Hawk Mountain Sanctuary

Acorn Project

Acorn Project

The Acorn Project

Hawk Mountain Sanctuary's Acorn Project, including this activity guide and coloring book, uses acorns and oak trees to introduce students to natural Appalachian Mountain habitats and to teach principles in biology and ecology.

About Hawk Mountain Sanctuary

Hawk Mountain Sanctuary, the world's first refuge for birds of prey, is a 2,400-acre nature reserve in the central Appalachian Mountains of Eastern Pennsylvania, 85 miles northwest of Philadelphia. The Mountain is part of the Kittatinny Ridge, an internationally significant migration corridor for hawks, eagles, and falcons. Each autumn, tens of thosands or raptors, including Ospreys, Bald Eagles, Golden Eagles, and Peregrine Falcons, migrate past the Sanctuary.

The Sanctuary was founded in 1934 by Rosalie Edge, who created the refuge to stop the slaughter of migrating raptors at the site, Since then, the Sanctuary's science-based conservation efforts have focused on raptor protection, local land protection, and public education.

Sanctuary Trails and Lookouts

Summit trails offer spectacular vistas of the Appalachian Mountains. A 200-degree panorama of the Appalachian Ridge and Valley Province awaits visitors at the North Lookout. The one-mile trail to this overlook connects with the Appalachian Trail via a two-mile spur. South Lookout is 300 yards from the visitor center parking area. A challenging four-mile-loop trail leads to the River of Rocks, a periglacial boulder field on the valley floor.

Nature provides a changing array of scenery and watchable wildlife throughout the seasons. The last half of April is the best time to see raptors migrating north. The first two weeks of May bring migrating warblers and the unfolding of Appalachian Spring.

Mountain Laurel blooms in mid-June, and in July and August, the Sanctuary's native plant garden features colorful butterflies and wildflowers. Sixty percent of Sanctuary lands are set aside as a study area and undisturbed wildlife refuge.

The visitor center, open year-round, houses a museum on birds of prey, an art gallery, and bookstore. An adjacent garden features over 250 species of plants, shrubs, and trees native to the Appalachian region. Facilities also include an outdoor amphiteater, classroom, intern, and staff residences.

Migrating Birds of Prey

An average 17,000 raptors, representing 16 species, are sighted on migration at Hawk Mountain because it is the easternmost ridge in the region and the raptors last chance to use slope soaring during this part of their journey. Prevailing northwesterly winds strike the southwest-to-northeast ridges of the central Appalachians at right angles. Deflected up and over the ridges, winds provide lift, creating an aerial highway for the migrating birds.

Daily hawk counts are conducted between August 15 and December 15. Monarch butterflies and birds such as Chimney Swifts, Warblers, and Hummingbirds, are also observed on their southern migration.

Sanctuary Education

Because of their size, beauty, and role as predators, raptors provide a compelling focus for teaching a range of conservation issues. Environmental education programs form pre-school to college draw on the special expertise of staff, outside naturalists and scientists. Thousands of students visit annually, many of whom enjoy guided hikes and instruction on birds of prey and Appalachain ecology.

Weekend public programs from spring through autumn feature live birds of prey and guided walks. Special classes and lectures spotlight the flora and fauna native to the central Appalachains.

An innovative international internship program trains aspiring young educators, reseachers and refuge managers from all over the world.

Visiting Hawk Mountain
Trail Fees: $5 Adults, $3 Seniors, $3 Children 6-12, under 6 and members free; except Fall weekends Sept 1-Nov30: $7 Adults and Seniors, $3 Children 6-12, under 6 and members free.

Trails open dawn to dusk everyday. Visitor Center: 9-5 daily, 8-5 Sept.-Nov. Closed Christmas, New Year's and Thanksgiving.

Though North Lookout Trail rises only 200 feet in elevation, it is ungraded and rocky in parts. Sturdy shoes and backpacks are recommended.

No pets, radios, bicycles, camping, smoking, or alcohol permitted.

Light snacks and juices are available. Please pack out trash and recyclables.

Visit on a weekday for a more leisurely, intimate experience during fall foliage season.

Binoculars can be rented at our visitor center.

Migration flights are unpredictable and weather dependant. For weather forcast and migration reports, call 610-756-6000 after sunset from August 15-December 15.

Oak Trees and Acorns

Topic Page

Oak trees produce clusters of small flowers called catkins. Pollination occurs between male and female catkins on the same tree whenever the wind blows in the spring. Female catkins produce acorns. The maturation time of the acorn, which depends on the species of oak tree, is either one or two years.

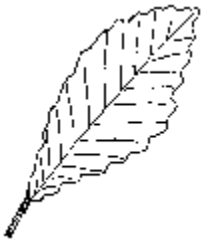
There are 59 oak species native to North America.

There are two groups of oaks, white oaks and red oaks. White oaks tend to produce acorns annually. Red oak acorns usually take two years to develop. Years when acorn production is extremely large are referred to as mast years. White acorns are edible and sweet. Red oak acorns contain tannin and are slightly toxic.

An acorn will generally turn from green to brown as it ripens. Acorns can be collected from August to December.

Other ways to distinguish white oaks from red oaks are (Peattie 1977):

Red Oaks	**White Oaks**
Leaves with veins usually running out beyond the margin in the form of a bristle	Leaves never with the veins extending beyond the margins in the form of a bristle
Stamens 4 in each flower	Stamens 6 to 8
Cup scales rather thin	Cup scales more or less woody, and knobby at the base
Inner surface of the acorn shell lined with woolly hairs	Inner surface of the acorn shell smooth
Only found in North America (including Mexico)	Found throughout the Northern Hemisphere



Oak leaves are variable even on the same tree, but most are alternate, simple, and usually lobed. The bark of oak trees is usually scaly or furrowed.

Native Americans grind acorns into meal used for cooking. The tannin found in the bark of oak trees is extracted and used for curing leather, etc.

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Oak Trees and Acorns

continued...

Acorns are a main staple of the diet of squirrels, deer, turkey, grouse, pheasant, bobwhites, red-bellied and red-headed woodpeckers, blue jays, crows, tufted titmice, white breasted nuthatches, brown thrashers, towhees, grackles and mice.

Oak trees are important not only for wildlife, but humans as well. The wood of the oak tree is hard and strong, and is used for lumber quite frequently. Oak also used as firewood.

Oak trees have large root systems.

All oaks grow slowly, but red oaks grow faster than white oaks.
Acorns contain about 35% water, 10% fat, 4% protein, and 4% crude fiber. Red oak acorns are higher in fat than white oak acorns.

When squirrels cache acorns for winter they improve the oak tree's reproductive success.

There are over 50 types of insects and mites that infect the foliage of oak trees.
At least 23 types of insects infect the bark, wood, and twigs of oak trees.
There are approximately five types of insects that infect the roots of oak trees.

There are approximately 14 types of insects that feed on the sap and inner bark of oak trees.

There are many types of insects that infect the foliage of Quercus including:

- Mormon cricket, Texas leafcutting ant, Walkingstick, Narrowwinged cricket
- Beetles: Fuller rose beetle, Basswood leafminer, Asiatic oak weevil, Locust leafminer, Cranberry rootworm, Willow flea weevil
- Caterpillars: Oak tubemaker, American dagger moth, Fall cankerworm, Orangestriped oakworm, Spiny oakworm, Pinkstriped oakworm, Fruittree leafroller, Oak webworm, Oak leafroller, Orange tortrix, Io moth, Oak skeletonizer, Obliquebanded leafroller, Chainspotted geometer, Shield bearer, Walnut caterpillar, Yellownecked caterpillar, Greenstriped mapleworm, Elm spanworm, Linden looper, Pale tussock moth, Buck moth, Satin moth, Green fruitworm, Gypsy moth, Eastern tent caterpillar, Western tent caterpillar, Forest tent caterpillar, Sonoran tent caterpillar, Winter moth, Rusty tussock moth, Western tussock moth, Spring Cankerworm, Stinging rose caterpillar, California Oakworm, Redhumped oakworm, ermine moth.
  Mites: Bud gall mites, pecan leaf scorch mite, eriophyid mites, oak spider mite, platanus spider mite
- Sawflies and other miscellaneous insects

There are many types of insects that infect the bark, wood, and twigs of oak including:

- Pacific oak twig girdler, twolined chestnut boreer, ambrosia beetle, flatheaded appletree borer, Pacific flatheaded borer, Columbian timber beetle, twig pruner, red oak borer, oak branch boreer, living beech borer, periodical cicada, painted hickory borer,

Oak Trees and Acorns

continued...

Topic Page

redheaded ash borer, narrowwinged cricket, twig girdler, oak clearwing moth, oak treehopper, little carpenterworm, carpenterworm, dogwood borer, pigeon tremex, leopard moth

There are several types of insects that infect the roots of oaks including:

- Periodical cicada, California prionus, broadnecked prionus, broadnecked root borer, cranberry rootworm

There are several types of insects that suck out essential parts of oaks including:

- Maple leafhopper, alder spittlebug, oak lace bug, rose leafhopper, apple mealybug, buffalo treehopper
- Aphids
- Scales: Golden oak scale, California red scale, greedy scale, cottony cushion scale, obscure scale, oak lecanium, cottony maple scale

The most common insects that you will find if you were to break open an acorn would be: grubs (larvae) of acorn weevils (more than 90%), filbert worm moths, acorn moths, short-snouted weevils, sap beetles, springtails, maggots, weevil grub, snails, slugs, minute fungus beetle, and braconid wasps.

The most common type of disease that affect the leaves of oaks is called anthracnose.

There are several types of bark infecting fungi that affect oaks including:

- Hypoxylon, Cryphonectria, Endothia, Botryodiplodia, Diplodia, and Sphaeropsis

Oaks can also show signs of butt rot, cankers, leaf blight, leaf blister, and root rot. All diseases that are caused by bacteria or fungi.

Recent studies have found that the size of the acorn crop is related to gypsy moth outbreaks and Lyme disease risk. Mice are a critical predator of the gypsy moth and a consumer of acorns. Deer are also a considerable consumer of acorns. Mice and deer are both primary hosts of the black-legged tick that carries lyme disease. Small acorn masts produce small rodent populations which increases the survival of the gypsy moth. A decrease in moth predation could lead to a gypsy moth outbreak. Adult ticks feed and mate on deer. Then they drop to the ground and lay eggs. The hatched larvae then feed on white footed mice which infects the ticks with the bacteria that causes Lyme disease in humans. Next they grow and search for hosts which includes deer and humans. Therefore, because the acorns increase the mice population the chance of lyme disease is greater because there are more infected hosts available for the ticks. Then there are more infected ticks and a humans chance of getting lyme disease is increased.

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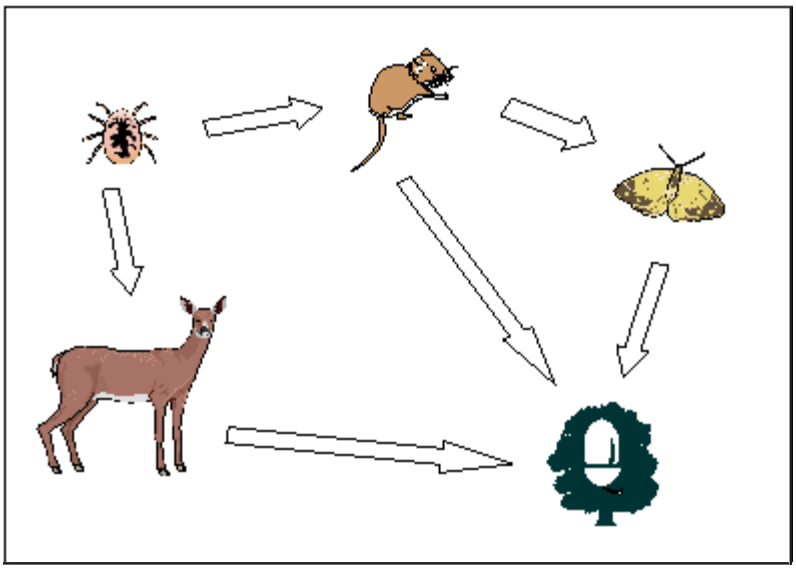
Oak Trees and Acorns

continued ...

The bumper crop of acorns during mast years may be the result of natural selection. During such times at least some seeds escape being eaten because so many are available. More importantly, bust, or non-mast years produce no acorns and oaks can store up energy for a boom year. Bust years drive populations of acorn eaters down, then a boom year occurs.



Researchers have discovered that acorn mast size is related to gypsy moth outbreaks and the risk of Lyme disease.

(From Ostfeld, Richard S., Jones, Clive G., and Wolf, Jerry O. Of mice and mast. BioScience. 46(5). 1996. 323-330.)

Both white-tailed deer and white-footed mice eat acorns.
White-footed mice also eat the larvae of the gypsy moth.
Small acorn crops result in small rodent populations.
Small rodent populations increase the survival of the gypsy moth.
Large acorn crops result in large rodent populations.
Large rodent populations decrease the survival of the gypsy moth.
Defoliation of oak trees by the gypsy moth can lower the acorn mast size.

White-footed mice carry the bacteria that cause Lyme disease in humans.
The larvae of ticks feed on the white-footed mice and then hatch and search for hosts.
Infected adult ticks then host on deer and humans causing Lyme disease.

An increase in acorns increases the white footed mouse population.
This increases the number of hosts for the black-legged tick.
There are so many ticks infected with the Lyme disease causing bacteria that they must search for hosts other than deer.
Our chance of getting Lyme disease is then increased.

Around the Oak Scavenger Hunt

Activity Page

Rationale

This activity is designed to introduce students to the ecology of oak trees in natural habitats. Students will learn about habitats used by oak trees at Hawk Mountain Sanctuary.

The activity meets several National Science Education standards for grades K-4, including:

Science as inquiry standards:
Abilities necessary to do scientific inquiry
Understanding scientific inquiry
Organisms and environments

Life Science standards:
Characteristics of organisms
Life cycles of organisms

For additional information on these and other NSE standards see: National Research Council. 1996. National science education standards. Washington, DC: National Academy Press.

Instructions

After reading Gerda Miller's Around the Oak Tree to your class, take your students on a short hike along the education trail at Hawk Mountain Sanctuary (see attached map). Everyone will need to be quiet while walking on the trail if you want to see the wildlife on the checklist.

As you walk along the trail, your students should be looking for the items mentioned or depicted in the story. The attached checklist includes items known to occur at Hawk Mountain Sanctuary. You may have to modify the list if you are not at the Sanctuary. Have your students check the items as they find them. Give clues to your students if they are having problems finding items. Some items are seasonal and may not be found on every trip. Your students can keep their checklists as a record of what they saw. Do not remove the items you find from the Sanctuary. Additional items can be added at the bottom of the checklist. Students can draw lines matching the pictures to the scavenged item. (Note: not all items are pictured.)

Time

30-60 minutes

Supplies

Muller G. 1991. Around the Oak. New York: Dutton. 39 p. (available from Common Ground Distributors, PO Box 25249, Asheville, NC 28813-1249. Fax: 888-684-5779, Phone: 800-654-0626, url: www.comground.com

Around the Oak checklists, pencils, Hawk Mountain Sanctuary trail guide and map

Activity Page

Around the Oak Scavenger Hunt

continued...

Questions for students

After the story:

1. What were some of the things that happened to the oak tree in the autumn? Why did they happen?

2. What were some of the things that happened to the oak tree in the spring? Why did they happen?

3. Would you expect to find the same animals that Nick, Ben and Caroline found where you live? Why? Why not?

After the scavenger hunt:

1. What items did you find close to an oak tree? Why do you think the items were where you found them?

2. What items were not near an oak tree? Why do you think the items were where you found them?

3. Were there any items that you did not find? Why do you think that you did not find them?

Note: Consult the *Additional Readings* for answers to these and other questions.

Around the Oak Scavenger Hunt

Activity Page

Scavenger Hunt Items Checklist

Birds

- ☐ Woodpecker
- ☐ Blue Jay
- ☐ American Robin
- ☐ A bird's feather
- ☐ A bird's nest



Mammals

- ☐ Squirrel
- ☐ Eastern Chipmunk
- ☐ White-tailed Deer
- ☐ Mouse or Vole



Insects

- ☐ Ants
- ☐ Wasp's nest
- ☐ Butterfly
- ☐ insect gall (not pictured)


Leaves

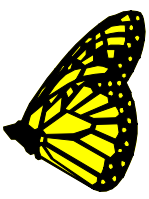
- ☐ Birch
- ☐ Pine
- ☐ Oak
- ☐ Maple

Other

- ☐ Mushroom
- ☐ Pinecones
- ☐ Acorns
- ☐ Oak tree flower or catkin (not pictured)
- ☐ Chipmunk or Squirrel feeding perch (not pictured)








Activity Page

Identifying Forest Leaves

Rationale

This activity is designed to teach students about similarities and differences among leaves; especially those associated with oak leaves.

The activity meets several National Science Education standards for grades K-4, including:

Science as inquiry standards:	***Life Science standards:***
Abilities necessary to do scientific inquiry	Characteristics of organisms
Understanding about scientific inquiry	

For additional information on these and other NSE standards see: National Research Council. 1996. National science education standards. Washington, DC: National Academy Press.

Instructions

Walk with your students along the education trail at Hawk Mountain Sanctuary (see attached map). As you do, have your students stop and pick up leaves of different shapes and sizes. Place the leaves in a gallon-sized plastic bag. Ask your students to collect one to two dozen leaves each. Many types of oak leaves look similar. Do not hesitate to choose two or more that look the same. Once your students have collected their leaves, return to your classroom.

Have your students sort their collections into piles of similarly shaped leaves. Then have your students compare their leaves to the ones on the pages that follow. Your students may be able to identify their leaves to species. If not, assist them using the picture key.

After everyone has identified their pile of leaves, discuss your findings. (Note: This activity can be adapted to any wooded trail if you are not at Hawk Mountain Sanctuary.)

Time

30-60 minutes in the field, 30-60 minutes in the classroom

Supplies

plastic bags, pencils, paper, leaf-identification sheets

Identifying Forest Leaves

continued...

Activity Page

Questions for students

1. Which leaves look similar to one another?

2. Why do they look so similar?

3. Why might they be similar?

4. What leaves look dissimilar to one another?

5. Why do they look dissimilar?

6. Why might they be dissimilar?

7. Why are leaves shaped the way they are?

8. Why are leaves as big or as small as they are?

9. Why do trees have many leaves? Why not just one big leaf per tree?

10. Are some types of leaves more common than others? Why?

11. Which types of leaves are most common?

12. What color are your leaves? Why?

13. How many of your leaves are damaged?

14. What do you think damaged the leaves?

Note: Consult the Additional Readings for answers to these and other questions.

Activity Page

Biology of the Acorn

Rationale

This activity is designed to help students understand the basic "anatomy" of an acorn. Differentiating between monocots and dicots is the foundation of angiosperm (flowering plants) taxonomy. Once students understand the structures that make up the acorn they can begin to recognize the relationships they have to other organisms.

This activity meets several National Science Foundation standards for grades 5-8, including:

Science as inquiry standards:
Abilities necessary to do scientific inquiry
Understandings about scientific inquiry

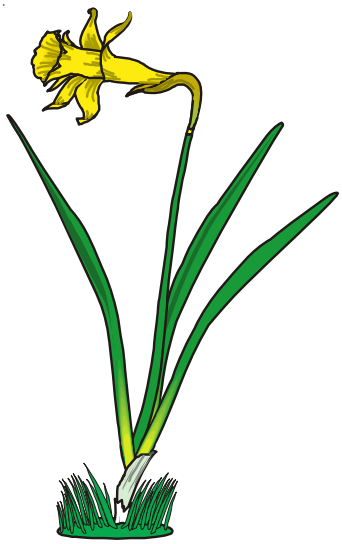
Life Science standards:
Structure and function in living systems
Reproduction and heredity

For additional information on these and other NSE standards see: National Research Council. 1996. National science education standards. Washington, DC: National Academy Press.

Introduction

The acorn is the fruit and the seed of the oak tree. Seeds have cotyledons. Cotyledons are the storage organs for the developing plant embryo (germ). The embryo of the plant uses the energy stored in the cotyledons as it develops. Seeds can have one (monocot) or two (dicot) cotyledons. You can often tell by the leaves of a plants, which ones are monocot and which ones are dicot.

Flowering Dogwood (Dicot)



Daffodil (Monocot)

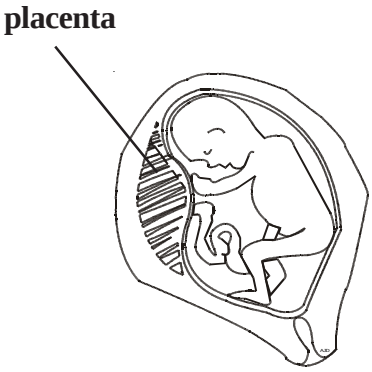
Biology of the Acorn

continued...

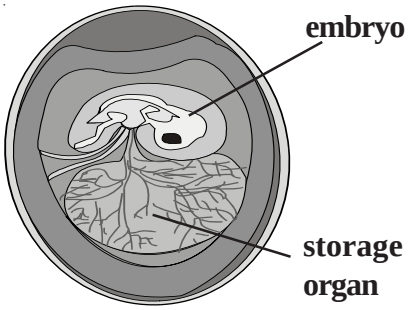
Activity Page

Instructions

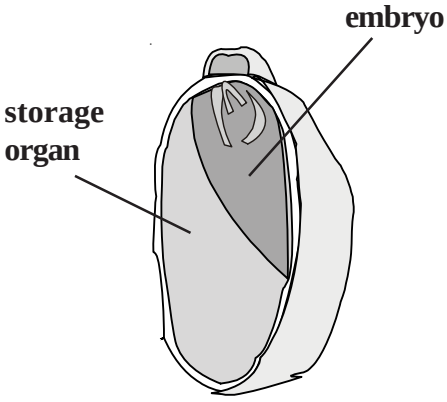
1. Compare and contrast the following illustrations of plant and animal "seeds." Notice the location of the embryo in each example. In the first case, the embryo has no storage organ but tissues are involved in placental transfer. In each of the following illustrations, the storage organ is evident.



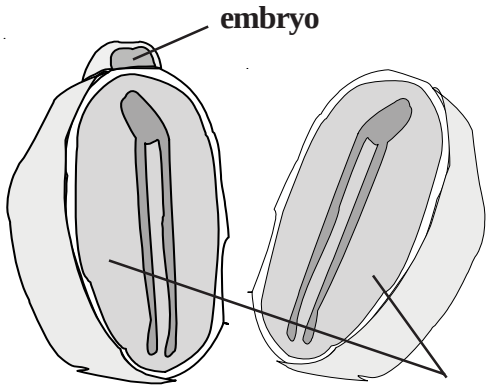
Human embryo



chicken embryo



Corn (monocot)



Peanut (dicot)

2. Dissect a peanut, and a kernel of corn (cornut). Find the embryo in each example.

3. Dissect your acorn, carefully removing the shell to get to the cotyledons. Answer the following questions.

a. Is the acorn a monocot or a dicot?

Activity Page

Biology of the Acorn

continued...

b. Can you find the embryo of the acorn?

c. With the shell removed, you can tell whether the acorn is from a red oak or a white oak? If it has velvety fuzz on the inside it is from a red oak, if it has a smooth paper-like inside it is from a white oak. Which one is yours?

4. Have students draw a picture of the dissected acorn and label the parts.

Time

30-60 minutes in the classroom.

Supplies

Acorns, peanuts, Cornuts, paper towels, pencils, paper, knives, cutting boards

Questions

After answering the above questions, students can do the *Exploring the Inside of and Acorn* activity.

Exploring the Inside of an Acorn

Activity Page

Rationale

This activity is designed to teach children about acorns and the animals that use acorns for food and habitat. The activity also will allow students to become familiar with items used in science.

The activity meets several National Science Education standards for grades K-4, including:

Science as inquiry standards:
Abilities necessary to do scientific inquiry
Understanding scientific inquiry
Organisms and environments

Life Science standards:
Characteristics of organisms
Life cycles of organisms

For additional information on these and other NSE standards see: National Research Council. 1996. National science education standards. Washington, DC: National Academy Press.

Instructions

Walk along the education trail at Hawk Mountain Sanctuary (see attached map). As you do, have your students stop to pick up acorns. Place the acorns in a small plastic bag. Be sure to have your students pick up acorns of different sizes and shapes. Include both rotten and ripe acorns. All acorns are interesting to explore. Each student should collect six to twelve acorns. Once you have returned to your classroom, cover a workspace with paper towels or newspaper so that it can be cleaned easily. Use a sharp knife to cut the acorns in half for the students. Note which kind of holes, if any, are in the acorn before cutting it. Have your students place the cut halves on the paper towel. Then have the students explore each acorn half using a low power magnifying glass (3x – 15x) and a toothpick. Have your students use their toothpicks to pry organisms from the acorns or to push organic material out of the way. A transparent bug box with a magnifying lens can be used to view organisms, but plastic petri dishes and a hand-held magnifying lens work just as well. Students should record their findings and draw what they see.

Use the attached handouts from several field guides along with other field guides (see Additional Readings) to identify the animals your students find inside their acorns. Acorns with single tiny holes are likely to have insects inside. Those with one tiny entrance hole and a larger exit hole probably will not have insects inside. You also may find worm burrows and fecal pellets. From these clues you may be able to determine what once lived inside the acorn.

Activity Page

Exploring the Inside of an Acorn

continued...

The most common insects inside acorns are acorn weevils, filbert-worm moths, acorn moths, short-snouted weevils, sap beetles, springtails, maggots (fly larvae), weevil grubs, snails, slugs, minute fungus beetles, and braconid wasps. (See attached illustrations.)

Use a ripe, but uninvaded, acorn to show your students what the inside of an acorn looks like before insects invade it. After the students have finished exploring their acorns, the collected organisms should be placed outside along with the acorn remains. Be sure to have your students wash their hands when they are done with this activity.

This activity can be adapted to any classroom if acorns are gathered ahead of time.

For more information about acorns see Hawk Mountain Sanctuary's Acorn Fact Sheet.

Time

30-60 minutes in the field, 30-60 minutes in the classroom

Supplies

magnifying lens (3x – 15x), bug boxes or plastic petri dishes, toothpicks, paper towels, pencils, paper, handouts and field guides, sharp knife, plastic bags

Questions for students

1. How many of your acorns had holes in them?
2. Did the acorns with holes have more animals inside than those without holes?
3. Did the insides of the acorns with animals inside look different than those that did not have animals inside? If so how are they different?
4. Why do you think they looked different?
5. How many different types of animals did you find?
6. What was the most common animal you found inside an acorn?
7. Why do animals live in acorns?

Note: Consult the *Additional Readings* for answers to these and other questions.

Decomposing Litter

Activity Page

Rationale

This activity is designed to help students understand the process of decompostion and the ways that they impact their environment when they litter. Decompostion (decompose is french for to breakdown) is a natural and essential ecological and process.

The activity meets several National Science Education standards for grades K-4, including:

Science as inquiry standards:	***Life Science standards:***
Abilities necessary to do scientific inquiry	Characteristics of organisms
Understanding about scientific inquiry	Organisms and environments

For additional information on these and other NSE standards see: National Research Council. 1996. National science education standards. Washington, DC: National Academy Press.

Instructions

Have your students collect items that are commonly seen as litter. Such items would be paper towels, candy wrappers, soda cans, and straws. You or your students will also need to collect natural materials such as leaves, acorns, sticks, and grass clippings. Have your students place some of the natural materials in a container with a lid. A clear plastic container is best, but coffee cans also work. Have your students shake the cans vigorously for a one minute. Then open the cans and pour the contents onto the work area. Compare to the sample that was not shaken. Discuss your findings using the attached Questions for students. Repeat the procedures with the litter. Discuss your findings using the attached *Questions for students.*

Time

10-15 minutes in the field, 60 minutes in the classroom

Supplies

At least 4 clear, plastic containers or coffee cans, and natural and litter items, water

Activity Page

Decomposing Litter

continued...

Next, simulate a storm by adding water to a new sample of natural materials. Shake vigorously for one minute. Discuss your findings using the attached Questions for students. Repeat the procedure with a new sample of litter and water. Discuss your findings using the attached Questions for students.

Questions for students

1. What happened to the natural material when you shook it? Does it look different than before you shook it? Do you think that this happens in the natural environment? How?

2. What happened to the litter when you shook it? Does it look different than before you shook it? Why or why not? Do you think that these items break down (decompose) in the natural environment?

3. What did water do to the natural materials? Do you think that this happens during a storm?

4. What did water do to the litter? Do you think that these items are affected by a storm?

5. Which type of material is broken up more easily then?

6. How do you think that litter ends up in the forest?

7. What can people do to keep their litter out of the forest?

8. Can any of the items that were used in the experiment be reused or recycled?

How to Raise an Oak Tree From an Acorn

Activity Page

1. Collect acorns in the Autumn from the tree itself. Taking acorns from the ground is not a good idea as they could be infested with weevils or too dry. Make sure that it is ripe by taking off the cap. If the cap comes off easily, it is ripe. A fresh acorn should also sink if placed in water.

2. Put acorns through cold storage. This is done by placing a handful of acorns in a plastic bag. Then add an equal volume of soil and seal the bag. Store in the refrigerator. Check every week for a root. Depending on the species this will take 30 to 90 days.

3. Once the root is visible, plant the acorn in one gallon plastic pot. Oak trees develop large root systems, therefore it is recommended that you use a large container. Make sure to poke drainage holes in the pot if they are not already there. The pot should be filled to within one inch of the top. The acorn should be placed horizontally in the pot and then covered with a half an inch of soil.

4. Next, water the plant. It should be watered again whenever the top two inches of soil are dry.

5. The root system will grow before any growth is seen above the soil. Once the seedling is above the soil place it in a spot with morning sun.
   Half strength liquid fertilizer may also be applied every six to eight weeks if you desire.

6. Seedlings can be safely transplanted outside after one or two years.

Adapted from "Raising a tree from a seed" by Janet H. Sanchez in Horticulture October 1994.

Activity Page

How to be a Gray Squirrel: Part I

Part I: Collecting and Storing Food

Rationale

By taking on the role of an eastern gray squirrel (*Sciurus carolinensis*), students can begin to understand how squirrels cache (store) there food, and by what means they relocate this food once it has been stored. This activity can serve to introduce students to more complex questions about the interaction of squirrels and acorns.

The activity meets several National Science Education standards for grades K-4, including:

Science as inquiry standards:	*Life Science standards:*
Abilities necessary to do scientific inquiry	Characteristics of organisms
Understandings about scientific inquiry	Organisms and environments

For additional information on these and other NSE Standards see: National Research Council. 1996. National science education standards. Washington, DC: National Academy Press.

Introduction

Eastern gray squirrels are well-known and popular creatures in Appalachian forests. They are a medium-sized mammal of about 18 inches in length, with half of the length being a large bushy tail. Adult gray squirrels can weigh over a pound, and their color can vary considerably. Most gray squirrels are colored silver-gray above and off-white below with rusty brown highlights on their bodies and tails. Albinism (lack of skin and hair pigmentation) is rare, but black morph (melanistic) squirrels are common in many portions of the species range, including northcentral Pennsylvania.

Gray squirrels eat a variety of foods. Acorns, hickory nuts, walnuts, and beechnuts are popular. They also favor berries, mushrooms, pine seeds, and corn. Dogwood berries, cherries, and black gum berries are also eaten. In spring, gray squirrels eat the buds and flowers of many forest trees.

Eastern chipmunks (*Tamias striatus*), and some other small mammals hibernate for much of the winter, but gray squirrels remain active all year. Gray squirrels collect and store nuts and seeds to eat through the winter months. Learning more about how squirrels hide and find these stored nuts is the basis for this activity.

How to be a Gray Squirrel: Part I

continued...

Activity Page

Instructions

1. Introduce students to the foraging behavior and natural history of squirrels. Discuss the following questions.
    a. What do squirrels eat?
    b. What do you call organisms that eat both plants and animals?
    c. How do squirrels prepare themselves for winter?
    d. Do you think squirrels store their food in one or many locations?
2. Give each student 10 to 20 small mudball or doughball (1/2" in diameter) "acorns."
3. In a section of forest (discuss the boundaries), ask students to bury their "acorns" as a squirrel would bury its acorns. (You can tape students thumbs to their palms so their hand are similar to that of squirrels).
4. Bring the students to an area away from the forest and discuss the methods squirrels employ to locate their cache' of acorns.
    a. What is the advantage of gathering and storing acorns?
    b. How might a squirrel find acorns it has cached away?
5. Have the students return to the forest and find their caches of acorns.
6. Discuss the results of this activity with the students.
    a. Were you able to find all of your hidden acorns?
    b. Did you find anyone else's acorns?
    c. As a gray squirrel, what might be the advantages of hiding your acorns in many different places? Are there advantages to hiding them in just one place?

Time

60-90 minutes in the field.

Supplies

Pencils, paper, mudballs or doughballs.

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Activity Page

How to be a Gray Squirrel: Part II

continued...

Part II: What to eat?

Rationale

This activity is designed to teach students about animal behavior, using eastern gray squirrels as study organisms. The activity will introduce students to the basics of scientific inquiry and experiment, and will exercise their observation skills. The activity is written for grades 5-8, but can easily be scaled up for grades 9-12.

The activity meets several National Science Education standards for grades 5-8, including

Science as inquiry standards:
Abilities necessary to do scientific inquiry
Understandings about scientific inquiry

Life Science standards:
Regulation and Behavior

For additional information on these and other NSE Standards see: National Research Council. 1996. National science education standards. Washington, DC: National Academy Press.

Introduction

A primary concern for most animals is getting enough food to eat. A few animals are highly specialized, feeding on just one or a few kinds of food, but most animals eat a variety of things. When there is more than one kind of food available, animals must decide what to eat. Behavioral ecologists are scientists who study (among other things) how animals decide what to eat. They have found that for many animals, it's about energy (which we measure as calories); animals try to maximize efficiency by consuming the most calories in the shortest time possible. Therefore, fatty or oily foods are often highly preferred, because fats contain nearly twice the number of calories per unit weight (ounce) as carbohydrates or protein.

Squirrels eat many different things. In addition to nuts, they eat almost anything: from tree bark to beetles, flower bulbs and leaf buds, occasionally even a baby bird! Since they do not hibernate, squirrels must eat enough food to stay active during the long, cold winter. Therefore, they are pretty good at choosing among different food types. In this exercise, we will conduct an experiment to see if squirrels prefer fatty foods.

Instructions

The exercise can be conducted using the platform bird feeders around the Sanctuary's visitor center. Squirrels can be viewed from the windows behind the visitor center, and the windows near the stairway down to the gallery. (Note: YOU MUST COORDINATE WITH HMS EDUCATION STAFF to use the bird feeders for your experiment.) This exercise can be conducted anyplace where squirrels are reliable visitors and allow themselves to be observed. If you have squirrels near a bird feeder at your classroom, keep the feeder well-stocked with sunflower seeds (restocking daily), and in a in a few weeks, you will have habituated the squirrels enough to conduct this experiment.

How to be a Gray Squirrel: Part II

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Activity Page

Place 50 red (fatty) peanuts and 50 green peanuts on each platform to be observed (see **Supplies**). Position 3-5 students to watch each platform. Each student should have a data sheet, a pencil, and a book, clipboard, or other flat surface to facilitate writing. Several different kinds of animals may feed on these platforms. Depending on the number of students, each student can watch a different part of the platform (front-left, back-left), a different species, or each student in turn can record the behavior of specific individual animals as they land on the feeder. Two or three students can record the same data simultaneously to check for errors. Data collection can continue until one type of peanuts has completely disappeared, or until each student has had a chance to record data. Once students have collected the data, collate the data from all students, and display it as a table or graph.

Time

Approximately 30 minutes to prepare the peanuts, 30-60 minutes to collect the data, and 30-60 minutes to collate and discuss the data. Peanuts may be prepared in advance to save time.

Supplies

100 peanuts for each feeder (50 unshelled peanuts dyed red and coated with Crisco and 50 peanuts dyed green), datasheets and pencils for each student, a watch or clock for each feeder, guides for identifying animals, food color, Crisco. Soak unshelled peanuts (i.e., peanuts still in the shell) in a bowl of diluted food coloring.

Adapting this exercise for older students

For younger students, merely examining the graphs and tables of data may be adequate to make the point that the fatty peanuts are taken first. For older students, you may expand this exercise by a careful outline of the scientific method, statistical analysis of the data, or both.

The Scientific Method. Although there are many different ways of explaining it, the scientific method consists of the following steps. First, there are observations, and the formation of a question about how the world works. Next, the scientist develops an hypothesis. An hypothesis is a trial answer to the question; it is based in part on the observations, the findings of other scientists, and the scientist's own intuition. Then, the scientist conducts an experiment to test her hypothesis. Finally, the scientist examines the results of her experiment, to see if it supports or refutes the hypothesis. This step almost always leads to additional questions --- either about the original hypothesis or experiment, or some other aspect of the organism, or both.

For this exercise, our observations are that squirrels eat a variety of foods, and our question is, what factors influence squirrel food preferences. Based on the work of other scientists, we hypothesize that one factor influencing squirrels is fat content ---- that squirrels will prefer foods with more fat in them.

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How to be a Gray Squirrel: Part II

continued...

Statistics. Young or old, scientists usually begin by "eyeballing" the data: looking over the table of numbers and graphs of the data for patterns. Most often, professional scientists must follow up the examination of data with statistical tests. Statistics are used to assess the strength of the pattern; whether the pattern is so weak that it might be due to chance alone. The simplest appropriate test here may be a Chi Square test, comparing the number of fatty peanuts taken with the number of nonfatty peanuts taken. (see References for Chi Square)

Questions for Students

1. What if certain colors are more attractive to squirrels than other colors? How might that have affected our experiment? Can you think of another experiment to make sure that the colors we used did not affect the results?

2. What else (besides calories) might be important to squirrels as they decide what to eat? (*specific nutrients, e.g., protein or vitamins: specific places to forage, e.g., where the squirrel isn't exposed to wind/rain or hawks*)

3. If animals prefer fatty foods, why are we always being told that we shouldn't be eating fatty foods? *(Before agriculture and civilization, humans probably had to struggle to get enough calories --- hence they developed a strong preference for fatty foods, which are rich in calories. That preference persists today, even though civilization has made it possible for us to get all the fat we need --- and in fact, considerably more fat than we need).*

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How to be a Gray Squirrel: Part II

continued...

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Sample Data Sheet

Student's Name:

Date:

Location of Feeder:

Observation	Species	Took RED-GREEN	Time	Notes
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				

Activity Page

How to be a Gray Squirrel: Part III

continued...

Part III: Where to eat?

Rationale

This activity is designed to teach students about animal behavior, using squirrels as a study organism. It can be done at Hawk Mountain, or any place where the squirrels are common and tame enough to feed on platforms. This activity will introduce students to the basics of scientific inquiry and experiment, and exercise their observational skills.

The activity meets several National Science Education standards for grades 9-12, including:

Science as inquiry standards:
Abilities necessary to do scientific inquiry
Understanding scientific inquiry

Life Science standards:
Characteristics of organisms
Regulation and Behavior
Organisms and environments

For additional information on these and other NSE Standards see: National Research Council. 1996. National science education standards. Washington, DC: National Academy Press.

Introduction

Most animals must balance several conflicting needs as they live their lives. For example, animals may need to run around in the environment to find things to eat, even if the best way to avoid being eaten is to stay still and quiet in a good hiding space. Behavioral ecologists are scientists who study (among other things) how animals balance these conflicting needs.

One way animals manage this conflict is to choose places to eat that are near places to escape. For example, squirrels run into the bushes or run right up a tree when threatened by a predator (or anything that might hurt them). Therefore, you can hypothesize that squirrels prefer to feed where there is a tree or bush nearby. They prefer not to be too far away from the trees and bushes, so they don't have too far to run when a hawk or a coyote or a dog (or a person!) goes after them. In this exercise, we will test that hypothesis. We will use a technique known as GUD to test our hypothesis.

GUD stands for Giving Up Density, and refers to the amount of food (density) left over in a particular place after an animal has decided to quit eating there and go someplace else (given up). This technique was developed by a scientist named Joel Brown and his colleagues (see Smith and Brown, 1991 for a detailed explanation written for biology teachers and students). The basic idea is that when animals find food in a place they regard as a safe place to forage, they will stay and eat almost all the food in that place.

How to be a Gray Squirrel: Part III

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Activity Page

Therefore, there is very little food remaining after the animals have stopped eating: the GUD is very low. On the other hand, if the animals don't like the place where they've found the food, they will give up much sooner, leaving more food behind–then the GUD is high. So, the lower the GUD,
the more the animals like that place to feed. Of course, this assumes that the two places have the same kind and same amount of food to start with. In this experiment, we set up two places for the squirrels to feed, a safe one near the trees, and a risky one further away from the trees.

Instructions

What is needed for this exercise is a place where squirrels regularly forage, with open ground, both close to and further from trees. One patch can be 3 feet from a tree, and the other patch 15-20 feet from the nearest tree. This exercise can be conducted on the grounds of Hawk Mountain Sanctuary. (Note: YOU MUST COORDINATE WITH HMS STAFF to do this exercise at the Sanctuary.) This exercise can take place anywhere squirrels are reliable visitors and allow themselves to be observed. If you have squirrels near your home classroom, set up a wooden platform (1' by 2' is a good size), and restock it daily with a handful of sunflower seeds. It may take a few days to a few weeks for the squirrels to discover the feeder, but once they do, it will only take another week or two for the squirrels to become tame enough to conduct this experiment.

GUD Trays

You need to make two "patches" of food, such that you can easily measure the amount of food placed in the patch at the beginning of the experiment, and the amount of food remaining after the experiment is over (the GUD). For squirrels (and chipmunks), what works well is a wooden tray, 2' x 2' by 3" deep. Fill the tray with sand–regular playground sand is great. For squirrels, a good food to use is ½ cup of sunflower seeds or small peanuts (without the shells). Weigh the food or count the number of nuts or seeds. Mix the food into the sand. Be thorough, so the food is evenly mixed throughout the sand. Set one "safe" tray close to the trees, and one "risky" tray out in the open. Ideally, you could have two or more trays in each location: animal behavior is usually variable, and you'll have a better chance of seeing the pattern if you use more trays.

Collecting the data

The trays should remain in place for a few hours, to give the animals time to feed. Ideally, you could set this experiment up as soon as you arrive at Hawk Mountain Sanctuary, and allow the animals to forage while your students do other activities. After a few hours, pick up the trays, pour the sand through a sieve to sift out the food items. You can count or weigh the amount of food remaining: this is the GUD for each tray. You can predict that the GUD will be higher for the tray that is farther from the trees. If you are conducting this experiment at home, best results may be obtained by setting the trays out early in the morning, and bringing them in as late in the afternoon as possible. Trays should not be left out overnight, as raccoons and other

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How to be a Gray Squirrel: Part III

continued...

nocturnal animals may overturn them.

Time

30-60 minutes to explain the experiment and set the experiment up. 2-3 hours to allow the animals to forage–your students can be doing another activity at this time. 30-60 minutes to collect and discuss the data.

Supplies

At least two trays, 2' by 2' by 3 inches deep. One bag of sand. Food for the squirrels–sunflower seeds or peanuts without the shells. A colander or sieve for sifting the food out from the sand. If you have the materials available, additional boxes can be set up. This allows you to have replicate safe and risky trays.

Adapting this exercise for older students

For younger students, merely examining a graph of the data may be adequate to see if the GUD was lower in the tray(s) closest to the trees. For older students, you may expand this exercise by a careful outline of the scientific method, statistical analysis of the data, or both. See the preceding exercise, "How to be a squirrel, part 2" for a quick outline of the scientific method. Here, our observations are that squirrels eat in a wide variety of places, and our question is, what factors influence where squirrels eat. Based on the work of other scientists, we hypothesize that one factor influencing squirrels is safety–how far is it from the feeding place to the trees and/or bushes they run to when threatened.

Variations

This same GUD technique can be used to investigate other questions, including what kinds of food animals prefer. You can use trays that are in the same kind of place (the same distance from trees), but with different kinds of food mixed in to the trays. If the animals prefer one type of food, they will leave a lower GUD in the tray(s) with that type of food. See Smith and Brown (1991) for further discussion.

Questions for Students (and "what to do if the prediction doesn't come true?")

1. We assume that animals are afraid of potential predators, but we almost never actually see a predator around. How would the animals change their behavior if there were a real predator around? We would predict that GUDs would go up–more food would be left in the trays. The difference between the safe and risky trays might also be larger.

How to be a Gray Squirrel: Part III

continued...

Activity Page

2. Squirrels sometimes carry items away to eat them, and other times eat it right where they found it. How might the size of a food item affect whether the squirrel carries a food item off before eating it? *The larger a food item is, the more likely the squirrel is to carry the food item over to a tree to eat it. Larger food items take longer to eat, so the squirrel will take it to a safe place to eat. (See Lima et al. 1985, and Lima and Valone 1986 for details. Even though these papers are primary science literature, they are relatively easy to understand.)*

3. What if other animals besides squirrels were feeding in these trays? *That's ok; most of the animals that will eat these types of food in the trays will have similar responses to predation risks. However, it may be that we were actually looking at GUD for chipmunks or some other animal instead of the squirrels.*

4. What if there was no food left in either the safe or risky trays? *It may mean that the squirrels (or other animals) wanted the food items SO much that they ignored the risks of feeding out in the open. You could try the experiment again with smaller food items. Or it could be that the "risky" trays aren't risky enough–maybe the risky trays should be further away from trees.*

5. What if there was no difference in the GUD for the two trays, or GUD was higher for the safe tray? *This is certainly possible if you have few or only one tray of each type. Animal behavior is usually variable–it may be that a predator or some other disturbance happened while they were feeding in the safe tray, and–by chance–did not happen while the animals were in the risky tray. The more trays you use, the less chance there is for these random events to influence your data.*

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Activity Page

Talking Points

Where do trees come from?

Most trees grow from seeds, and young trees are called seedlings. It takes years for a tree to become as large as the ones you see in the Sanctuary's forest.

What are acorns?

Oak trees begin life as seeds called acorns. Many animals that eat acorns, including mice and blue jays, bury them in the soil for later use. Sometimes, animals forget where they put their acorns and the acorns start to sprout and grow into seedlings.

When are acorns produced? How often are acorns produced?

Some types of oak trees produce acorns every year in the spring. Other kinds of oak trees have acorns that grow on their branches for two years before falling off.

Why are acorns important?

Acorns are an important source of food for many animals including squirrels, mice, deer, bears, foxes, turkey, and blue jays. Ants, insects, and caterpillars use acorns as places to live. Caterpillars (juvenile moths) often eat part of an acorn and then live inside the shell of the acorn for the winter. When the caterpillar gets hungry it does not have to go outside, because it just eats more of the inside of the acorn. By the time the caterpillar changes (metamorphoses) into a moth in the spring, the acorn is completely eaten. The adult moth feeds on oak leaves.

Why aren't there many acorns in spring?

Oak trees produce acorns in the autumn. In spring oak trees produce leaves and flowers. Oak tree flowers, called catkins, are pollinated by the wind and will grow into acorns. Initially the acorns will be green, but eventually they will turn brown as they mature and then fall from the tree. Animals eat many of the acorns that fall on the ground. The ones that do not get eaten stay on the ground. Leaves that fall from the oak trees and cover the acorns. This protects the acorns from animals and lets them grow into oak saplings which will grow and grow until they become a big tree.

How can you tell the age of an oak tree?

A young oak tree is short and skinny. Its bark is smooth. The older the tree is, the taller and thicker it becomes. The trunks of older oak trees usually have rough, cracked bark. Older trees also lose their branches at the bottom of the tree. When a tree is cut down you can determine the exact age of the tree in years. The cross-section of a tree trunk has many growth rings, each of which represents one year of growth. Counting the number of rings allows you to age a tree in years.

Talking Points

continued...

Activity Page

How long does an oak tree live?

Oak trees can continue growing for more than 200 years. Most of the oak trees in the Sanctuary's forest are less than 150 years old.

Why do trees have bark?

Bark protects the tree in much the same way that our skin protects us.

Why are there so many leaves on the ground?

Trees grow more slowly, and sometimes even stop growing when the weather gets cold. The leaves of the trees may change colors from green to yellow, red or brown. The leaves then fall off the tree. The fallen leaves provide food for insects, worms and fungus. Over time the leaves get smaller and smaller and become part of the soil. This makes the soil better for the tree to grow in.

Why do leaves change color in autumn?

Leaves contain green pigments called chlorophyll. During photosynthesis, the leaves use chlorophyll to make food. Leaves also contain pigments that are not used for photosynthesis. These pigments are called carotenoids and anthocyanins. Carotenoids are yellow pigments that give the leaf its yellow coloration when chlorophyll starts to deteriorate. Carotenoids do not need light to function, but chlorophyll does. Anthocyanins are red and purple pigments that need light to function. They are not always present within the leaf. They are actually formed by chemical reactions. In the summer, the leaf's production of its growth hormone, auxin, decreases and its growth-inhibiting hormone, abscisin, increases. High abscisin levels cause a layer of cells to develop where the leaf joins the twig of the tree. The leaf is now cut off from receiving nutrients from the tree. Chlorophyll starts to break down faster than it can make more which allows the other pigments to take over. The leaves will dry out, their colors fade, and fall from the tree.

How does an oak flower become an acorn?

At the end of winter the buds on the white oak (Quercus alba) swell. They continue to swell until the beginning of spring when the buds open. The female flowers then extend their stigma (the tip of the pistil, which is the female part of the flower). This is how the female flowers receive pollen (the spore-like male cells) dispersed by the wind from another tree. The pollen begins to grow tubes down to ovules (eggs) inside ovary (sac-like structure at the base of the pistil). The ovary is what later becomes the acorn. Next, the megaspore inside the ovule grows into the embryonic sac. Once the pollen tube has completed its journey, it releases two sperms (male cells). This is when fertilization occurs. One sperm fuses with the egg. The other sperm fuses with two polar nuclei in the embryonic sac. The ovule becomes a sac with the developing embryo (fertilized egg) inside. In late spring the acorns are continuing to grow. By late summer the acorns have reached full size and the embryo is nearing maturity inside the seed. Throughout the autumn the acorns will turn from green to brown. This signifies that the embryo inside is

Activity Page

Talking Points

continued...

mature. At the end of autumn the acorns will have dropped to the ground. In the winter, the acorns that have not been eaten by animals are stored usually by burying them in piles under the ground called caches. These acorns can either germinate immediately or wait for spring to germinate. When the white oak buds start to grow again in the spring, the process begins again.

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