investigated and have each team do the following:

1. Randomly select three points within the study area.
2. At each point, lay the quadrat marker on the ground with the point at its center. (Disconnect at one corner, if necessary, to get around trees too large to reach over.)
3. In each quadrat, count all the woody plants and all herbaceous plants and record the numbers. Plants that are partially within the quadrat should be counted. Consider as one plant anything that grows in a clump, such as some grasses, or plants that are joined

above the ground by runners, such as strawberries.

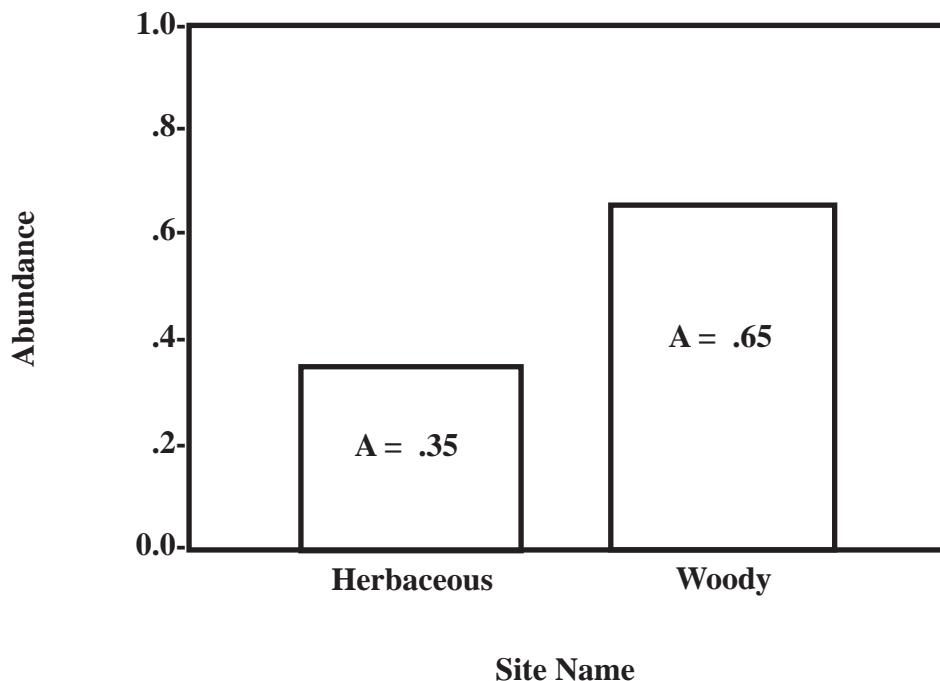
4. Repeat the above steps two more times and use the total counts to calculate the abundance of the woody plants for the location.

Follow-up:

1. Each team compares their predicted rankings for the locations with the results of their field study. Take a show of hands to determine which teams ranked the locations accurately. Discuss their results:
 - *How did the mowing regime seem to affect the abundance of woody plants growing in a location?*
 - *Why might woody plants be less able to survive in frequently mowed areas than herbaceous plants?*
 - *What factors, other than mowing, might affect the abundance of woody plants? (e.g. A swampy area might never be mowed but might not have woody plants in lower areas due to the influence*

of frequent flooding. The floor of densely shaded forests may have few or no woody plants, if the mature trees are not counted.) Consider also the effects of natural and human-made fires.

2. Take the class totals for the woody and herbaceous plants counted at each study location and calculate abundance using these numbers. Make a bar chart on the board showing the results for each team.
3. Discuss the results shown on the graph with questions such as:
 - *Which is likely to give more accurate results—large samples or small samples? Many samples or fewer samples?*
 - *If each team had taken 20 samples at each site, and the class results were again graphed, would the difference between individual team results be greater, smaller or about the same? (Team results should approach the class average with increased sample size.)*



A Forest Grows

Blowing in the wind, stuck to fur, or pre-packaged with fertilizer, today's seeds are tomorrow's forests. Through this activity, students discover some of the forest's reproductive strategies.

Background

Forests add to the diversity of plant and animal species. They shade streams, keeping shallow waters cool and free of certain types of prolific algae. They allow rain water to **percolate** into the soil, recharging **aquifers** and keeping streams and rivers flowing at relatively consistent rates. Forests provide inviting places for people to hike, camp, picnic, and hunt, and they provide the raw materials for a vast array of products from lumber and turpentine to paper and flowerbed mulch.

Forests go through a process of **succession**, where certain species become established in an area only after other species have grown there first. Pines grow best in open sunlight and are often the first trees to grow in an area. Eventually, pines are replaced by other species such as sweet gums, maples and tulip poplars. These in turn are replaced by oaks, hickories and beeches. When a forest reaches the stage where the tree species change very little over time (about 150 years), it is called a **climax forest**.

Because a seedling often has a better chance of surviving if it can grow away from its parent tree, many tree species have evolved ways to disperse their seeds. Pine, tulip poplar, ash and maple seeds have "wings" that permit them to be carried by the wind as they

flutter to the ground. Sycamore seeds have "parachutes" and can ride the wind for miles. Beeches, oaks, hickories and walnuts produce nuts that are relished by squirrels. The squirrels eat many of these nuts, but they also plant some by burying them for winter storage. Tupelo, dogwood, persimmon, cherry, and holly produce fruits which are consumed by raccoons, opossums and song birds. The seeds, adapted to endure the rigors of digestive systems, are eventually dropped, complete with a little dose of fertilizer.

Procedure

Before the Trip:

1. Discuss with the class the basic concepts of forest succession and how it is to the advantage of many tree species to disperse their seeds.
2. Ask students to give their ideas about how tree seeds might travel and write these ideas on the board.
3. Then, ask students to classify these methods into groups and subgroups similar to the listings on the illustrated seed dispersal chart; write the classified list on the board.
4. Have students name or describe trees (or other plants) that they know use the methods listed on the board. Write these beside the methods.
5. From this list, make a chart similar to the one illustrated. Give each type of seed dispersal described by the class a block on the chart. Group similar methods together. Do not include the names of trees listed by the class.
6. Divide the class into teams of two to four students each.

Grade Levels: 4–10

Objectives

Students will *investigate* variation in seed structure and methods of dispersal by:

- *observing* seeds' physical appearances and evidence of trees' reproductive strategies; and,
- *inferring* possible relationships among types of seeds, seed dispersal methods, and location of seedlings.

Materials

- large envelope
- bag or box for holding collections

Per team:

- notebook or plain paper
- clipboard
- pencils or pens
- clear adhesive tape
- flagging tape or bright ribbons
- 5-10 plain sheets of paper

When

Any daylight hours. Late summer to early fall is best, since seeds and fruits are most abundant then.

Where

All parks.

Time Required

At the Site: 45 minutes to 1 hour, plus walking time to and from study location.

Resources

- Fox, B. 1995. *Tree Trekking*. Virginia Cooperative Extension Service, 4-H. Box 9081. Virginia State University, Petersburg, VA 23806. (804) 524-5848.
- Grimm, W.C. 1962. *The Book of Trees*. Hawthorn Books, Inc., NY.

A Forest Grows

7. Make at least two copies of the seed dispersal chart for each team.

At the Site:

1. Lead the class to a forested area of the park or natural area preserve.
2. Make sure everyone can recognize poison ivy, which can cause a terrible rash. It may appear as a woody vine or look more like a low shrub. The leaves are usually smooth and shiny above, and are divided into three distinct leaflets. The fruits, which usually grow in clusters, are round, slightly fuzzy, about 5 mm wide and white when ripe. For an illustration, see the previous activity, "Changing of the Green."
3. Give each team two copies of the seed dispersal chart and a roll of clear tape.
4. Instruct the teams to collect one sample of each type of seed or fruit they can find and to tape each onto the chart in the block for the dispersal method that they think applies to the seed.
5. Set boundaries for the search for seeds and fruits.
6. Allow teams to spread out and collect seeds and fruits for about 15 minutes.
7. Reassemble the students and place their charts together on the ground where everyone can see them.
8. Discuss:
 - Which seed(s) seems to be most common?
 - Which dispersal method seems to be most common?
 - Were any of the seeds or fruits taken directly off the parent tree?
 - Could anyone tell if a fruit or seed was laying on the ground directly under the parent tree or if any seeds were obviously not under the parent tree?
9. Explain that the next part of the activity will help them better discover how far seeds might have traveled from the parent tree.

10. Give each group some flagging tape or bright ribbon, plain sheets of paper, and tape. Instruct them to:
 - Find a tree seedling (or sapling) two to four feet tall.
 - Mark the seedling with a flag.
 - Pick one (and only one) leaf from the seedling and tape it to a piece of paper.
 - Search the forest for a big tree with leaves that look like the one from the seedling. Consider this to be the parent tree, though in reality it may not be. (Since it may be hard to see the leaves on very tall trees, suggest that they look for fallen leaves under tall trees as well.)
 - If a leaf can be reached on the parent tree, pick one leaf and tape it next to the seedling leaf.
 - As one team member stand by the parent tree, another returns to the seedling and stands by it. A third team member walks directly from the parent to the seedling, counting the number of steps between them, and records this number on the paper under the leaves.
 - Repeat this process with as many different types of seedlings and parent trees as possible in the allotted time.
 - If no obvious parent tree can be found for a particular seedling, students should note this on their paper.
11. Allow 15 to 20 minutes to conduct the activity. Reassemble the class and place the collections on the ground where everyone can see them. Discuss:
 - Which seedling was closest to the parent tree?
 - Which seedling was farthest from the parent tree?
 - Were there any seedlings for which a parent tree could not be found?
 - How do you think each seedling was planted?
 - Was there any evidence that any of the seedlings came from seeds like

Harlow, W.M. 1941. *Fruit Key & Twig Key*. Dover Publications, Inc.
 Knopf, A.A. 1980. *The Audubon Society Field Guide to North American Trees*. Chanticleer Press, Inc., NY.
 Perry, B. 1985. *A Sierra Club Naturalist's Guide to the Middle Atlantic Coast*. Sierra Club Books, San Francisco.
 Petrides, G.A. 1958. *A Field Guide to Trees and Shrubs*. Houghton Mifflin Co., Boston.
Project Learning Tree. Virginia Department of Forestry. 900 Natural Resources Drive, Charlottesville, VA 22903. (804) 977-6555.

those found in the first part of the activity?

- What seems to be the most common seedling?
- What seems to be the most common tree in this forest?
- Are the most common tree and seedling the same species?
- Based on the above question, will the forest look very different when the seedlings are full grown?

Follow -up:

1. Tape or tack the papers with the leaf samples on a wall in rows. Group those with similarly-shaped leaves together in columns.
2. Give each leaf type an identifying letter or number.
3. Each student should study the leaf display and make a bar chart showing the distance, in footsteps, of each type of seedling from its parent tree. (Students should calculate and use averages for those species represented by more than one seedling.)
4. Students can use field guides to identify the seeds and leaves they collected and, where appropriate, to match the seeds to the leaves.

A Forest Grows

Seed Dispersal Chart

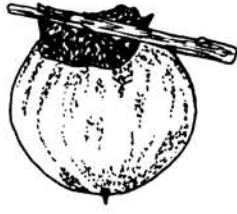
Seeds Carried by Animals		
Eaten and left in droppings	Buried for “storage”	Other

Seeds Carried by Wind		
“Parachutes”	“Wings”	Other

A Forest Grows



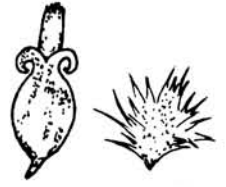
Hickory



Persimmon



Beech



Black willow



Hop hornbeam



Sweetgum



Sycamore



Dogwood



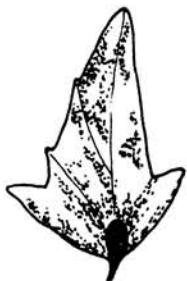
Pine



Water tupelo



Live oak



Ironwood



Red maple



Pawpaw



Tulip poplar

Changing Forest, Changing Trees

Students will learn to identify plants from several major groups ranging from mosses and algae to flowering plants. They will learn how plants changed through time as first one, then another group became the dominant “forest formers” and will learn to recognize the humble descendants of ancient coal swamp trees. Students will also determine the habitat preferences of a variety of plants from both ancient and modern groups.

Background

While the history of life is often discussed in terms of changes in animal life, many of the most striking and important changes have involved plant life. These include the evolution of our atmosphere from one rich in carbon dioxide to one rich in oxygen and major changes in the food sources available to animals.

The first land plants were probably lichens, mosses and algal films that covered rocks near water. These plants are still common today, even in backyard or urban park environments. These primitive plants require periodic immersion in water to survive. About 400 million years ago, some plants (**vascular plants**) evolved a system for transporting water from the ground up into and throughout the plant. Vascular plants spread quickly, and by 350 million years ago, forests of these new plants—including ferns, horsetails, and club mosses—covered much of the

globe. The best known ancient forests in Virginia are the coal swamps that covered much of the western part of the state about 300 million years ago.

Over time, new groups of plants evolved and replaced these pioneers as forest-forming species. Early in the Age of Dinosaurs, **conifers** became abundant. By the middle of the Dinosaur Age, flowering plants had evolved. Today's forests are dominated by flowering plants (oaks, maples, and other deciduous trees) and conifers (pines and cedar). However, if we look closely we can still find representatives of the early pioneer groups, especially ferns. Even very primitive plants, such as mosses and lichens, are still common.

Procedure

Before the trip:

1. Review the basic types of plants. Discuss the differences between **vascular** and **non-vascular** plants (those that have an internal plumbing system vs. those that do not). Discuss the familiar trees of modern forests, the conifers (pines, cedars, hemlocks, spruces etc.), and flowering plants. Then discuss some of the more ancient plant lineages. Be sure to include ferns, club mosses and horsetails in the discussion. You are sure to find two of these on every trip. You can expand the discussion to include other groups (e.g. cycads). For non-vascular plants, discuss mosses,

Grade Levels: 7–10

Objectives

Students will *investigate* the major plant groups and learn how the groups have changed and evolved with time. To do this they will:

- *work in teams* to collect, assemble, graph, and present (orally and in written form) scientific information;
- *make and record* field observations, including use of map skills and technology;
- *determine* the differences among the major groups of plants;
- *evaluate* environmental factors that control plant distribution;
- *compare and contrast* groups dominant in ancient forests with groups dominant today; and,
- *formulate* a hypothesis to explain the change.

Materials

For the class:

- plant field guides

For each team:

- worksheets, notebook
- measuring tape
- park map

To wear:

- appropriate seasonal clothing.

Credits

J.S. Beard, Virginia Museum of Natural History

Where

All parks.

Changing Forest, Changing Trees

lichens and, if you wish, others such as liverworts. Again, you will likely encounter all of these on the park visit.

- In the course of the discussion, be sure to include some of the distinguishing physical characteristics of each group. Have several plant field guides on hand so that students may familiarize themselves with some of the species that they will likely encounter in the park.
- Discuss “fitness” in evolutionary terms. *What are some ways to determine whether one group of organisms has been more successful than another in the competition for resources?* Example: abundance, quality of habitat.
- Break the class up into teams of three or four. Assign each team a particular area or habitat and ask them to take an inventory of the plant life in that particular area.
- Have the teams study a park map and locate assigned areas, if any. If you want to limit the search, have students find a total of twenty different species that includes at least one or two from each group. The number of species and complexity of the search can be tailored to the age and experience of the students. It will also be important to note which species and/or plant groups are common and which are rare. One way to do this is to have each group decide which major plant groups are the most common in any given area. You might wish to have two measures of abundance: 1.) numbers of individual plants; and, 2.) How much living material is made up of a given species (biomass). For example, a single oak tree may contain several tons of **biomass**, more than thousands of ferns.
- See Student Activity Worksheet. The worksheet parameters can be scaled as indicated or set up your

own scales:

- Light.** Light ranges from 10 for full sunlight to 1 for permanent, deep shade. Bear in mind that it is the sunlight falling on the leaves that matters. The tallest trees will generally all be 10’s.
 - Moisture.** Moisture ranges from wet (10) – standing or running water – to dry (1). Very dry soil (1) will be dusty. Damp soil will generally cling to fingers. Bear in mind recent rain or drought.
 - Soil.** Rich soil is usually dark in color and rich in organic matter. Poor soil is often rocky and lacking in organic matter. It may also contain a lot of reddish clay. Sandy soil contains sandy gritty material and can be a component of either rich or poor soils. No soil/thin soil includes rocks and tree trunks.
 - Size.** Coatings are plants (including most mosses, lichens, and liverworts) that lack any stems and closely hug the ground, rock, or other surface on which they are growing. Plants lacking a woody stem that are less than one foot in height are herbs. Plants having a single main woody stem that are greater than 10 feet tall are trees. Everything else is a shrub. Some plants may have individuals in more than one category.
 - Abundance.** Rank in terms of the total plant population. Again, it is desirable to rank both by numbers of plants and by biomass if possible.
 - Notes.** Any other pertinent information like visible fruits or flowers, evidence of disease or insect damage, and local abundance (e.g. “Alder is the most common tree in a small wetland in the SE corner of the study area”).
- Once you’ve set up the worksheet, decide which characteristics define relatively desirable or undesirable habitats.

When

Anytime except winter, however spring or fall is best.

Time Required

At least 2 hours at the park.

Extensions

- Have students research plant varieties in other types of ecosystems and compare with those from the Park.
- If possible, a Poloroid or digital camera could be used to record species and surroundings. This method of recording field data is becoming scientific standard. Also, the use of Global Positioning System (GPS) equipment could be used as a means to measure location, elevation, and distance.

Variations

For younger students:

This can be adapted by having the teacher identify various plant groups or provide a detailed visual handout. Students could then discuss why some plant groups have flourished while others have not.

For older students:

Split students into teams of three or four. Have one team (or series of teams) be responsible for certain types of plants. One group could be responsible for mosses and lichens, another for ferns and clubmosses, another for conifers or flowering plants, etc. You may suggest finding at least 10 species in their group. Have them also record the most abundant species in their specialty groups Rank their abundance in terms of plant population and population within individual, main groups (the 3 most abundant ferns, for example).

Devise a method to estimate biomass quantity. Research optimal soil types and moisture contents and compare field data. Formulate the parameters of an “ideal” plant habitat. Have students present information to the class and defend their findings.

Changing Forest, Changing Trees

8. Go over in detail the park rules regarding collecting or damaging vegetation. Most parks will not allow collecting of live plants without a permit. Many parks, however, will allow you to collect small amounts of dead material (fallen leaves etc.) to be used for educational purposes.

At the Park:

1. Have teams gather and go to their assigned areas or in search of their assigned plant types. Make sure that each team has a field notebook, worksheets, writing implements and a park map.
2. When a plant is located, plot the location on the map and then record its name, size, etc. Be sure to include distinguishing characteristics that were used in identification. Also note the habitat. *Is the ground damp or dry? Are there large numbers of this species or is it the only one? Is it a sunny or shady area? Is the plant growing on rich soil? rock? sand? tree bark? Is there standing or running water nearby? Is the plant actually in water?* This information can be entered in the worksheet in the field.
3. Either the individual groups or the class as a whole should try to estimate what plant groups are the most abundant, in terms of number of plants; number of species; and biomass (e.g. a single shrub may contain as much biomass as thousands of small herbs).

Follow-up:

1. Back in the classroom, each team will compile their findings. This will include all of the worksheet data.
2. Each team should prepare a presentation for the class that includes graphs and charts as appropriate. Every member of the team should participate in the presentation.

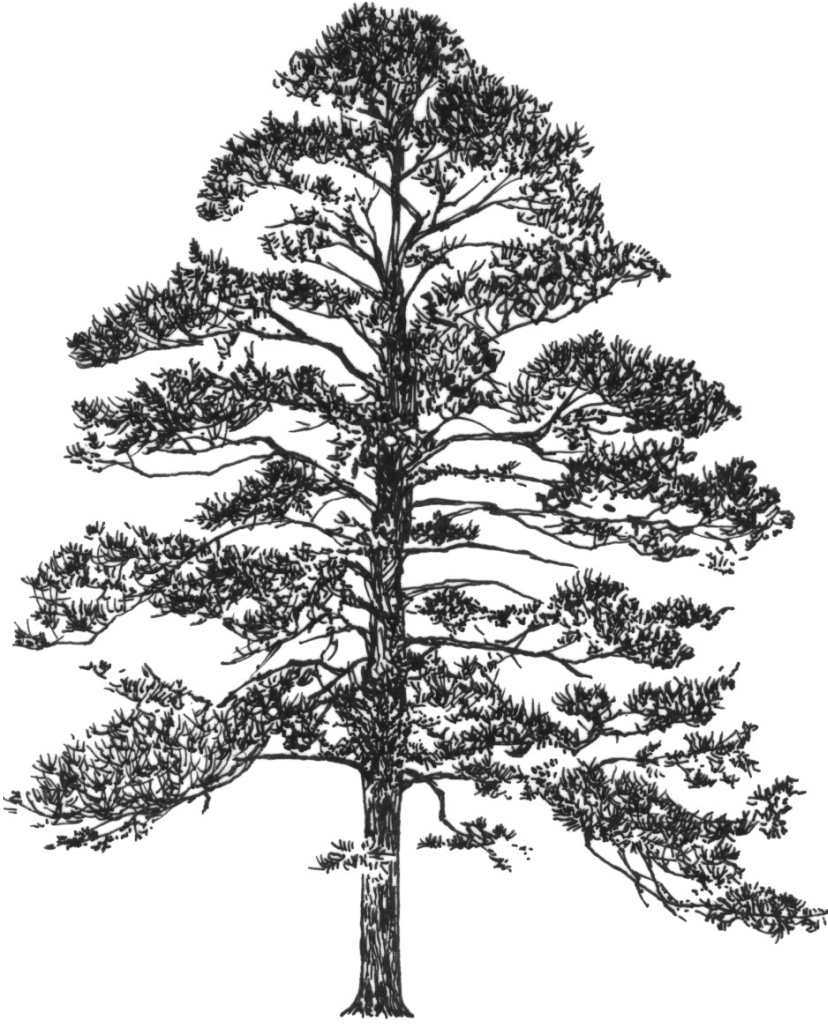
3. All teams should collate their data into a single set for each class. For each major group (angiosperms, ferns etc.) the class should graph abundance, size and habitat preference data. Note:

- Students may find that most or all trees and shrubs are either conifers or flowering plants. These groups also occur as herbs. Most or all horsetails, club mosses, and ferns will be herbs. Mosses and lichens will mostly occur as coatings on the surface on which they grow.
- Biomass is mainly held in flowering plants in most Virginia forests. However, there are some conifer-dominant forests.
- Diversity (number of species) will likely go to flowering plants.
- Numbers of individual plants may be another matter. *How many moss or lichen plants are in a single patch?* It may be difficult to know. *What about single-celled algae in pond water?* This is why, when determining species that dominate an ecosystem, it is important to consider biomass and not just numbers of plants.
- There will be much room for interesting discussion about habitat preference. In particular, many species of fern grow in areas with very rich soil, while many mosses, other fern species and horsetails like wet areas.
- Some mosses and lichens grow in full sunlight, but only if the soil is poor or nonexistent. The question really is what is the most “plant-friendly” local environment. The teams may want to discuss this and come up with a set of desirable features. Have each team defend their choices.
- One good selection of environmental factors might be rich soil, plenty of (but not excess) water and lots of sun. Flowering plants

probably dominate areas like this. *What plants dominate the most marginal habitats?*

4. Review the evolutionary history of the plant kingdom. *How did the coal forests differ from modern forests? Why are modern forests different?* Focus on adaptations that may give one plant group an advantage over another. Compare the various groups feature for feature, focusing on food production, acquisition of water and nutrients, and reproduction. *How do these features restrict or liberate various plant groups? What has been the fate of the ancient groups?*
 - An obvious example is that an internal plumbing system allows plants to escape the need for periodic immersion in water. Broad leaves may be more efficient at gathering sunlight than narrow leaves. A protected seed may have a better chance of survival than a spore. Insect pollination may promote genetic diversity more effectively than wind dispersal. Have the class think of as many examples as possible.
5. Have each student write a short paper on their favorite plant group, explaining its characteristics and where it might be found in a forest.

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Pine



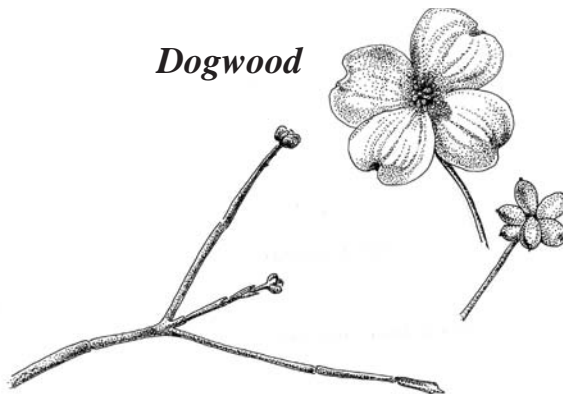
Juniper



Fern



Paw Paw



Dogwood

Changing Forest, Changing Trees

Student Activity Worksheet

plant	light	moisture	soil	size	abundance	notes
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						
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Additional observations, notes, or comments:

Wetland Walk

Squish . . .squish . . .squish . . . in a marsh. Your students walk on water and on land at the same time. Wetland habitats reflect this in-betweenness. In this activity, students look for the indicators of transition from the aquatic to the terrestrial.

Background

By definition, wetlands are areas that have soil saturated or covered with water for a period of time, and have plants that are adapted to living, at least part of the time, in water. The most familiar wetlands in the mountains are fresh water marshes and wooded swamps or bogs found in relatively low areas, valleys, or along the banks of streams and lakes.

Wetlands have many values. The stems and leaves of wetland plants trap eroded soil washing from the land and absorb the energy of storm waters. Nutrients that might over-enrich the waterways are trapped and used by wetland plants for growth. When these plants die, they enrich the waterways with decaying matter called **detritus**, a vital food source for microscopic organisms near the base of the food chain. Countless aquatic animals find food and shelter in wetlands including juveniles of many fish species. An array of wading birds, song birds, waterfowl and birds of prey are attracted to wetlands for food and nest sites.

Historically, wetlands have been maligned by humans. Blamed as sources of insect pests, they were drained or sprayed with pesticides.

Steadily over the past few decades, scientific evidence of the benefits of wetlands has mounted and recently laws have been enacted for their protection. However, the future of wetlands rests in the hands of today's youth.

Procedure

Before the Trip:

1. Study the site information in this guide and visit the site to identify the best location for exploration.
2. Divide the class into teams of three to five students.
3. Give each team a copy of the accompanying Wetlands Investigation Guide. Ask if anyone happens to already know the answers to any of the questions. After obtaining an answer to one of the questions, ask the student how he/she knows that answer is true. Do not tell the student whether he or she is correct, but thank the student for the information and point out that part of a scientist's concept of "true facts" is that they may be verified by anyone who takes the time and trouble to make careful observations. Explain that the class will be visiting a wetland to make careful observations which will enable them to infer answers to the question posed in the Investigation Guide.
4. Give each team a copy of the Wetlands Observation Sheet. Point out that the 12 observation suggestions already listed should be helpful in developing inferences about wetlands, but that the students will

Grade Levels: 4–12

Objectives

Students will *investigate* natural organization of a wetland and the interrelationships between the wetland and the surrounding environment by:

- *planning* a study;
- *observing* wetlands; and,
- *inferring* cause and effect relationships.

Materials

- waterproof footwear
- Wetlands Observation Sheets (1 per team)
- Wetlands Investigation Guides (1 per team)
- Wetlands Investigation Guide – Teacher's Version (1 per teacher)
- clipboards
- pencils
- insect repellent
- trowel

Where

All parks.

When

Any time of year is suitable. In spring and summer, new green plants are emerging or at peak growth. In fall, some will be in flower. By winter, most plants will be brown and dying back. Any daylight hours are suitable.

Time Required

At the Site:

Allow up to 1 hour for observations and discussion, plus time to walk to and from wetland area.

Wetland Walk

also need to make other observations. Allow time for the teams to consider what kinds of additional observations may be needed to address all of the investigation questions, and to add these to the back of the observation sheet. Collect all of the Investigation Guides and completed Observation Sheets. Check the students' observation lists to make sure that everything they have added may actually be seen, felt, smelled, or heard.

5. Review the field trip plans.

At the Site:

1. Return the Wetlands Observation Sheet to each team without the Investigation Guides.
2. Explain the importance of approaching the wetland area quietly in order to improve chances of seeing wildlife. Lead the class to the edge of the wetland. Pause for a few minutes of silent observation.
3. Remind students that they might not observe wetland features in the order listed on the Observation Sheet and that they may record any observations of interest, whether or not they are suggested on the sheet. Lead them into the wetland at an area accessible from a nearby road or trail. In some areas, this will be along a boardwalk. In others, where the footing is sound, it will be directly onto the wetland. The teams make as many observations as possible in 30 minutes. Lead the class to key areas of the wetland (particularly where the elevation, and hence, the flora, changes dramatically) and encourage them to use all of their senses. Dig (and replace after observation) small plugs of soil so teams may observe below surface conditions. If possible, make a photographic record of the areas/items observed.
4. When students have completed

their observations, lead them out of the wetland to an assembly area suitable for a group discussion about their observations. Compare the teams' observations.

- *Did everyone see everything the same way?*
 - *Which observations does the group think will be most useful for suggesting possible answers to the investigation questions?*
5. If you have the knowledge (or access to a knowledgeable guide), tour the wetland with commentary on the value of wetlands.

Follow-up:

1. Return to each team its Investigation Guide. Have teams consult their list of observations and identify those which should be helpful in responding to each of the questions on the Investigation Guide. On the guide sheet after each of the investigation questions, ask students to note the numbers of their observations which may lead to an answer, and, within the right hand column, state what they believe to be a likely answer to the question, based on those observations. Copy the example provided on the blackboard.
2. Work through the first two questions as a class, then allow the teams time to do the remaining seven questions. Some observations will have bearing on several questions; some may have nothing to do with any of the questions.
3. Ask teams to share and explain their inferences. As you moderate the discussion, recognize inferences which lead students towards the ideas suggested in the teachers' version of the Investigation Guide, but also pursue discussion of other logical and interesting inferences that your students have made.

Resources

- Silberhorn, G. 1982. *Common Plants of the Mid-Atlantic Coast: A Field Guide*. Johns Hopkins University Press, Baltimore, MD.**
- Wading Into Wetlands*. National Wildlife Federation. 8925 Leesburg Pike, Vienna, VA 22184-0001. (703) 790-1400.**

Extensions

1. Investigate ways to verify the inferences made.
 - Discuss the scientific method. Have the teams develop one inference into a testable statement, design, and then conduct the research.
 - Investigate scientists' views on certain topics and the basis of those views.
2. Students map the distribution of plants and animals observed.
3. Visit the same area at another time of year. Compare both sets of observations and develop inferences about seasonal changes.
4. Students design an advertising campaign to inform others about wetland values and issues.
5. Students find and share media reports about wetlands.
6. Students research current wetland legislation and express their written opinions to appropriate politicians.

Variations

Younger students: Eliminate use of teams and Observation Sheets. Discuss key wetland features before the field trip and guide class observations of these features, using the Teacher's Version of the Investigation Guide. Consider questions individually, seeking out pertinent observations. Take pictures of these features and your observers, collect representative leaves, and make an informative classroom display.

Wetland Walk

4. Discuss the following:

Thinking of the conditions in which wetlands can exist, what are some human activities that might destroy them?

- Damming the waterway downstream might flood wetlands.
- Damming the waterway upstream may dry them up.
- Water drawn from the waterway for irrigation or a draw-down in the water table by nearby wells could dry up a wetland.
- Cutting a ditch across a wetland may drain it.
- Pushing dirt onto the wetland, as for preparing a construction site, would obviously destroy it.
- Dramatically disturbing the soil on the nearby uplands might result in enough sediment being washed onto the wetland to fill it in.
- Repeated wakes from excess boat traffic could destroy a marsh by erosion.
- Potentially, global warming could raise sea level enough to destroy coastal wetlands by flooding.

How does the wetland help life forms in the adjacent waterway by trapping sediments?

- Suspended particles intercept light essential to aquatic plant life.
- Suspended particles clog gills of fishes and other estuarine organisms.
- Sediments cover and smother oysters and other stationary bottom dwellers.

How do wetlands help life in the estuary by removing excess nutrients?

- Excess nutrients, such as nitrogen and phosphorous, cause sudden population explosions of algae. The algae block light necessary for beneficial plant life and deplete oxygen in the water, especially when they die and are being decomposed.

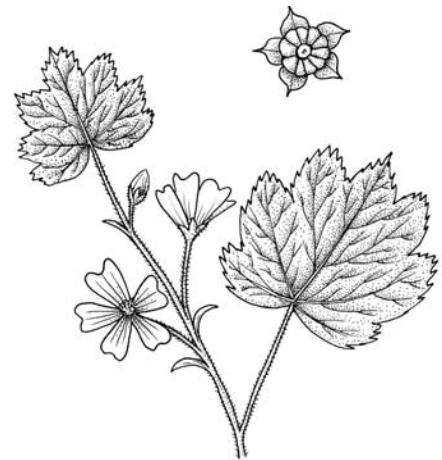
Where might the excess nutrients come from?

- Agricultural runoff from fertilizers and live stock wastes
- Human wastes from inadequate or failing sewage treatment systems
- Lawn fertilizers
- Possibly acid rain

Older students:

1. Students design quantitative techniques to investigate a wetland (e.g. determine elevation of wetland's upper limit and water depth of lower limit; identify and list specific plants; catch and identify animals; compare soil particle size and organic content with samples from different areas of the wetland and the upland.)

2. Design and conduct an "E.Q." survey (environmental quotient) to assess public knowledge of wetlands and their values.



Common mallow

Example:

Investigation Question	Relevant Observations	Inference
1. Where does the wetland and the upland begin?	# 3 # 4 # 8 # 11	The borderline between upland and wetland separates drier soil where bushes and trees grow from wetter mud where mostly grass-like plants grow.

Wetlands Observation Sheet

Scientific observations are descriptions of what we actually see, hear, feel, taste, or smell. We make inferences when we use logic, or even guesses, to interpret or explain our observations. One set of observations may lead you to many inferences or none. How do you know if your inferences are on the right track? Use the scientific method to test your ideas. This observation guide suggests where to direct your observations in order to make some logical inferences about a wetland.

1. Are all the plants in the marsh the same kind?	7. Are some specific types of plants usually found close to the water?
2. How many kinds of plants are there?	8. Are some types of plants never found close to the water?
3. Are the plants distributed evenly, randomly, in clumps, or in some pattern?	9. Is the soil everywhere equally damp and of the same feel (texture) and smell?
4. Are some kinds of plants always found close together?	10. Are there any kinds of plants you find only in areas of a particular smell, texture, or dampness?
5. Are some kinds of plants never found close together?	11. What does the soil look (smell, feel) like under the surface?
6. Is the same amount of water visible everywhere?	12. Are there any plants that are not green? Where did you see them?

List other observations on the back of this sheet. Your team will need these observations in order to suggest answers to the inference questions.

Wetlands Investigation Guide

Investigation questions	Relevant observations	Inferences (possible answers)
1. Where does the upland end and the wetland begin?		
2. Does the wetland have a <i>lower limit</i> ? If so, what is it?		
3. What seem to be the conditions necessary for a wetland to thrive?		
4. Where might the wetland be changing or being destroyed?		
5. What characteristics of the wetland indicate that it can catch and hold sediment such as eroded soil?		
6. What features of the wetland might help remove excess nutrients and toxins from the water?		
7. What indicates that the wetland might be part of the aquatic or estuarine food chain?		
8. What indicates that the wetland is important to land and water animals?		
9. How might the marsh protect adjacent higher ground from some effects of storms and flooding?		

Wetlands Investigation Guide—Teachers’ Version

- | | | |
|--|---|--|
| <p>1. <i>Where does the upland end and the wetland begin?</i></p> <ul style="list-style-type: none"> • The upper limits of wetlands are usually marked by changes in vegetation and ground moisture. In most state park marshes, there is a clear transition from trees and shrubs to tan, grass-like plants such as cattails, sedges, rushes or cord grasses. The vegetation changes are less clearly defined on the upper edge of swamps, which are forested. There, soil moisture changes might be the best clue. Unless it has rained very recently or there has been a prolonged dry spell, wetland soil will be noticeably wetter, often squishy or even inundated. | <p>4. <i>Where might the wetland be changing or being destroyed?</i></p> <ul style="list-style-type: none"> • Over geologic time, wetlands are very dynamic places, undergoing rapid change. Trapped sediments can fill in wetlands. Perhaps the majority of “inland” wetlands are only an early stage in normal succession and convert into dryland eventually. Only erosion may be readily apparent. This is best observed along the lower limits of wetlands bordering swift tidal creeks or open bays or rivers. | <p>7. <i>What indicates that the wetland might be part of the aquatic or estuarine food chain?</i></p> <ul style="list-style-type: none"> • Encourage students to observe the abundance of dead plant matter (detritus) in the wetland. If necessary, point out that most of the detritus along the waterway edge is likely to be washed into the estuary. From this, students might deduce the importance of wetland plants as a major component of estuarine food chains. |
| <p>2. <i>Does the wetland have a lower limit? If so, what is it?</i></p> <ul style="list-style-type: none"> • The lower limit will be the adjacent waterway. Not every wetland will have a visible lower limit but may seem bound on all sides by uplands or stretch on indefinitely. | <p>5. <i>What characteristics of the wetland indicate that it can catch and hold sediment such as eroded soil?</i></p> <ul style="list-style-type: none"> • Encourage students to observe the abundance of plant stems and leaves and to think of them as filters of water washing off the uplands. | <p>8. <i>What factors indicate that the wetland is important to land and water animals?</i></p> <ul style="list-style-type: none"> • Wildlife benefits can be inferred by observing animals present, such as turtles, snakes, insects and birds, and by finding their signs, such as droppings, tracks and nests. Other wildlife values can be identified by noting seeds and fruits that might be food items. |
| <p>3. <i>What seem to be the conditions necessary for a wetland to thrive?</i></p> <ul style="list-style-type: none"> • By finding the upper and lower limits to wetlands, students can infer the conditions required for wetlands (i.e. an abundance of water but not deep water or swiftly moving water as by current or wave.) | <p>6. <i>What features of the wetland might help remove excess nutrients and toxins from the water?</i></p> <ul style="list-style-type: none"> • (This question might best be reserved for advanced students.) Basically nutrient and toxin removal occurs in two ways. Many nutrients and toxins will be bound to the sediments trapped in the wetland. Others will be assimilated directly into plant tissues. Remind students that nutrients in the water can be taken up as fertilizer by the lush wetland plants. | <p>9. <i>How might the marsh protect adjacent higher ground from some effects of storms and flooding?</i></p> <ul style="list-style-type: none"> • Shoreline erosion protection can be inferred by observing eroded areas along the shoreline where marshes are absent. Examination of the peatlike soil may lead to inferences about its role in absorbing water and buffering flooding effects. |

Sedimentary My Dear Watson

Students will visit sites with moving and still water and determine what kind of sediment is being moved by the water. They will then relate sediment types to stream types (slow vs. fast moving) and compare both to still water sites. They will determine proportions of various sediment types at each site.

Background

Sediment is solid material that is transported and eventually deposited by moving water (or wind). It can be clay, silt or sand that is suspended in the water or rocks that roll along the streambed. It can also include organic material, especially the remains of plants. The kind of sediment that is carried by a stream depends on several factors, most importantly, how much water is in the stream and how fast it is moving. Other factors, such as recent rain or drought, plant cover and the presence of man-made structures such as dams can also affect the character and volume of sediment. In general, fast-moving streams can move coarse sediment such as gravel or stones. Slow-moving or still water carries only fine particles like mud or silt.

Procedure

Before the trip:

1. Discuss the various types of sediment—mud, silt, sand, gravel (pebbles, cobbles, boulders), and organic matter.

2. Discuss the factors that control what sort of sediment might be found in a particular stream or lake environment.
3. Divide the class into teams. Collect at least 3 spice jars, about 100 ml each (one for each site for water samples), and at least 3 empty coffee cans with tight-fitting plastic lids (one per site for sediment samples). Every team should have at least one jar and one coffee can.
4. Study the park map and plan sampling sites. If a topographic map of the park is available, this will aid planning. Sites should include at least 3 of the following:
 - pond or lake bottom (away from any artificial beach)
 - natural river, lake, or stream sand bar
 - bottom of a slow-moving stream (obvious current, but no riffles)
 - bottom of a moderately quick moving stream (riffles, but no whitewater)
 - bottom of an energetic stream (some whitewater)

If streams are too large for comfort (and for smaller children), mud, sand or gravel bars or beaches can be sampled instead of the actual stream bottom.

NOTE: Never wade out into a river or large stream with a noticeable current. These activities should be done in small, shallow streams.

Grade levels: 6–10

Objectives

Students will *investigate* the relationships between streams and sediment types by:

- *formulating and testing* a hypothesis about sediment type;
- *making and recording* field observations;
- *graphing and interpreting* data obtained by processing and measuring sediment samples;
- *practice* math skills including using a small sample to evaluate a larger sample; and,
- *recognize* sources of error in measurement.

Materials

For each class:

- scales
- hotplate (optional)

For each team:

- 2 spice jars or other jar holding about 100 ml
- 1 coffee can with tight-fitting plastic lid
- 2 five-gallon buckets
- measuring tape
- yardstick
- a 1 liter and a 3 liter plastic bottle
- one 4' by 2' piece of cheesecloth, folded in half (you may be able to substitute a cloth diaper)
- 2 flat pans (9" by 9" aluminum cake pan will work)
- clipboard and notebook
- graph paper, worksheets

For each student:

- waterproof boots and tennis shoes
- old clothes that can get dirty and wet

Sedimentary My Dear Watson

5. Have the students predict what type of sediment they might find at each site.
6. Have the students discuss what factors besides water speed and volume might affect sediment distribution (e.g., recent rain or drought, plant cover, availability of suitable source materials, human influences).
7. Discuss how organic matter might behave differently from mud, sand or stones.
8. Discuss what measurements will be made in the park. In particular, design one or more techniques for measuring the speed of water. For example, drop a small, lightweight object like a ping-pong ball or a cork into the water and record the time it takes to travel a measured distance. $\text{Speed} = \text{distance}/\text{time}$.
9. Discuss the protocol for sample collection. (e.g. collect water samples before disturbing the sediment. Why?).
10. Just before the trip, determine what the weather in the park has been like for the past week (and/or day and/or month etc.) and record this information.

At the Park

1. Divide into teams. One team (or group of teams) will go to a pond or lake with standing water, avoiding areas where sand has been brought in to make beaches (ask park personnel for guidance). A second team will go to a gently flowing stream, one where the current produces ripples (surface waves), but no white water. A third team will go to a more energetic part of the stream (or a different stream if necessary), to an area with white water. Other sites may be added or substituted.
2. Each team will note the average width, depth and water speed in the area that they have selected.

This information will be written into a field notebook kept by one team member. The team will also make observations about vegetation around their site and note any other factors that might influence the study (e.g. the presence of a dam upstream).

3. Each team will collect a water sample using the 100 ml spice jars. This should be done before the sediment is collected or disturbed. Make field observations about the clarity of the water and write them in the notebook.
4. Each team will then fill a coffee can with sediment from the site. Get as much sediment and as little water as possible into the can. Carefully empty as much of the excess water from the sample as you can without losing the finer sediment. Cover with a tight-fitting lid. Make field observations about the sediments and write them in the notebook.

Follow-up

1. Collect the starting materials. Weigh the cheesecloth and the flat pan and record weights. Also weigh an empty coffee can and the coffee can containing the sediment sample.
2. Set a large sieve, colander or screen over a five-gallon bucket in an outdoor area with access to water. The sieve should hold back small rocks, but allow sand to pass through.
3. Carefully rinse the sediment with 10 liters of water (use the plastic bottles to measure) so that the finer material washes through the sieve into the bucket below. If materials such as leaves or sticks interfere with the washing process, remove them by hand and set aside.
4. Empty the material that remains in the sieve (along with any hand removed leaves etc.) onto a section of a newspaper to dry.

Credits

J.S. Beard, Virginia Museum of Natural History

Where

All parks.

When

Spring or fall. Water warmer in fall.

Time Required

1 hour

Extensions

1. Discuss the benefits and drawbacks of stream sedimentation. Benefits might include enriching farmland (think of Egypt and the Nile). Drawbacks might include infilling of lakes or silting in spawning beds.
2. After the activity is completed, mix some of the sandy and muddy sediment (together and/or separately) with water in a mayonnaise jar with a tight lid. Shake and observe the settling behavior.
3. Observe local streams during times of rain and drought and record observations.
4. Use knowledge of stream sedimentation to determine the environment of deposition of sample of sedimentary rock.

Variations

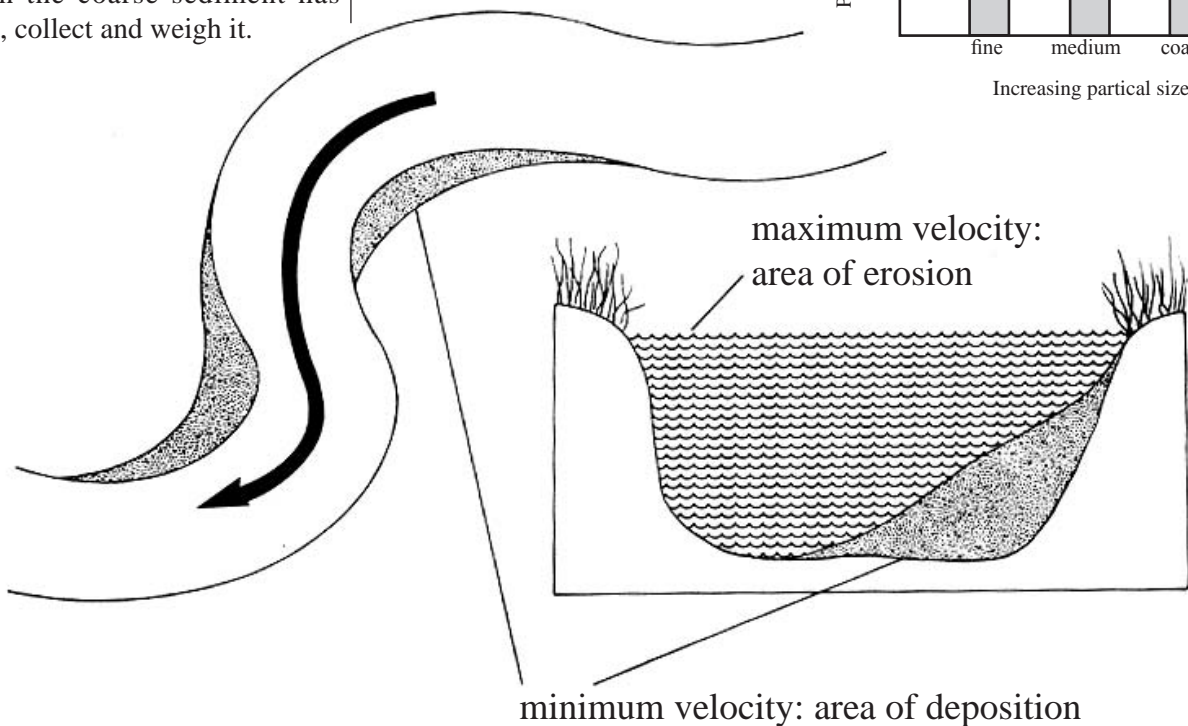
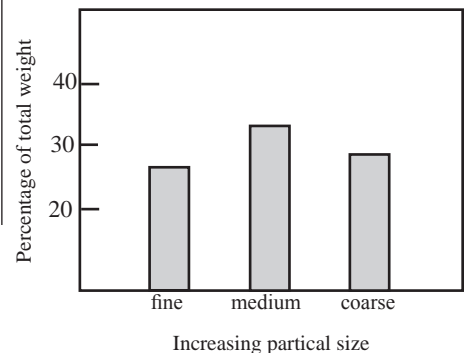
Younger students: Gather several samples of coarser (gravelly) sediment. These will be easier to process than mud. Help with predictive and measurement activities. Teacher does sampling calculation.

Older Students: Using the measured mass of the suspended sediment and rate of stream flow, calculate annual amount of sediment carried to lake by a stream. Discuss the assumptions and (considerable) sources of error in this calculation. Tie activity into sedimentary rocks and depositional environments.

Sedimentary My Dear Watson

5. Stir the water-sediment mixture in the bucket vigorously and pour slowly through cheesecloth (make sure that you have determined the dry weight of the cheesecloth first!) into a second 5-gallon bucket. Have one or two students hold the cheesecloth tight over the bucket while another pours. Stir the mixture often to make sure that the sediment remains in suspension. Pour slowly to avoid clogging the cheesecloth. When the bucket is empty, rinse with a liter of water and pour this through the cheesecloth. Rinse the cheese cloth with an additional 3 liters of water so that most of the fine material washes through. Set the cheesecloth and the sediment it holds on a section of newspaper to dry.
6. Determine the volume of water and fine sediment in the bucket (it should be between 12 and 15 liters). Stir vigorously so the sediment comes into suspension and take a 100 ml sample of the water-sediment mixture. You may discard the rest.
7. When the coarse sediment has dried, collect and weigh it.
8. When the cheesecloth and sediment has dried, collect and weigh it, subtracting the dry weight of the cheesecloth.
9. Shake the 100 ml sediment-water sample well and pour into a pre-weighed, flat pan. Evaporate the water on a hot plate (or by leaving it on a radiator or in a sunny place). Weight the pan and remaining sediment, then subtract the weight of the pan.
10. Calculate the total weight of fine sediment from the ratio of the sample volume to total volume.
11. Add up the total sediment weight and determine what fraction falls in the coarse, medium and fine category for each location. Graph and discuss the results. Compare with predictions.
12. If the sample contains rocks, remove, measure and weigh the 3 largest. Why might this information be useful?
13. Compare the total weight of the three fractions with the original weight of the sample. Account for any differences.
14. Discuss possible sources of error.
15. Set the spice jars with the water samples in a quiet place out of the sun for 24 hours. Note any sediment that has settled out of the samples. Note water clarity and compare with that observed in the field.
16. Shake the samples to remix the settled material and pour the sample into a flat pan. Evaporate the water over a hot plate, radiator etc. Determine the weight of the solid material.
17. Compare and contrast this material to the fine material separated from the sediment sample.
18. Calculate the weight of suspended sediment carried by one liter of water.
19. Discuss possible sources of error.

Stream Beach Sample



Wetland in a Pan

A wetland model demonstrates some of the critical functions of wetlands, and illustrates how wetlands effectively buffer the impact of flooding and filter runoff from land.

Background

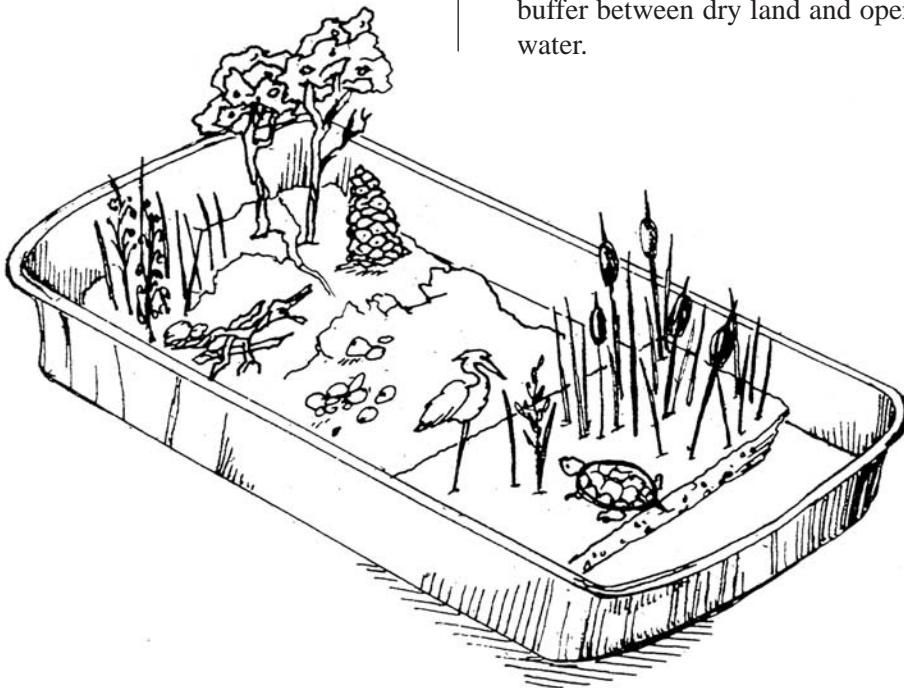
It's hard to tell just by looking at wetlands that they help filter silt and pollutants from runoff (water coming from land) as well as tidal waters, and often reduce flood damage. By building a simplified wetland model, some of these important wetland functions can be demonstrated.

For more background information on wetland values, see "Wetland Walk," page 98.

Procedure

Make the Model:

1. Along the bottom of one side of an aluminum roasting pan, spread a layer of modeling clay to represent land. Leave the other half of the pan empty to represent a stream, pond, or lake.
2. Form the clay into a gradual slope toward the center of the pan.
3. Smooth the clay along the sides of the pan to seal the edges. If desired, form meandering streams in the clay.
4. Cut a carpet scrap or sponge two to three inches wide, and long enough to stretch across the bottom of the pan along the entire edge of the clay (see diagram). The carpet or sponge will represent the wetland buffer between dry land and open water.



Grade Levels: K-9

Objectives

Students *investigate* the interrelationship among precipitation, runoff and wetlands by *modeling* and *observing* flood buffering and filtering effects of wetlands in class.

Materials

- modeling clay
- aluminum roasting pan
- carpet scraps
- 4 jars of clean water
- 2 jars of soil

For in-class extension:

- small aluminum pans
- modeling clay
- florist foam
- an assortment of paints, papers, toothpicks, twist ties, cotton swabs
- an assortment of natural materials such as twigs, pine needles, soil, pebbles, feathers, etc.

Credits

Adapted with permission from *Ranger Rick's NatureScope*, "Wading into Wetlands," 1986©. Artwork by Tina Isom. National Wildlife Federation, 8925 Leesburg Pike, Vienna, VA 22184-0001. (703) 790-1400.

Where

In the classroom.

When

Any time. Try to tie in with field trip to a wetland area.

Wetland in a Pan

Prepare the Class:

1. Show the class pictures of different types of wetlands, including swamps and fresh and saltwater marshes, and discuss the different types of plants and animals found in these wetlands.
2. Lead a class discussion by asking the students what they consider to be the characteristics of wetlands. List these characteristics on the board.
3. Explain that the wetland model will be used to demonstrate, in a simplified way, two important functions of wetlands.

First Demonstration:

1. Explain that water will be poured slowly on the upland portion of the model twice to represent rain. The first time, the wetland strip will be in place. The second time, the strip will be removed.
2. Ask the students which time they think the water will accumulate fastest in the open side of the pan, or if they think there will be no difference. Take a count of hands for each option.
3. With the marsh in place, pour water slowly on the upland as shown. The students observe and describe what happens. (The water should move across the pan and accumulate slowly.)
4. Remove the carpet strip, pour the water out of the model and repeat the demonstration. Again, the students observe and describe what happens. (The water should reach the other side of the pan and accumulate more quickly without the barrier.)
5. Explain that wetlands function like the carpet or sponge, by slowing and retaining rain water running off the land, and thus help prevent flooding.

6. Discuss:

- *If a wetland is destroyed and houses are built there, what might happen to the houses during a severe rain storm? Why?* (They might be flooded because the wetlands will not be there to absorb and slow the rush of water off of the higher ground.)
- *If many wetlands are destroyed along a river and many houses are built near the river, which houses will probably experience the worst flooding—the ones upstream or downstream? Why?* (The ones downstream because the water will be accumulating in the river from a larger area. The more wetlands that are destroyed in a watershed, the greater the flooding problems.)

Second Demonstration:

1. Explain that the second demonstration will be just like the first, except that soil will cover the clay. The rain should pick up and carry some of the sediment as it travels over the land.
2. Ask the students if they think the water accumulating in the open part of the pan will be cleaner with the marsh in place or with it removed, or if they expect no difference. Take a tally of hands.
3. Pour the water from the previous demonstration out of the pan and replace the carpet or sponge. Spread soil over the clay and slowly pour water on the upland as before. The students observe and describe the water that accumulates in the pan. (The water in the pan should be fairly clear since the carpet or sponge should trap most of the sediment.)
4. Repeat the demonstration with the carpet or sponge removed. Have students describe the results.

Time Required

Allow 1 to 2 hours for demonstration and discussion.

Resources

Buck, L. 1974. *Wetlands: Bogs, Marshes and Swamps.* Parent's Magazine Press.

Educational Images, Inc. *Ecology of a Swamp; Freshwater and Salt Marshes* (slide sets). P.O. Box 3456, West Side, Elmira, NY 14905.

Niering, W.A. 1975. *Audubon Society Nature Guides: Wetlands.* Alfred A. Knopf, NY.

Teal, J. and M. 1969. *Life and Death of the Salt Marsh.* Ballantine Books, NY.

Extensions

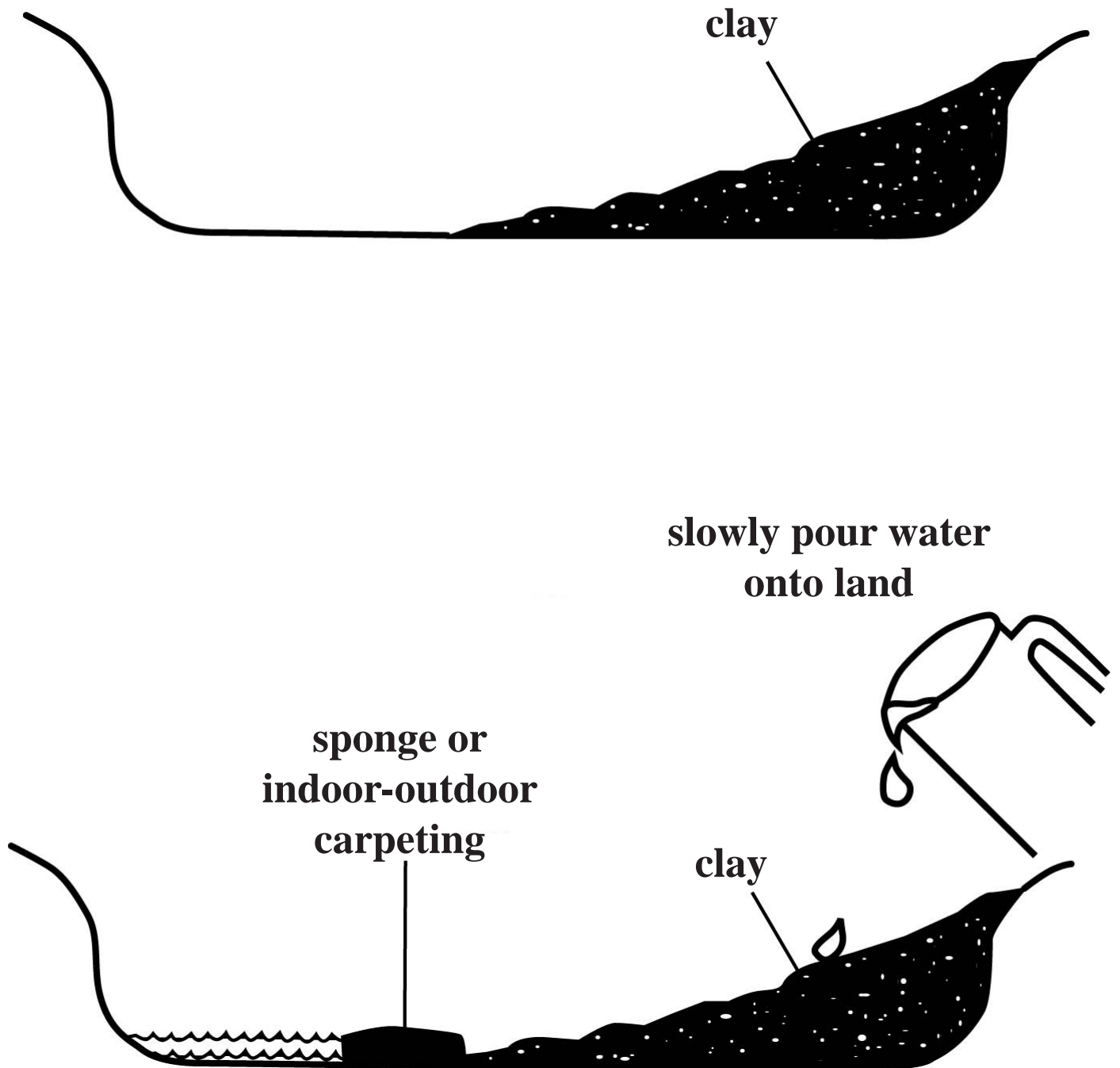
1. Students, individually or as small groups, make their own, more detailed, wetland models, using small aluminum pans and, instead of carpet, use florist foam. Provide reference books with pictures of different types of wetlands. Students can use their imaginations to make plants and animals from an assortment of materials and stick them in the foam and clay. Some ideas:

- for cattails, use cotton swabs painted brown or toothpicks painted green with bits of brown clay stuck to the tops;
- use pine needles for reeds;
- shape wetland creatures from clay or cut them from paper and glue them onto toothpicks;
- make trees by gluing pieces of green sponge onto twigs.

2. Follow-up by doing "Wetland Walk," (page 98) a wetlands field observation activity in this guide.

Wetland in a Pan

5. Explain that the thick mat of roots and plant stems in a real wetland helps trap sediments that wash off of the land, much as the carpet or sponge did, and thus helps keep waterways free of silt and some other pollutants.
6. Conclude with a discussion:
- *What might a river look like after a heavy rain if much of its wetlands have been destroyed? (Muddy)*
 - *How might muddy water affect fish in a river? (It makes it hard for them to see and clogs their gills.)*
 - *How might muddy water affect oysters in an estuary? (The mud settles out and smothers the oysters.)*
 - *How might muddy water affect boats and ships? (The mud settles out and fills channels important for navigation.)*



Hide and Seek

In this activity, an age-old game takes on an educational twist, helping students recognize the importance of a few adaptations that help keep animals from being seen. This is a brief activity that can be used together with another activity to fill an entire day when visiting a state park with younger students.

Background

Many animals, whether living in a stream or pond, in the woods or a thicket, or in a garden or lawn, have evolved behaviors, shapes and colorings to avoid being seen by other species of animals. For **prey** species, avoiding detection means a better chance of not being eaten. For **predators**, it means a better chance of catching a meal. For many animals, it means both.

One common strategy is **camouflage**. Often, a few stripes or spots are all an animal needs to break up its outline and blend with its surroundings. Most species of fish have some form of camouflage—the most basic being a dark-colored back, to blend in with the bottom and avoid being seen from above, and a light-colored belly, to blend in with the sky and avoid being seen from below. Some, like many species of darters, have blotchy color patterns that help them blend in with their stream-bottom habitat. The white-tailed deer fawn is camouflaged with light spots, resembling the dappled light that reaches the forest floor. Another form of camouflage is to be shaped like some part of the surrounding habitat. Insects called walking sticks are shaped and colored like small twigs and are

difficult to detect in the shrubs and trees where they live.

Perhaps the most common strategy to avoid detection is to remain motionless. A fawn will instinctively lay curled on the ground when danger is near, even when its mother bounds away to safety. Many birds will freeze when they detect a predator, only to scoot into the safety of vegetation or other shelter when the predator comes within the critical distance of a few feet. Many snakes typically wait motionless to ambush any prey that wanders into striking distance. Usually animals with **cryptic coloration** will also remain still, allowing their coloration to hide them rather than risking the motion that would give them away.

Procedure

Before the Trip:

1. Contact park personnel to discuss plans and to confirm the best location for this activity, preferably one free of poison ivy, thorny plants, ticks and chiggers.
2. Brainstorm with the class, and list on the board, examples of animals that can avoid being seen without completely hiding. For each example, list the strategy or strategies the animal uses and whether the strategy protects the animal from being eaten, helps it catch food, or both. For younger students, list strategies on the board and use pictures to illustrate them.
3. Explain the field trip plans and the activity described below.

Grade Levels: K-7

Objectives

Students will *investigate* variations in color patterns, body form and movement which allow for camouflage by:

- *observing* organisms in relation to environmental settings;
- *simulating* predator-prey dynamics; and,
- *inferring* explanations for camouflage success.

Materials

- blindfolds (one per student)

To wear:

- take or ask one student to wear a camouflage outfit

Credits

Adapted from "The Thicket Game," *Project WILD*, Elementary Edition. 1983© Permission to adapt should not be interpreted in any way as an endorsement of this adaptation by Project WILD®. For more information, please contact Project WILD Coordinator Suzie Gilley at Suzie.Gilley@dgif.virginia.gov. For more information about Project WILD®, please visit the organization's national web site at www.projectwild.org.

Where

All parks.

When

When leaves are on the trees is best, but can be done in the winter; daylight hours.

Hide and Seek

At the Site:

1. Lead the class to the previously chosen location, and set perimeters for the game.
2. Blindfold one student who will be the predator.
3. The predator counts to 15 slowly while the others hide. The students hiding must be able to see the predator at all times.
4. After counting, the predator removes the blindfold and looks for prey. The predator can turn around, squat and stand on tiptoes, but cannot walk or change location.
5. The predator spots as many classmates as possible within 30 seconds to one minute, identifying them out loud and describing where they are found. When identified, the prey come to the predator because they have been eaten.
6. After the time is up, all the eaten prey become predators and put on blindfolds.
7. The original predator counts aloud to 10 while all the remaining prey come closer but still try to stay undetected.
8. All the predators remove their blindfolds and take turns naming

- the prey they can see (30 seconds to one minute time limit.)
9. Repeat the process if several prey are still hidden.
 10. When only one or two are left hidden, have them stand up and identify themselves. It may be surprising how close the prey get to the predators.
 11. Conduct the activity again.
 12. Afterward, discuss why some prey were able to get close to the predators without being caught. Some answers might include: some had clothes colored more like the surroundings or had patterns such as stripes or checks; some were able to be more still than others; some were smaller in size.

Follow-up:

Each student invents an animal that lives and hides in a particular habitat, real or imaginary, and draws a picture of it in its environment, showing how it hides. Examples might be “wallagators” with brick patterned backs for life on a brick wall, or “sneaker snakes,” that disguise themselves as shoelaces.



Time Required

At the site: 45–60 minutes for activity and discussion.

Resources

Wood, J.N. 1985. *Nature Hide and Seek: Oceans*. Knopf, NY.

Extensions

1. Take along some camouflage material, jackets, pants or shirts. Play a round of the activity with a few students wearing these and see if they can get closer than anyone without camouflage. Play another round but this time the camouflaged prey must keep moving slowly, even after the predator stops counting. How do the results change?
2. Students suggest ways other than the use of camouflage materials that they might disguise themselves to avoid detection in various surroundings. Allow them to alter their appearance in some way, then play another round of the activity to see if the results change.

Variations

Younger students: Practice the activity at school before the trip. To foster a better understanding of the objectives, observe colors and patterns against different backgrounds and pictures of animals camouflaged in their surroundings.

Small Fry Spies

Natural environments display endless combinations of shapes, colors, textures, and sounds to be explored by the curious young learner. In this activity, small groups visit different locations for a structured version of “I Spy,” and organize their observations into an exhibit after the field trip. The activity is intended for very young students.

Procedure

Before the Trip:

1. Visit the site, decide which trails to use, and identify good places for observation stops.
2. Arrange for one adult or youth leader to work with every group of five on the activity. Meet with the leaders (ideally at the site). Provide each leader with a complete copy of the activity directions, and review the activity procedure. Discuss equipment. A camera and a small portable tape recorder are needed. Only the adult leaders will be using the cameras and tape recorders. Perhaps the leaders will be willing to use their personal equipment.
3. Explain to the class where they will be going for the field trip and that they will play a game while walking along trails in the park or natural area preserve. When they find special things that their group leaders see, smell, hear, or touch, they will get “medals” to wear.
4. As a several-session class project, work from the directions and patterns on the accompanying “I Spy” sheet to prepare the medals. Prepare one of each kind for

each student. Divide each kind into batches of five, placing them in separate bags or clipping them together with a label.

5. Students will be wearing lots of these medals during the activity at the site. One way to attach the medals is to clip a big metal shower curtain clip or a large paper clip into a belt loop or buttonhole. The medals can be hung on this clip.
6. Put each leader’s set of medals into a basket or bucket along with five clips. (There will be 16 different medals, so each leader should have 16 batches of five medals.)
7. Divide the class into groups of five students.
8. Prepare the class for the trip by telling them such things as what to wear, and details about the bus ride, lunch, and bathrooms.

At the Site:

1. Assemble the students into their groups and introduce each to its leader. Give the baskets of medals to the leaders and help students attach the hooks to their clothing.
2. Review the activity plan and schedule.
3. Before leaving the assembly area, each group leader should try one of the “I Spy” items. For example: “I spy something round under the school bus.” As students locate the item (a tire obviously qualifies, but if somebody happens to see something else that is round and under the bus, like a bottle cap, that would be acceptable, too), the leaders get the round medals out of their baskets and put them on the students.

Grade Levels: K–2

Objectives

Students will *investigate* variations in colors, shapes, smells and textures of specimens in the park or natural area preserve by:

- *making* directed observations; and,
- *classifying* items encountered on the field trip based on one variable.

Materials

For every 5 students:

- camera and film or digital
- small portable tape recorder (optional)
- 16 small plastic bags and marker
- basket or bucket

Per student:

- copies of the five medal patterns cut from heavy paper

For class:

- about 10 yards of string (metallic elastic preferred)
- glue, tape, scissors
- items for decorating medals (glitter pens, crayons, markers, bits of cotton, fabric, tissue, cellophane, feathers, bits of yarn, and so on)

Where

All parks. Ask park staff for the appropriate location.

When

Any time.

Time Required

At the Site:

Lesson takes about 1 hour.

Small Fry Spies

The leaders then take photographs of the round items observed. After everyone is clear on the general procedure, the groups set out on the trails.

4. Allow about 40 minutes for the trail walks and observations. Leaders should try to have the group see, smell, touch, or hear all of the items, and if possible, get photographs of all items observed and a tape recording of all sounds heard for the game.
5. Reassemble the group and admire all the medals. Discuss some of the observations made during the game. Supplement, if you like, by sharing some specimens that you have collected.
6. Observe and describe the weather at the site. Decide which senses are necessary to tell if it is hot, cold, rainy, foggy, and so on.

Follow-up:

1. Get the photographs developed as quickly as possible.
2. Divide the class into work groups. Give each work group a poster labeled prominently with one of the “observable characteristics” from

the field trip (e.g., shiny things, rough things)

3. Working with one group at a time, help them select the photographs of their observations. Then have them glue the appropriate photographs to the poster. After they write their names on their medals, the medals can be attached to the poster as well. Time permitting, each group could do several posters so that all of the photographs and medals get classified and displayed. For the sounds that were observed, assemble any tapes made and display photos of the sound sources.
4. Discuss the items pictured and speculate about the possibilities of change. Will all of the spotted items be spotted forever? Are the sounds always there?
5. Plan an open house session. Invite the principal, other office or building staff, the group leaders from the field trip, and parents. The groups who made the posters can explain their research to the guests.

Variations

Enrichment:

Use the same general format, but incorporate measuring and comparing sizes and weights of observed items or two or three criteria. For example: “I spy with my eye a round long thing that is bigger than a pencil but smaller than a trash can” (log); and “I spy with my eye something that is green, smooth, and triangular” (leaf or blade of grass). Posters created for follow-up should arrange photographs in some order, i.e. smallest to largest.

Second grade:

Conduct game more like a scavenger hunt where students do all the “spying” and get medals after pointing things out to the leader.

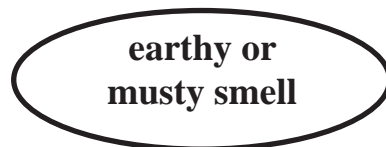
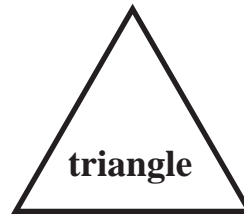
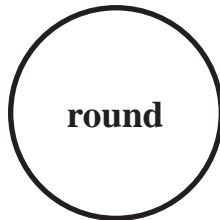


Small Fry Spies

I Spy Medals:

For each student, redraw these patterns onto heavy paper, making each twice the size shown. Write the key word on the back of each shape. Punch a hole on the top of each and tie on a 6" to 8" loop of string or yarn. If desired, replace some of the selections with others more appropriate for the class,

making sure to note any changes on the Group Leader Instructions. Students decorate the front of each medal with magazine pictures or other materials to represent the selections. Work on two or three medal types at a time. As they are completed, place five of each type in a small-labeled bag.



Small Fry Spies

Group Leader Instructions

With this lesson, students find and identify shapes, patterns, smells, textures and sounds in nature with a game of “I Spy.”

Your role is to find along the trail the characteristics listed below and get students to find them. When you see one of the visual characteristics, say:

I spy something _____” (name of one of the characteristics) “_____” (give a hint about where it is with words like under, over, on top of, behind, etc.). For example, if you see a mushroom, say, “I spy something round beside the big tree.”

If it is a sound, say, “I hear something that sounds _____” (e.g. soft, high pitched, low pitched).

If it is a smell, say, “I smell something that smells _____” (e.g. musty, pleasant). If it is something to be touched, say, “I feel something _____” (e.g. rough, smooth, fuzzy).

You and your group will be “spying” only the 16 things listed. If the students have trouble finding the things you have spied, give more hints, especially those that describe where to look. If they are finding things too quickly, give harder hints.

You will be given a basket with “medals” that the students made in school. The medals are in bags that are labeled for each of the characteristics. Be sure to put a medal on each student for each successful observation. Try to make sure everybody observes all 16 things and gets a medal for each. Check the characteristics off as they are found.

rectangle

triangle

round

square

striped

spotted

shiny

pleasant smell

earthy or musty smell

fuzzy

rough

smooth

soft sound

high pitch

low pitch

crackling sound

Feathered Feeders

A truly “birdbrained” lesson, this activity requires students to think like hungry birds, who must find food at the park.

Background

Different habitats provide an abundance and variety of food for many species of birds. The shape and size of a bird’s beak gives clues to what kind of food it eats, how it catches its food, and what sort of habitat it might prefer.

Herons use long, pointed, spear-like beaks to catch fish, frogs, and snakes. Many songbirds have pincer-like bills for grasping insect prey. Other songbirds (finches for example) have short, sturdy beaks for cracking seeds. Woodpeckers have sharp, chisel-like bills for drilling into wood to reach the insect larvae deep within. Hawks and other raptors have sharp, curved beaks for tearing apart the meat that they eat. The long, probing bill of the woodcock is used for extracting earthworms out

of moist soil. The thin pointed bill of the hummingbird is perfectly adapted for getting nectar out of flowers. The whippoorwill has a short, broad beak surrounded by bristles that help it scoop insects out of the air. Kingfishers dive into the water, catching food with their spear-like beak. Many ducks have wide bills for eating aquatic plants and straining food out of water or mud.

Procedure

Before the Trip:

1. Identify the types of birds common to a variety of habitats such as marshes, fields, woodlands, and lakes.
2. Describe bird adaptations and their advantages (e.g., feathers, hollow bones, eyes, talons, webbing, etc.).
3. Make enough copies of the accompanying bird head illustrations to allow one bird drawing per student. Cut out the bird heads and their names from the copies. Do



Grade Levels: K–9

Objectives

Students will *investigate* variation in bird beaks and the interrelationships of form and function by:

- *classifying* birds with similar beak shapes;
- *inferring* about possible bird foods based on beak shapes; and,
- *locating* and *identifying* possible bird foods in the field.

Materials

- colored construction paper
- string or yarn
- glue
- stapler
- clear plastic bags
- index cards, 5 per student
- pencils

Where

All parks.

When

All seasons. Daylight hours.

Resources

- Niering, W.A. 1966. *The Life of the Marsh*. McGraw-Hill Book Co., NY.
- Pasquier, R.F. 1977. *Watching Birds*. Houghton Mifflin Co., Boston.
- Perry, B. 1985. *A Sierra Club Naturalist's Guide to the Middle Atlantic Coast*. Sierra Club Books, San Francisco.
- Ranger Rick's NatureScope*. 1985. “Birds, Birds, Birds!” McGraw-Hill Book Co., (800)262-4729.
- Sisson, Edith A. 1982. *Nature With Children of All Ages*. Prentice-Hall, Inc., Englewood Cliffs, NJ.

Feathered Feeders

not permit the students to see how the illustrations are grouped or the group labels.

4. Distribute the illustrations. Ask the students to:
 - cut out the drawings and mount them on colored construction paper;
 - measure and cut a piece of yarn long enough to go over their own heads comfortably;
 - attach the yarn to the top corners of the construction paper.
5. Talk about adaptation, focusing on bird beak shapes. Encourage the class to make some inferences about what a beak shape can tell about a bird (i.e. type of food it feeds on), and what ways birds can be classified into groups (i.e. beak shapes).
6. After each student studies the shape of the beak on his or her bird picture, direct the students to form groups of similar beaks. Discuss with each group their logic in forming the group.
7. Have each group make inferences as to which food items their beaks might be adapted to eat. Pictures of habitats, reference materials, or samples of possible food types would be helpful to assist students in determining the range of food sources available to birds.
8. Lead a class discussion with each group sharing their beak adaptation speculations. Conclude by explaining how the bird beaks are grouped and labeled on the original illustrations.

At the Site:

1. The students put on their bird heads and re-form into the groups established in class.
2. Provide each group with a strong, clear plastic bag, five index cards and a pencil per person.
3. Explain that they will have 15 minutes to look for food items,

food item remains or signs of feeding which match the feeding habits of the birds in their group. Food items or remains that can be collected such as seeds, are to be placed in the bag. Students should briefly note on one index card each item put in the bag and where it was found. Items that cannot be collected, such as feeding signs (e.g. woodpecker holes), or living organisms (e.g. swimming fish or insects) should be described on an index card, with locations indicated, and the numbers of each noted.

4. Lead the students to a wooded area, marsh or other area suitable for the students to conduct their hunt. Survey the area with the class, set the boundaries for the activity, and point out any hazards.
5. Have students patrol the areas they predict will have the food for which their beak types are specialized.
6. After 15 minutes, call the groups back together to share their discoveries in a “show and tell” style discussion.
 - *Which group found the most food? Which group found the least?*
 - *Based on the food types found, predict which types of birds might be the most common in this habitat? Which might be the least common and why?*
 - *Were any real birds observed that had beak types like theirs? If so, where were they seen and what were they doing?*
7. After discussion, the food items should be returned close to where they were found.
8. If a bird skull collection or taxidermy specimen is available at the site, study the skulls. Students can guess what species the skulls are and what they might eat, or match the skulls to pictures. Students could also group the skulls according to their own classification system.

Credits

Illustrations used with permission of the artists, Enid Kotschnig[©] and John Hamberger[©]. From: Terres, J.K. 1980. *The Audubon Society Encyclopedia of North American Birds*. Chanticleer Press, N.Y.

Extensions

Assemble materials with which the class can make beaks. Determine the types of food they could possibly eat using that type of beak. Examples of materials: chopsticks, popsicle sticks, strainer, tongs, pliers, spoons, sponges, nutcrackers, etc.

Variations

Younger students:

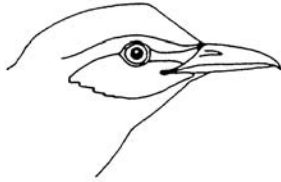
1. Use cutouts from colored construction paper to represent foods found in each habitat. Scatter the “foods” in an area of the site and let the children go on a food hunt.
2. Assign a chaperone to each group to assist the students in developing their observation skills.

Follow -up:

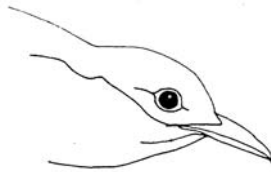
1. As a class, construct a large chart listing the birds for each group, the beak shape, the types of food found, and the locations where the food was found. Additional cutout illustrations can be added.
2. Discuss and analyze the importance of bird beak adaptations. Encourage the students to make inferences about habitat selection based on the groups of birds found there.
3. Encourage students to research bird feet adaptations.
 - *In what ways are some feet used by birds in feeding?*
 - *In what ways are bird feet adapted for the bird's habitat?*

Feathered Feeders

Pincer-like bill for grasping caterpillars, beetles, bugs, and other insects found among the foliage of trees and thickets



Mockingbird



Cuckoo



Vireo

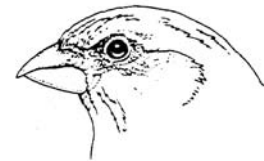
Crushing bill for cracking seeds of many different types of land plants



Cardinal

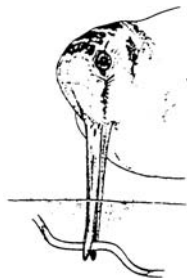


Evening Grosbeak



Purple Finch

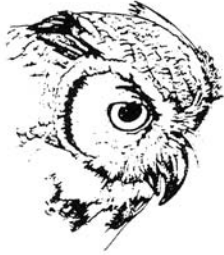
Probing bill for poking into mud and soil for worms



Woodcock

Feathered Feeders

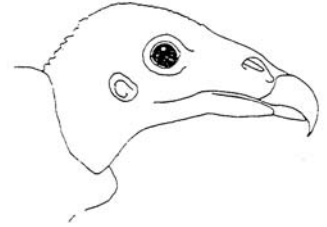
Ripping bill for eating meat of birds, mammals, reptiles and fish



Great Horned Owl



Hawk



Vulture

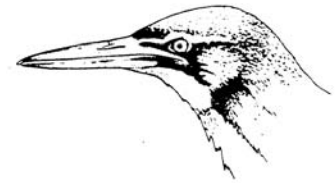
Long grasping bill for catching fish, crustaceans and other aquatic prey



Heron

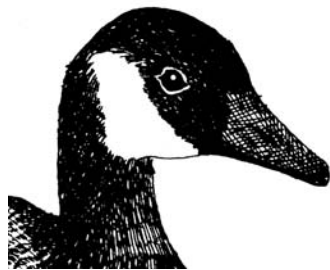


Belted Kingfisher

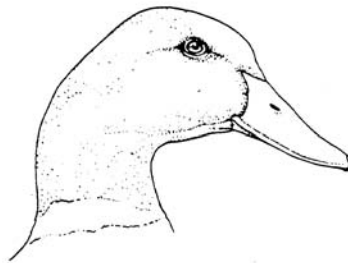


American Bittern

Wide bill for straining seeds and aquatic plants from water and muddy bottoms of waterways



Canadian Goose



Mallard

Beaver Tales

There is something intriguing about beavers. It is easy for us to see them in terms of human roles: engineers, architects, and home-makers. Beavers, like humans, don't just live in their environment, they change it in ways that are obvious to us, and their changes affect their neighbors. Beaver activity has shaped some of our state park environments, and this activity explores their effects.

Background

The beaver is an ideal species for environmental education studies. Its many physical and behavioral **adaptations** for its lifestyle; its abilities as an engineer; its habits of altering the environment to meet its own needs; the dependence of other species on the beaver; the unmistakable signs it leaves in an area; the prominent role it holds in the settlement of this nation; and the story of its eradication and reintroduction in many parts of this country could all combine to give the beaver the status of "most favored study animal."

The beaver might easily have been the product of a "create-a-wetlands-animal" activity in which students build an imaginary animal with every part being adapted for some aspect of its environment. For protection against the chilling effect of life in water, the beaver has a dense pelt, a layer of **subcutaneous** (under the skin) fat, and specialized circulation for heat exchange in its extremities. Organs in its groin, called **castor glands**, secrete an oil that the beaver uses to mark its territory. **Sebaceous glands** produce oil that waterproofs the beaver's fur.

On each hind foot, the second claw is split and used like a comb to keep the fur groomed for maximum water repellency. The hind feet are webbed to provide propulsion through the water. The outermost digits on the forepaws are modified for grasping, much like human thumbs, and the front claws are long and adapted for digging.

This animal's characteristically large front teeth grow continuously, keeping pace with the constant wear from gnawing on wood. To seal out water during dives, the beaver's ears and nose have special flaps. Its front teeth project through the lips to permit gnawing, chewing and swallowing underwater without forcing excessive amounts of water into the digestive tract and lungs. A beaver's eyes have **nictitating membranes** that serve as underwater goggles.

The beaver's astounding array of specialized behaviors has led many to credit the animal with high intelligence, but most of its behaviors are probably instinctive. Perhaps best known is its compulsion to build dams. On the bottom of the ponds they create, beavers store small trees, branches, and twigs to consume when the water freezes. Beavers build elaborate lodges complete with underwater entrances and emergency exits, overhead ventilation, and separate grooming and sleeping areas. Their tendency to **girdle** trees (gnaw the bark off completely around the trunk) too large to actually cut down, kills the trees and opens the forest **canopy**, permitting new sapling growth and thus ensuring a food source for future generations. Tail-slapping may be a warning signal of danger.

Grade Levels: K–10

Objectives

Students will *investigate* changes in beaver habitat areas caused by beavers and interrelationships between beavers and their environment by:

- *suggesting* adaptive functions;
- *observing* clues to beavers' life history;
- *modeling* beaver-predator behavior; and,
- *inferring* protective importance of hearing and smelling.

Materials

- dark bandanna or similar material for a good blindfold
- odor source such as bottle of cologne
- guided imagery reading selection (optional)
- paper, pencil and clipboards for poems or drawings (optional, one set per student)
- "wetable" footwear

Where

Many Piedmont parks have active beaver populations. Contact the park staff prior to your trip for exact locations.

When

Any time is suitable, but in fall there will be more fresh signs, since beavers are most active then.

Time Required

At the Site:

1 to 2 daylight hours. Small quiet groups may glimpse a beaver in evening or early morning; special arrangements may be necessary.

Beaver Tales

Since beavers significantly alter their surroundings, a wide variety of plant and animal species rely on beavers for their own **habitat** requirements. Beaver ponds become home for amphibians, turtles and many slow-water fish such as bluegill. Aquatic and wetland plants take root in and around beaver ponds, benefitting from the continuous water supply and open canopy. Wading birds and waterfowl are attracted by the fishes and plants. Other parts of the **ecosystem** also benefit from beavers. Their ponds serve as firebreaks and sediment traps, thus protecting nearby forests and keeping waterways cleaner downstream.

Throughout North America's past, beavers have been cherished and pursued by humans. Their meat has been eaten by many, and the tail is considered a delicacy. Beavers' castor glands have been used to manufacture perfumes and medicines (but not castor oil, which comes from plants). The beaver has been most sought for its fine fur. Beaver pelts were among the earliest items of trade between the first settlers and Native Americans, and, for a time, were very fashionable for use in coats and top hats.

Trappers, in pursuit of the beaver, led the way for the settler's westward advance. As a result of relentless trapping pressure, beavers were virtually eliminated from Virginia. However, today beavers represent a great success story in wildlife management.

In the 1930s, about 12 pairs of beavers from other states were released in a few Virginia Piedmont and mountain counties. For many years thereafter, beavers enjoyed unofficial endangered species status protection (federal endangered species laws were first passed in the 1960s). Today, numerous headwaters across Virginia hold beaver populations, and they once again contribute to the fur trade through a carefully managed trapping program.

Unfortunately for would-be observers, beavers tend to be most active at twilight and night, thus they cannot predictably be seen by groups visiting state parks. However, beavers leave many signs which can be examined, including gnaw marks on trees and stumps; dams; lodges; canals radiating from pond edges; foot prints and tail drag marks in the mud; and small piles of slightly **odiferous mud** and leaves that mark the beaver's territory. These signs, plus an abundance of beaver literature ranging from fables to scientific papers, make the beaver an ideal subject for interdisciplinary studies.

Procedure

Before the Trip:

1. Visit the site to locate areas with the most beaver activity. Consult with the park staff.
2. Review the activity procedure with the class, but do not provide information about beavers yet. Assign several students to find pictures or drawings of beavers to bring to class, and find some yourself.
3. Divide the class into teams of three or four students.
4. Assign each team one or more of the following questions. Brainstorm at least three plausible answers to each:
 - *Since the beaver spends much of its life in the water, even in winter, how might the beaver be adapted to stay warm?*
 - *Beavers have special organs, called castor glands, which secrete an odorous oil. How might the beaver use this oil?*
 - *Some of the claws on a beaver's hind paws are split. What could be the function of these split claws? (Hint: It has to do with staying dry.)*
 - *The beaver's "little fingers" are offset slightly to oppose the other digits for grasping, somewhat*

Resources

- Beavers: Wetlands and Wildlife.** www.beaversww.org
- George, W.T. and L.B. 1988. *Beaver at Long Pond*. Greenwillow Books, NY.
- Johnson, P. 1984. "The Dam Builder is At It Again!" *National Wildlife Magazine*, June-July.
- Kalas, S. and K. 1987. *The Beaver Family Book*. Picture Book Studio.
- Kipling, R. 1987. *Just So Stories*, reprint edition. Grossman.
- Mills, Enos. 1990. *In Beaver World*. Reprint ed. University of Nebraska Press.
- Sattler, H.R. 1982. *Noses Are Special*. Abingdon Books, Nashville.
- Schroeder, H. 1983. *The Beaver-Wildlife Habits and Habitat Series*. Crestwood House, MN.
- Von Frisch, K. 1974. *Animal Architecture*. Van Nostrand Reinhold Co., NY.
- Wood, M. 1981. *Spirits, Heroes, & Hunters From North American Indian Mythology*. Schocken Books, NY.

Extensions

1. Assign some additional beaver-related research topics, if appropriate references are available. Some might include:
 - Investigate the influence of wildlife, such as the beaver, on human history as reflected in the names of places.
 - Read some Native American and folk tales in which the beaver has a role. Compare the characteristics given to the beaver in these stories with what is known about beavers today.
 - Investigate the history of beaver trapping and beaver reintroduction and management. Find some numbers (e.g. of trapped animals, lowest and current population estimates) and use them to graph and explain changes in beaver populations over the last 200 years.
2. Take a field trip to or encourage students to visit a zoo which has live beavers on display.

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like the human thumb. How can this be important for the beaver's lifestyle?

- *Why are a beaver's hind feet webbed?*
- *How might the beaver use its flat tail?*
- *Beavers have clear, eyelid-like structures (called nictitating membranes) over their eyes. What function(s) might these serve?*
- *The beaver's front claws are long and strong. What might they be used for?*
- *Why do a beaver's front teeth grow continuously?*
- *What could be the purpose of special flaps inside the beaver's ears, nose and mouth?*
- *Why might beavers store small trees, branches, and twigs on the bottom of their pond?*
- *How can it be to the beaver's advantage to girdle trees which are too large for the beaver to completely cut down? (Hint: Think about how the forest might change.)*
- *What are some plants and animals that might be attracted to an area after beavers have moved in?*
- *How might a forest benefit from having beaver ponds in its watersheds?*
- *How might the aquatic animals and plants living downstream benefit from beaver ponds upstream?*

5. At the end of the brainstorming session, a representative from each team can present their answers to the rest of the class. If available resources permit, the teams could also research their questions in the library and make quick follow-up presentations. In either case, provide students with the accompanying background information.

6. Show the accompanying pictures of beaver signs so students will recognize these in the field.

At the Site:

1. Lead the students into an active beaver area.
2. Give each team a different kind of beaver sign to look for. After a few minutes, re-assemble the groups and ask each team to point out their sign if they found it. Discuss any other signs that were found as well as the effects of the beavers on the environment.
3. Find a comfortable spot within the beaver area for the class to sit quietly. Explain that the beaver has relatively poor vision but has good senses of smell and hearing. Ask students to close their eyes and to sense the beavers' world for two to five minutes using only their senses of smell and hearing. *What do they smell and hear?*
4. When time is up, ask students to share things they sensed by using a "memory circle." The first student begins by saying, "In the beaver habitat, I heard . . ." or "I smelled . . ." and adds an observation. The next student repeats the first student's observation and adds a new one. To avoid reciting a chain of 25 observations, the fourth student can start repeating only the three most recent observations (i.e. that student adds one to the end of the list and drops one from the front). Next, if time allows and it is appropriate for your group, you can play a beaver simulation game. This can be played in the beaver area or another part of the park, preferably covered with leaf litter to make the hearing part of the game easier. Try a sample run with the "beaver" not blindfolded.

Variations

While at the site and still seated in the beaver habitat, read a selection describing the activities of a beaver from one of the resources listed. Back in the classroom, ask students to express their feelings about the reading and the beaver's habitat by writing poetry or drawing pictures.

Younger Students:

Omit the library research, but present some background information in class. Play memory (using only 2 memories) and tag games, or have the children can take turns acting out different beaver behaviors while the rest of the class guesses.

Enrichment:

1. Design a field study to answer a question about beaver behavior and describe the method of implementation. Sample questions:

- When are beavers most active?
- Is lodge or dam building behavior learned or innate?
- What are their food preferences?
- Are they evenly distributed throughout Virginia?

2. Students research the following: Tens of thousands of years ago some beavers in North America were 7.5 feet long. Why and when did they die out?

3. Several research projects focused on the social significance of beavers are possible. Students could summarize the current economic significance of trade in beaver pelts, some aspect of the historic trade in pelts (e.g. their role in early settler-Native American interactions), or the process of converting raw beaver skins to tanned skins to items of clothing.

Credits

Beaver signs from *A Field Guide to Animal Tracks*. Copyright 1950 by Olaus J. Murie. Copyright 1974 by Margaret E. Murie. Reprinted by permission of Houghton Mifflin Co. All rights reserved.

Hind foot and split nail redrawn with permission from *Mammals of Pennsylvania* ©. Douth, K., et. al. 1977. Pennsylvania Game Commission, Harrisburg.

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5. The procedure is as follows:

- Students form a large circle.
- One student, designated “the beaver,” stands in the middle of the circle.
- Another student, designated “the predator,” is given an odor source such as a bottle of cologne. In places where they coexist, beaver predators include bobcats, bears and coyotes. In most of Virginia, the main predators are humans and stray dogs.
- All the other students are non-predators.
- The leader points to one of the students, either the predator or a non-predator.
- The selected student walks slowly toward the beaver, pausing between steps. If the selected student is the predator, he or she must wave the odor source in front of him or her with each step.

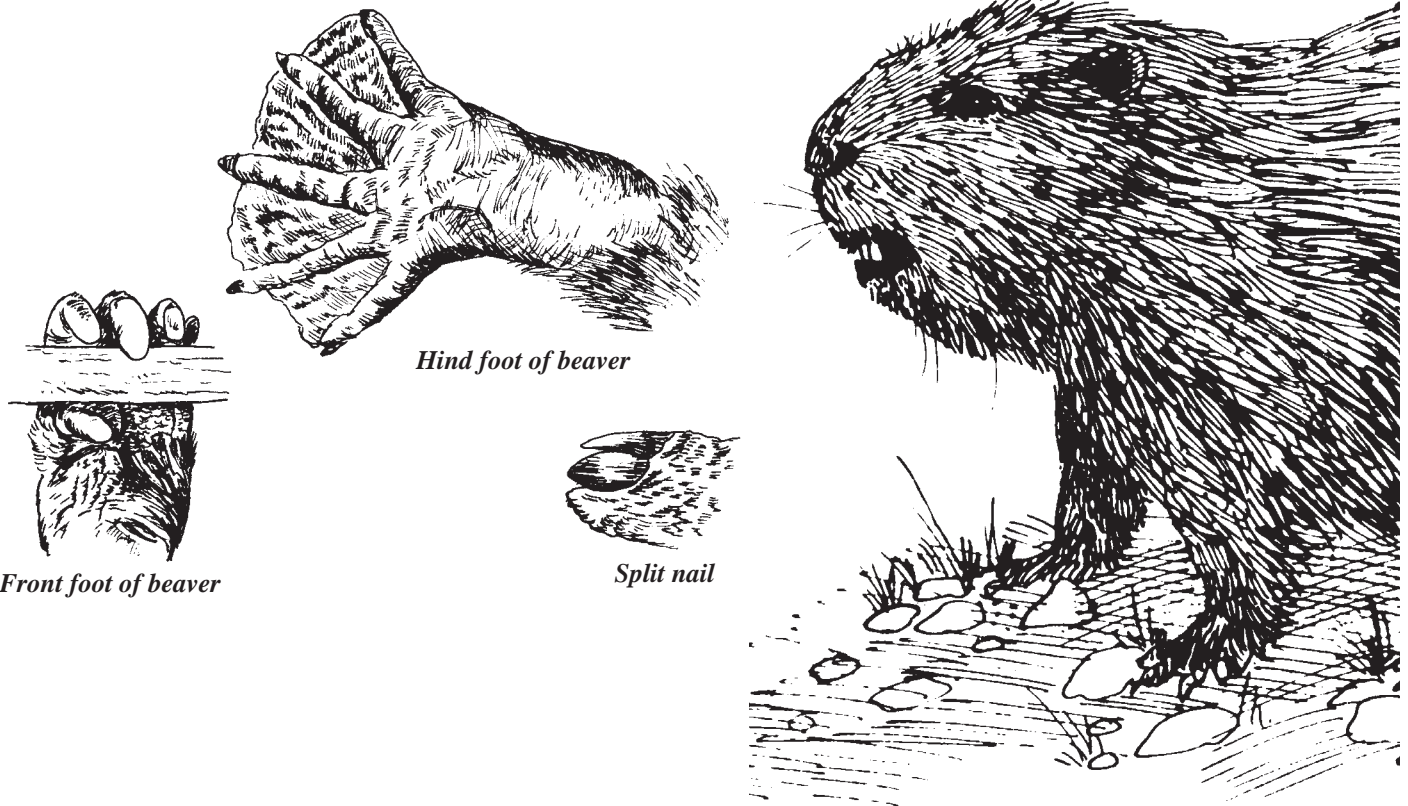
- If the “beaver” detects an approaching predator, it claps its hands (simulating the tail slap), and points to the predator. If the beaver has correctly located the predator, the predator must return to the circle edge.
 - If the predator gets close enough to tag the beaver before it claps, it becomes the next beaver.
 - If a non-predator is selected, it also slowly walks toward the beaver, but passes by without tagging it. If the beaver claps its hands as a false alarm, the non-predator becomes the next beaver. (In nature, it would be to the beaver’s disadvantage to frequently signal danger and flee if there is no danger, since it might not get enough to eat or be able to perform other important tasks on land.)
6. After playing the game for several rounds (teacher’s discretion), ask

the students to discuss the game. Some questions to ask include:

- *What were the best strategies for the beavers and the predators?*
- *In nature, why would the beaver lose if it frequently made the danger noise and fled from non-predators?*
- *Why would it be important for a beaver to use its senses of smell and hearing rather than just sight?*
- *Would a beaver be more cautious to sounds and smells on land or in the water and why?*

Follow-up:

As a class, read some of Rudyard Kipling’s *Just So Stories*. Ask students to write and illustrate their own “How the Beaver got its . . .” stories about different beaver adaptations, individually or as a team effort.



Beaver Tales

Beaver Signs

