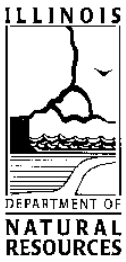
Illinois Biodiversity Basics

a biodiversity education program of

Illinois Department of Natural Resources
Chicago Wilderness
World Wildlife Fund



Adapted from *Biodiversity Basics*, **© 1999,**
a publication of World Wildlife Fund's Windows on the Wild
biodiversity education program. For more information see
<www.worldwildlife.org/windows>.

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About *Illinois Biodiversity Basics*

Relevance of Biodiversity

Humans are part of an incredibly complex and interdependent web of life, and we're just beginning to understand our place in it. We're beginning to realize how dependent we are on biodiversity for most, if not all, our needs. We're also beginning to realize that a significant loss of biodiversity could seriously undermine our long-term economic, intellectual, physical and emotional well-being. Why haven't we been more aware of biodiversity and it's importance before now? The answer may be partly due to our loss of intimacy with other living things. In many cases we've lost contact with the natural foundations on which our lives are built. Our ignorance of nature and the way it works may be catching up with us. The challenge now is to learn as much as we can to gain a new perspective on our place in the natural world, so that not only will we be better able to protect living things, but we'll also create a more sustainable and responsible society.

The diversity of life on earth shapes and nourishes every facet of our existence. But the connections between species are seldom obvious. Due to a variety of factors (see page 4), biodiversity is rapidly declining. To ensure the long-term health of the planet, an informed and motivated citizenry needs to be developed that understands what biodiversity is and why it's important. Citizens are needed who have the skills and confidence to rise to the challenge of protecting biodiversity and who feel empowered to do so. Education is one of the best tools for achieving this goal.

In education, biodiversity is an important topic that encompasses many disciplines and provides real-world contexts and issues that promote critical- and creative-

Illinois Biodiversity Basics is built on a set of underlying principles about education. The activities are based on many familiar strategies and approaches from constructivist learning to innovative assessment strategies, group-learning, problem-solving and interdisciplinary teaching.

Format

Illinois Biodiversity Basics was designed to give educators access to as much information as possible in an easy-to-use format. You'll find an overview of Illinois biodiversity (pages 4-5) followed by 12 field-tested, standards-led activities. While designed with specific learning standards in mind (standards-led), the activities also allow educators to help meet other learning standards. Each activity provides basic information and detailed procedures. The Appendices include supplemental material such as vocabulary definitions, scientific names for species used in the text, the conceptual framework and activity correlations to the Illinois Learning Standards and Benchmarks, subject areas and skills. Cross reference and planning charts provide an overview of all 12 activities "at-a-glance."

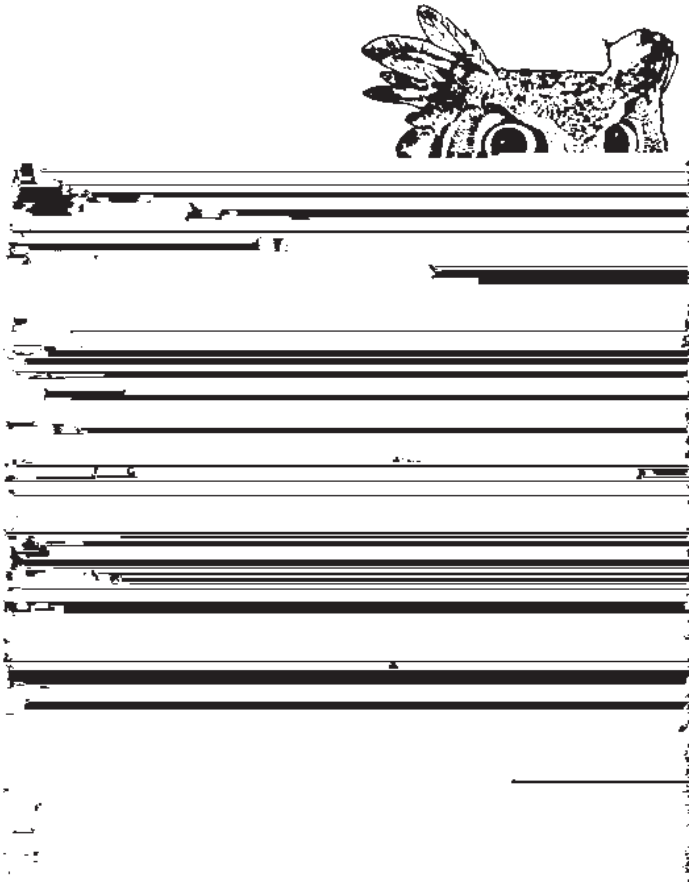
Illinois Biodiversity Basics* and *Windows on the Wild

Illinois Biodiversity Basics is adapted from World Wildlife Fund's (WWF) publication, *Windows on the Wild: Biodiversity Basics.** Through the cooperative efforts of WWF, the Illinois Department of Natural Resources and Chicago Wilderness, Illinois has become the first state to publish its own version of this curriculum guide to exploring the web of life.

Windows on the Wild

If you are interested in teaching more about biodiversity, you may want to obtain a copy of the educator and student guides for *Windows on the Wild: Biodiversity Basics* and/or other materials from WWF. The core of the *Windows on the Wild (WOW)* program is a series of middle school modules on key topics related to biodiversity, including *Biodiversity Basics*, *Wildlife for Sale*, *Marine Biodiversity* and *Building Better Communities*. Each module contains background information, resource ideas and unit plans for the educator, as well as creative and challenging interdisciplinary activities for students. *WOW* curriculum materials are designed to help students explore the social, scientific, economic and ethical issues surrounding biodiversity and to give them the knowledge and skills they need to build a more sustainable future. Working with partners around the world, WWF developed a Biodiversity Education Framework to help guide people in life-long learning about biodiversity, sustainability and conservation.

Windows on the Wild: Biodiversity Basics is available for purchase from Acorn Naturalists at www.acornnaturalists.com or 800/422-8886. Visit WWF's Internet site at http://www.worldwildlife.org/windows/biobasics.html for more information.



Windows on the Wild is funded with major support from Eastman Kodak Company. Additional support has been provided by the Environmental Education and Training Partnership, the Evan Frankel Foundation, the Ittleson Foundation, John and Adrienne Mars, the Mars Foundation, the McKesson Foundation, the National Environmental Education and Training Foundation, the National Fish and Wildlife Foundation, the Pew Charitable Trusts, the U. S. Fish and Wildlife Service and the U. S. Environmental Protection Agency.

Biodiversity Background
What is Biodiversity?

Biodiversity is the variety of life on earth. There are three levels of biodiversity: species diversity; ecosystem diversity; and genetic diversity. *Species diversity* includes all living things from the tiniest bacterium to the large white-tailed deer and white oak tree. As of 2002, about 1.7 million species had been identified worldwide. It has been estimated that the number of species on earth is somewhere between 10 million and 300 million. Biodiversity also includes *ecosystem diversity*, the habitats that house all life forms and the interconnections that tie living things together. Ecosystem diversity includes the prairies, marshes, swamps, deciduous forests and all other environments where species live. Ecosystems not only provide habitat for species but also perform functions such as flood control and water purification. Biodiversity includes the variety within species, which is determined by the genes. *Genetic diversity* makes every living thing unique. Each species is like a book of genetic information, containing billions of genetic letters that give it a particular code of life. Its traits are the result of coded messages in the genes that are passed from one generation to the next. When a species becomes extinct, all the information is lost. Genetic diversity is a safeguard against future problems, such as disease or natural disasters.

Why is Biodiversity Important?

Biodiversity is important for many reasons. It helps maintain the atmosphere, keeps the soil fertile, purifies water and provides other functions that enable life to exist on this planet. It provides a variety of resources and products for humans, including many foods and medical products, and is the potential source for many more. Species variety may provide the ability to avert major disasters, such as crop failures from drought and disease. Biodiversity provides products that help to boost the economy. The natural world also offers us a place to relax and reflect. Many people believe that biodiversity is important not just because it is valuable, but simply because it exists.

What is the Status of Biodiversity?

According to the world's leading scientific and environmental experts, loss of biodiversity is one of the most urgent environmental problems facing the planet. As human populations grow, they exert increasing pressure on natural resources—pressure that is endangering species and ecosystems around the world. Habitat loss, introduced species, pollution, population growth and over-consumption are the main threats to biodiversity. The extinction of any species brings the irreversible loss of unique genetic codes and the potential loss of medicines, foods, products and jobs. At the same time, degradation of natural systems threatens the very services, such as water purification and nutrient recycling, that support all life on earth.

Illinois: Biodiversity and the Natural Divisions

Some people believe that Illinois is a state with little more diversity than corn and soybeans. However, Illinois actually has a surprising variety of organisms and habitats. Nearly 54,000 species have been identified in Illinois so far, not including bacteria. It is believed that millions of bacterial species may exist. The rich diversity of life in Illinois is due to the variety of habitat types provided by 14 natural divisions.

The natural divisions concept is a classification system of natural environments and biotic communities based on the bedrock, glacial history, topography, soils and distribution of organisms. Each natural division contains its own similar landscapes, climate, soils and bedrock and supports similar vegetation and wildlife. In general,

the more natural divisions, the more species diversity. Some species live in only one or a few of the natural divisions while others are more generalized in their needs and can survive in many different habitats.

Illinois' natural divisions include the Wisconsin Driftless, Rock River Hill Country, Grand Prairie, Northeastern Morainal, Illinois and Mississippi Rivers Sand Areas, Wabash Border, Southern Till Plain, Shawnee Hills, Coastal Plain, Lower Mississippi River Bottomlands, Ozark, Middle Mississippi Border, Western Forest-Prairie and Upper Mississippi and Illinois River Bottomlands. The largest natural division in Illinois is the Grand Prairie Division. Each of these areas contains unique habitats and species. Because they are so diverse, the biodiversity in Illinois is very diverse. For more information about Illinois' natural divisions, and to see a map of them, visit http://dnr.state.il.us/lands/education/biodiversity on the Internet or obtain an *Illinois' Natural Divisions* poster from the Illinois Department of Natural Resources (see the "Resources" section, page 178).

People and Biodiversity

The people of Illinois make a significant impact on the landscape and its diversity. Clearing forests, plowing prairies, draining wetlands, developing urban areas, building roads and conducting other human activities have drastically reduced the diversity of habitats in Illinois and the overall biodiversity of the state. When people alter habitats they kill and/or force out the organisms that live in them, upset ecological relationships and reduce the ecosystem's ability to perform services like flood control, water purification and nutrient recycling. Some of the habitats that originally occurred in our state can only be found in nature preserves, state parks, conservation areas and other protected sites that shelter the state's biological diversity. However, we can help protect biodiversity, a task that involves all of us. All species are significant, many in unknown but, perhaps, vitally important ways. We must value biodiversity and try to preserve it.

How Can We Protect Biodiversity?

One of the greatest challenges we face in protecting biodiversity is how to balance the needs of the present without jeopardizing those of the future. There is no one way to address this challenge, partially because there is no single reason why we are losing biodiversity. There are several goals, however, which can be attained by people working together. One proposal is to maintain a state of relative equilibrium with our environment, called sustainability. A society that reaches sustainability is one that is able to persist for many generations without producing significant amounts of pollution, depleting natural resources and causing a decline in biodiversity. Many different points of view need to be taken into consideration before sustainability can be achieved. Land-use planning is needed so that space may continue to exist for species and ecosystems. Restoration of habitats is an important goal. Research must be done rapidly to find out as much as possible about what species exist, how they depend on their habitats and how habitats can be managed to ensure healthy populations. Legal protection is necessary for some species. Stewardship of natural resources should be considered when corporations make business decisions. Captive breeding can be used to increase the population of some species. Gene banks are being developed to store seeds and plant parts to preserve biodiversity for future generations. Citizens can take action in their own communities to solve biodiversity problems. Educating people about the problem will lead to better understanding and solutions. Ensuring the survival of species, genes and ecosystems will require a combination of approaches, and the collective thinking of people from all disciplines and backgrounds. It will mean fostering compassion for other species, educating ourselves about the connections among all elements of biodiversity and coming to terms with the consequences of our behavior for other people and other species.

Want to learn more about biodiversity? For additional information and materials about biodiversity contact the organizations responsible for bringing you this book. See the "Resources" section of the guide.

Biodiversity of Illinois CD-ROM Series

You will find frequent reference made in this guide to the *Biodiversity of Illinois* CD-

Did you know that there are insects that masquerade as plant parts, birds that map their migration by the stars, and fungi that find their way into your favorite foods? In

4. **Develop a class definition of biodiversity and a list of reasons why it's important.**
   Explain to the students that the quiz was designed to point out some interesting facts about the natural world, as well as to introduce the concept of biodiversity. Ask the students what they think biodiversity means, and have them write their ideas on the board. Then use the background information, along with the glossary, to explain the three levels of biodiversity (genes, species and ecosystems).

   Next, have the students use the information on the board and in the quiz to list reasons biodiversity is important. Afterward, combine their group lists to form a single class list. Your class list might include food, clothing, housing, ecosystem services, natural beauty, camping and hiking.

WRAPPING IT UP

Assessment

1. Write each letter of the alphabet on a separate slip of paper. Fold the slips, put them into a container and have each student pick one. Then have each student write a poem or limerick about an animal, plant or other life form that lives in Illinois and starts with his or her letter. As an option, have the students draw or cut out pictures to go along with their writings and compile them into a book. Possible titles for the book include *Biodiversity A to Z, An Encyclopedia of Biodiversity* or *A Poetic Look at Biodiversity*. You could also have the students present their poems to younger students.

2. Students could use the *Biodiversity of Illinois* CD-ROMs from the Illinois Department of Natural Resources to write their own Illinois Biodiversity IQ quiz. They can test other students in the class or test students who are not currently studying biodiversity.

Portfolio

Either at the beginning or end of a unit, the quiz can serve as documentation of the students' general knowledge of biodiversity, if you have each student take the quiz separately. Have the students note why they answered as they did and record their own definition of biodiversity on the quiz.

Extensions

1. Create a bulletin board or other display featuring the class definition of biodiversity and magazine photos and student artwork that illustrate biodiversity. Students should choose photos and create artwork that portray the different levels of biodiversity. Encourage students to connect facts from the quiz with their artwork or photos. If the class continues studying biodiversity, the bulletin board can be updated to include new knowledge and ideas.

2. Have students develop a TV or radio informational program of one to three minutes to help people understand the meaning of biodiversity. They can use the IQ test as part of the program content. Remind students that the more creative and entertaining their spots are, the more likely others are to get the message. When they've finished, have them share their efforts with the rest of the class.

3. Create a collage or diorama about Illinois biodiversity. Create and hang mobiles featuring Illinois species in the classroom.

4. Have each student select a quiz question that he/she answered incorrectly or a question that interests him/her. Ask the students to research the subject of the question and use the information they find to write a paragraph that either explains the correct answer or gives more details on the subject.

5. You can turn this activity into a quiz show game with you as the host. Give each group a copy of the quiz and choose a spokesperson for each team. Then start the game by reading a quiz question aloud. Give the groups a minute or so to discuss possible answers. Have team spokespersons raise their hands to indicate their team's readiness to answer the question and have the groups answer on a first-come, first-served basis. Score one point for each correct answer per question. If the first group misses an answer, other groups may try. Tally the points on the board and see which team wins!

Resources

Borror, D. J. and R. E. White. 1970. *A field guide to insects*. Houghton Mifflin Company, Boston. 404 pp.

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Wilson, Edward O. 1992. *The diversity of life*. Belknap Press, Cambridge, Massachusetts. 424 pp.

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"Biodiversity, or natural riches, is a new term that describes something very old."

—Alfredo Ortega, writer

the zappers' blue light attracts harmless insects in droves, many of which provide food for birds, bats and fishes. Some of the insects that zappers zap are also important to plants, which need the insects for pollination.

7. Blackpoll warblers are tiny birds that migrate between North America and South America each year. Which of the following statements about them are true?

a. They use the stars for navigation.
d. If they burned gasoline instead of body fat for fuel, they'd get 720,000 miles to the gallon.

Animals that migrate often have remarkable navigational skills. Many use the sun, stars, land patterns and other means to reach their destination, which may be thousands of miles and several countries away. And many migrators are able to get where they're going on very little fuel. For example, migrating birds often travel huge distances and eat very little along the way. They have incredibly energy-efficient bodies that "burn" body fat for fuel. Some birds, such as the tiny blackpoll warbler, get the equivalent of thousands of miles per gallon of fuel! But being able to get from point A to point B doesn't matter much if the habitat an animal is traveling to has been destroyed. That's one reason why international efforts to conserve habitat are so important.

8. Which of the following can be considered an enemy of the Great Lakes?

Bats are amazing animals. Though bats reproduce at a relatively slow rate, the large size of the babies, called pups, helps to increase the chance of survival. Little brown bats only eat insects they catch while flying. All this activity produces a heart rate of up to 1,000 beats per minute. They also have an unusually long life span for a small mammal and may live 20 to 30 years.

12. Without fungi, which of the following would you not be able to do?

a. eat pizza topped with pepperoni and mushrooms
b. bake bread
c. live in a world free of dead things lying all over the place
d. put blue cheese dressing on your salad

While some forms of fungi may seem less than noble—athlete's foot fungus, for example—the world could not function long without these humble life forms. Fungi and bacteria play a key role in breaking down organic matter and recycling it back into usable nutrients. Without them, dead things would definitely pile up! Besides, without fungi we wouldn't have tasty treats such as mushrooms, yeast bread or blue cheese.

13. Which of the following statements are true?

c. More than 5,000 different kinds of potatoes have been identified in South America's Andes Mountains.

The potato actually originated in South America. In Peru, some family farmers grow as many as 12 kinds of potatoes. Can you imagine eating purple potato chips or red mashed potatoes? It's possible with the thousands of kinds of potatoes out there. Most supermarkets, however, carry only four or five different varieties. And most of the country's baking potatoes are grown in Idaho. (Washington is the second largest producer of potatoes.)

14. Which of the following are actual species of animals found in Illinois?

a. antlion
b. hoary elfin butterfly
c. pimpleback
d. hoop snake

These are just a few examples of some of the many strange and wonderful creatures of Illinois. The antlion is an insect that can be found throughout the state. Its larva hides in the bottom of a small, cone-shaped pit dug in dirt or sand, waiting to eat ants and other small insects that fall in. The hoary elfin butterfly is a small, gray-brown butterfly that is endangered in Illinois. It lives in northeastern Illinois, most often along the shore of Lake Michigan, and is one of the first butterflies of spring. The pimpleback mussel is found statewide. It can live up to 100 years. No snakes actually form hoops and roll like a hula hoop although there is a mud snake that is sometimes called a hoop snake.

15. If you decided to throw a party to celebrate the diversity of life on earth and wanted to send an invitation to each species, how many invitations would you need?

d. more than 1.5 million

Scientists have estimated that as many as 100 million species may actually exist—they just haven't gotten around to identifying all of them yet.

16. Which of the following statements about short-tailed shrews are true?

a. Your cat may bring one to you.
b. They use a form of echolocation, like bats.
c. Shrews are known as the "tigers of the small animal world."
d. Shrews are venomous.

Short-tailed shrews are seldom seen in nature because of their size and ability to hide, although, house cats seem to find their share. Short-tailed shrews make up for their poor eyesight by using a

Bees are worth billions of dollars to the agriculture industry. Each year bees pollinate millions of acres of almond and apple trees, cucumbers and celery. Other favorite foods we'd miss without bee pollina-

knowing it, most human beings have mites on their forehead. Mites are slender creatures with a worm-like body and a spidery head. A mite is so small it is almost invisible. One species (

1. Which of the following could the fastest human outrun in a 100-yard race?

a. cheetah
b. wart hog
c. American woodcock
d. domestic cat
e. wild turkey

2. Which of the following actually exist?

a. ants that "herd" aphids for food
b. slime molds that creep across the ground
c. trees that can grow with their roots under water
d. none of the above

3. Which of the following animals can consume at least half of its body weight in food each day?

a. little brown bat
b. masked shrew
c. ruby-throated hummingbird
d. none of the above

4. Which of the following best describes the word "biodiversity"?

a. endangered species
b. different kinds of planets in the solar system
c. the variety of all life on earth
d. biographies about famous biologists

5. United States Fish and Wildlife Service agents at O'Hare International Airport in Chicago once found which of the following?

a. 18 California kingsnakes
b. 45 pounds of elephant ivory
c. 10 baby turtles
d. 16 vampire bats

6. Scientists studying bug zappers have learned some interesting facts. Which of the following are among them?

a. Insects are attracted to bug zappers because of the zappers' smoky smell.
b. Bug zappers are great for ridding summer nights of mosquitoes.
c. Bug zappers could be bad news for certain bird, fish, bat and flower species.
d. There are more than four million bug zappers being used in the United States.

7. Blackpoll warblers are tiny birds that migrate between North America and South America each year. Which of the following statements about them are true?

a. They use the stars for navigation.
b. They make frequent pit stops at fast-food restaurants.
c. They don't really need to migrate.
d. If they burned gasoline instead of body fat

10. The items on the left have been (or are being) developed into important medicines for humans. Match each item with the medicine made from it by writing the letters in the appropriate blanks.

__ bread mold	a. heart medicine
__ willow tree	b. antibiotic
__ vampire bat saliva	c. pain reliever
__ mayapple	d. medicine to unclog arteries
__ coneflower	e. immune system booster

11. Which of the following are true statements about little brown bats?

a. Baby bats weigh 20 to 25 percent of their mother's weight at birth.
b. Heart rate during flight can reach 1,000 beats per minute.
c. Little brown bats drink the blood of birds and small mammals.
d. A little brown bat may live 20 to 30 years.

12. Without fungi, which of the following would you not be able to do?

a. eat pizza topped with pepperoni and mushrooms
b. bake bread
c. live in a world free of dead things lying all over the place
d. put blue cheese dressing on your salad

13. Which of the following statements are true?

a. Potatoes originated in Ireland.
b. The United States grows most of its baking potatoes in Washington.
c. More than 5,000 different kinds of potatoes have been identified in South America's Andes Mountains.
d. The French fry, invented by Madame Bonaparte during the French Revolution, became one of Napoleon's favorite snacks.

14. Which of the following are actual species of animals found in Illinois?

a. antlion
b. hoary elfin butterfly
c. pimpleback
d. hoop snake

15. If you decided to throw a party to celebrate the diversity of life on earth and wanted to send an invitation to each species, how many invitations would you need?

a. 150
b. about 3,000
c. 652,983
d. more than 1.5 million

16. Which of the following statements about short-tailed shrews are true?

a. Your cat may bring one to you.
b. They use a form of echolocation, like bats.
c. Shrews are known as the "tigers of the small animal world."
d. Shrews are venomous.

17. If the number of species on earth was represented by physical size, which of the following would most accurately illustrate the proportion of insects to mammals?

(—continued)

Student Page

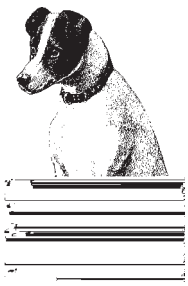
What's Your Biodiversity IQ?

BEFORE YOU BEGIN! PART I

Make a copy of the "Arthropod Pictures" and the "Arthropod I.D. Chart" for each student. Depending on your students' choices, you may also need scissors and glue.

WHAT TO DO! PART I

1. **Introduce classification.**
   Begin by explaining to your students that scientists classify living things into various groups. The system they use classifies organisms into ever more closely related groups and gives scientists from all over the world a common way to refer to particular organisms. To give the students a sense of how this classification system works, use the following information to compare the classification of a house cat with a dog (see "Classification Chart"). The students should notice that the cat and the dog share many classification groupings. Cats and dogs are in the same kingdom, phylum, class and order, but they belong to different families. You might also ask the students to name other species that would be in the same family as a house cat (lynx, bobcat, lion, tiger, puma and other cats) as well as other species that would be in the same family as a dog (wolf, fox, coyote, jackal and so on). You can also have the students name nonmammal chordates (animals with a backbone like fishes, amphibians, reptiles and birds) or noncat and nondog carnivores (bears, raccoons, weasels, mongooses and so on).



2. **Use the "Arthropod I.D. Chart" to introduce the process of classifying organisms.**
   Hand out a copy of the "Arthropod Pictures." (Please note that this is a simplified chart and that all classes and orders in the Phylum Arthropoda are not represented.) Start by writing the names of the five kingdoms on the board or overhead (see page

SORTING OUT TAXONOMY

Naming Things

The work of classifying organisms is done by scientists called taxonomists. Taxonomists divide organisms into a hierarchical series of more and more specific groupings. The most general division of life is into five kingdoms: Monera, Protista, Fungi, Plantae and Animalia. (See page 30 for a description of each kingdom.) Within each kingdom, there are groups of increasing specificity, each one containing fewer species of increasingly close evolutionary relationships to each other. These groups are phylum, class, order, family, genus and species (see page 22). This hierarchy enables taxonomists to group organisms based on their characteristics and evolutionary relationships. Species in any given order are more closely related to each other than to species in any other order; species in any given family are more closely related to each other than to species in any other family; and so on.

What's in a Name?

Most organisms have more than one common name. For example, what some people call a woodchuck might be called a groundhog by other people. And a tree might be called downy serviceberry, shadbush or downy Juneberry, all for the same species. Or a bird might be called a house sparrow or an English sparrow, depending on who is talking about it. Common names can be very confusing! Taxonomists use Latin words to give scientific names to organisms. Not only does this clear up the confusion over common names in any one language, but it also allows scientists who speak different languages to clearly identify any particular organism or group of organisms.

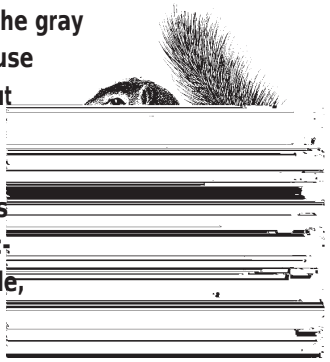
When scientists refer to a particular organism by its scientific name, they are using a combination of the genus (plural: genera) and species (singular and plural) to which the organism belongs. For example, a coyote is referred to as *Canis latrans* **(***Canis* **is the genus name and** *latrans* **is the species name). The gray wolf, a closely related species, is** *Canis lupus***. The genus and species names are always italicized or underlined. The genus name is capitalized, but the species name is not.**

Keeping Relationships Straight

Figuring out just where an organism belongs—how it should be classified—is not always easy. Scientists look for structural and genetic similarities among organisms that they classify together. But differences and similarities among living things are not always clear cut. Taxonomists sometimes disagree about where organisms should be classified, how genera should be arranged within families, and so on. As new information becomes available, taxonomists often revise where an organism is placed within the classification system. For example, giant pandas, which share some characteristics with raccoons and some with bears, have long been classified, along with red pandas, in their own group. However, recent genetic analysis has confirmed that giant pandas are actually true bears, and taxonomists are revising the species' classification based on those findings.

Defining a Species

A species is a population of organisms that interbreeds and produces fertile offspring in nature. For example, the red fox and the gray fox are different species because they coexist in many areas, but they do not interbreed.



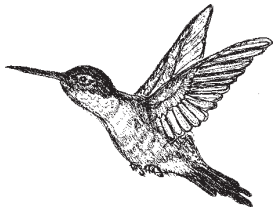
Taxonomy organizes organisms in increasing levels of specificity. A gray squirrel, for example, would be classified like this:

Kingdom: Animalia (animals)
Phylum: Chordata (animals with backbones)
Class: Mammalia (mammals)
Order: Rodentia (rodents)
Family: Sciuridae (squirrels and chipmunks)
Genus: *Sciurus* (squirrels)
Species: *carolinensis*

To refer to a gray squirrel, scientists call the animal by its scientific name: *Sciurus carolinensis.*

3. Use the "Arthropod I.D. Chart" to classify scorpions, spiders, centipedes and other arthropods.

Explain to your students that they will be using the identification chart to identify each of the organisms on the "Arthropod Pictures" page. Remind them that all of the organisms are in the Kingdom Animalia and the Phylum Arthropoda. Their job is to find out which class and order each organism belongs to.



Finally, reveal to the students that so far scientists have identified approximately 1.7 million different organisms in the biosphere and about 54,000 species throughout the state of Illinois. But they predict that there may be an additional two to 100 million species that haven't been identified yet worldwide.

Help students gain an appreciation for how many 1.7 million is. Group the students into small teams (three to five students per team). Provide them with a ruler and a stack of 100 sheets of paper. Ask them to work together to solve this problem: If you were to write the name of every known living species (1.7 million) on a different sheet of paper and then stack up all the sheets, how tall would the stack be?

A number of different approaches may be used to solve the problem. One possible solution is to measure the height, in inches, of 100 pages, and use this measurement to calculate the height of 1,700,000 pages. Answers will vary depending on the thickness of the paper. See the "Number Crunching" box for an example.

Compare your answer to a football field, which measures 300 feet long; the Statue of Liberty, which measures 302 feet high; and the Sears Tower in Chicago which is 1,450 feet high to the top of its roof, making it the tallest building in this category in the world!

Now that students have a better feel for 1.7 million, challenge them to determine how tall the stack of paper would be if they had a sheet of paper for each species that scientists predict exists but hasn't yet been discovered—1.6 to 100 million. Have the students use the same procedure to arrive at a range representing 1.6 to 100 million. Using the same type of paper, we calculated a height of 333 feet to 20,833 feet (that's more than one to almost 70 football fields tall, or more than one to 69 Statues of Liberty tall or about one-fourth to 14 times the height of the Sears Tower.

In order to help students grasp the concept of 54,000 species in Illinois, repeat the above activity, but substitute 54,000 for 1.7 million (11.25 feet). In addition, have the students calculate what percentage 54,000 is of 1.7 million (3.18 percent).

Number Crunching

Having trouble with the math? Follow these steps to find the height of your tower of paper.

First, measure the height in inches of a stack of 100 sheets of paper. In this example, the height is one-fourth inch. (We'll use the decimal .25.) If the height of your 100 page stack is different, substitute the measurement of your stack for the .25 used in this example.

Then, use the following ratio to find the height of 1.7 million sheets of paper.

1. .25/100 = x/1,700,000
2. 100x = .25 (1,700,000)
3. 100x/100 = 425,000/100
4. x = 4,250 inches
5. To calculate feet, divide by 12 inches.
   4,250 inches/12 inches = 354 feet

If you want to find the height of a different number of pages (1.6 million or 100 million), substitute that number of pages for 1,700,000.

2. Decide how many species are in each group of organisms.

Hand out a set of number cards (representing the worldwide numbers, see "Before You Begin") to each team, and explain that each card represents the number of species worldwide that scientists have identified in a particular group of organisms. Hold up a number card (for example, 19,000) and explain that 19,000 refers to the number of bird, plant,

mammal, insect, fish or fungi species that scientists have identified. (Remind your students that this number is not the number of individuals but the number of species—there may be millions or billions of individuals.) Now explain that each team has to work together to decide which group of organisms listed on the signs posted around the room this number refers to. Once their decisions have been made, the teams should tape their number cards on or below the appropriate signs on the wall. Teams should record their choices so they will remember them. Leave the cards on the signs. Repeat the process for the set of Illinois cards.

3. **Discuss the students' decision-making process.**
Ask your students to share the methods they used for making decisions. Did they guess or reason? Many teams may start with what they believe are the groups with the highest and lowest number of species. Some may start with the number they are most certain about and then use a process of elimination. Other teams may base their guesses on experience and observation.

4. **Reveal the actual numbers.**
Go to each sign and tell your students the correct answers. Then have your students discuss their reactions. Did any of the answers surprise them?

WORLDWIDE:		***STATEWIDE:***	
Insects	950,000	Insects	17,000
Plants	270,000	Plants	2,500

f ...mh3 03v

WRAPPING IT UP

Assessment

1. Use both the classification activity and the graphing activity as bases for assessment. Have the students write an explanation of how the "Arthropod I. D. Chart" works. On the graph, have the students write the educated guesses the class discussed and how the data on the graph either do or do not support each guess.

2. Select 10 organisms from one of the *Biodiversity of Illinois* CD-ROMs. Print the information sheet for each organism and discuss the classification information. Give a set of these sheets to each student. Have the students develop their own identification chart for the organisms.

3. Have students make a collage that includes the different classifications of species or have students choose a classification, such as mammals, and make a collage of just that classification.

4. Write a short magazine article that discusses the amazing diversity of life on earth. Include illustrations and captions.

Portfolio

1. Graphs can be part of the portfolio. The collage could also be added to the portfolio.

Extensions

1. Survey the species diversity of your school grounds or a nearby park or reserve. Your students don't need to identify the species by name; they just need to be able to tell that one species is different from another. Afterward, find out if the ratios of species in different organism groups are similar to the ratios illustrated on the graphs your students made.

2. Have students research a class (or order) of organisms within the Phylum Chordata. Tell them to find out what characteristics the animals within the class share, examples of species within the class, and the approximate number of species that have been identified to date. Have each student write a paragraph to summarize that information. Then pool the data for the group and have each student create a bar graph (on graph paper or using a computer program) that illustrates the relative numbers of species in each group. (Note: Separate the classes and orders when creating the bar graphs.)

   Here are some suggested classes: Osteichthyes (bony fishes); Amphibia; Reptilia; Aves (birds); Mammalia. Here are some suggested orders: within the Class Reptilia, Testudines (turtles), Squamata (snakes, lizards); within the Class Mammalia, Insectivora (moles, shrews), Rodentia (rats, mice), Carnivora (cats, dogs, weasels, raccoons), Artiodactyla (even-toed ungulates such as deer, camels, hippos).

Resources

Illinois Department of Natural Resources. 1999. *Biodiversity of Illinois, volume I: aquatic habitats*. Illinois Department of Natural Resources, Springfield, Illinois. CD-ROM.

Illinois Department of Natural Resources. 2000. *Biodiversity of Illinois, volume II: woodland habitats*. Illinois Department of Natural Resources, Springfield, Illinois. CD-ROM.

Illinois Department of Natural Resources. 2001. *Biodiversity of Illinois, volume III: prairie and edge habitats*. Illinois Department of Natural Resources, Springfield, Illinois. CD-ROM.

May, R. M. 1992. How many species inhabit the earth?" *Scientific American* (267): 42-48.

Wilson, E. O. 1987. The little things that run the world. *Conservation Biology* 1(4): 344-346.

Wilson, E. O. 1988. *Biodiversity*. National Academy Press, Washington D.C., 538 pp.

World Wildlife Fund. 1994. *WOW!—A biodiversity*

KINGDOMS

Monera

The monerans are the earth's bacteria.* They are single-celled organisms that are organized into two divisions—those that obtain energy by making their own food (autotrophs) and those that eat other organisms to obtain food (heterotrophs). Unlike the cells of other organisms, a moneran's cell has no nucleus, which is the control center in the cells of other organisms. In fact, monerans do not have many of the structures found in the cells of other living things. Monerans are one of the oldest life forms on earth. Scientists estimate that the earth is about 4 billion years old and that the monerans have been around for 3.5 billion years.

Protista (or Protocista)

The kingdom Protista consists of single-celled organisms. Protists have a nucleus as well as other cell structures that perform specific jobs. Protists include certain types of algae, slime molds, amoebas and diatoms.

Fungi

Most fungi are made of many cells. Mushrooms, molds, yeasts and mildews are examples of fungi. Until recently, fungi were classified as plants. Scientists now place fungi in their own kingdom because, unlike plants, they are not able to make their own food from sunlight, carbon dioxide and water. Instead, they get their food energy by digesting the organisms on which they grow (usually plants).

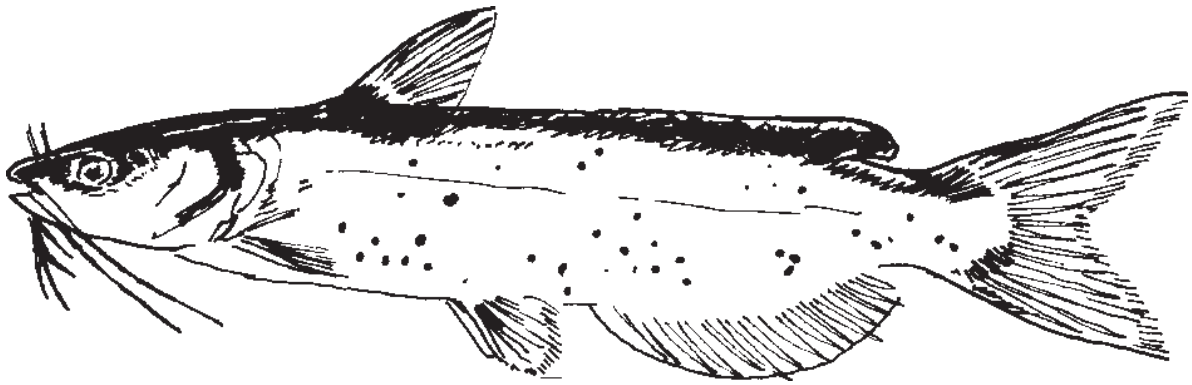
Plantae

As you might guess, this is the kingdom of plants. Most plants produce their own food energy through photosynthesis—a chemical reaction involving sunlight, carbon dioxide and water in the presence of chlorophyll. Flowering plants, mosses, ferns and certain types of algae are members of this kingdom.

Animalia

Most animals are multicellular organisms that have specialized tissues, organs and organ systems. Unlike plants, animals cannot make their own food, and their cells don't have cell walls. Fishes, amphibians, reptiles, birds, mammals and insects and other invertebrates are all part of the Kingdom Animalia.

*The number of kingdoms is often under debate, depending on how scientists interpret current research. For example, some scientists separate the monerans into two kingdoms: eubacteria (bacteria that get their nourishment from other living things) and archaebacteria (recently discovered bacteria that make their own food and live in extremely harsh conditions such as hot springs and hydrothermal vents).



You don't have to travel to the rain forests of the Amazon or the coral reefs of Australia to discover biodiversity. Just walk out the door and you'll find an amazing diversity of life in backyards, vacant lots, streams and ponds, fields, gardens, roadsides and other natural and developed areas. In this activity, your students will have a chance to explore the diversity of life in their community. They'll also get an introduction to how scientists size up the biodiversity of an area—and why it's so hard to count the species that live there.

BEFORE YOU BEGIN! PART I

You will need to gather field guides and other resources about your area. To best prepare your students for this activity, acquire resources in advance. Suggested Illinois resources can be found in the "Resources" list with this activity (page 37). You can use the "Ecoregional Survey" as it is written, or you can adapt it more specifically to your area and situation. You'll need a copy for each student, plus one copy for each team of four to five students. You'll also want to take the survey yourself in order to generate possible answers. If you are unsure, you can check your answers against resources found on the "Resources" list, such as the Illinois Department of Natural Resources' *Biodiversity of Illinois* CD-ROMs and the Chicago Wilderness' *An Atlas of Biodiversity*.

WHAT TO DO! PART I

An Ecoregional Survey

In this part of the activity, your students will get a chance to com•ÿn-1.244 TD0.07777777775ac Tcthis part of the
chance to com•ÿn-1.244 TD0.07777777775ac Tcthis part of the

1. **Take the ecoregional survey.**
   Give a copy of the "Ecoregional Survey" to each student and review any unfamiliar terms, such as native and introduced species. Then give students about 10 minutes to complete the survey. Afterward ask the students how they think they did. (Don't share possible answers at this point.) Collect the completed sheets as a pretest of the students' knowledge.

2. **Divide the class into teams to complete the survey.**
   Divide your class into teams of about four students each. Give each team a clean copy of the ecoregional survey. Tell the students that the members of each team should work together to complete the survey as accurately as possible. Explain that the students can use whatever resources they can find to answer the questions, including the resources listed on the "Resources" list, additional resources you gathered, the library, the Internet, community elders or a local naturalist. Stress that they should find the most accurate information they can and encourage them to collect drawings or pictures of the animals and plants they list.

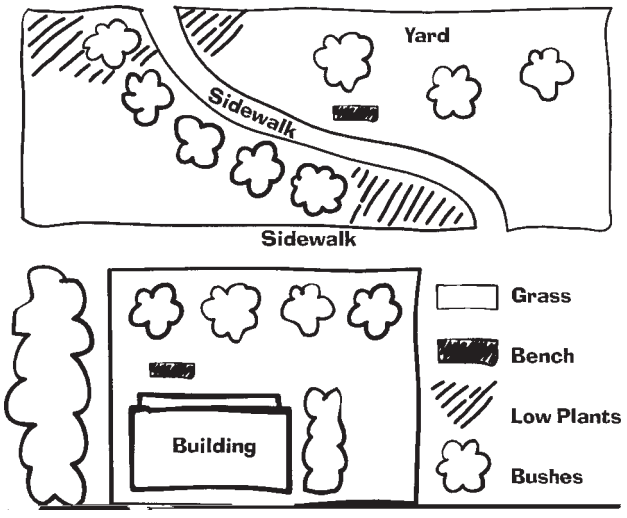
3. **Set a time limit on research.**
   Give the students at least two days to find answers to the questions. If you plan on doing the entire "BioBlitz" activity, this is a good place to stop and skip ahead to Part II. Research for the "Ecoregional Survey" should be done as homework on the days you spend on Part II, the "BioBlitz Survey." By the third day, Part II should be completed. You can go over the "Ecoregional Survey" results from their research as a wrap-up for this activity.

4. **Go over the survey results.**
   Once the students have finished the survey, have them share the information they found and compare their answers to the pretest. Did students find different answers to some of the questions? (For example, how extensive was the group's list of native plants?) What sources proved to be the most helpful? Were they surprised by any of the information they found?

The survey discussion can also be used as the wrap-up to Part II and as a way to discuss things the students observed during the "blitz."

BEFORE YOU BEGIN! PART II

You will need to find a nearby natural area where the students can conduct their "BioBlitz Survey." School grounds, a nearby park or the grounds around a neighborhood nature center can all work. Just be sure that your area is safe for your students (no broken glass or other hazards) and that you have the permission of the owners, if needed. For example, if you're using your own school grounds, you probably don't need permission, but if you're using a nearby city park, you should check with the city parks department first. You will also need to sketch a quick "site map" for the students. This map should show the boundaries of the study area and a rough delineation of different plant types. For example, areas with shrubs would look different from grassy areas (see sample below).



Be sure to have a copy of the "BioBlitz Survey" for each student (optional: thermometers; magnifying glasses; binoculars; and field guides). If you live in the Chicago area, you may want to borrow a *Chicago Wilderness Biodiversity Education Kit*, available from nature preserves and other sites. The kit contains field guides and rubber animal tracks that may be of value to you in this activity. Contact Chicago Wilderness (page 178) for more information and a list of checkout sites.

Getting to Know Biodiversity

When scientists want to know what lives in a particular area or region, they rely on a number of tools and techniques. Here's a quick look at some of them.

Bird's-Eye View

Aerial photographs and satellite images can give conservation biologists, wildlife managers and others a lot of information about a region. For example, different cover types such as coniferous forests, deciduous forests or grassy areas show up in these pictures as different colors or patterns. Scientists can use the photographs to delineate features on the ground before they ever visit an area. Knowing what grows on the ground can be useful for predicting where animals might be, whether areas could sustain certain animal populations, and for planning strategies to manage these populations. Scientists can also compare pictures taken at different times to look for changes in such things as forest cover and land-use patterns.

See It for Themselves

No matter how much aerial photographs or satellite images tell us about a study area, scientists like to visit the area to see for themselves if the information they gleaned from the photos is accurate. The process of going to an area to verify information is called ground-truthing. Ground-truthing gives scientists a firsthand look at the areas they're interested in and can help guide further studies.

Sampling

Scientists rarely have the time to identify every single plant and animal that lives in a particular area. And even if they did have the time, it would be extremely expensive for them to do so. For these reasons, scientists rely on statistics to get an idea of species diversity. The scientists look closely at only small portions–or samples–of the total area they're interested in. Then they use mathematics to extrapolate their findings to the larger whole. Scientists frequently use aerial photographs or satellite images to decide where to do their sampling. If an area they want to study is covered by both

particular areas? If there were distribution differences, where did they find the greatest diversity? Do they think that as a group they found everything out there? What factors might have affected the number of species they found? For example, would they have expected to find the same number and types of species if they'd done their "BioBlitz" at a different time of year? Or with magnifying glasses? Did one team have a way to complete the investigation that worked particularly well? What was the hardest thing about conducting their "BioBlitz?" Were they surprised by anything they found or didn't find?

7. **Discussion.**
Have the students look back at the questions they generated in step 1 of Part II. Based on their recent field experience, is there any other information they need to know about the land in order to make a complete inventory of its biodiversity? What kinds of organisms have they probably missed? Do they think these kinds of rapid inventories are useful?
(

Student Page

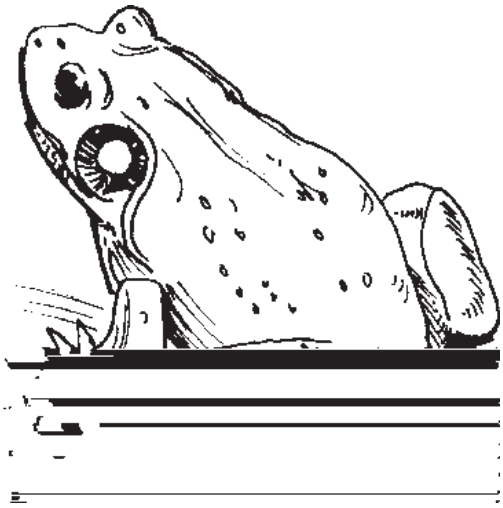
Backyard BioBlitz

Student Page

Ecoregional Survey

How much do you know about where you live?

1. *What major habitat type do you live in? (temperate forest, temperate rain forest, grassland, shrubland, taiga, tundra, desert and so on)*



2. *Name three native trees that live in your area.*

3. *Name five native edible plants that grow in your region and list in which season(s) each is available.*

4. *Name one poisonous plant that lives in your area.*

5. *Name ten native animals that live in your region.*

6. *Name three native animals that you can see in your area at any time of the year.*

7. *Name three migratory animals that visit or live in your area, and list in which season(s) you're able to see them.*

8. *Do white-tailed deer live in your area? If so, when during the year do they give birth?*

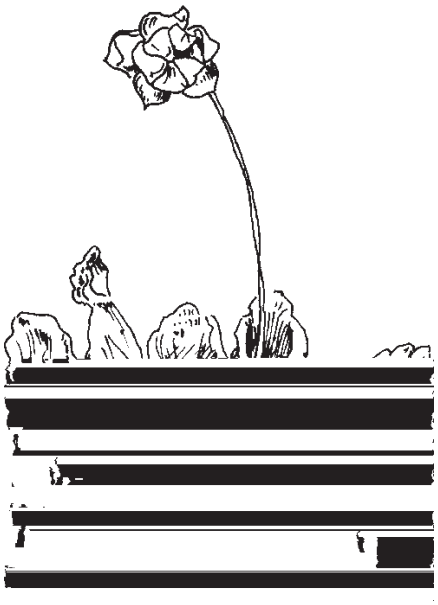
9. *How much average rainfall does your community get each year?*

10. *When (during what season or month) does your community normally get the most precipitation?*

(—continued)

Student Page

Ecoregional Survey (continued)



11. *How long is the growing season in your community?*

12. *What is the average temperature in July? In December?*

13. *What are some natural signs in your community that show that the seasons are changing?*

14. *What body of water—lake, pond, stream or river—is closest to your school?*

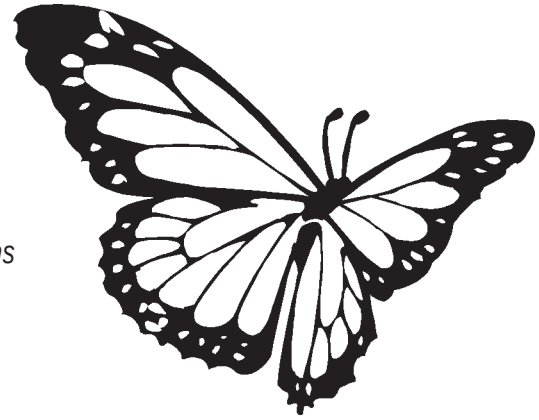
15. *How has your area changed in the past 25 years? (Ask your parents or neighbors.)*

16. *What types of plants and animals lived in your area 10,000 years ago? What was the climate like then?*

17. *What species in your area—if any—are threatened or endangered?*

18. *What natural events or processes influence the land around your community? How have they affected the land? (For example, have there ever been glaciers, earthquakes or volcanic eruptions in your area? Do frequent fires, high winds or flooding shape where and how things grow?)*

19. *Are there any threatened ecological areas in your community? (Are any wetlands, rivers or forests, for example, in trouble?)*



20. *Name a nonnative species that has created problems in your community.*

BioBlitz Survey

Site _____ *Date* _____

_____ *Weather* _____

City _____ *Temperature* _____

State _____ *Team Members* _____

_____

Description (what the area looks like in general) _____

_____

site map

Plants

Insects

Mammals

Other Invertebrates

Birds

Reptiles and Amphibians

Other / Animal Signs

Activity 1-4
The Gene Scene (continued)

BEFORE YOU BEGIN! PART I

For each student, make a copy of the "Human Genetic Wheel" and "Checking Out Your Genetic Traits."

WHAT TO DO! PART I

1. **Introduce genes.**
   Your students may know that the physical characteristics of all creatures on earth are determined by their genes. But what are genes and how do they work? Genes are sections of DNA that manifest themselves as visible traits, such as eye color and hair texture, and nonvisible traits, such as a susceptibility to a certain disease. Genes form visible bars on threadlike structures called chromosomes, which are inside the central part, or nucleus, of every plant and animal cell. Chromosomes contain the genetic material of each cell, made up mostly of DNA. Chromosomes become visible under a microscope when any animal or plant cell divides.

   In mammals, most healthy cells have two copies of each chromosome—one from each parent. Reproductive cells (egg and sperm) have one copy of each chromosome. Different species have different numbers of chromosome pairs. In humans, for example, there are normally 23 pairs of chromosomes.

2. **Discuss genetic diversity.**
   Explain that in a healthy population (a group of organisms of the same species living in a certain geographic area) there is a wide variety of genes that combine in many different ways to form a broad diversity of individuals. If the population is suddenly subjected to stress, such as disease or environmental change, the genetic variety makes it likely that at least some individuals will be adapted well enough to survive and continue the species.

   Populations of some species have become so small or fragmented that they have lost much of their original genetic diversity. If these populations are suddenly subjected to a disease or other stress, there might not be any individuals with the genes that provide protection from the disease and enable the individuals to survive.

5. Pool the results.
There are 128 possible combinations of the seven traits. To find out how many different combinations are present in the class population, go around the room and have each student give his or her "Genetic Wheel" number. Record the numbers on the board. If there is more than one student with the same number, place a check next to that number.

6. Discuss your findings.
Are there any two students in the class who have the same seven traits? Then ask the students if they can think of an eighth trait that would set these two people apart. Are there any numbers that have

Genetic Numbers of Individual White-tailed Deer	5 5	8	11 11	12 12	17 17 17 17	23	24 24 24 24 24 24	30	31
Genetic Combinations	1	2	3	4	5	6	7	8	9

number of each white-tailed deer in their population. They should use the "White-tailed Deer Genetic Wheel" to find the number of each white-tailed deer in the same way they used the "Human Genetic Wheel" (Part I) to find their own numbers. Students should write the genetic number of each white-tailed deer on each white-tailed deer card.

4. Determine the genetic diversity of each group's population of white-tailed deer.

Next ask the students to determine the genetic diversity of their group of white-tailed deer. Ask the student groups to count how many different individual genetic numbers are exhibited by their 20 white-tailed deer. This is the group's diversity number. Consider that a student group has a population of white-tailed deer with the genetic numbers shown in the table above.

In this case, the student group would have a total of nine different genetic combinations represented by their white-tailed deer group so the diversity number is nine. Write a tally on the board, recording each student group's number of white-tailed deer and diversity number. The larger a group's diversity number, the more genetically diverse the population of white-tailed deer.

Each student group should start with 20 white-tailed deer. The diversity number of group one should be 4, group two should be 8, group three should be 12, group four should be 14 and group five should be 20. Some students may realize that they have an advantage—or disadvantage— at this point.

Rules and Strategies

Before students begin the game, share the following information:

- If a white-tailed deer dies, the students should turn the card that represents that white-tailed deer face down.
- Only the dominant male white-tailed deer can mate with the females. If the dominant male dies, a new dominant male must be designated. If a group loses all its males or females, it cannot reproduce.
- Events usually affect half of a population. If you have an odd number of white-tailed deer that are affected by an event, round down to find the number of white-tailed deer affected.
- Female fawns cannot reproduce in this game.
- During reproduction events, each qualifying female will receive a fawn card. Students must choose traits for each fawn based only on the traits of that female and the dominant male. See the following example:

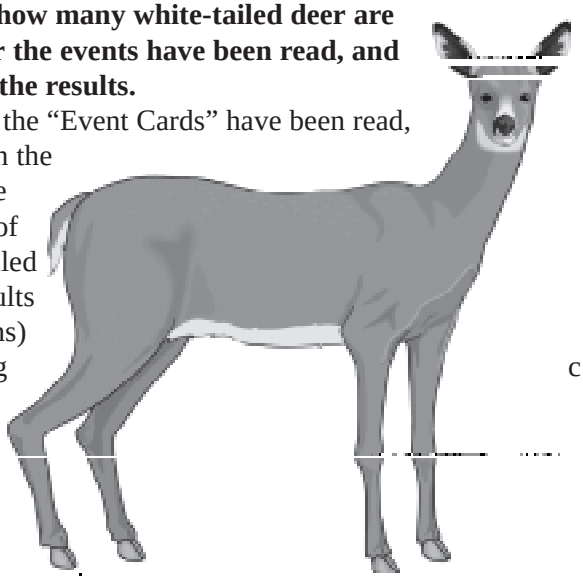
Female	**Dominant Male**
excellent hearing	poor hearing
resistant to disease	resistant to disease
poor sense of smell	good sense of smell
large home range	large home range

The fawn can have either excellent hearing or poor hearing and have either poor sense of smell or good sense of smell, but the fawn must be resistant to disease and have a large home range (because both parents have these traits). Every time a female has a fawn, the students will assign traits in this manner. Circle the traits on the fawn cards.

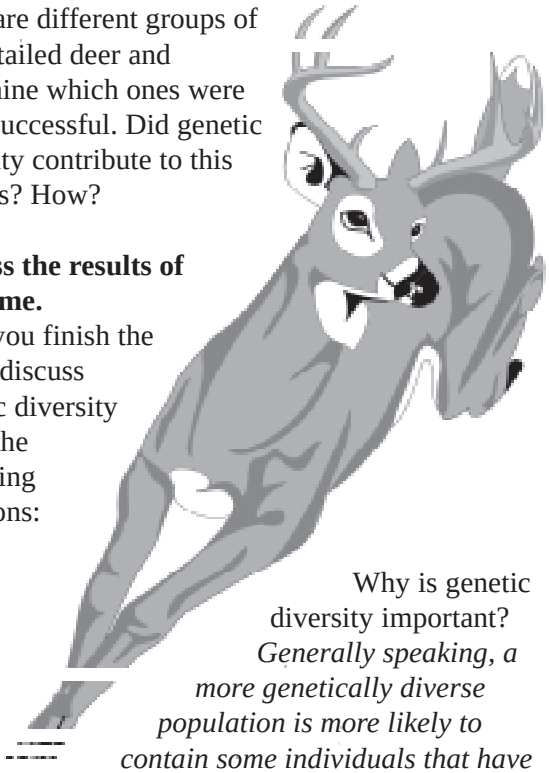
5. **Have each group select a dominant male.**
Each group of students should select one male in its white-tailed deer population to be the dominant male. Students should place a big letter "D" on the dominant male white-tailed deer's card. This white-tailed deer will be the only one that mates with the females in the population during the course of the game. If this male dies, the group will have to designate a new dominant male to take its place.

6. **Have students choose cards from the "Event Cards" and read them to the class.**
"Event Cards" depict scenarios of environmental change that the white-tailed deer populations must confront. Italicized text on the cards indicates the impact that the environmental change has on individuals in the population: loss (death) and reproduction. Remind your students that this exercise is a simulation of what could happen to a real white-tailed deer population. While the events are not real, they do represent some of the many pressures exerted on populations by natural and human forces. Allow your students to take turns picking an event card at random and reading it aloud to the class. Tell your students to pay attention to the event being read and respond to that event based on the white-tailed deer they have in their population. Every group follows the directions of each event card.

7. **Record how many white-tailed deer are left after the events have been read, and analyze the results.**
After all the "Event Cards" have been read, record on the board the number of white-tailed deer (adults and fawns) surviving in each group's population.



Compare different groups of white-tailed deer and determine which ones were more successful. Did genetic diversity contribute to this success? How?



8. **Discuss the results of the game.**
After you finish the game, discuss genetic diversity using the following questions:

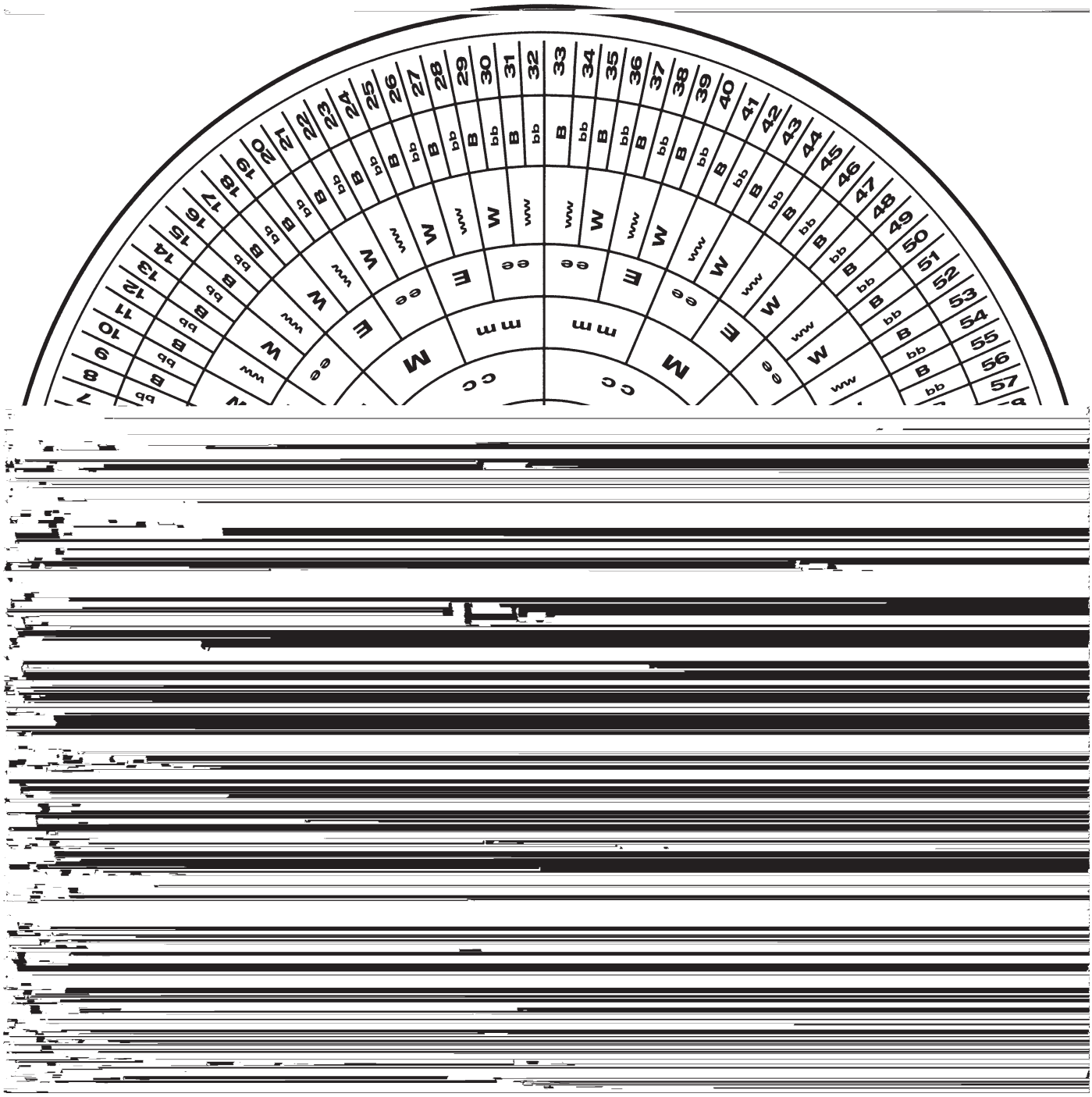
a. Why is genetic diversity important?
Generally speaking, a more genetically diverse population is more likely to contain some individuals that have the traits necessary to survive and adapt to changes in the environment than populations that aren't as genetically diverse.

b. What is the relationship between the size of a population and its genetic diversity?
As a population becomes smaller, some variation in traits is lost. Because there are fewer individuals in a smaller population, it is less likely that there will be individuals with the traits necessary to survive in times of environmental stress. This is one reason smaller populations are more vulnerable to extinction. Many species that once had large populations, such as the greater prairie-chicken and American bison, have lost a great deal of their genetic diversity in a short time because of habitat loss and overhunting.

c. What can be done to prevent the loss of genetic diversity?
To preserve genetic diversity, it is important that wild populations of plants and animals do not

become small or fragmented. Preservation is becoming more and more challenging as human populations expand and increase their level of consumption as well as demand for space.

Human Genetic wheel

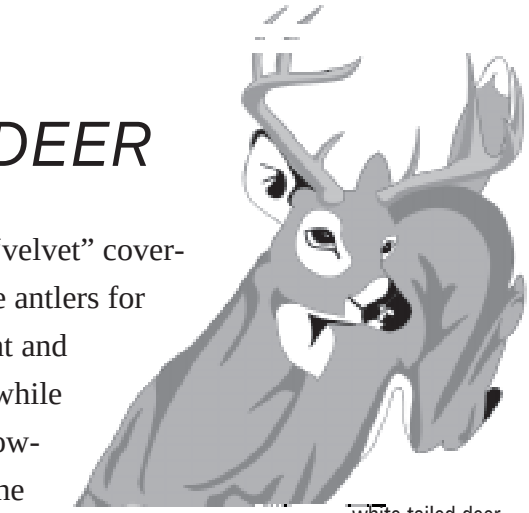


ALL ABOUT WHITE-TAILED DEER

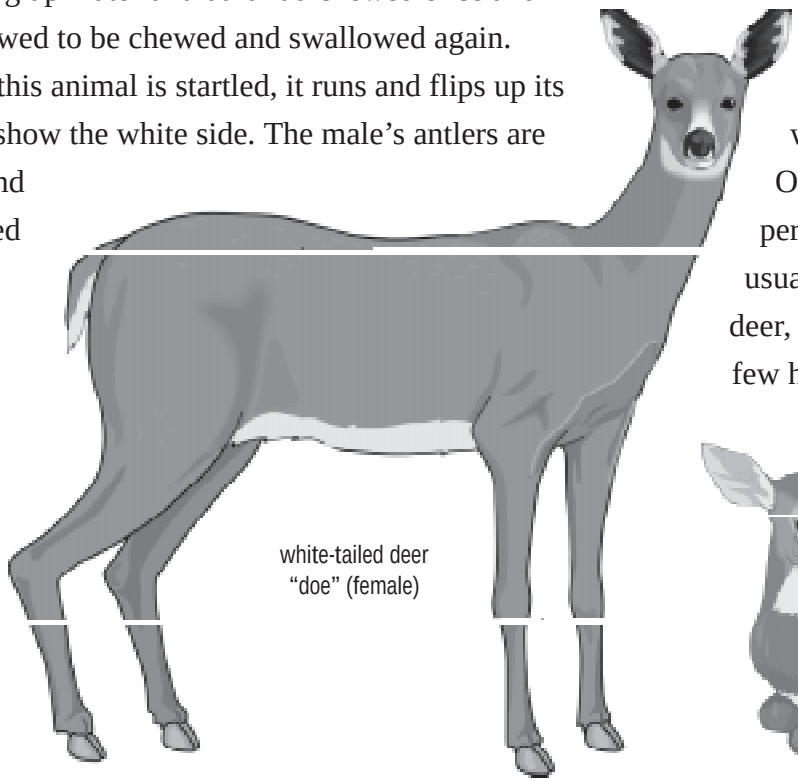
The white-tailed deer is a large mammal, weighing 100 to 300 pounds. Color varies seasonally. During the summer, the hair has a red tint, but during the fall and winter, it is gray-brown. The belly is white. The large tail has a white underside. Young white-tailed deer have white spots on their back. Males grow and shed antlers annually. There are no incisors or canine teeth on the upper jaw.

The white-tailed deer may be found statewide in Illinois. It lives in wooded areas but may be seen feeding far from such locations. The white-tailed deer is an herbivore, feeding on fruits, grasses, grains, vines, mushrooms, nuts and the leaves and twigs of trees and shrubs. It chews its cud, that is, bringing up material that it had chewed once and swallowed to be chewed and swallowed again. When this animal is startled, it runs and flips up its tail to show the white side. The male's antlers are shed and replaced each year.

There is a "velvet" covering over the antlers for nourishment and protection while they are growing. After the antlers are done growing in the fall, the deer will rub this "velvet" off on small trees. The white-tailed deer is active mostly at night and during the sunrise and sunset hours. The female and her offspring may stay together for several months. The male white-tailed deer is called a "buck," and the female is a "doe." A male will mate with several females. Mating occurs October through January. The gestation period is about seven months, and the doe usually produces two offspring. Young deer, called fawns, are able to run within a few hours of birth. Males drop their antlers during February and March.



white-tailed deer "buck" (male)



white-tailed deer "doe" (female)

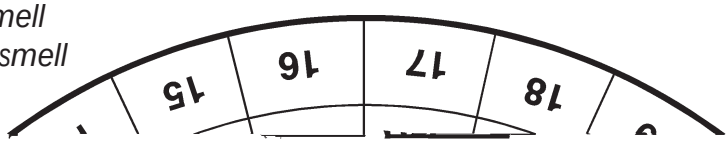
white-tailed deer "fawn" (young)

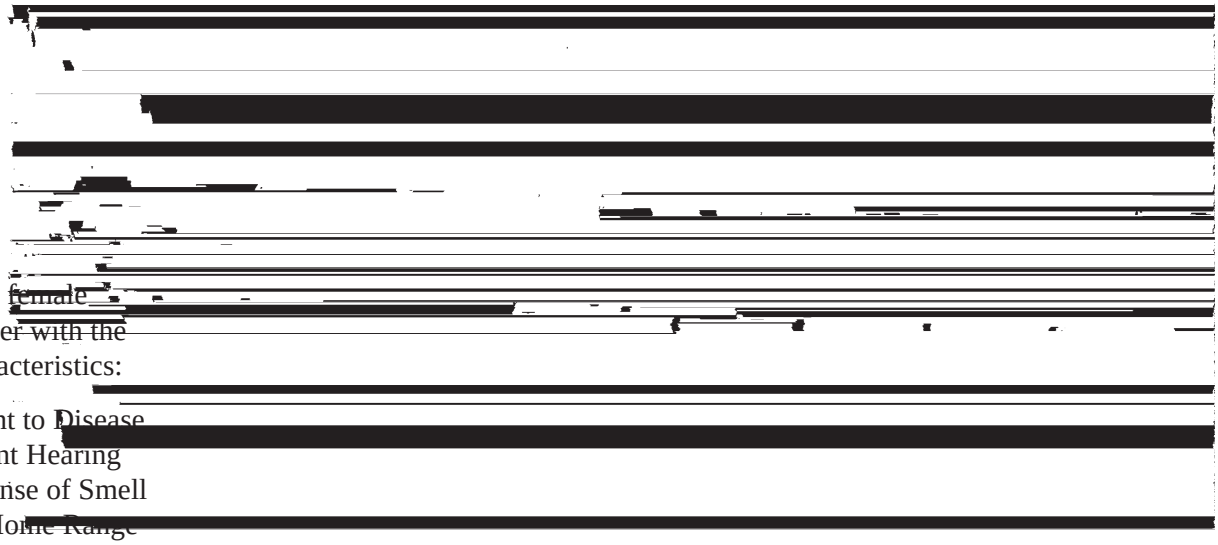
WHITE-TAILED DEER GENETIC WHEEL

Begin with the center and move outward based on your white-tailed deer's traits.

Key:

***Poor S of S** = poor sense of smell*
***Good S of S** = good sense of smell*
***LHR** = large home range*
***SHR** = small home range*





For example, a female white-tailed deer with the following characteristics:

- ✔ Resistant to Disease
- ✔ Excellent Hearing
- ✔ Poor Sense of Smell
- ✔ Large Home Range

would have a genetic number of 13.
A male with the same characteristics would have a genetic number of 29.

WHITE-TAILED DEER CARDS—GROUP 3

WHITE-TAILED DEER FAWN CARDS

EVENT CARDS

The deadly EHD (epizootic hemorrhagic disease), a disease spread by a virus, is killing many deer. White-tailed deer with resistance to the disease are much more likely to survive and reproduce.

Lose half of your white-tailed deer

EVENT CARD

Activity 1-4
The Gene Scene (continued)

BEFORE YOU BEGIN! PART I

For each student, make a copy of the "Human Genetic Wheel" and "Checking Out Your Genetic Traits."

WHAT TO DO! PART I

1. **Introduce genes.**
   Your students may know that the physical characteristics of all creatures on earth are determined by their genes. But what are genes and how do they work? Genes are sections of DNA that manifest themselves as visible traits, such as eye color and hair texture, and nonvisible traits, such as a susceptibility to a certain disease. Genes form visible bars on threadlike structures called chromosomes, which are inside the central part, or nucleus, of every plant and animal cell. Chromosomes contain the genetic material of each cell, made up mostly of DNA. Chromosomes become visible under a microscope when any animal or plant cell divides.

   In mammals, most healthy cells have two copies of each chromosome—one from each parent. Reproductive cells (egg and sperm) have one copy of each chromosome. Different species have different numbers of chromosome pairs. In humans, for example, there are normally 23 pairs of chromosomes.

2. **Discuss genetic diversity.**
   Explain that in a healthy population (a group of organisms of the same species living in a certain geographic area) there is a wide variety of genes that combine in many different ways to form a broad diversity of individuals. If the population is suddenly subjected to stress, such as disease or environmental change, the genetic variety makes it likely that at least some individuals will be adapted well enough to survive and continue the species.

   Populations of some species have become so small or fragmented that they have lost much of their original genetic diversity. If these populations are suddenly subjected to a disease or other stress, there might not be any individuals with the genes that provide protection from the disease and enable the individuals to survive.

5. Pool the results.
There are 128 possible combinations of the seven traits. To find out how many different combinations are present in the class population, go around the room and have each student give his or her "Genetic Wheel" number. Record the numbers on the board. If there is more than one student with the same number, place a check next to that number.

6. Discuss your findings.
Are there any two students in the class who have the same seven traits? Then ask the students if they can think of an eighth trait that would set these two people apart. Are there any numbers that have

Genetic Numbers of Individual White-tailed Deer	5 5	8	11 11	12 12	17 17 17 17	23	24 24 24 24 24 24	30	31
Genetic Combinations	1	2	3	4	5	6	7	8	9

number of each white-tailed deer in their population. They should use the "White-tailed Deer Genetic Wheel" to find the number of each white-tailed deer in the same way they used the "Human Genetic Wheel" (Part I) to find their own numbers. Students should write the genetic number of each white-tailed deer on each white-tailed deer card.

4. Determine the genetic diversity of each group's population of white-tailed deer.

Next ask the students to determine the genetic diversity of their group of white-tailed deer. Ask the student groups to count how many different individual genetic numbers are exhibited by their 20 white-tailed deer. This is the group's diversity number. Consider that a student group has a population of white-tailed deer with the genetic numbers shown in the table above.

In this case, the student group would have a total of nine different genetic combinations represented by their white-tailed deer group so the diversity number is nine. Write a tally on the board, recording each student group's number of white-tailed deer and diversity number. The larger a group's diversity number, the more genetically diverse the population of white-tailed deer.

Each student group should start with 20 white-tailed deer. The diversity number of group one should be 4, group two should be 8, group three should be 12, group four should be 14 and group five should be 20. Some students may realize that they have an advantage—or disadvantage— at this point.

Rules and Strategies

Before students begin the game, share the following information:

- If a white-tailed deer dies, the students should turn the card that represents that white-tailed deer face down.
- Only the dominant male white-tailed deer can mate with the females. If the dominant male dies, a new dominant male must be designated. If a group loses all its males or females, it cannot reproduce.
- Events usually affect half of a population. If you have an odd number of white-tailed deer that are affected by an event, round down to find the number of white-tailed deer affected.
- Female fawns cannot reproduce in this game.
- During reproduction events, each qualifying female will receive a fawn card. Students must choose traits for each fawn based only on the traits of that female and the dominant male. See the following example:

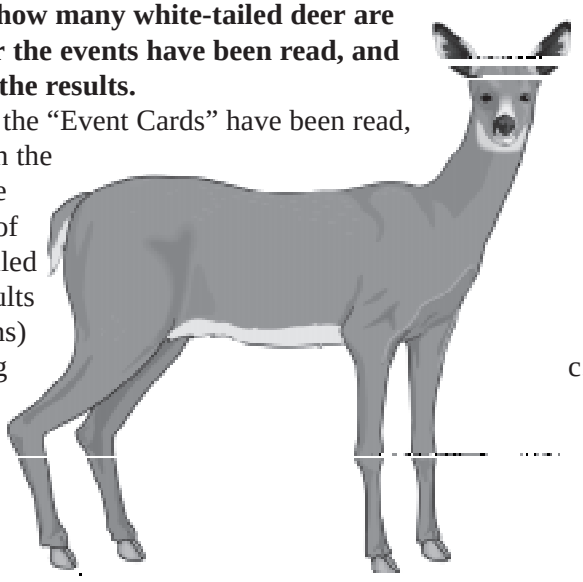
Female	**Dominant Male**
excellent hearing	poor hearing
resistant to disease	resistant to disease
poor sense of smell	good sense of smell
large home range	large home range

The fawn can have either excellent hearing or poor hearing and have either poor sense of smell or good sense of smell, but the fawn must be resistant to disease and have a large home range (because both parents have these traits). Every time a female has a fawn, the students will assign traits in this manner. Circle the traits on the fawn cards.

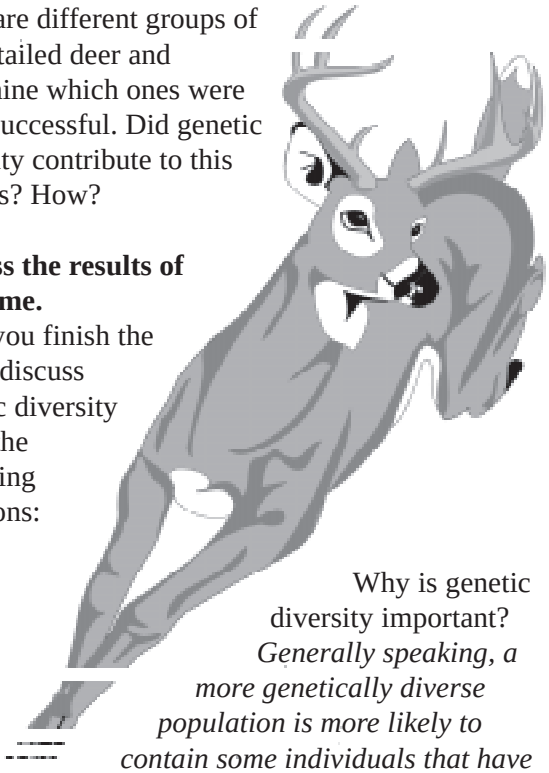
5. **Have each group select a dominant male.**
Each group of students should select one male in its white-tailed deer population to be the dominant male. Students should place a big letter "D" on the dominant male white-tailed deer's card. This white-tailed deer will be the only one that mates with the females in the population during the course of the game. If this male dies, the group will have to designate a new dominant male to take its place.

6. **Have students choose cards from the "Event Cards" and read them to the class.**
"Event Cards" depict scenarios of environmental change that the white-tailed deer populations must confront. Italicized text on the cards indicates the impact that the environmental change has on individuals in the population: loss (death) and reproduction. Remind your students that this exercise is a simulation of what could happen to a real white-tailed deer population. While the events are not real, they do represent some of the many pressures exerted on populations by natural and human forces. Allow your students to take turns picking an event card at random and reading it aloud to the class. Tell your students to pay attention to the event being read and respond to that event based on the white-tailed deer they have in their population. Every group follows the directions of each event card.

7. **Record how many white-tailed deer are left after the events have been read, and analyze the results.**
After all the "Event Cards" have been read, record on the board the number of white-tailed deer (adults and fawns) surviving in each group's population.



Compare different groups of white-tailed deer and determine which ones were more successful. Did genetic diversity contribute to this success? How?



8. **Discuss the results of the game.**
After you finish the game, discuss genetic diversity using the following questions:

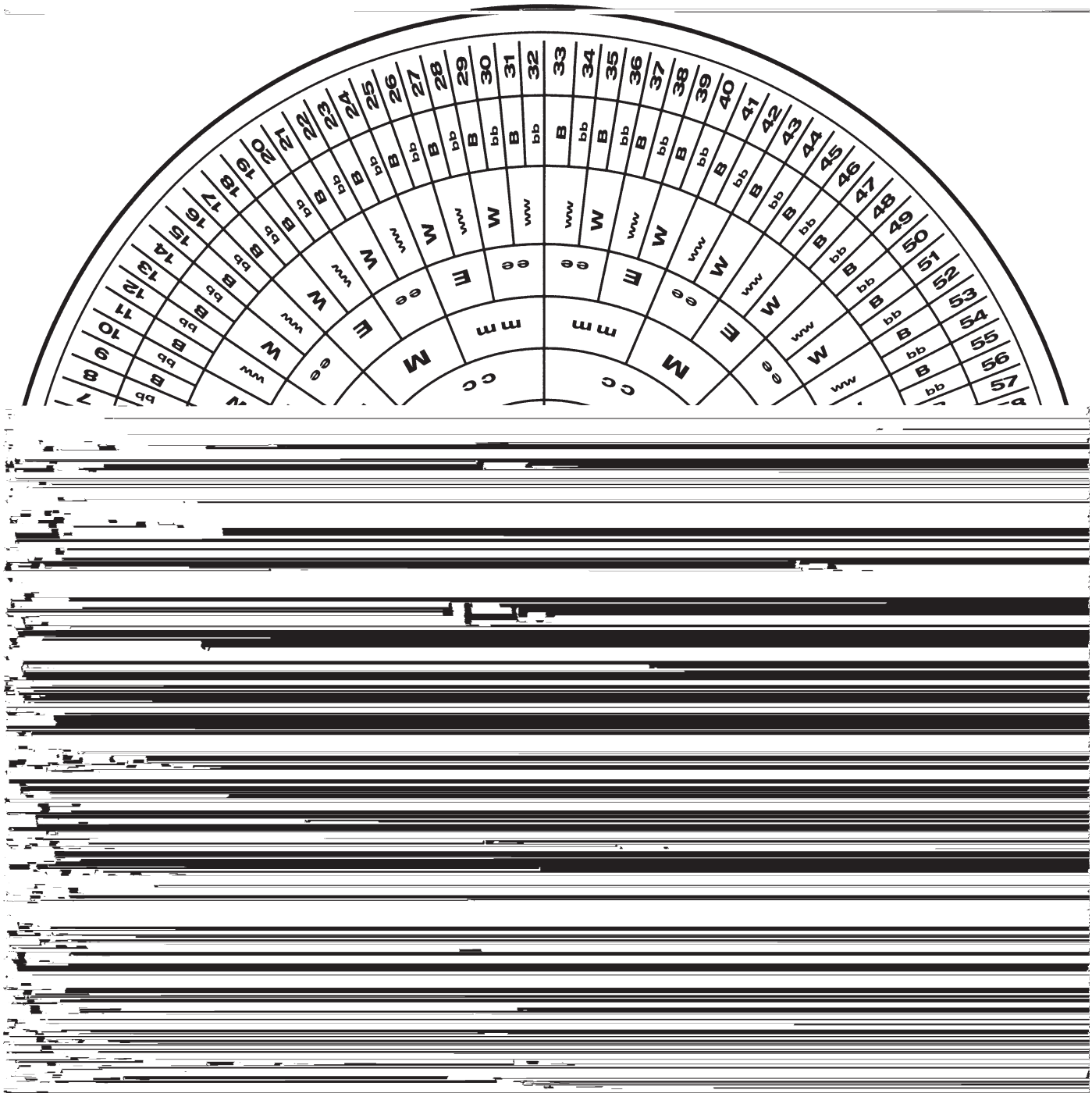
a. Why is genetic diversity important?
Generally speaking, a more genetically diverse population is more likely to contain some individuals that have the traits necessary to survive and adapt to changes in the environment than populations that aren't as genetically diverse.

b. What is the relationship between the size of a population and its genetic diversity?
As a population becomes smaller, some variation in traits is lost. Because there are fewer individuals in a smaller population, it is less likely that there will be individuals with the traits necessary to survive in times of environmental stress. This is one reason smaller populations are more vulnerable to extinction. Many species that once had large populations, such as the greater prairie-chicken and American bison, have lost a great deal of their genetic diversity in a short time because of habitat loss and overhunting.

c. What can be done to prevent the loss of genetic diversity?
To preserve genetic diversity, it is important that wild populations of plants and animals do not

become small or fragmented. Preservation is becoming more and more challenging as human populations expand and increase their level of consumption as well as demand for space.

Human Genetic wheel

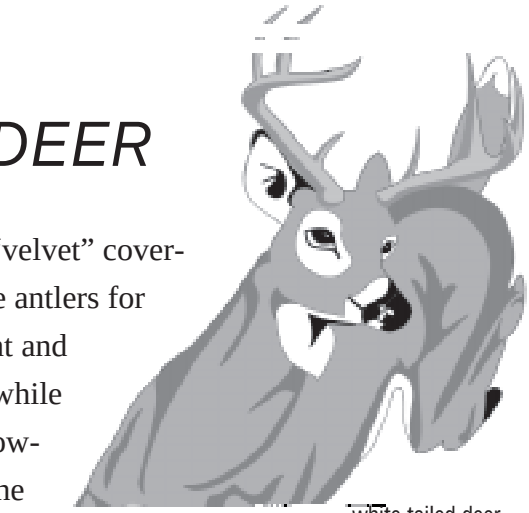


ALL ABOUT WHITE-TAILED DEER

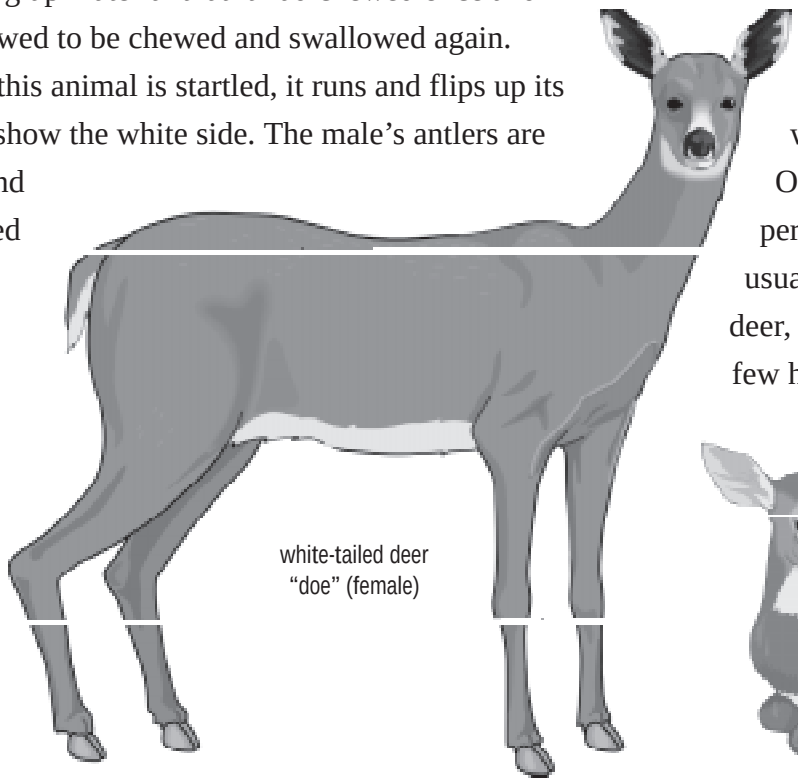
The white-tailed deer is a large mammal, weighing 100 to 300 pounds. Color varies seasonally. During the summer, the hair has a red tint, but during the fall and winter, it is gray-brown. The belly is white. The large tail has a white underside. Young white-tailed deer have white spots on their back. Males grow and shed antlers annually. There are no incisors or canine teeth on the upper jaw.

The white-tailed deer may be found statewide in Illinois. It lives in wooded areas but may be seen feeding far from such locations. The white-tailed deer is an herbivore, feeding on fruits, grasses, grains, vines, mushrooms, nuts and the leaves and twigs of trees and shrubs. It chews its cud, that is, bringing up material that it had chewed once and swallowed to be chewed and swallowed again. When this animal is startled, it runs and flips up its tail to show the white side. The male's antlers are shed and replaced each year.

There is a "velvet" covering over the antlers for nourishment and protection while they are growing. After the antlers are done growing in the fall, the deer will rub this "velvet" off on small trees. The white-tailed deer is active mostly at night and during the sunrise and sunset hours. The female and her offspring may stay together for several months. The male white-tailed deer is called a "buck," and the female is a "doe." A male will mate with several females. Mating occurs October through January. The gestation period is about seven months, and the doe usually produces two offspring. Young deer, called fawns, are able to run within a few hours of birth. Males drop their antlers during February and March.



white-tailed deer "buck" (male)



white-tailed deer "doe" (female)

white-tailed deer "fawn" (young)

WHITE-TAILED DEER GENETIC WHEEL

Begin with the center and move outward based on your white-tailed deer's traits.

Key:

***Poor S of S** = poor sense of smell*
***Good S of S** = good sense of smell*
***LHR** = large home range*
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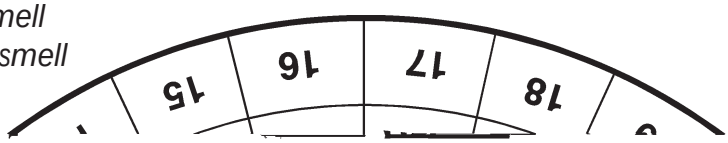
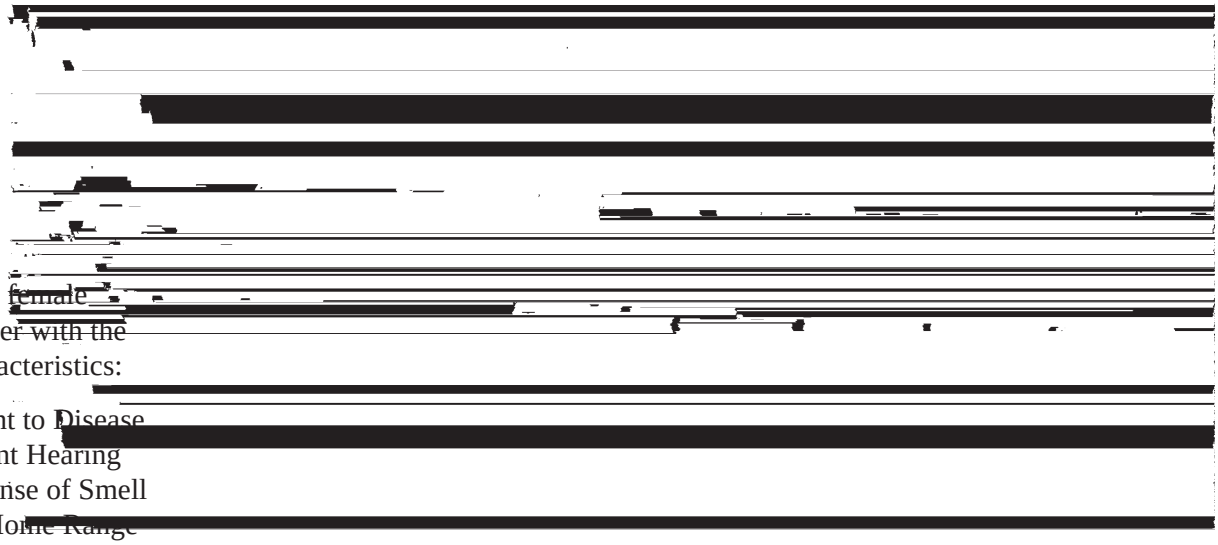




For example, a female white-tailed deer with the following characteristics:

- ✔ Resistant to Disease
- ✔ Excellent Hearing
- ✔ Poor Sense of Smell
- ✔ Large Home Range

would have a genetic number of 13.
A male with the same characteristics would have a genetic number of 29.

WHITE-TAILED DEER CARDS—GROUP 3

WHITE-TAILED DEER FAWN CARDS

EVENT CARDS

The deadly EHD (epizootic hemorrhagic disease), a disease spread by a virus, is killing many deer. White-tailed deer with resistance to the disease are much more likely to survive and reproduce.

Lose half of your white-tailed deer

EVENT CARD

"Elm Buds" by Carl Sandburg, from *Honey and Salt: A New Volume of Poems* (see "Resources" list)
"Tomorrow" by Ann Carlson, from *Prairie Poetry* (see "Resources" list)
"I Could Not Swallow the Lake" by Andrea L. Change, from *Power Lines* (see "Resources" list)

2. **Discuss the poems.**
   Encourage your students to discuss their reactions to each of the poems. You may want to start with general questions regarding students' likes and dislikes of the poems and their reasoning for such feelings. Ask the students if any poem captured their feelings about nature and/or biodiversity. You may also want to ask specific questions about each poem. Be sure to discuss the tone, setting and images evoked by each poem. Allow the students to speak freely and give recognition to any answer that they can support thoughtfully.

3. **Have students write their own poetry.**
   To assist students in writing original poetry, it is important to help them focus their writing. You might begin by asking them to recall some of the different emotions or ideas conveyed in the poetry they have read (awe, delight, humor, fear of wildlife and so on). Have they had similar or different reactions to the plants, animals and places they have seen or read about? With the students working in small groups, encourage them to share specific emotions about significant experiences with nature that they have had. You might even want the students to share images that capture the feeling or idea they are remembering.

   Alternatively, you might want to take students outside for a nature walk. Encourage them to look closely at one or a few specific elements of the natural world. They can draw pictures or jot down ideas before going back inside.

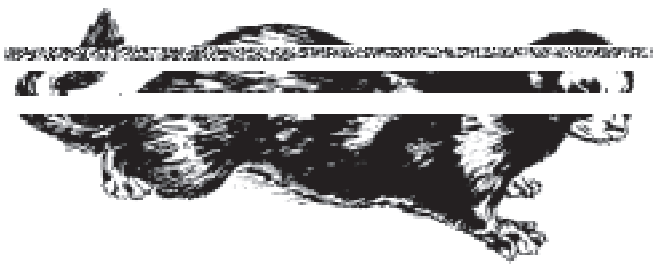
   Pass out copies of the "Student Page—Types of Poems." Go over the descriptions of the different kinds of poems to make sure the students understand them. Explain to the students that they will be writing their own poems about biodiversity. They can choose any form of poetry, from one of the forms described on the sheet to rhyming verse. And they may write about any aspect of biodiversity they choose. They should write at least two poems, each using a different style.

   Allow the students to begin writing their poetry. Again, they can write about any aspect of

Resources

Philosophical

Berry, Wendell. 1968.



Carpenter, Jill, editor. 1998. *Of frogs and toads*. Ione Press, Sawanee, Tennessee. 131 pp.

Cowden, Frances B. and Eve B. Hatchett. 1994. *Of butterflies and unicorns and other wonders of the earth*. Grandmother Earth, Germantown, Tennessee. 63 pp.

Daniel, Mark. 1986. *A child's treasury of poems*. Dial Books for Young Readers, New York. 160 pp.

Fulcrum Resources Contest Winners, Third Annual. 2000. *From ants to zorapterans: pesky poems about bugs*. Fulcrum Resources, Golden, Colorado. 144 pp.

Livingston, Myra, editor. 1992. *If you ever meet a whale*. Holiday House, New York. 32 pp.

Teaching Poetry

Hopkins, Lee Bennett. 1987. *Pass the poetry, please.* Harper Collins Children's Books, New York. 262 pp.

Larrick, Nancy. 1991. *Let's do a poem*. Delacorte, New York. 122 pp.

Lies, Betty B. 1993. *The poet's pen: writing poetry with middle and high school students*. Libraries Unlimited, Englewood, Colorado. 201 pp.

"In the end, the poem is not a thing we see; it is, rather, a light by which we may see—and what we see is life."

—Robert Penn Warren, writer

TYPES OF POEMS

Free verse

Any number of open lines with no set rhyme or pattern.

Sun sets gently
through the horizon cushion
to be absorbed
beyond view.

Cinquain

Verses with the following pattern:

Activity 2-2
The Spice of Life

AT A GLANCE
Explore beliefs and values about why biodiversity is important and why it should be protected.

OBJECTIVES
Explain personal beliefs and values about protecting biodiversity. List several reasons why people believe it is important to protect biodiversity.

SUBJECTS
English language arts, science, social science

SKILLS
organizing (prioritizing), analyzing (discussing), presenting (articulating), citizenship (debating, evaluating a position, taking a position, defending a position)

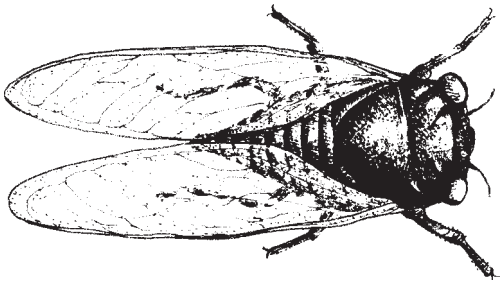
LINKS TO *ILLINOIS BIODIVERSITY BASICS* CONCEPTUAL FRAMEWORK
values and beliefs

VOCABULARY
ecological processes, economics, extinct, pollination

TIME
one class period

MATERIALS
poster-sized paper; markers

CORRELATION TO ILLINOIS LEARNING STANDARDS
English language arts 4.B.2a, 4.B.2b
science 13.B.2f, 13.B.3d
social science 17.C.2c



People's feelings about biodiversity issues, including the importance people place on wild species and spaces and whether they think biodiversity should be protected, do not depend on just their knowledge of these issues and the sciences that relate to them (ecology, biology, sociology, political science, economics and so on). People's feelings also depend on personal belief systems and values. This activity is designed to give your students a chance to examine their values and to sharpen their own thinking by sharing their opinions and feelings with their peers. The students first discuss their points of view in small groups and then talk about biodiversity conservation as a whole group. A series of questions is provided to get the students thinking about a range of biodiversity-related concerns, as well as additional guiding questions to help direct the discussions. You may want to add your own questions to these lists and think about other ways to engage your group.

BEFORE YOU BEGIN

Write each of the "Why Care About Biodiversity?" statements (page 71) on six separate pieces of poster-sized paper. You can adapt, shorten, add or combine as needed. Write the word "Other" on a seventh piece of poster-sized paper. Make sure that the students can read the statements from all areas of the room.

WHAT TO DO

1. **Discuss the meaning of biodiversity with your students.**
   Biodiversity is the variety of life on earth. It includes the sheer variety of species on earth, the earth's many ecosystems and genetic diversity, which refers to the variety of genes within a species.

2. **Ask your students whether protecting biodiversity is important and why they feel the way they do.**
   Explain that many people feel that it's important to protect biodiversity and that they have diverse reasons for thinking so. Ask your students how they feel. What reasons can they give to protect biodiversity? These may be reasons they have read, reasons they have heard others express or their own,

personal views. Write their ideas on a piece of poster-sized paper or a chalkboard. (It may also help to give them a few minutes to write their ideas before talking.)

2. Have the students use the following statement as a journal starter: "Some ideas or thoughts I had before the activity are different now. They include . . ."

3. Have the students write a dialogue between two people who have different viewpoints on protecting biodiversity.

Portfolio
The student's biodiversity protection statement (created in the assessment) can be included in the portfolio.

Extension
Have each student or small group of students choose one of the "Why Care About Biodiversity?" statements to use as a theme for a collage. Have the students make a display of the collages.

Resources

Kellert, Stephen. 1997. *The value of life: biological diversity and human society*

Educator Page
Valuing Biodiversity

1. It is important to conserve the diversity of life for medical and economic reasons.

Guiding Questions
- Do people actually need wild plants and animals for either medicinal or economic reasons?
- Can't people synthesize in a laboratory all the medicines they need?
- If genetic material is what's important, wouldn't it be sufficient if people froze wild plant and animal tissue samples, didn't worry about the actual organisms and then used the samples when needed?
- If a plant or animal species is not known to have any medical or economic benefit to people, is it then OK to let the species die out?

2. It's important to protect the diversity of life because biodiversity helps maintain important ecological processes that help support life on earth.

Guiding Questions
- What sorts of ecological processes does biodiversity help maintain?
- People have developed an amazing array of technologies to deal with particular problems—everything from water treatment plants that purify sewage water to scrubbers that can take pollutants from factory smokestacks out of the air. Isn't it fair to assume that people will be able to develop technologies that can perform essential ecological processes in place of biodiversity?
- Are there any down sides to technological solutions?

3. Our lives would not be as rich if we lost species such as river otters, fireflies, red-tailed hawks, treefrogs, Illinois mud turtles and bobcats.

Guiding Questions
- Is there anything about these species that makes them special?
- Would you feel the same way if the species we lost were venomous snakes, biting insects and other species that may be harmful to people?
- Are there species that you think are more important to protect than others? Which ones? Why?

4. All species have a right to exist.

Guiding Questions
- Do people have the right to use any of the world's resources as they see fit? Why or why not?
- Does the right to exist apply to ugly, obscure species that are of no use to people?
- Some species have been around for millions of years—and have survived incredible periods of destruction and change on the planet. Should that influence whether we decide to protect a species?
- Do people have any responsibilities to other living things?
- Do people have the right to drive species to extinction?

5. No generation has the right to destroy the environment and resources that future generations will depend on.

Guiding Questions
- Why should people today do without things they want, when we don't even know what future generations will need or want?
- How do you feel about the state of the world? Do you feel that past generations have left you with the environment and resources you need to live?
- There used to be millions of passenger pigeons in the United States. Today these birds are extinct. Has your life been affected in any way by the lack of passenger pigeons in the world? Will future generations really care about species that disappeared before they were born?

6. Diversity of life is important for inspiring inventors and artists and for spurring curiosity and imagination.

Guiding Questions

- What human pursuits look to nature for inspiration?
- What inventions, stories or works of art can you think of that were inspired by living things? Could these have been produced without the inspiration of nature?
- Isn't it reasonable to assume that all the photographs and films that have been made of wild plants and animals can provide inspiration to future writers and artists?

7. Diversity of life is important for recreational activities.

Guiding Questions

- What kinds of recreational activities rely on wild spaces or species?
- Can well-tended golf courses and manicured parks provide the outdoor green space people need?
- Is it right to save an area so people can hike and fish if it means that other people lose their jobs?
- Does the fact that someone has done a particular job all his or her life—and that perhaps his or her parents or grandparents also did the same job—give the person a right to keep doing that job, even if it means wiping out a species or harming the environment?
- Should people be allowed to take part in any recreational activity (such as some off-road vehicle races) even if it harms the environment? How do we balance the rights of individuals and the rights of society as a whole?

Why Care about Biodiversity?

It is important to conserve the diversity of life for medical and economic reasons. Plants and animals could provide us with additional foods, mediceeherftm other arodutns that wial

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It is important to prtecte the diversity of life

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Activity 2-3
Secret Services

AT A GLANCE
Perform simulations that demonstrate some of the important ecosystem services that biodiversity provides.

OBJECTIVES
Perform a series of simulations that demonstrate ecosystem services. Identify and discuss the services illustrated in the simulations.

SUBJECTS
English language arts, science, social science

SKILLS
organizing (manipulating materials), interpreting (identifying cause and effect, inferring, making models), presenting (demonstrating, explaining), citizenship (working in a group)

LINKS TO *ILLINOIS BIODIVERSITY BASICS*
CONCEPTUAL FRAMEWORK
genetic/species/ecological diversity

VOCABULARY
atmosphere, evaporation, heavy metals, impurity, mineral, pesticides, photosynthesis, sediment, toxic substance, transpiration, wetland

TIME
two class periods

MATERIALS
station #1: clear funnel or clear plastic soda bottle with the bottom cut off and the label removed; clear plastic cup, tall jar or flask; cotton balls or toilet paper; activated charcoal; sand; potting soil; water

station #2: fresh celery stalks with leaves; a jar or beaker; red or blue food coloring; water; paring knife; magnifying glass

station #3: several sponges; a doormat or a piece of artificial turf; two flat sheets of wood or plastic similar in size to the doormat; two shallow aluminum trays; soil; two containers of water; props to tilt the models

station #4: two large, clear-plastic cups; a six-inch square piece of waxed paper; geranium plant leaf with stem; cobalt chloride paper (available from science supply catalogs); petroleum jelly; paper clip; tape; water

station #5: large bowl; water; measuring cup; tablespoon; baking soda; drinking glass; lamp; water plant such as *Elodea* or *Anacharis* (available from stores that sell live fish)

copy of "The Secret's Out!" for each student

CORRELATION TO ILLINOIS LEARNING STANDARDS
English language arts 4.B.2a; 4.B.2b; 4.B.3a
science 11.A.2e; 12.E.2a; 12.E.2b; 12.E.3b
social science 17.B.2a; 17.B.2b; 17.B.3a

Ecosystems and the variety of species within them provide many important services that help make life possible or at least more livable. These services are happening all the time—they are so common that we often don't notice them or think about how important they are. This activity is a series of five simulations that illustrate a variety of these services. (More advanced students can try to develop their own simulations after learning more about ecosystem services.)

BEFORE YOU BEGIN

There are a number of ways you can use this activity with your students. We suggest that students be grouped into five secret service teams. Assign each team the task of setting up and testing one of the simulations on Day 1. On Day 2, have each team present its secret service simulation to the class. After watching each presentation, students will use the handout "The Secret's Out!" to identify the ecosystem service being demonstrated in the simulations.

You will need to arrange stations for each team's simulation. Put a copy of the directions and the necessary materials at each station. Label each of the five stations. Also make one copy of "The Secret's Out!" for each student. (Please note that Station #2 is shorter than the others, yet it still requires two days. It can be combined with Station #3. Stations #2 and #3 require some preparation ahead of time. Stations #1, #4 and #5 require activated charcoal, cobalt chloride paper and *Elodea*, respectively. Activated charcoal and *Elodea* can be found in most pet stores that sell fish. Cobalt chloride paper can be ordered through science supply catalogues.)

WHAT TO DO

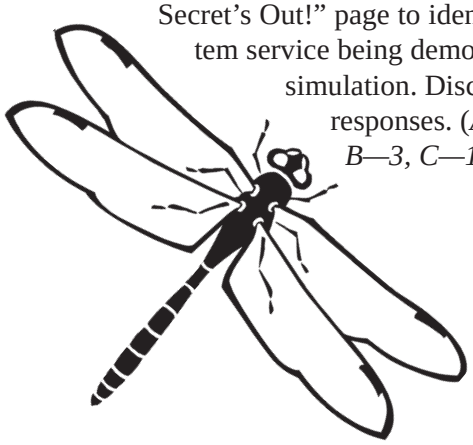
1. **Day 1: Setting the stage.**
   Divide your class into five teams and assign one team to each station. Explain that the students will be working together to complete a simulation. Each team will be responsible for a different simulation. Students should not discuss their simulation with other members of the class. The simulations illus-

trate various ways that ecosystems provide important services for us and the environment. Identify the five stations around the room.

When they arrive at a station, all the members of the team should read the directions completely before setting up the simulation. Students should then set up and run their simulation. Tell them that on Day 2, each team will run its simulation for the class. Each team should discuss the expected outcome of the simulation. Each member of the team should also answer the questions listed under "Think About It."

Note: Remind the students that after they try their simulation, they have to get it ready for the next day, so they might have to dry their equipment and/or supplies or replace some of the parts. Stations #2, #4 and #5 require 24 hours to complete. Let the students at these three stations know that they will not need to run the simulation again on Day 2 but that they'll have to explain what they did on Day 1.

2. **Day 2: Presenting the simulations and matching the analogies.**
Distribute the "The Secret's Out!" page to each student. Explain to the students that each team will have a few minutes to explain their simulation to the class. Ask each team to briefly review its procedures, perform the simulation (or explain the results of an overnight simulation) and discuss the results. Students should provide information to the class that answers the "What Happened?" and "Think About It" sections on their handout. After watching each presentation, have the students use "The Secret's Out!" page to identify the ecosystem service being demonstrated in the simulation. Discuss student responses. (*Answers: A—2, B—3, C—1, D—5, E—4*)



3. **Review and summarize.**
When all the teams have completed their presentations, review and summarize the different ways ecosystems provide important services to people and to the planet. The list should include flood control, water filtering and purification, erosion control, oxygen production and climate control.

WRAPPING IT UP

Assessment

1. Use the last step of the activity ("What to Do," Step #3) as the assessment. Encourage students to include on each list how the service is conducted in the "real" world and to give local, regional or state examples of where the ecosystem services are taking place (e.g., local marsh, Shawnee National Forest, Volo Bog State Natural Area).

2. Students may keep a lab manual and make a report for each station. Lab reports should include an overview of the simulation, a description of what happened and an analysis of the secret service that was simulated.

Portfolio

The lab reports for each station from Assessment #2 can be placed in the portfolio.

Extensions

1. Identify places in your community where the ecosystem services that you simulated are occurring.

2. Have students propose or create simulations that model other ecosystem services.

3. Using the Illinois Department of Natural Resources' *Biodiversity of Illinois*

Resources

Bernstein, Leonard, Winkler, Alan and Linda Zierdt-Warshaw. 1995. *Environmental science: ecology and human impact.* Addison-Wesley Publishing Company, Inc., Menlo Park, California. 452 pp.

Environmental Concern, Inc., and The Watercourse. 1995. *WOW! The wonders of wetlands.* Environmental Concern, Inc., and The Watercourse, Bozeman, Montana. 332 pp.

Illinois Department of Natural Resources. 1999. *Biodiversity of Illinois, volume I: aquatic habitats*. Illinois Department of Natural Resources, Springfield, Illinois. CD-ROM.

Illinois Department of Natural Resources. 2000. *A field guide to the wetlands of Illinois*. Illinois Department of Natural Resources, Springfield, Illinois. 252 pp.

Illinois Department of Natural Resources. 2000. *Biodiversity of Illinois, volume II: woodland habitats*. Illinois Department of Natural Resources, Springfield, Illinois. CD-ROM.

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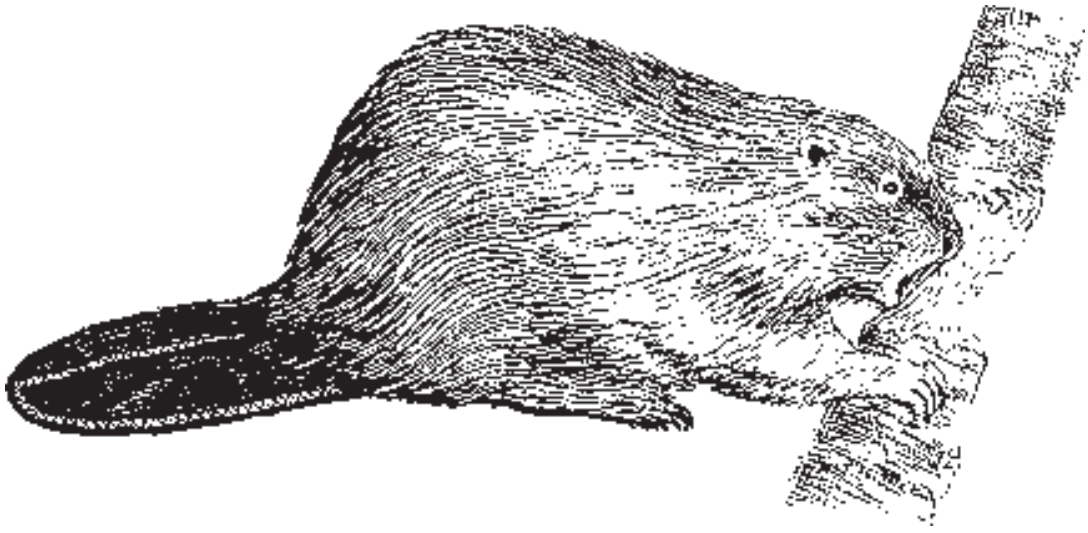
Oates, Maureen. 1995. *Ecosystems (science is elementary—a science teaching resource publication)*. Museum Institute for Teaching Science, Boston. 46 pp.

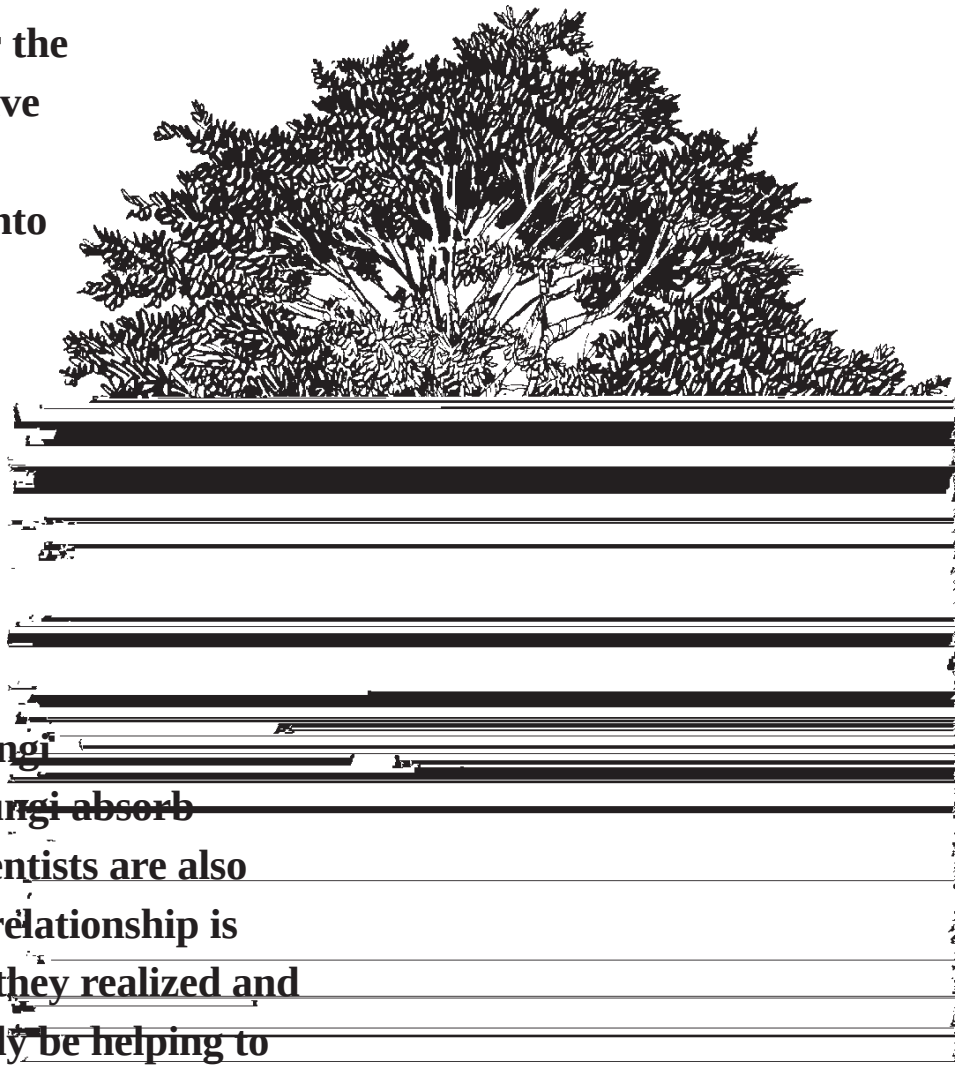
Washington State Department of Publications Office. 1996. *Discover wetlands*. Washington State Department of Publications Office, Olympia, Washington. 235 pp.

The Watercourse and Western Regional Environmental Education Council. 1995. *Project WET*. The Watercourse and Western Regional Environmental Education Council, Bozeman, Montana. 518 pp.



Activity 2-3
Secret Services

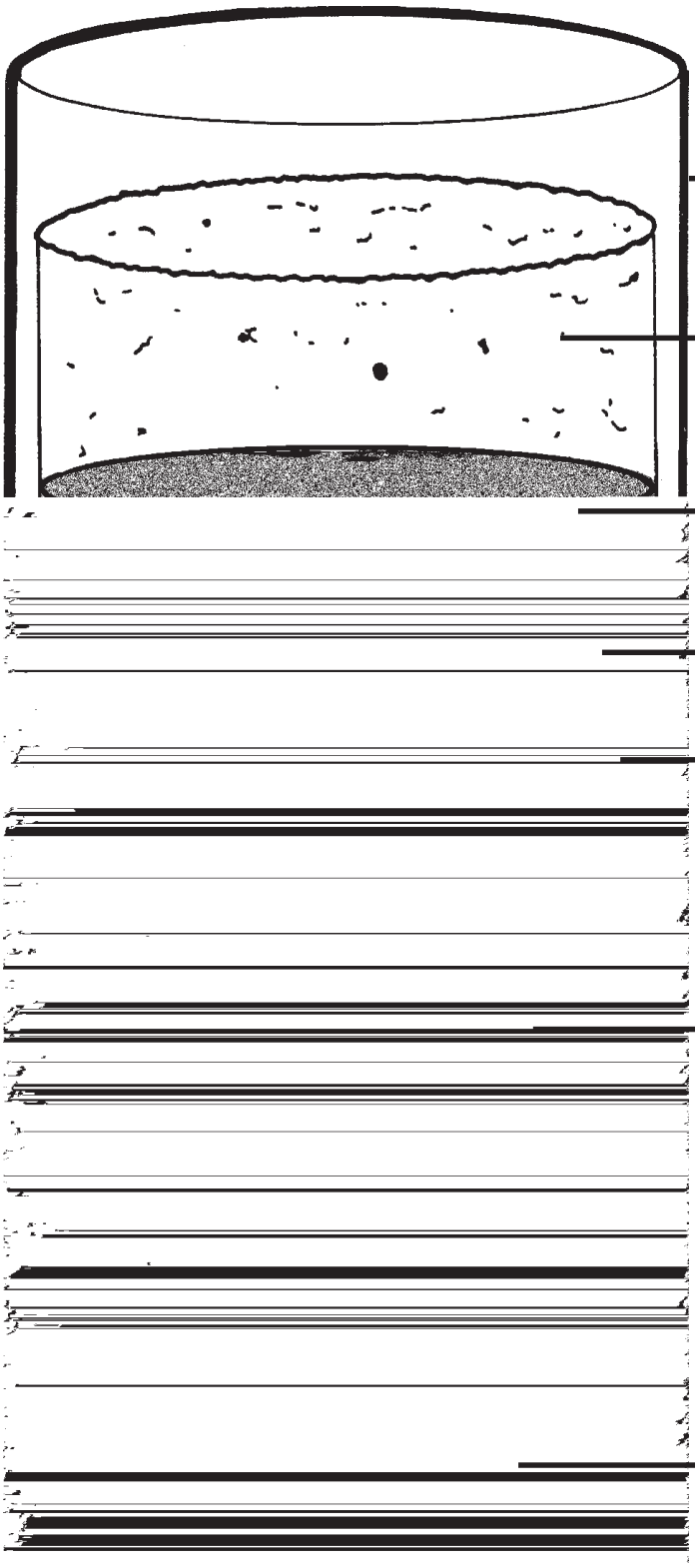
Nearly half of a tree's biomass is hidden in a vast tangle of roots under the ground. And scientists have found that these roots, in turn, are usually woven into an even bigger web made of fungi. Fungi and trees have a symbiotic relationship that benefits both. Fungi help trees absorb important nutrients like nitrogen and phosphorus from the soil. And trees provide fungi with carbon, which the fungi absorb from the trees' roots. Scientists are also finding that this tangled relationship is even more complex than they realized and that the fungi may actually be helping to "manage" the forest by giving some trees more nutrients than others.

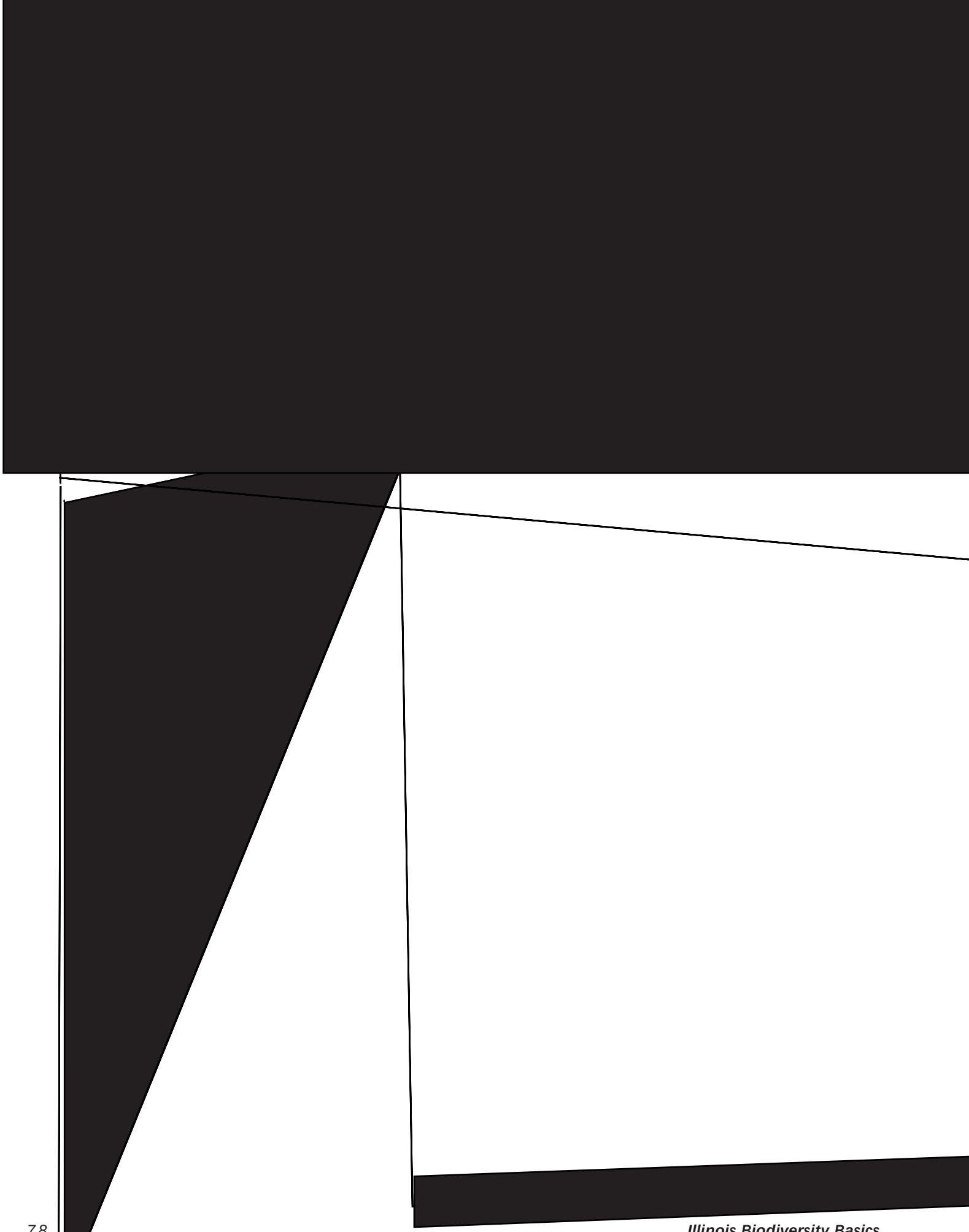


—Adapted from "The Web Below," by Carl Zimmer in Discover*, November 1997.*

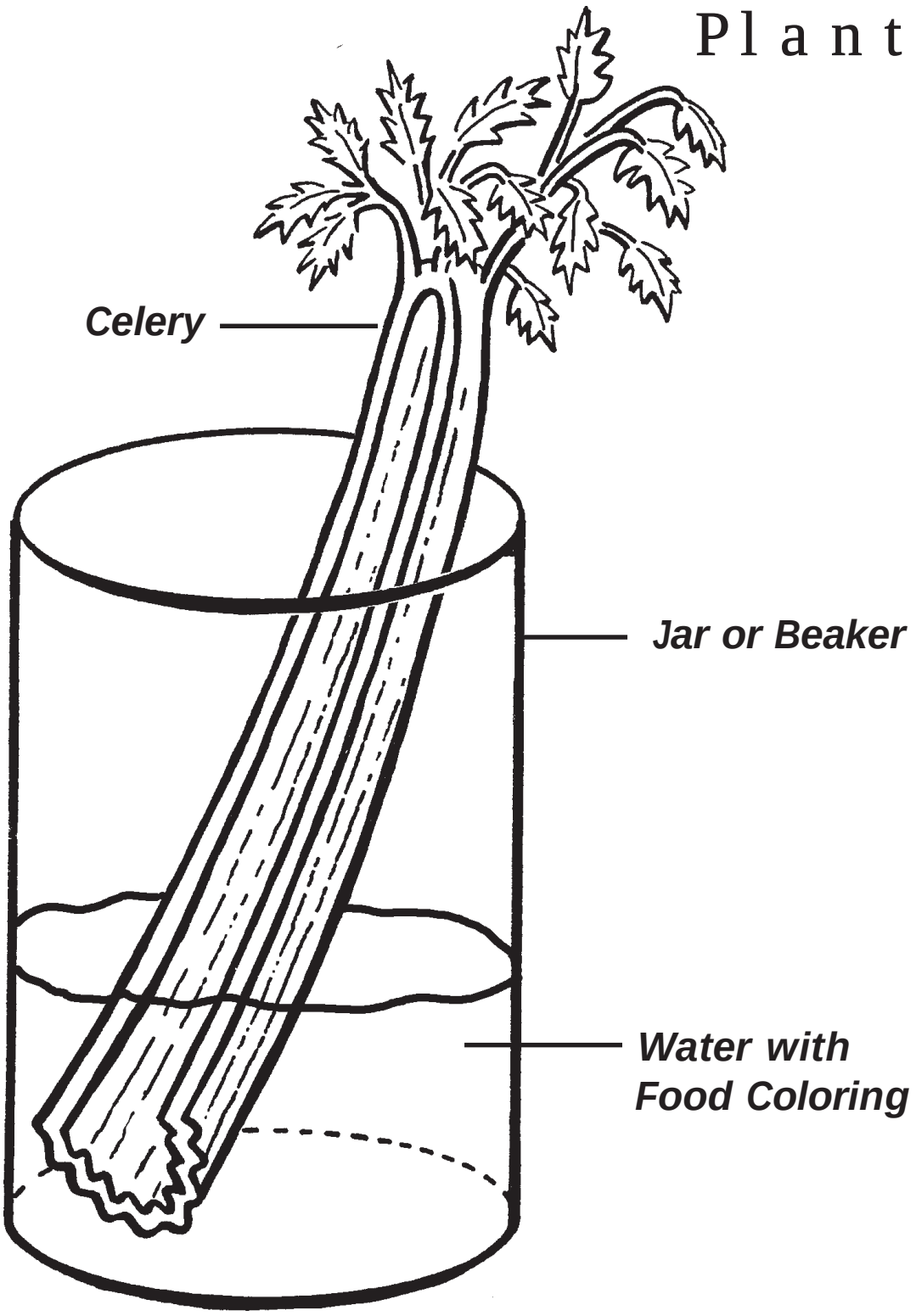
MATERIALS

STATION 1: DIRTY WATER



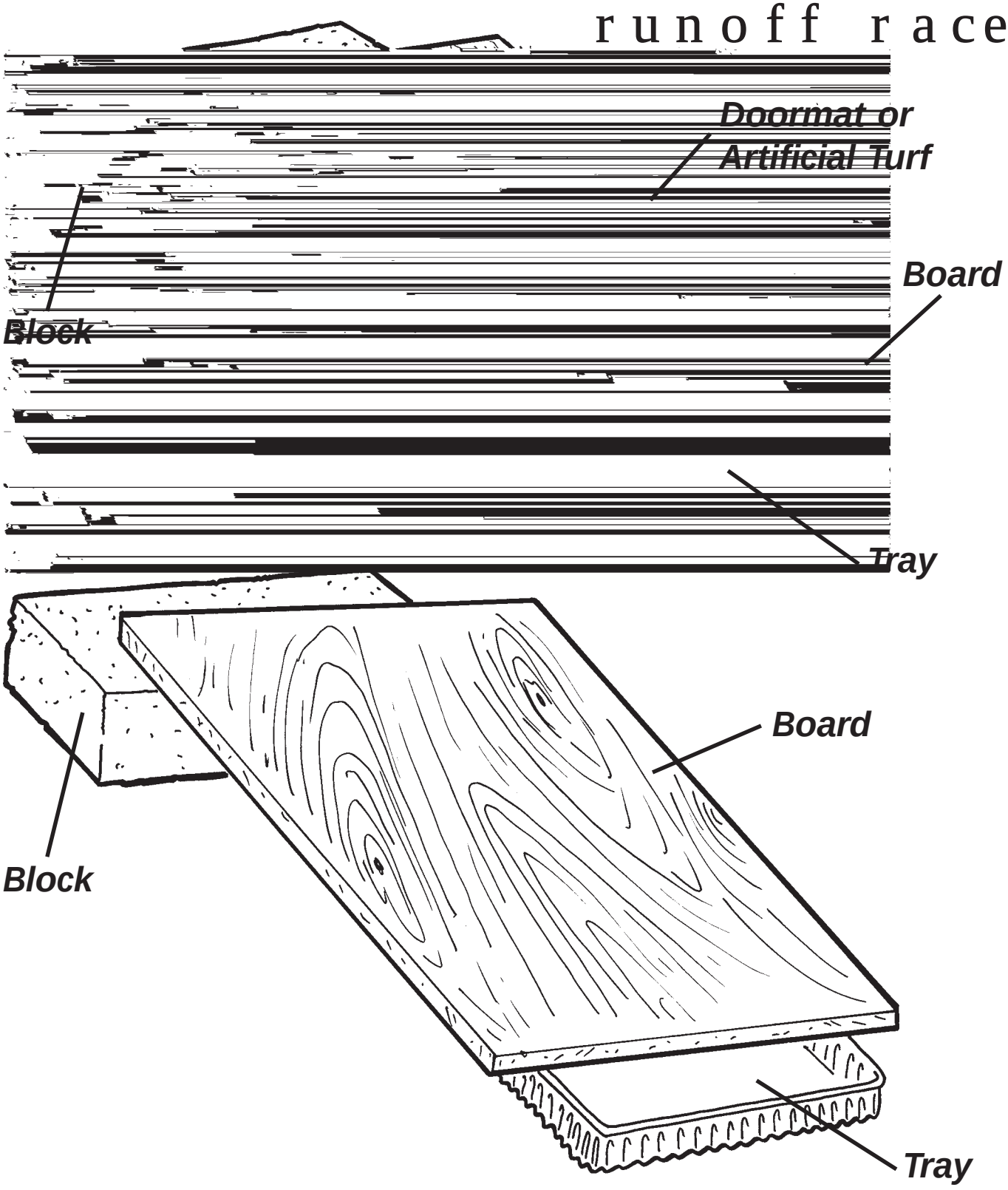


STATION 2: Treatment Plants



STATION 3:Srunof

STATION 3: runoff race

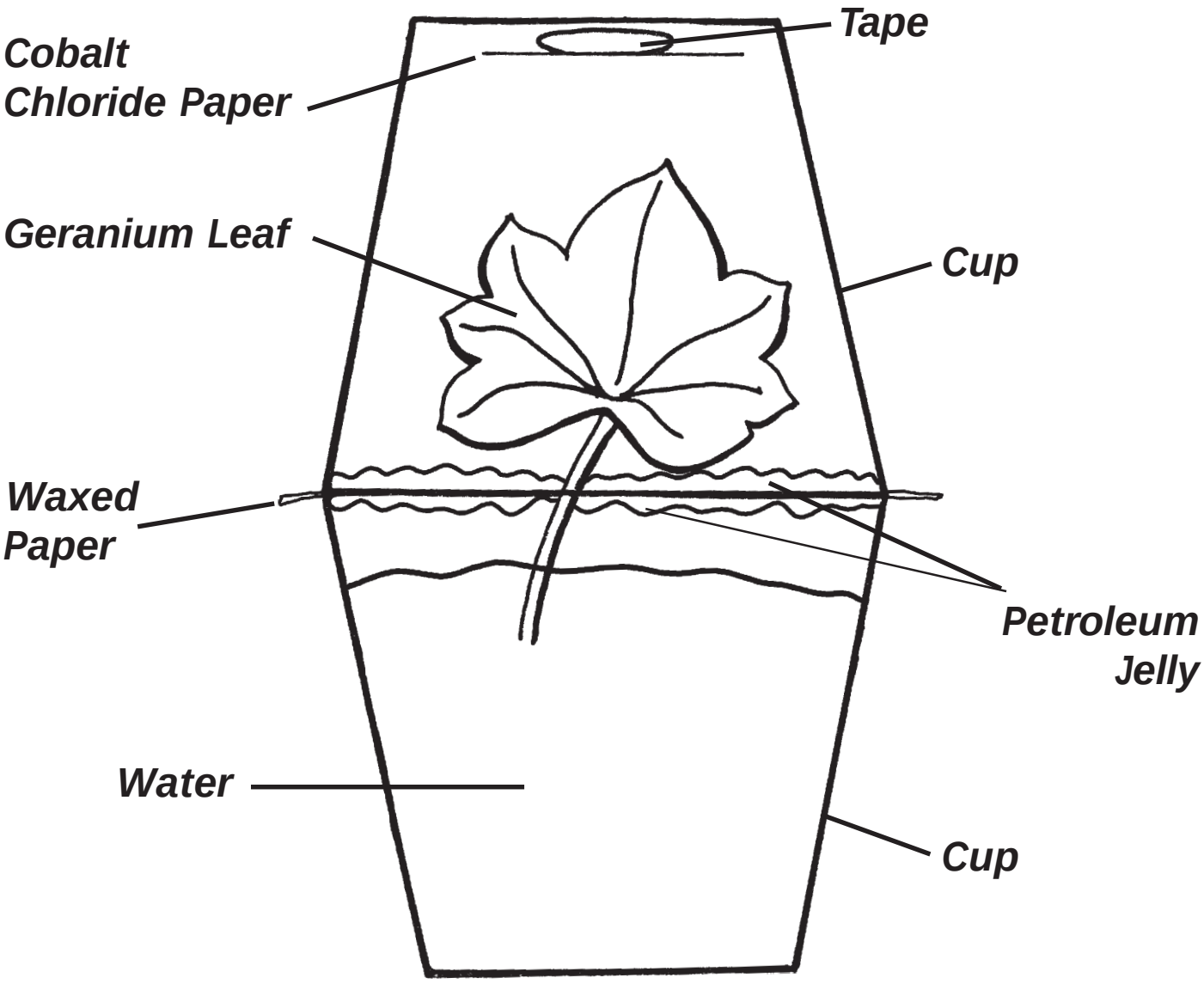


STATION 4:
natural climate control

Because cobalt chloride paper turns pink in the presence of water vapor, the cobalt chloride paper changed color.)

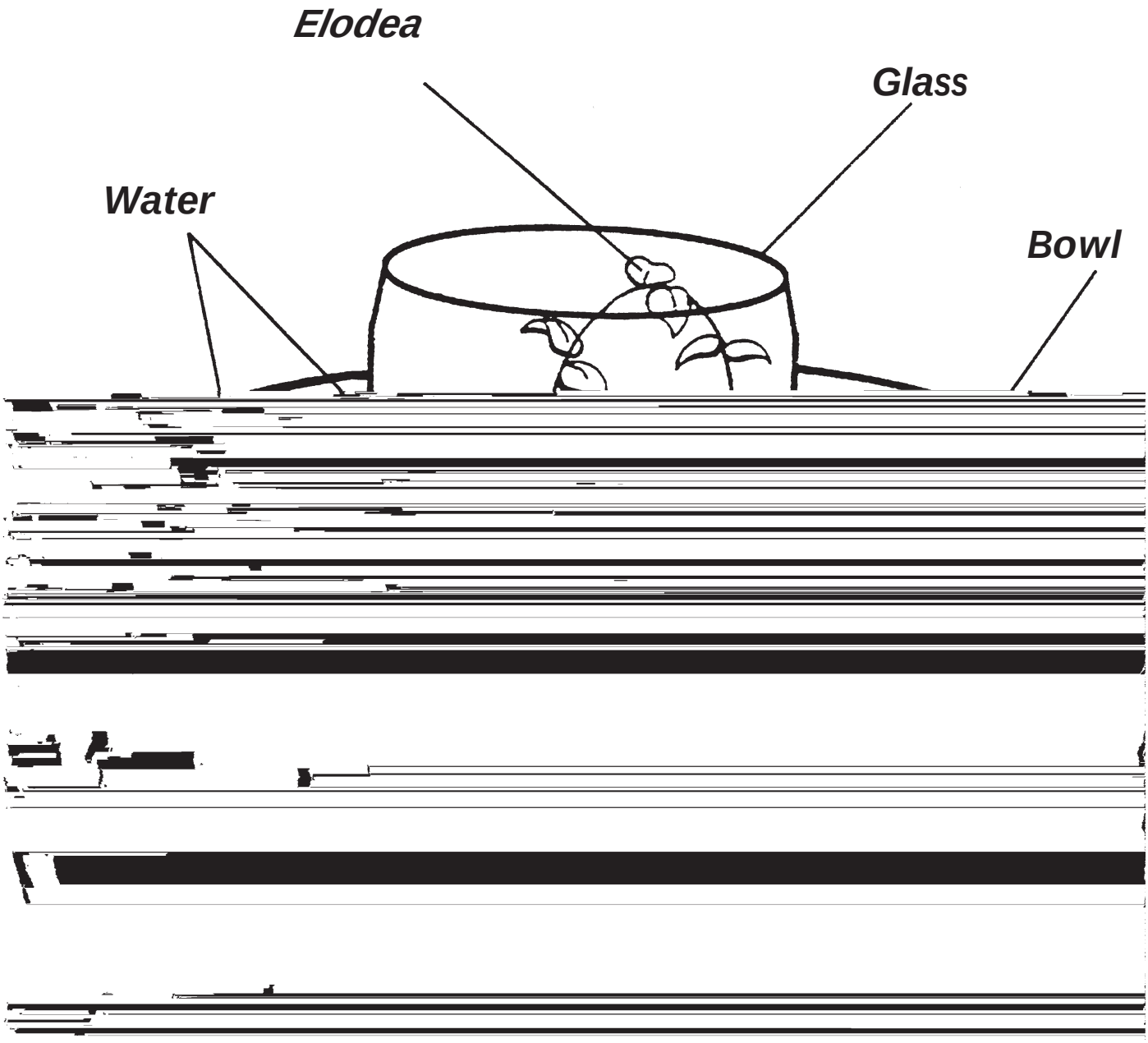
THINK ABOUT IT

Using the results of the demonstration, what role do you think plants play in the water cycle? How do plants affect local climates? Describe the differences in climate between two Illinois ecosystems (e.g. forest, prairie, wetland, etc.). Do you think the climate would be different in a community with many trees compared to a community with few trees?



STATION 5: Producing Oxygen

STATION 5: Producing Oxygen



Activity 3-1
Endangered Species Gallery Walk

Have your students ever heard of a hellbender? Do they know what a yellow-headed blackbird looks like? Have you smelled the white lady's slipper? By researching threatened/endangered species, your students will put a face on species biodiversity and gain insight into some of the problems that threaten all living things. As they share their research, they'll begin to understand broader issues of biodiversity loss—such as the HIPPO dilemma. HIPPO is an acronym that represents the five major threats to biodiversity, which are caused by human activity: **H**abitat loss, **I**ntroduced species, **P**ollution, **P**opulation growth and **O**ver-consumption. This activity provides a way to help students understand the threats to biodiversity and what the word "endangered" means. It also provides students an opportunity to use their creativity to design a poster and share information with their peers.

BEFORE YOU BEGIN

WHAT TO DO

Portfolio
The student's endangered species poster can be added to the portfolio.

Extension
Have students create a group database using the information they found about their species. They can also do an Internet search to add to their information—see sample pages below in the "Resources" section. The students can use the database as a reference. It could include the following entry fields: name of species; type of species (mammal, bird, fish, reptile, amphibian, plant, etc.); method of obtaining food (herbivore, carnivore, omnivore, producer); size or height (less than 5 pounds, 6–25 pounds, 26–100 pounds, 101–500 pounds, more than 500 pounds); habitat type (woodland, prairie, wetland, etc.); and the main reason it's threatened/endangered (habitat destruction, introduced species, pollution, over hunting, over-collecting, etc.). After

FISHES

Endangered

Acipenser fulvescens (lake sturgeon)
Etheostoma camurum (bluebreast darter)
Etheostoma exile (Iowa darter)
Etheostoma histrio (Harlequin darter)
Hybognathus hayi (cypress minnow)
Ichthyomyzon fossor (northern brook lamprey)
Macrhybopsis gelida (sturgeon chub)
Moxostoma valenciennesi (greater redhorse)
Nocomis micropogon (river chub)
Notropis anogenus (pugnose shiner)
Notropis boops (bigeye shiner)
Notropis heterolepis (blacknose shiner)
Notropis maculatus (taillight shiner)
Notropis texanus (weed shiner)
Noturus stigmosus (northern madtom)
Platygobio gracilis (flathead chub)
Pteronotropis hubbsi (bluehead shiner)
Scaphirhynchus albus (pallid sturgeon)**

Threatened

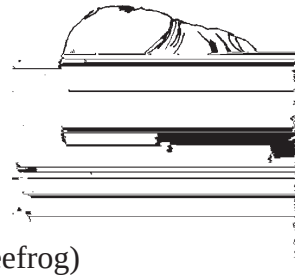
Catostomus catostomus (longnose sucker)
Coregonus artedi (cisco or lake herring)
Fundulus diaphanus (banded killifish)
Lampetra aepyptera (least brook lamprey)
Lepomis symmetricus (bantam sunfish)
Moxostoma carinatum (river redhorse)
Notropis chalybaeus (ironcolor shiner)
Notropis heterodon (blackchin shiner)

AMPHIBIANS

Endangered

Ambystoma platineum (silvery salamander)
Cryptobranchus alleganiensis (hellbender)
Desmognathus fuscus (dusky salamander)

Threatened



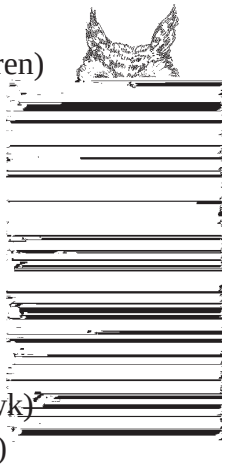
Ambystoma jeffersonianum
(Jefferson salamander)
Hemidactylium scutatum
(four-toed salamander)
Hyla avivoca (bird-voiced treefrog)
Pseudacris streckeri illinoensis
(Illinois chorus frog)

REPTILES

Endangered

Clemmys guttata (spotted turtle)
Kinosternon flavescens (Illinois mud turtle)

Botaurus lentiginosus (American bittern)
Buteo swainsoni (Swainson's hawk)
Charadrius melodus (piping plover)**
Chlidonias niger (black tern)
Circus cyaneus (northern harrier)
Egretta caerulea (little blue heron)
Egretta thula (snowy egret)
Falco peregrinus (peregrine falcon)
Ictinia mississippiensis (Mississippi kite)
Laterallus jamaicensis (black rail)
Limnothlypis swainsonii (Swainson's warbler)
Nyctanassa violacea (yellow-crowned night-heron)
Nycticorax nycticorax (black-crowned night-heron)
Pandion haliaetus (osprey)
Phalaropus tricolor (Wilson's phalarope)
Rallus elegans (king rail)
Sterna antillarum (least tern)**
Sterna forsteri (Forster's tern)
Sterna hirundo (common tern)
Thryomanes bewickii (Bewick's wren)
Tympanuchus cupido (greater prairie-chicken)
Tyto alba (common barn-owl)
Xanthocephalus xanthocephalus (yellow-headed blackbird)



Threatened

Buteo lineatus (red-shouldered hawk)
Certhia americana (brown creeper)
Gallinula chloropus (common moorhen)
Grus canadensis (sandhill crane)
Haliaeetus leucocephalus (bald eagle)*
Ixobrychus exilis (least bittern)
Lanius ludovicianus (loggerhead shrike)
Podilymbus podiceps (pied-billed grebe)

MAMMALS

Endangered

Corynorhinus rafinesquii (eastern big-eared bat)
Myotis austroriparius (southeastern bat)
Myotis grisescens (gray bat)**
Myotis sodalis (Indiana bat)**
Neotoma floridana (eastern woodrat)

Threatened

Lontra canadensis (river otter)
Ochrotomys nuttalli (golden mouse)
Oryzomys palustris (marsh rice rat)

INVERTEBRATES

Endangered

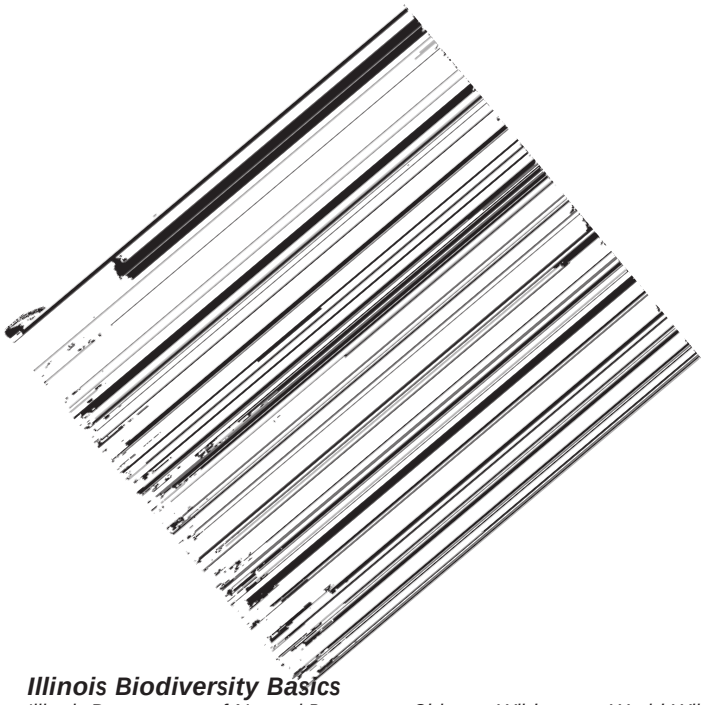
Snails

Discus macclintocki (pleistocene disc)**

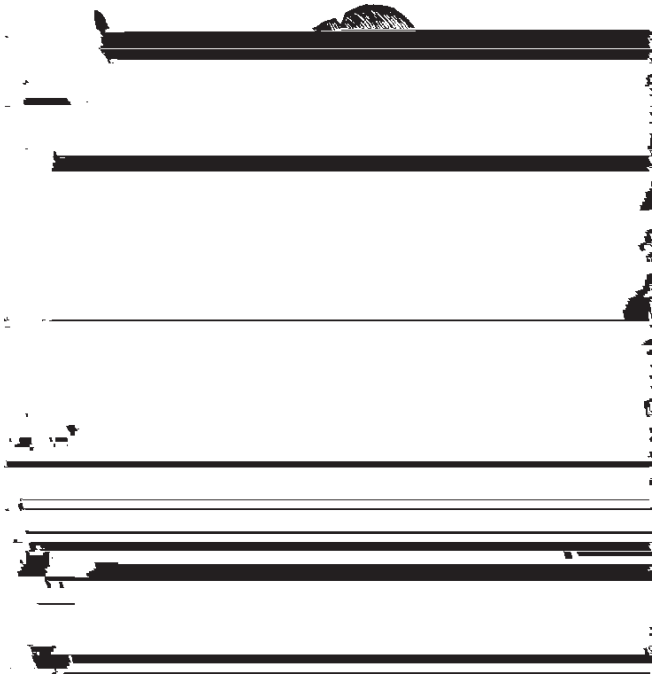
Mussels

Cumberlandia monodonta (spectacle case mussel)
Cyprogenia stegaria (fanshell mussel)**
Epioblasma triquetra (snuffbox mussel)
Lampsilis abrupta (pink mucket)**
Lampsilis fasciola (wavy-rayed lampmussel)
Lampsilis higginsii (Higgins eye)**
Obovaria subrotunda (round hickorynut mussel)
Plethobasus cooperianus (orange-foot pimpleback)**
Plethobasus cyphyus (sheepnose mussel)
Pleurobema clava (clubshell mussel)**
Pleurobema cordatum (Ohio pigtoe)
Pleurobema rubrum (pyramid pigtoe)
Potamilus capax (fat pocketbook pearly mussel)**

Ptychobranchus fasciolaris (kidneyshell mussel)
Quadrula cylindrica (rabbitsfoot mussel)
Simpsonaias ambigua (salamander mussel)
Toxolasma lividus (purple lilliput mussel)
Villosa fabalis (rayed bean mussel)
Villosa iris (rainbow mussel)
Villosa lienosa (little spectace sTDıe mussel)



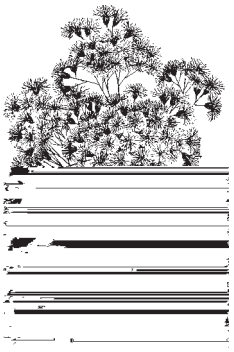
Artemisia dracunculus (false tarragon)
Asclepias lanuginosa (woolly milkweed)
Asclepias meadii (Mead's milkweed)*
Asclepias ovalifolia (oval milkweed)
Asclepias stenophylla
(narrow-leaved green milkweed)
Asplenium bradleyi (Bradley's spleenwort)
Asplenium resiliens (black spleenwort)
Astragalus crassicarpus var. trichocalyx
(large ground plum)
Astragalus tennesseensis
(Tennessee milk-vetch)
Bartonia paniculata (screwstem)
Beckmannia syzigachne (American slough grass)
Berberis canadensis (Allegheny barberry)
Berchemia scandens (supple-jack)
Betula alleghaniensis (yellow birch)
Betula populifolia (gray birch)
Bidens beckii (water marigold)
Botrychium matricariifolium
(daisyleaf grape fern)
Botrychium multifidum (northern grape fern)
Botrychium simplex (grape fern)
Bouteloua gracilis (blue grama)
Bumelia lanuginosa (wooly buckthorn)
Calamagrostis insperata (bluejoint grass)
Calla palustris (water arum)
Calopogon tuberosus (grass pink orchid)
Camassia angusta (wild hyacinth)
Cardamine pratensis var. palustris
(cuckoo flower)
Carex alata (winged sedge)
Carex arkansana (Arkansas sedge)
Carex aurea (golden sedge)
Carex brunnescens (brownish sedge)
Carex canescens var. disjuncta (silvery sedge)
Carex chordorrhiza (cordroot sedge)
Carex crawfordii (crawford sedge)



Carex cryptolepis (sedge)
Carex decomposita (cypress-knee sedge)
Carex disperma (shortleaf sedge)
Carex echinata (little prickly sedge)
Carex garberi (elk sedge)
Carex gigantea (large sedge)
Carex lucorum (sedge)
Carex nigromarginata (black-edged sedge)
Carex oligosperma (few-seeded sedge)
Carex physorhyncha (Bellow's-beak sedge)
Carex reniformis (reniform sedge)
Carex striatula (lined sedge)
Carex trisperma (three-seeded sedge)
Carex tuckermanii (Tuckerman's sedge)
Carya pallida (pale hickory)
Castilleja sessiliflora
(downy yellow painted cup)
Ceanothus herbaceus (redroot)
Chamaesyce polygonifolia (seaside spurge)
Chimaphila maculata (spotted wintergreen)
Chimaphila umbellata (pipsissewa)
Cimicifuga americana (American bugbane)

Cimicifuga racemosa (black cohosh)
Circaea alpina (small encge[p0 Tcı″0.004 Twı″(Cimi(CimnIllity22)53(s)0(nightshade9 -1.33 TDı″0 Tcı″0.6Twı″[(C

Lycopodium dendroideum (ground pine)
Lycopodium inundatum (bog clubmoss)
Lysimachia fraseri (loosestrife)
Lysimachia radicans (creeping loosestrife)
Malus angustifolia (narrow-leaved crabapple)
Matelea decipiens (climbing milkweed)
Medeola virginiana (Indian cucumber root)
Melanthera nivea (white melanthera)
Melica mutica (two-flowered melic grass)
Milium effusum (millet grass)
Mimulus glabratus (yellow monkeyflower)
Mirabilis hirsuta (hairy umbrella-wort)
Nothocalais cuspidata (prairie dandelion)
Opuntia fragilis (fragile prickly pear)
Orobanche fasciculata (clustered broomrape)
Oxalis illinoensis (Illinois wood sorrel)
Panicum boreale (northern panic grass)
Panicum columbianum (panic grass)
Panicum joorii (panic grass)
Panicum ravenelii (Ravenel's panic grass)
Panicum yadkinense (panic grass)
Paspalum dissectum (bead grass)
Penstemon brevisepalus
(short-sepaled beardstongue)
Penstemon grandiflorus
(large-flowered beardtongue)
Phacelia gilioides (phacelia)
Phlox pilosa ssp. sangamonensis
(Sangamon phlox)
Pinus banksiana (Jack pine)
Pinus echinata (shortleaf pine)
Pinus resinosa (red pine)
Plantago cordata (heart-leaved plantain)
Platanthera ciliaris (yellow fringed orchid)
Platanthera clavellata (wood orchid)
Platanthera flava var. flava (tubercled orchid)
Platanthera flava var. herbiola
(tubercled orchid)

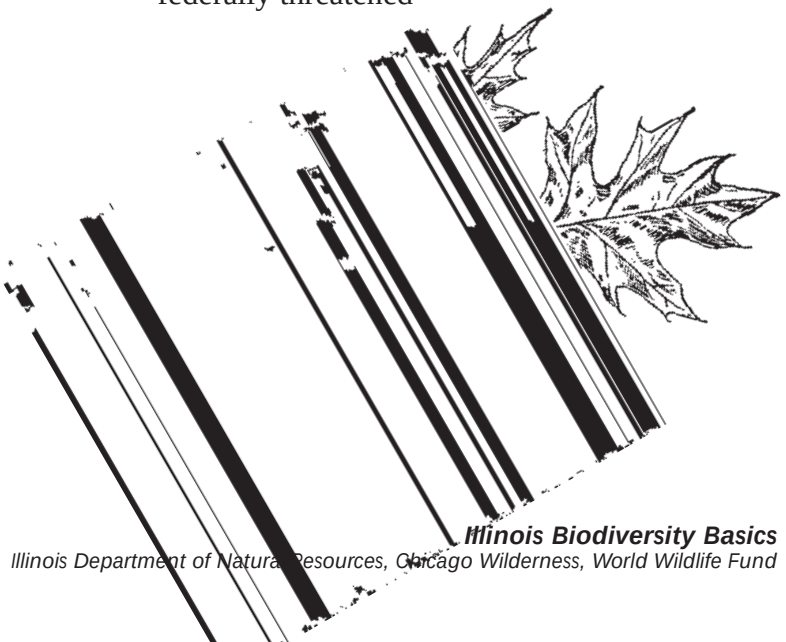


Platanthera leucophaea
(white fringed orchid)*
Platanthera psycodes (purple fringed orchid)
Poa alsodes (woodland bluegrass)
Poa languida (woodland bluegrass)
Poa wolfii (meadow bluegrass)
Pogonia ophioglossoides (snake-mouth)
Polanisia jamesii (James clammyweed)
Polygala incarnata (pink milkwort)
Polygonatum pubescens
(small Solomon's seal)
Polygonum arifolium
(halbred-leaved tearthumb)
Polygonum careyi (Carey's smartweed)
Populus balsamifera (balsam poplar)
Potamogeton praelongus (pondweed)
Potamogeton pulcher (pondweed)
Potamogeton robbinsii (pondweed)
Potamogeton strictifolius (pondweed)
Potentilla millegrana (cinquefoil)
Primula mistassinica

Sagittaria longirostra (arrowleaf)
Salix serissima (autumn willow)
Salix syrticola (sand-dune willow)
Sambucus pubens (red-berried elder)
Sanguisorba canadensis (American burnet)
Sarracenia purpurea (pitcher plant)
Saxifraga virginiensis (early saxifrage)
Schizachne purpurascens (false melic grass)
Scirpus cespitosus (tufted bulrush)
Scirpus hattorianus (bulrush)
Scirpus paludosus (alkali bulrush)
Scirpus purshianus (weak bulrush)
Scirpus smithii (Smith's bulrush)
Scirpus verecundus (bashful bulrush)
Shepherdia canadensis (buffalo berry)
Silene ovata (ovate catchfly)
Silene regia (royal catchfly)
Silphium trifoliatum (rosinweed)
Sisyrinchium atlanticum (blue-eyed grass)
Sisyrinchium montanum (blue-eyed grass)
Sorbus americana (American mountain-ash)
Sparganium americanum (bur-reed)
Sparganium chlorocarpum
(greenfruited bur-reed)
Spiranthes lucida
(yellow-lipped ladies' tresses)
Spiranthes romanzoffiana
(hooded ladies' tresses)
Spiranthes vernalis (ladies' tresses)
Stellaria pubera (great chickweed)
Stenanthium gramineum (grass-leaved lily)
Stylisma pickeringii (Patterson bindweed)
Styrax grandifolia (bigleaf snowbell bush)
Symphoricarpos albus var. albus (snowberry)

Carex intumescens (swollen sedge)
Carex oxylepis (sharp-scaled sedge)
Carex prasina (drooping sedge)
Carex viridula (little green sedge)
Carex willdenowii (Willdenow's sedge)
Carex woodii (pretty sedge)
Chamaedaphne calyculata (leatherleaf)
Cimicifuga rubifolia (black cohosh)
Cirsium hillii (Hill's thistle)
Cirsium pitcheri (Pitcher's [dune] thistle)*
Corallorhiza maculata
(spotted coral-root orchid)
Cyperus grayioides (Gray's umbrella sedge)
Cypripedium candidum
(white lady's-slipper orchid)
Drosera intermedia (narrow-leaved sundew)
Eleocharis rostellata (beaked spike rush)
Epilobium strictum (downy willow herb)
Equisetum pratense (meadow horsetail)
Erythronium mesochoreum
(white dog-tooth violet)
Eupatorium incarnatum (thoroughwort)
Galium labradoricum (bog bedstraw)
Helianthus angustifolius
(narrow-leaved sunflower)
Juniperus communis (common juniper)
Lactuca hirsuta (wild lettuce)
Larix laricina (tamarack)
Lathyrus ochroleucus (pale vetchling)
Lechea intermedia (pinweed)
Liatris scariosa var. nieuwlandii (blazing-star)
Matelea obliqua (climbing milkweed)
Melanthium virginicum (bunch-flower)
Melothria pendula (squirting cucumber)
Oenothera perennis (small sundrops)
Orobanche ludoviciana (broomrape)
Planera aquatica (water elm)
Potamogeton gramineus (pondweed)
Quercus montana (rock chestnut oak)
Quercus phellos (willow oak)
Ranunculus rhomboideus (prairie buttercup)
Rhynchospora alba (beaked rush)
Rubus pubescens (dwarf raspberry)
Salvia azurea ssp. pitcheri (blue sage)
Scirpus hallii (Hall's bulrush)
Scirpus polyphyllus (leafy bulrush)
Solidago sciaphila (cliff goldenrod)
Styrax americana (storax)
Sullivantia renifolia (sullivantia)
Thuja occidentalis (arbor vitae)
Tofieldia glutinosa (false asphodel)
Tomanthera auriculata (earleaf foxglove)
Tradescantia bracteata (prairie spiderwort)
Trientalis borealis (star-flower)
Triglochin maritimum (arrow-grass)
Triglochin palustris (arrow-grass)
Urtica chamaedryoides (nettle)
Veratrum woodii (false hellebore)
Veronica scutellata (marsh-speedwell)
Viburnum molle (arrowwood)
Viola conspersa (dog violet)

** = federally endangered
* = federally threatened



Activity 3-2
The Case of the Greater Prairie-Chicken

AT A GLANCE

Work in small groups to discover how the greater prairie-chicken's decline is tied to the major causes of biodiversity loss in Illinois and discuss what people are doing to help protect the greater prairie-chicken.

OBJECTIVES

Describe how habitat loss, introduced species, pollution, population growth and over-consumption are threatening the greater prairie-chicken and biodiversity in general. Discuss ways people are trying to protect the greater prairie-chicken.

SUBJECTS

English language arts, science, social science

SKILLS

gathering (reading comprehension), analyzing (comparing and contrasting, discussing), applying (proposing solutions)

LINKS TO *ILLINOIS BIODIVERSITY BASICS* CONCEPTUAL FRAMEWORK

endangered, threatened and extinct; the five major causes of biodiversity decline

VOCABULARY

endangered species, habitat loss, introduced species, over-consumption

TIME

two class periods

MATERIALS

one copy of the "Prairie-Chicken Problem" and one set of "Prairie-Chicken Cards" for each group; one copy of "Prairie-Chicken Solutions" for each student; five index cards or pieces of paper per student (for Assessment #1)

There are less than 100 greater prairie-chickens left in the wild in Illinois, making them one of the most endangered birds in the state. Habitat loss has forced this small population into isolated groups in two counties (Jasper and Marion). In this activity, your students will learn about the threats to greater prairie-chicken survival. They will discover that prairie-chickens are beset by the same problems that threaten biodiversity around the world—something we call the HIPPO dilemma. HIPPO is an acronym for the five major problems threatening earth's biodiversity: **H**abitat loss, **I**ntroduced species, **P**ollution, **P**opulation growth and **O**ver-consumption. Students will also learn some of the ways people are trying to protect the greater prairie-chicken and to slow other kinds of biodiversity loss in Illinois.

BEFORE YOU BEGIN

For each group of four to five students, copy one "Prairie-Chicken Problem" summary and make one set of "Prairie-Chicken Cards." For each student, make one copy of "Prairie-Chicken Solutions."

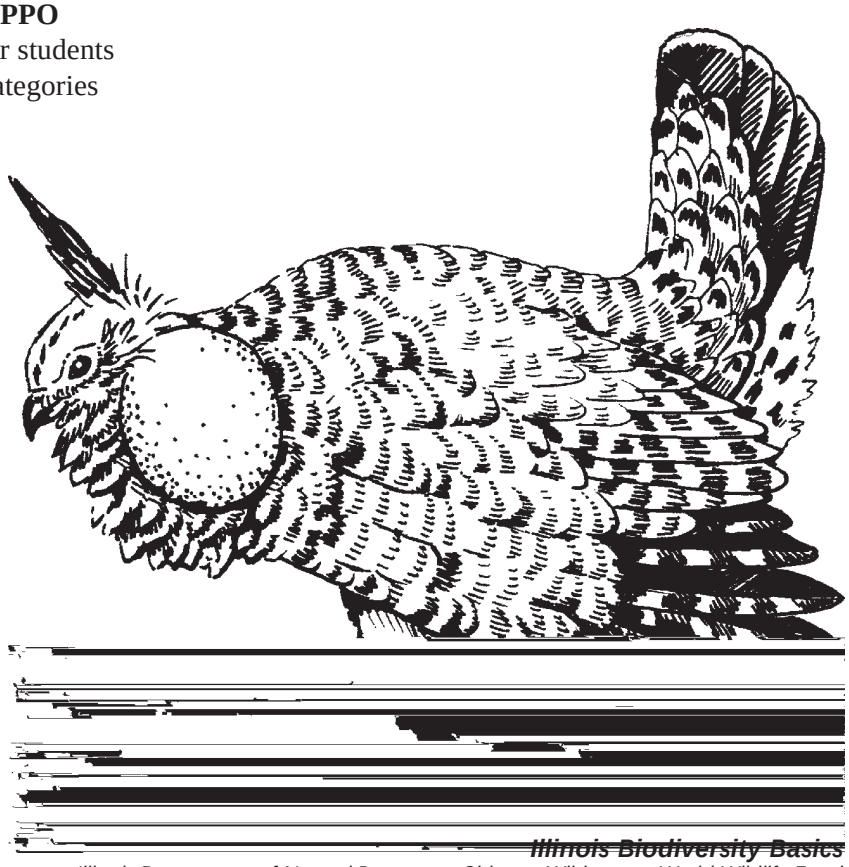
WHAT TO DO

1. **Divide the class into groups and describe the assignment.**

   Divide the class into groups of four or five students and explain that they're going to be learning about one of the endangered animals in Illinois—the greater prairie-chicken. Give each group a copy of the "Prairie-Chicken Problem" summary and have one student in each group read the summary to the rest of the group. When the students have finished, give each group a set of "Prairie-Chicken Cards." Tell the students to read each card out loud in their group. Next have them try to organize the cards into four or five major categories of threats to the prairie-chicken. Tell the students that it's OK if each group organizes the cards differently and if some categories have only one or two cards. Explain that some cards may seem to fit into more than one category. In that case, students should pick the category that seems most appropriate to them. Then have each group make a list of the categories of threats that it developed.

2. Discuss as a class the threats to the greater prairie-chicken.
Have each of the groups name the threats (categories) it came up with and the problems that fit into those threats. Record the ideas on the board. After all the groups have participated, have the students compare the categories. Are there categories that can be lumped together? (Draw lines to connect similar categories.)

3. Explain and discuss the HIPPO dilemma.
Explain that one way to think about the major threats to biodiversity worldwide is by creating broad categories that characterize the threats. Have the students compare their categories of threats to the greater prairie-chicken with those threats we've included, which are based on the thinking of many conservationists around the world. The categories are easy to remember by the acronym **HIPPO**. Review each of the categories with the students: **H** = habitat loss; **I** = introduced species; **P** = pollution; **P** = population growth; **O** = over-consumption. Can the students assign each of the prairie-chicken problems they read about to one of the **HIPPO** categories? (See answers below.) Ask your students to compare the HIPPO categories to the categories



A Note to Educators

As your students will discover, there are many different efforts taking place that are designed to assist the survival of the greater prairie-chicken in Illinois. But it's also important to understand that protecting any endangered species and/or subspecies can be controversial and that not everyone agrees on how best to conserve those species that are in the most serious trouble—or even if we should protect them. Although the issues are complex, you might

2. For older students, you may want to explore through a debate the controversy surrounding the greater prairie-chicken and other endangered species that live in Illinois. Although most people recognize the value of biodiversity, much controversy centers on the following issues:

Saving Species Versus Saving Habitat

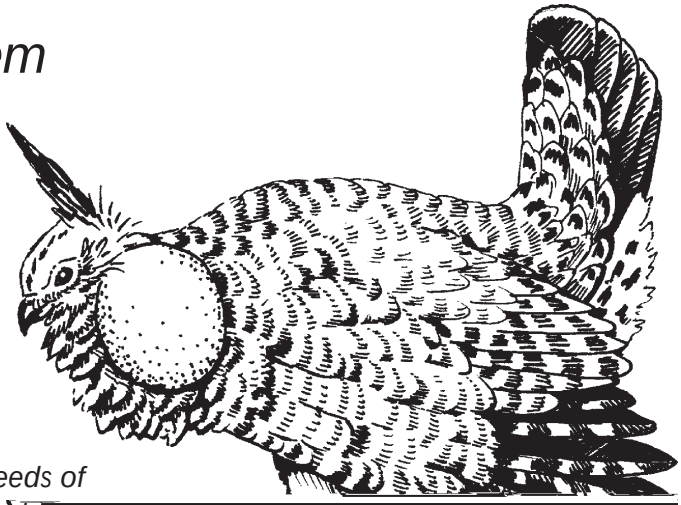
In the past, many conservation programs focused on saving individual species. The current Endangered Species Act is an example of the species approach to protecting biodiversity. Under the act, species and subspecies are listed as threatened or endangered. The U.S. Fish and Wildlife Service, which oversees the act, is required to develop a recovery plan for each endangered species or subspecies. Although protecting habitat is a key component of most species recovery plans, the emphasis is on individual species and subspecies. Today, many people would like to see the Endangered Species Act include more of a focus on protecting habitat than individual species. By protecting habitat, many argue that more species will be protected in the long run. They also feel that too much time and money are being spent on individual species and subspecies—and that we need to protect larger tracts of habitat if we want to protect biodiversity. Others argue that we need to do both and that there are some key species that need special protection if they are to survive.

Saving Species Versus Subspecies

Another debate centers on the difference between species and subspecies and the importance of each. Although the Endangered Species Act currently protects species and subspecies, some people feel that subspecies are so genetically similar to their relatives (which are often not endangered) that little genetic information will be lost if a subspecies becomes extinct. This is the case with the great plains rat snake, which is a subspecies of the corn snake. The great plains rat snake is found in only a few counties along the Mississippi River in southwestern Illinois. Other conservationists argue that it's just as important to save a subspecies as it is to save a species. A subspecies develops when a small population is isolated from its main population and, over time, develops distinct characteristics that help it adapt. For sus rfeneoither population 8˝˝T*ı˝g as he case

Student Page

Prairie-Chicken Problem



Have you ever heard of prairie-chickens? What about old yellowlegs, the prairie hen or the prairie grouse? All of these names describe the same species, the greater prairie-chicken. The common name of this bird comes from its chicken-like body shape and its occurrence in grasslands. A relative of the domestic chicken, this bird occurs from Canada, south to Oklahoma and Texas in the United States. It was once common in the prairies east of the Mississippi River but is now a rare resident in Wisconsin and Illinois.

Prairie-chickens are brown with dark bars, and they have dark feathers on the sides of the throat. Their feet are feathered all the way to the toes. Male prairie-chickens have fleshy orange "eyebrows" and yellow-orange sacs on the sides of the throat. The sacs are inflated as part of their courtship display. Their body is about 16 to 18 inches long, and the wingspan is about 28 inches. Males weigh about two pounds, while females are a little smaller and usually weigh between one and one-half and two pounds.

Prairie-chicken courtship behavior is unique. On spring mornings, males move onto short-grass areas known as "booming grounds." At these sites, they go through a pattern of displays to attract females. The male raises the dark feathers on his neck, inflates his air sacs, droops his wings, spreads his tail and stomps his feet while producing sounds that have been described as "booming," "hooting" or "yodeling."

Most prairie-chickens nest in April and May. The nest is built on the ground and consists of a shallow depression lined with grasses. The female lays seven to 17 eggs, which hatch in about 25 days. Young prairie-chickens are able to leave the nest just a few hours after hatching. They can fly one to two weeks after hatching.

Food for prairie-chickens consists of insects, mostly grasshoppers, from May to October each year. At other times, they eat the fruits, shoots, leaves and seeds of various plants. They also feed on waste grain in farm fields.

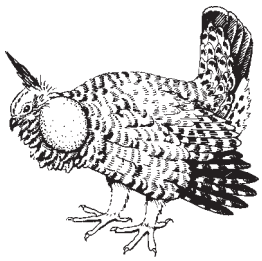
Prairie-chickens were once abundant on black soil prairies throughout the northern two-thirds of Illinois, reaching their estimated peak population of about 10 million birds by 1860. The population began to decline soon after this time, and prairie-chickens were considered on the brink of extinction by the early 1900s. Prairie-chickens were a game bird popular with hunters and at one time they were

Prairie-Chicken Card

Prairie-Chicken Card

Prairie-Chicken Card

Prairie-Chicken Card



Prairie-Chicken Card

Illinois laws are designed to keep people from killing, disturbing, injuring, harming or harassing prairie-chickens. People who violate these laws can be ordered to pay a large fine and/or serve time in jail.

Prairie-chickens have been imported from Nebraska, Minnesota and Kansas to help increase genetic diversity in the Illinois prairie-chicken population. As a result, fertility rates have increased.

Money from the Illinois Wildlife Preservation Fund has been instrumental in funding studies regarding the inbreeding problems in the native prairie-chicken population. This funding also contributes to the costs associated with the restoration efforts. Funds are donated by citizens through their Illinois state income tax returns.

The Illinois Department of Natural Resources now manages the ring-necked pheasant population in areas of prairie-chicken habitat.

Prairie-chickens imported to Illinois are each outfitted with a radio transmitter shortly before release so that researchers can monitor their movements.

The Conservation Reserve Program, a federal farm bill, was enacted to encourage farmers to set aside marginal and highly erodible farm land as wildlife rmers

Activity 3-3
Space for Species

AT A GLANCE

Play an outdoor game, conduct a survey of plant diversity and analyze current research to explore the relationship between habitat size and biodiversity.

OBJECTIVES

Describe factors that affect the relationship between habitat fragmentation and biodiversity loss. Create a graph that demonstrates the relationship between biodiversity and the size of a habitat. Describe different strategies for designing reserves that could help lessen the effects of fragmentation.

SUBJECTS

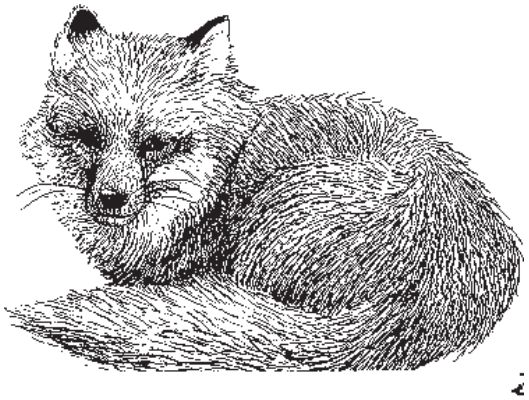
English language arts, mathematics, science, social science

SKILLS

Habitat loss is one of the biggest threats to biodiversity. Roads, shopping centers, housing developments, agricultural fields and other types of development are breaking up our large forests and other natural areas into smaller and smaller chunks—a problem conservationists call fragmentation. Many scientists compare the remaining habitat fragments to islands because they are so isolated. And like islands, habitat fragments are often too small and isolated to support a large number or a wide variety of species. Conservationists have the tough job of trying to figure out how fragmentation is affecting biodiversity. They're asking questions like "How small is too small?," "Which species are we losing?" and "How can we balance our need for development with other species' need for space?"

Development and fragmentation can be difficult concepts for students to understand. Seeing the relationship between the two will help students realize there are certain tradeoffs that result from our decisions to develop natural areas. Most development occurs to fill people's needs for schools, homes, roads, food and income. While most people recognize that developers are not trying to destroy biodiversity when they build roads or homes, many people also feel that the value of biodiversity is not factored into our decisions to develop. Many conservation biologists would like to see communities consider how development impacts biodiversity and work to accommodate natural systems as much as possible.

In Part I of this activity, your students will play a game that will allow them to explore some of the actions we can take to try to balance human need for development



reduce those threats by planning development with biodiversity in mind.

1. **Introduce the activity.**
   Explain to the students that they'll be investigating a well-known ecological theory called the theory of island biogeography. Briefly explain that scientists Robert MacArthur and Edward O. Wilson wanted to study species that traveled from the mainland to nearby islands in the ocean. (You might want to introduce the scientific term "immigration" here, explaining that MacArthur and Wilson were studying species that immigrated to islands from the mainland.) The scientists wanted to know how many species from the mainland lived on islands of different sizes at different distances from the mainland. They were also interested in those species that became "locally" extinct, which means they were no longer living on the islands but could still be found living on the mainland.

   Tell students that they'll be doing a similar investigation outside. Some students will be animals immigrating to "islands." Other students will be playing predators, diseases and different forces out in the "open ocean" that can cause animals to become extinct.

2. **Explain the rules.**
   Familiarize the students with the playing area. Show them the islands and their sizes and distances from the mainland. Select about 22 students (or three-fourths of the group) to be species immigrating to the islands and about eight students (or one-fourth of the group) to be taggers that represent threats that can cause immigrating species to become extinct. Explain that immigrating species will have one minute to run from the mainland to an island, but they'll have to avoid being tagged by the students in the playing area because being tagged will make them extinct on the islands. As you select students to be the extinction taggers, you can have them think of some of the causes of extinction (predators, diseases, pollution, severe weather and so on) they might represent to species immigrating across the ocean.

   Explain that once you give the signal, species on the mainland should begin immigrating to the islands by making a run for them. Species can be tagged out of the game only when they are out in the open ocean. If they are on an island or the mainland, they can't be tagged. Although they're safe on the mainland, tell students that at the end of the game you'll only count the species that successfully have made it to an island.

3. **Play Round One: Immigrate!**
   Tell the taggers to spread out in the playing field and make sure they keep moving all the time that students are immigrating. Explain that, as in nature, threats to species are spread all around the landscape, so the taggers should also be spread out. Keep taggers from crowding around islands and not allowing any students to pass. Try to make the game fair for everyone. Yell "Immigrate!" to let students know when to begin. Keep time and tell the students to stop after one minute. Ask any students who become extinct to help you monitor the game.

4. **Evaluate the results.**
   Have the students count the number of animal species on each island. Keep track of the results on a piece of easel paper (poster-sized). You can make a chart or a graph, or you can write the number of species on each island in a diagram of the playing area.

   Have the students gather around to go over the results of Round One and to talk about what they'll do in Round Two. Figure out the percent of students who survived (divide the number of students who made it to an island by the total number of students who started on the mainland, then multiply by 100) and record the percentage on the poster-sized paper.

   Tell the students that, according to MacArthur and Wilson, the large island close to the mainland should have the most species. Is that what your group found? Why are there more species close to the mainland? Ask students to think about their experiences while immigrating. *(Those who tried to*

What's the problem with patches?

Habitat fragmentation is one of the most serious threats to biodiversity. A researcher studying birds in one part of Australia, for example, found that the numbers and ranges of almost half the birds native to the region have decreased since the early 1900s. He thinks that almost all the decline is a result of habitat fragmentation. Small, fragmented habitats, called habitat islands, usually can't hold as many species as large, more continuous ones. Here are some of the reasons we lose species, and biodiversity, in small patches of habitat:

Luck of the draw: *When a piece of habitat is destroyed, some species could be wiped out by chance alone. If a species uses only a small part of a larger area, and that part happens to be destroyed, that species and its habitat are lost. Species that are very rare or that are found only in small populations are especially at risk when their habitats are broken up into smaller and smaller chunks.*

Less habitat, less diversity: *Large areas usually contain a wider variety of habitats than smaller ones. Since different habitats usually support different species, a fragmented area will often contain fewer habitats and fewer species than a larger area. Many scientists think this is the main reason diversity is lower in habitat patches.*

Road blocks: *Some species can live in habitat fragments if they can move from one area to another to get everything they need, such as food, shelter and mates. Unfortunately, many fragments are surrounded by barriers that prevent species from moving between different areas. Roads are a common barrier that many species can't cross but buildings, parking lots and fences can also keep species from getting where they need to go. When a species is isolated from others of its kind, it can become subject to inbreeding and lose some of its genetic diversity. Species that need a lot of space or that spend a lot of time on the move can be very sensitive to these "road blocks."*

On the edge: *When we build developments and break a habitat into small chunks, we create more boundaries between the habitat and the outside world. Conditions at these boundaries, called edges, are very different than the conditions in the habitat's interior. There may be more sunlight and wind at the edge, and because there's no canopy overhead to keep the moisture in, the edge is often much brighter and drier than the interior. These different conditions can change the plant and animal species living in the area. There can be different predators and prey, making it harder for animals to find food and to avoid being food themselves. In small fragments, edge conditions can take up most of the habitat. Scientists call this problem the edge effect, and species that can't adapt to the edge often become threatened.*

Fragmentation doesn't affect all species in the same way. Some are more sensitive to habitat loss than others. And some species can even benefit from fragmentation and the edge effect. All of the factors listed above affect different kinds of species in different ways and that's what makes the problem of fragmentation so difficult for conservationists trying to protect a wide variety of species.

going over the threats they came up with in their discussion in step five.

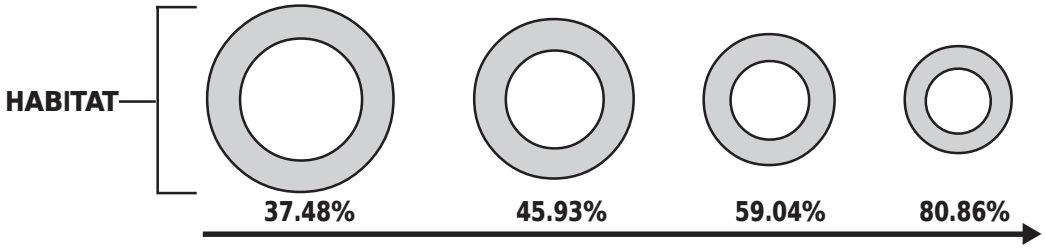
Tell students that the two different colors of tokens you have represent some of the things that species need. The tokens may be food and water, shelter and mates, or any of the other needs you discussed in step five. Tell the students that they'll be competing for these resources in the habitat islands. Count out enough tokens so that there is one of each color for every student in the habitat islands. Scatter the tokens throughout the four islands so that larger islands, which can hold more resources, have more tokens. State the following rules:

- Students must collect at least one token of each color to survive, but they can collect more if they like.
- Students can pick up only one token at a time from any island. So if a student picks up a token on the island he or she starts from, the student must run to at least one other island for another token. Students can return to their first island for tokens if they need to.

Shout "Immigrate!" to start the game again. This time give students as much time as they need to move between the islands. Stop the game when every student either has been tagged or has collected at least two tokens. Tell taggers they should spread out in the landscape, just as threats to species are spread out. They shouldn't stand in front of moving species and keep them from passing. Use your judgment about how to keep the game fair. After they finish the round, count the number of students who survived and record it on poster-sized paper.

7. **Go over the results of Round Two.**
Have the students gather together to figure out the percent of species that survived. Most likely, a large percent became extinct. Ask students why they

The Edge Effect



were tagged if they were tagged on the edge or outside an island. Students tagged on the edge are much like species that can't adapt to the new conditions or like species that are easily spotted by predators, and so can't survive as well on the edge. Had any students who were tagged outside an island been pushed out of an over-crowded island? Did they notice that their amount of "safe," or healthy, habitat had been decreased by the edge effect?

Tell the students that although many of the original species didn't survive in the game, the total number of species in real habitat islands with lots of edges can actually go up. Ask if anyone knows how this could happen. *(Many species that are well adapted to the conditions on the edge can move in and take the place of a smaller number of species that were adapted to the interior and not to the edge.)* In the game, when a species was tagged out, it wasn't

Reserve Design Choices

replaced with another species, but in nature this can happen. Some disturbed habitats actually have more species than healthy ones, but they don't necessarily play the same ecological roles as these species do in a healthy habitat. And the disturbed habitats often contain widespread, nonnative species rather than the more rare local species that are important in the area.

11. Discuss reserve design: Making a good plan.
Tell the students that the challenge of understanding species' need for space is in building developments like roads, homes and schools so that both people and wildlife can get the things they need. Because it's not always easy to do, many species are in trouble. But it can be done. Ask the students to think about how we can help wildlife in fragmented areas, whether in reserves or in developments.

For example, one way to make sure that there's enough habitat for species is to set aside land in reserves. Ask the students if they can think of any potential problems with reserves. *(If they have trouble thinking about problems, lead them back to the concepts they learned in the game. Many reserves are like habitat islands—they are surrounded by developments and can become isolated. Small reserves might be too small to support many species. And wildlife moving between reserves can face many threats. Your students may come up with*

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On roads:

- Post wildlife crossing signs to alert drivers that they are likely to encounter an animal on the road.
- Construct highway underpasses so animals can cross roads without the threat of being hit by a car.
- Where possible, use less salt, or use an alternative to salt, on roads in the winter to reduce damage to plants along the road.

In backyards:

- Plant native plants so that the yard is more like the surrounding habitat and attracts natural species.
- Put up bird feeders for birds traveling between habitat fragments in search of food.
- Cut down on the use of pesticides so that birds and invertebrates can use backyard habitats without the threat of being poisoned.
- Keep pet cats indoors so that they do not prey on the lizards, snakes, birds, squirrels and other wildlife that may be living in the backyard habitat.

Around the school and other buildings:

- Convert part of your schoolyard or community center to a wildlife habitat.
- Provide water sources such as bird baths, marshy areas or ponds.
- Put up boxes that birds can use for nesting.

In the community:

- Plan "greenways" such as bike paths and hiking trails that preserve habitat in tracts that could provide wildlife with passageways, or corridors, connecting different reserves that are far apart.
- Encourage members of the community to become involved in making decisions about what land will be developed and how it will be done. Once your students have come up with some ideas, give them the option of taking some type of action—from conducting more research to creating a wildlife habitat area nearby. You may want to try some of their ideas as part of a class or group project. The National Wildlife Federation's Backyard Wildlife Habitat Program, which has a Web site at www.nwf.org/nwf/habitats, can give your group ideas about how to create or enhance wildlife habitat. Whether or not you decide to take action as a group, make sure that your students understand that although habitat loss and fragmentation are serious problems for wildlife, making the decision to build roads, homes or schools doesn't mean we have decided not to protect biodiversity. There are many ways we can share space with other species.

2. **Explain the collection procedure.**
Bring students to the plots (see "Setting Up Plots" page 121) and explain how they should work in groups to collect their samples. Tell each group to take a leaf from each different species they find in their plot and put it in their plastic bag. Encourage them to be as gentle as possible and not to take more than one leaf if they can avoid it. Be sure to caution them about not picking poison ivy or other poisonous plants. Always obtain landowner permission before entering the property and before collecting anything. **Note:** You may want to ask students to sketch or photograph the leaves instead of collecting them.

Review with students how to tell different plant species apart. Choose leaves of two very different species and ask the students if they think the two leaves are the same species. They should recognize that the leaves are from two different kinds of plants. Ask them how they know. *(The leaves look different.)* Ask them to be specific about what's different. Refer to the handout "Leaf I.D." for some basic leaf characteristics that students can use to tell one kind of plant from another. Make sure they understand that the names of all the different characteristics of leaves are not important for this activity. What's important is that the students realize that these characteristics, which have been named, are ways that people tell if plants are the same species or not.

Choose leaves of two different species that look more similar and ask students if the leaves are from the same kind of plant. Students should again be specific in telling how the leaves are different. Have a few copies of the "Leaf I.D." handout for students to refer to while they're collecting.

It's best if you don't allow more than 25 students in the plot area at once because it can become too crowded for them to work. You might arrange them this way: one student per one-square-yard plot, three students per four-square-yard plot and four students per 16-square-yard plot. If you have more

than 25 students, have students who aren't collecting help the students working in the smallest plots identify the plants after they've finished collecting. Or have them trade the job of collecting plants. If you have fewer than 25 students, reduce the number of students in the mid-size plots first and in the large plots second.

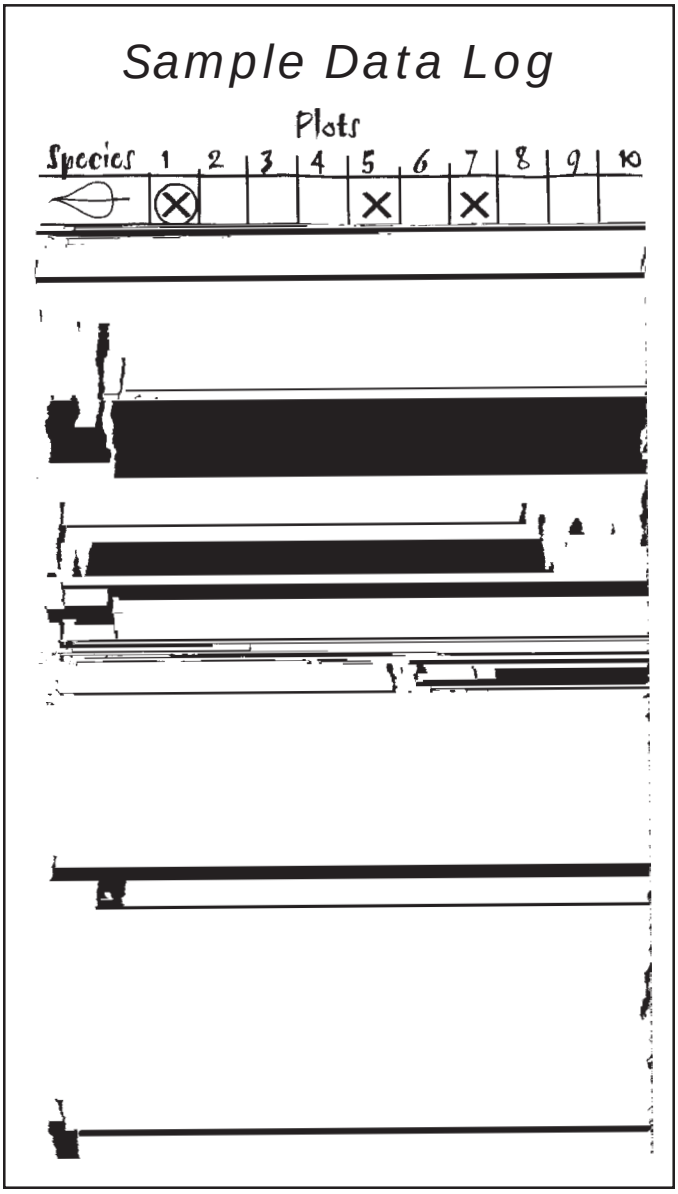
3. **Collect the samples.**
   Give the students as much time as they need to collect their samples. Times will vary according to the number of species and the number of students. Plan to spend at least 15 minutes collecting.

4. **Log the samples.**
   Bring all of the samples back inside and have the groups empty their bags and sort through the samples in their collection groups. Have them make sure that each group has only one sample of each species. If they have more than one, have them select the leaf that's in the best condition to represent that species.

   While the students are sorting through their samples, prepare a data log, like the "Sample Data Log," for them to use to record their data. A piece of butcher paper that you can unroll as you need more space would work well. You can also use poster-sized paper, but you'll probably have to use a few sheets to hold all the samples. **Note**: You may want to prepare the log in advance to save time while doing the activity.

   Once you're ready, have the students bring their samples to the data log in order by plot number, beginning with Plot 1. Have the student(s) from Plot 1 tape up a sample of each species in the "species" column and put a circled "X" under the "Plot 1" column next to each species to show that they were first found in Plot 1. Every other time one of these species is found in a plot, simply mark an "X" to show that it is in the plot, but it isn't new to the entire sample of species.

   Next have the student(s) from Plot 2 post their samples. You should tape up only samples of new species. If a student has a sample of a plant that is already on the data log, he or she should mark an "X" in that species' row. Any new species should be taped up and a circled "X" should be placed in that species' row under Plot 2 to show that it first appeared in Plot 2. Do the same for the rest of the plots.



Ovenbirds in Illinois Woodlands: A Down-Time Idea

While you're filling in the data log, there will be a lot of time when most students don't have a task. If you would like to give your group an assignment related to the species-area theme, you can give them the "Ovenbirds in Illinois Woodlands" activity (page 131). This activity is designed for independent student work while you fill in the data log. It should give the students a good idea of how scientists use graphs both to make sense of data and to learn how different species use space in their habitats. You can have students work individually or in groups while students add their plants to the log.

Alternatively, you could give your students this assignment at the end of the "Space for Species" activity as a follow-up to get them thinking about other ways of graphing the species-area connection. In that case, you'll need to have some other activity for them to work on while you're making the data log. You might want them to focus on the plant samples they've collected, having the students identify the samples, classify them or make rubbings of them as a science or an art project.

Answers to "Ovenbirds in Illinois Woodlands:" Forest Size in Acres; Chance of Encountering or Attracting Birds; 3.5 percent, 25 percent, 70 percent; large; there is an increase in nest predation and nest parasitism by cowbirds; answers will vary.

5. **Fill in the "Graphing Greens Data Log."**
   Once you have finished the data log, have the students use the information in the log to fill in the data summary table at the bottom of the "Graphing Greens Data Log." This table will help them make the species-area curve (see sample table below). They'll use the "Total Number of Species" row (the cumulative total of species found in the plots) for their y-axis and the "Total Sample Area" row (the cumulative area of plots that make up the sample area) for their x-axis when they make the graph.

   Students can make this graph as a group, or they can make the graph as a homework or an in-class assignment if they need the practice. If they're going to make their graphs on their own, have each student fill in a data summary table. If you're going to make the graph as a class, you can summarize the data into one table as a group. On Day 2, you can either go over the graphs that the students made at home, or you can make one group graph.

DAY 2: Plotting the Species-Area Curve

6. **Graph the results.**
   The graph should be labeled "Total Area" on the x-axis and "Total Number of Species" on the y-axis. Data for the x-axis will come from the "Total Sample Area" row of the data summary table. Data for the y-axis will come from the "Total Number of

Data Summary Table

Plot Number	1	2	3	4	5	6	7	8	9	10
New Species (first seen in sample area; ⊗s in this plot)	7	5	1	1	1	0	1	1	1	2
Total Number of Species (all ⊗s up to now)	7	12	13	14	15	15	16	17	18	20
Plot Area (sq. yd.)	1	1	1	1	4	4	4	16	16	16
Total Sample Area (total of plot areas in sq. yd.)	1	2	3	4	8	12	16	32	48	64

Species" row of the data table. The number of data points will equal the number of plots (10 in this example). Your students' graphs should look similar to the sample below.

be rare if they have more specialized needs than other species and depend on a certain type of soil or food. These species would only be found where the resources they need are found.] As you look at bigger and bigger areas of a habitat, the chances increase that you'll find these rare species, but you won't find them at the same rate that you found the more widespread species. So the curve will usually rise sharply at the small plot areas, then more slowly as the area increases.)

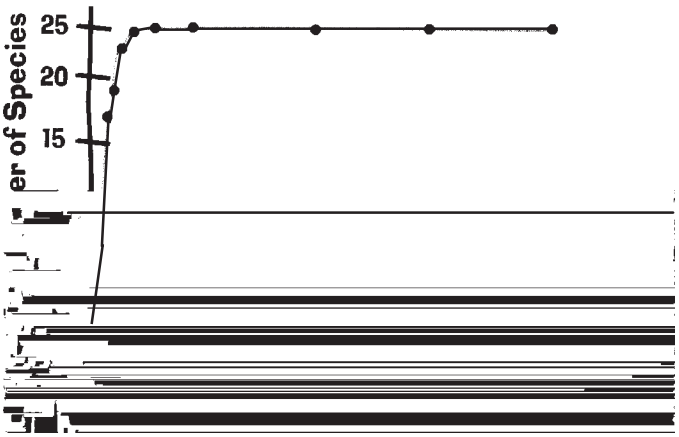
8. **Discuss how scientists use the species-area curve.** Graphs are important tools of scientists. The graphs help scientists make sense of a lot of data by putting it in a form that allows the scientists to see quickly what the numbers mean. Talk with your students about how the curve might allow them to see the connection between species and habitat area better than the log would. What kinds of things do they

the curve levels off, and how quickly it levels off can be different for different habitats.

Draw a species-area curve that is less steep and that levels off at a lower number of species than the one you made as a class. (See the example below). Ask the students what the different shape tells us about *area, species are most likely more spread out, and there are probably fewer species.)*

Species-area curves can also be used to look at one habitat over a long period of time to see how it changes. The students could look at their schoolyard at different times of year or after major disturbances such as big storms, insect population explosions or pesticide applications to see if these events changed the species-area connection.

9. **Discuss the species-area curve and conservation.** What does the species-area curve tell us about the problem of fragmentation? Since many curves level off at relatively small plot areas, does it mean that small habitat fragments will still contain most of the species that were in the larger habitat? Unfortunately not. Ask students if they can think of any reasons this isn't true. *(Remind students that they looked at plots that were part of a larger habitat. They weren't looking at habitat fragments. If they've played "Island Hopping," they should remember that, in fragments, the edge effect will affect the number of species. It can change the habitat drastically and can cause a loss of more of the original species frokeda1irme lar45o telng, s, does69/hat iemı˝T*ı˝[(spec*



WRAPPING IT UP

Assessment

1. Distribute a sheet of graph paper (with one-half inch to one-inch squares) to each student. The students are to be "developers" in charge of developing the land represented by the graph paper. One-fourth of the space will be used for housing, one-eighth of the space will be used for roads/parking, one-eighth of the space will be used for commercial development and one-fourth of the space will be used for industrial development. The remaining space (one-fourth of the total area) will be natural or landscaped area. Have the students design their development. They should label or color-code the design and, on the edges, explain why they used the land in the way they did.

2. Have the students write an interview between a journalist for *BioTimes* magazine and an animal or plant whose habitat has gotten smaller because of development. The interview could include questions such as these: *"Why are you leaving home?," "Where do you think your travels will take you?," "What are your special habitat needs?"* and *"How could people have reduced the damage this development has caused?"* You might want to have the students do some research using the *Biodiversity of Illinois* CD-ROMs in advance to find out about the specific needs of their species. Afterward, students can share their interviews by taking turns playing the roles of journalists and species being interviewed.

Portfolio

Part I has no portfolio documentation. For Part II, use the tables and graphs in the portfolio.

Extensions

1. Stage an in-class debate about a current development issue in your area. Have half the students in favor of developing the land and the other half against it. Those in favor of development should be able to cite some of the potential social and economic benefits of the proposed project, and those opposed should cite some of the project's potential environmental consequences, especially its potential effect on biodiversity. Can the two sides agree on a compromise?

2. Look for fragments of the same type of habitat in your community. You might find fragments of wetlands, prairies, beach-dune systems or woodlands. Then take your students on a field trip to investigate some different-sized fragments. Have them think of ways they could investigate the level of biodiversity in the fragments and then compare the fragments. You might ask a local park ranger, a naturalist or some other expert to help you organize the trip.

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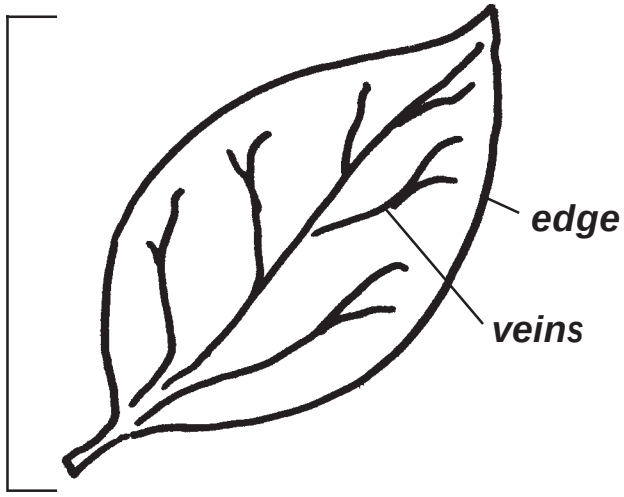
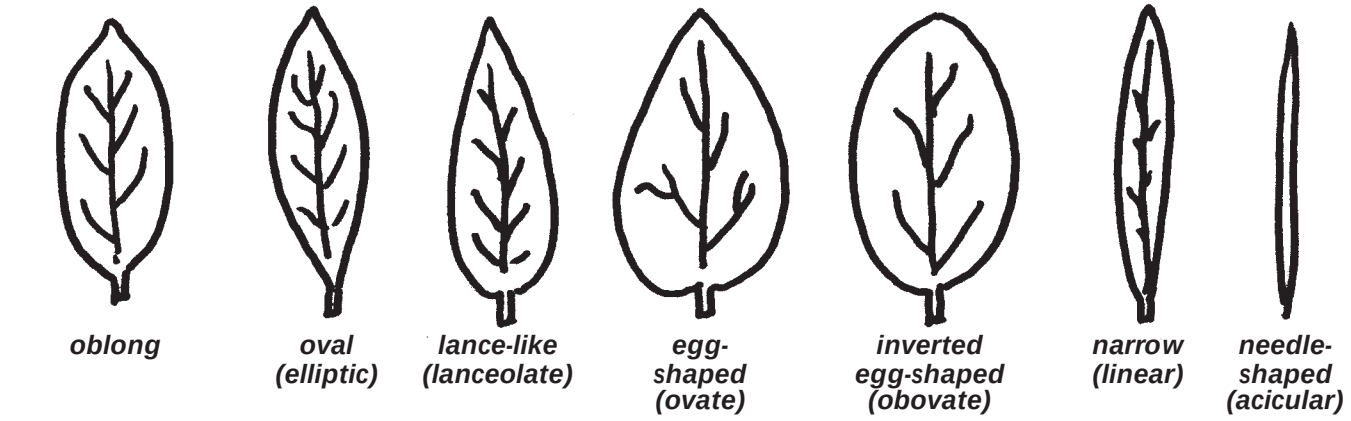
Student Page

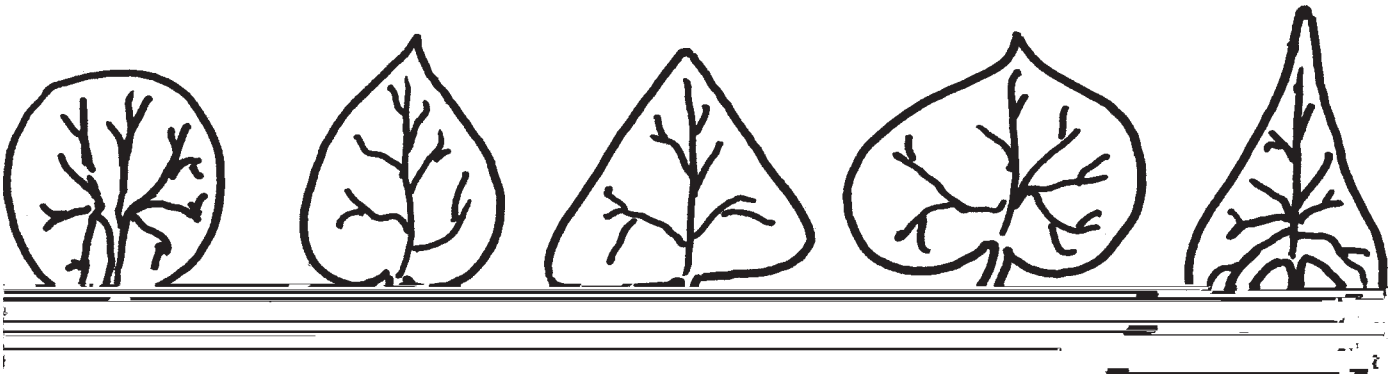
Leaf I.D.

One way to tell plants apart is by looking at their leaves.

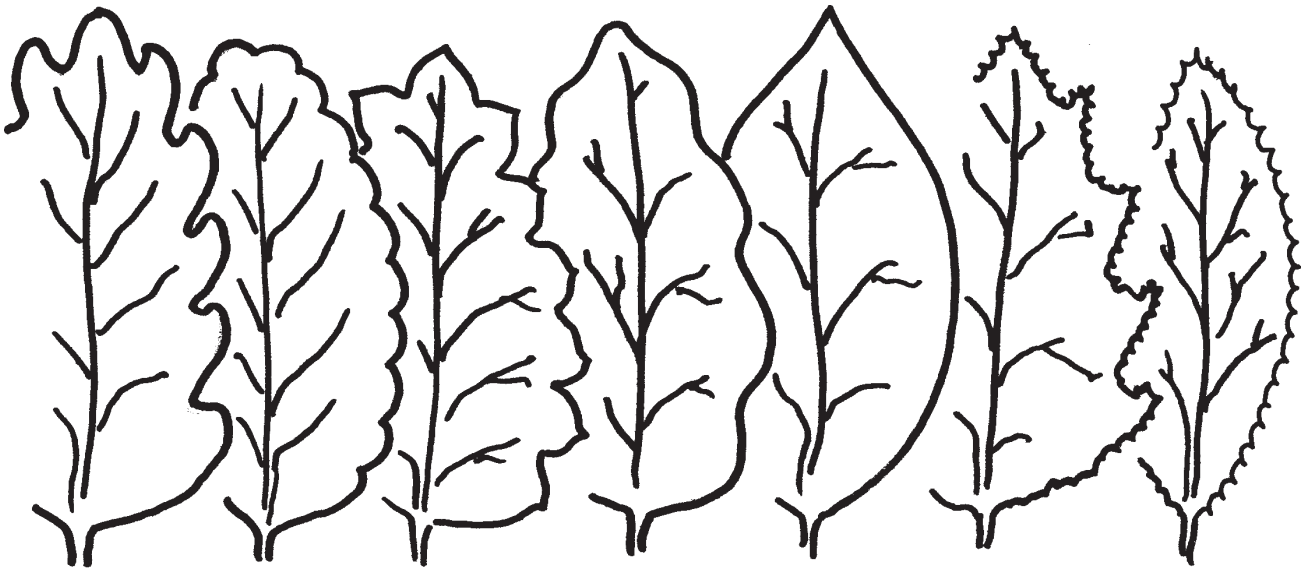


Shapes





Edges



lobed ***rounded (crenate)*** ***tooth-like (dentate)*** ***wavy (undulate)*** ***smooth (entire)*** ***double saw-like (double serrate)*** ***saw-like (serrate)***

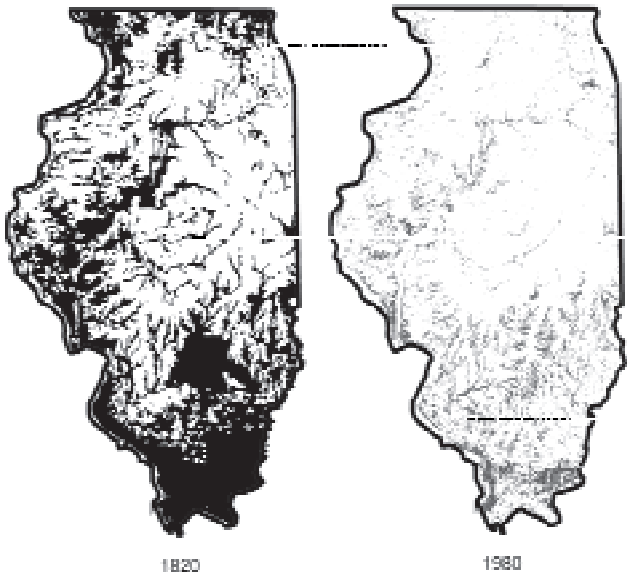
Veins ***(There are three main ways that veins are arranged on leaves.)***

parallel ***palmate*** ***pinnate***

Graphing Greens Data log

PLOT NUMBER

SPECIES	1	2	3	4	5	6	7	8	9	10
DATA SUMMARY TABLE										
NEW SPECIES (first seen in sample area; Ⓧs this plot)										
TOTAL NUMBER OF SPECIES (all Ⓧs up to now)										
PLOT AREA (sq. yard)	*1*	*1*	*1*	*1*	*4*	*4*	*4*	*16*	*16*	*16*
TOTAL SAMPLE AREA (total of plot areas in sq. yards)	*1*	*2*	*3*	*4*	*8*	*12*	*16*	*32*	*48*	*64*


1820
1980

Activity 4-1
Future Worlds

AT A GLANCE

Build a pyramid to reflect personal priorities for the future. Investigate the way humans affect the natural world and discover how people are working to protect the environment and improve the quality of life in Illinois and on earth.

OBJECTIVES

Express personal values by creating a personal vision for the future, especially as it relates to biodiversity. Reach group consensus using negotiation and conflict resolution skills. Discuss ways to arrive at the envisioned future. Analyze various approaches people in Illinois and around the world are taking to arrive at those futures.

SUBJECTS

English language arts, social science, physical development
AT A GLANCE

Some people look into our future and see a gloomy, inhospitable picture: a world that is less healthy, less safe, less diverse, more crowded and more polluted. While such portraits of doom may scare some people into action, they often have the opposite effect. Negative forecasts can become self-fulfilling prophecies, making people—especially young people—resigned and hopeless. This activity doesn't take a doom and gloom approach. Instead, it is designed to get your students to begin envisioning the future they want to inhabit and to learn about some real-life examples of how people in Illinois and around the world are working to make the future brighter.

CHICAGO PLANS FOR THE FUTURE

In 1909, the Commercial Club of Chicago released "Burnham's Chicago Plan of 1909," one of the most influential and famous city plans in world history. Among its many provisions, that plan envisioned that the shore of Lake Michigan and a regional network of natural landscapes be protected as public parklands. Because of this foresight the Chicago region is ecologically healthier and more beautiful than it might have been. The air is cleaner, the water purer, there are more lakeside, parkland and forest preserves than if previous generations had not thought of the future. Therefore, what we do today helps determine what will happen in the future. Today the Northeastern Illinois Planning Commission, the City of Chicago and the Metropolis 2020 Project are working on projects to promote sustainable long-range planning for Chicago.

BEFORE YOU BEGIN

Option #1

Make a copy of "Future Blocks," "Priority Pyramid" and "Making It Happen" for each student and for each group. Also provide scissors and glue or tape.

Option #2

Make a copy of the "Priority Pyramid" and "Making It Happen" for each student and for each group. Also provide scissors and glue or tape.

Poached Eggs: *healthy fish populations*
A New Crop of Farmers: *enough food for all people*
Stewardship Volunteers Hard at Work: *fewer invasive species*
Populations at Risk: *otters, bobcats and eagles*

WRAPPING IT UP

Assessment

1. Use both "Priority Pyramid" worksheets and observed student interaction for the assessment. Inform the students that they will be evaluated on these assignments.

2. Before constructing pyramids, ask your students to write about their top priority for the future and the reasons it is most important to them. Use the following journal starter: "When I imagine a sustainable future, I think of . . ."

3. Have each student write a newspaper article on an imaginary, but realistic, event that addresses the number one concern from his or her personal pyramid.

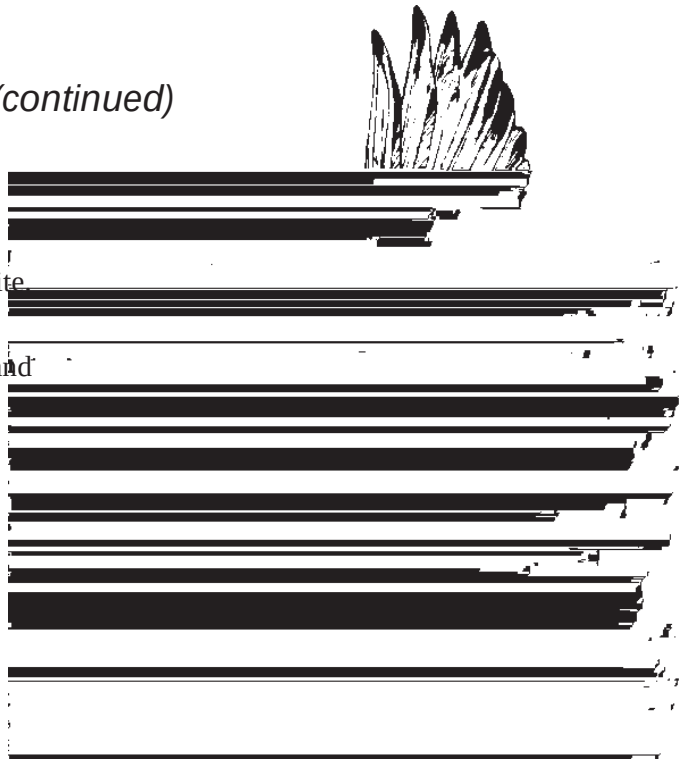
Portfolio

The personal "Priority Pyramid" can be used in the portfolio.

Extension

1. **Future logs**
   Have the students keep a "future log" for a day. Explain that the point of the log is to focus on how their activities, behaviors and even their thoughts can affect the future. In the log they should simply write down what they do, think, say and so forth—just as they would in a diary. In the log, however, they should use "bullet style" instead of paragraphs. At the end of the day, they should think about and write down how each "bullet" affects the world around them, either positively or negatively, and what the ramifications could be for the future. For example, if a bullet reads, "Had a PBJ sandwich for lunch, with a bag of chips and ginger ale," the student might write down the fact that he or she recycled the soda can—a positive action for the future that saves natural resources and landfill space. But the student might also mention throwing away his or her lunch bag instead of using it again, or instead of bringing lunch to school in a heavy-duty container that can be used over and over. Have the students add ways that they can do more to create a positive future by changing their daily actions.

2. **Class action project**
   Determine the block that holds the highest priority for the class. Have students brainstorm a range of activities that might be appropriate related to this block. Do the consensus building activity/nominal group technique as a whole class to prioritize a class action that they would carry out. Then have students implement the goal by creating the "I Make a Difference Club."
   .



Resources

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Bee Good to Your Lips

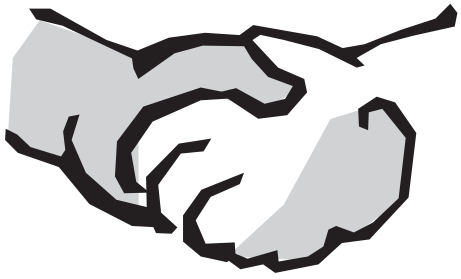
A company called Burt's Bees purchases beeswax for the production and sale of lip balm. That's good news for beekeepers across the United States who use the income from beeswax sales to better manage their honey bees. Most people don't know it, but honey bee populations have declined in the last few years. If the trend continues, the cost to farmers could be billions of dollars a year. The reason? Bees are very important for pollinating crops. Saving bees will require changes on many fronts—from reducing pesticide use to saving bee habitats.

Now, That's More Lichen It!

Forest scientists need lots of high tech instruments to measure air quality, right? Well, traditionally, they have had to spend thousands of dollars a year to buy and operate electronic air-monitoring instruments. But now they have a new, more cost-effective instrument: lichens! Lichens are actually two organisms in one: a fungus and either an alga or a bacterium. Together these "partners," which grow on rocks and other surfaces, can live in some of the harshest environments on earth—including the frigid reaches of Antarctica. Tough as they are, though, lichens are very sensitive to air pollution. A botanist discovered how certain lichens respond to three different air pollutants—ozone, sulfur dioxide and nitrogen oxide. By monitoring where lichens are growing and how healthy they are, scientists can draw conclusions about the presence of these pollutants in an area. And many forest scientists are doing just that!

Beautifying Neighborhoods

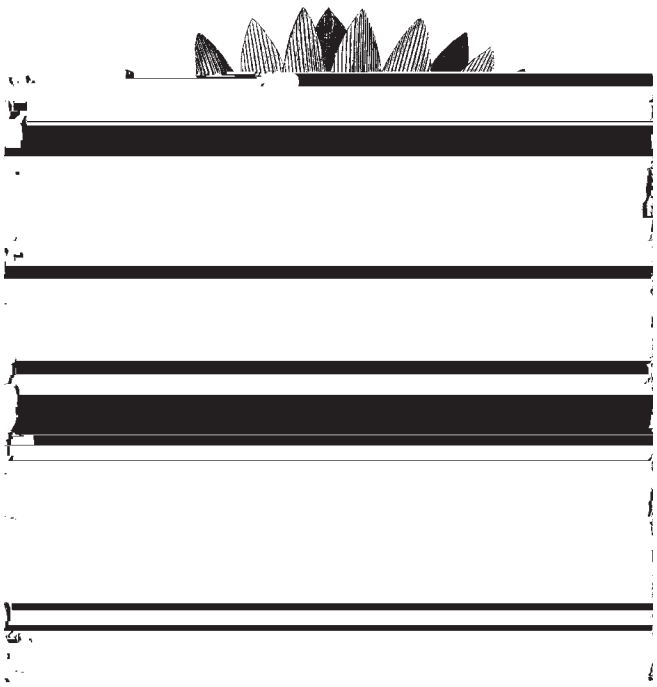
Want to help be a crime buster in your community? Follow the "Clean and Green" program



MAKING IT HAPPEN

Restoring the Tallgrass Prairies

The Midewin lands (southwest of Chicago) are a piece of the 36 million acres of prairie that once existed in Illinois. Beginning in the 1830s, the rich prairie soils were plowed by settlers, who wanted to farm the land. Later, with World War II looming, the U. S. Army commandeered many thousands of acres in Midewin for use as an ammunition plant. That use continued for more than 50 years, until the Army abandoned the land and environmentalists succeeded in winning approval for an ambitious plan to restore Midewin. Much planning, cooperation and hard work have gone into restoring this prairie. As part of the plan, the U. S. Forest Service is growing acres of native plants on parts of the site. The seeds of those plants are harvested and planted to create this new "prairie forest."



Concerned Citizens Unite

Altgeld Gardens is a Chicago Housing Authority community of about 10,000 people on the southeast side of Chicago. It is located in the center of a toxic doughnut of heavy industry and waste dumps. A mammoth water treatment plant that contains acres of waste-drying areas is present as are more than 100 industrial plants and 50 active or closed waste dumps. The area contains 90 percent of Chicago's landfills. Altgeld Gardens, whose residents are virtually all African-American, was built on the edge of an old industrial dump. Today airborne pollutants from this industrial area cause a host of ailments: watery and burning eyes; skin rashes; conjunctivitis; asthma; and other respiratory illness. Residents suffer from high rates of bladder and lung cancer. A citizens group, People for Community Recovery, working with other environmental groups, like the Southeast Environmental Task Force, decided to fight the area's powerful industrial companies. They have won some key battles. In 1998, an incinerator was shut down, and plans to build another landfill were blocked.

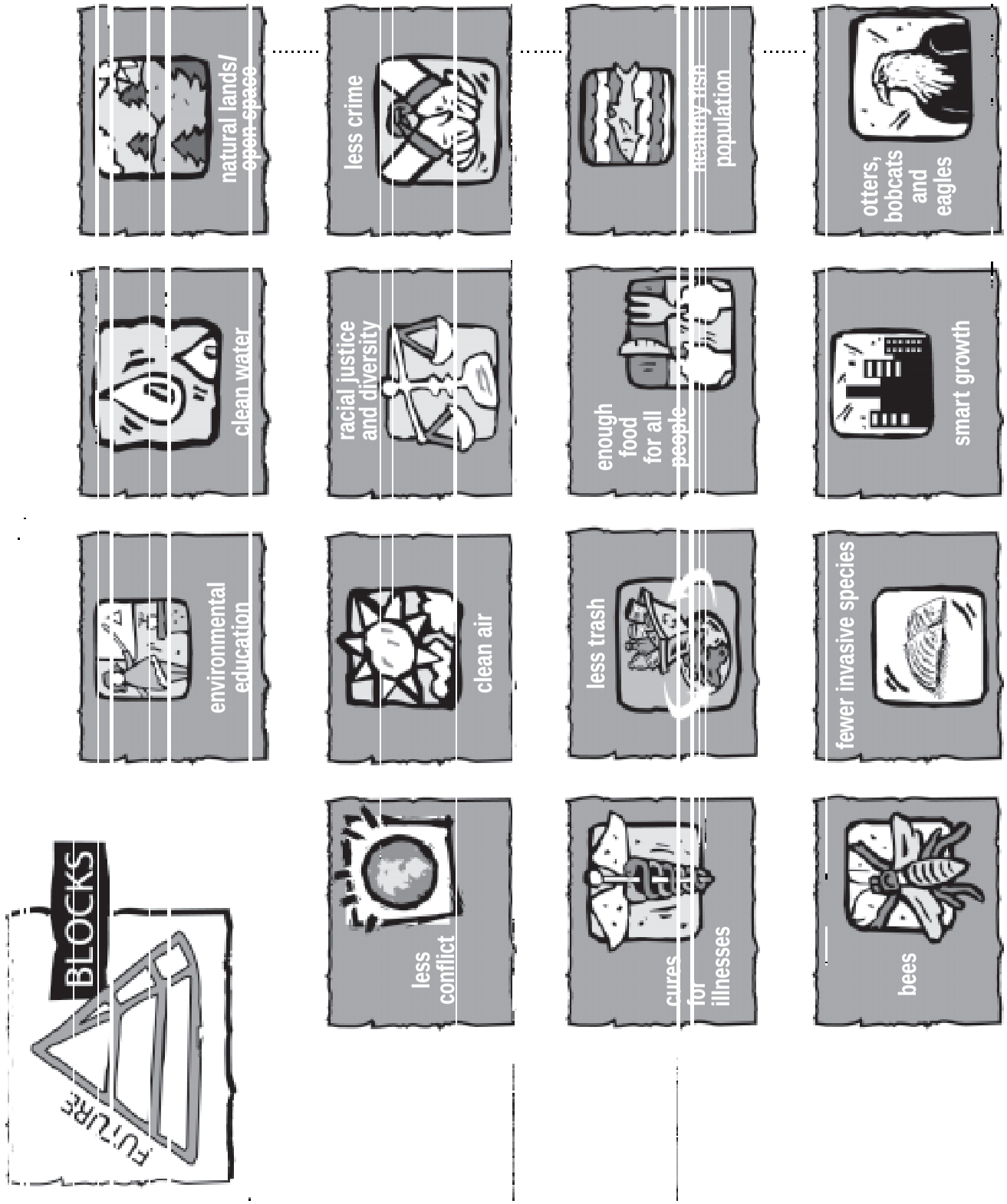
The Power of Plants

How did people treat illness and disease before there were grocery stores and pharmacies? They looked to nature to treat their symptoms. Many native plants in Illinois were used for food and for their healing properties. Bloodroot, a spring woodland wildflower, can be used to treat respiratory illnesses, including bronchitis, asthma and laryngitis. The compound salicin, closely

MAKING IT HAPPEN ***(continued)***

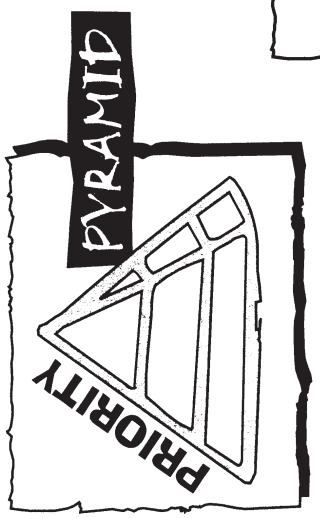
Today, people throughout the Midwest are working hard to save the paddlefish. Since the fish travels great distances, fishermen and fed-

Future Worlds (continued)



Student Page

Future Worlds (continued)



2. Hand out the "Career Profiles" (one profile per pair) and explain the project.
Give the students time to read the profile. Then tell them that each pair of students will be working together to locate and interview someone in the community who has an occupation similar to the one in the profile they read.[1] The work that the community member does may differ from the work of the person profiled, but the occupation should be the same or similar. For example, the journalist in the "Journalist with a Passion" profile focuses on television journalism. But the students may find an environmental journalist who writes for a local newspaper. (If the students are unable to find someone with an occupation similar to the one in their profile, they can choose another occupation from the "Career Corner" list.)

Explain that the students can conduct their interviews either over the phone, by e-mail or in person. (Be sure to allow time for coordinating the students' use of a phone.) Afterward, the students will be using the information they've gathered to develop a creative presentation.

3. Discuss ways to locate people to interview.
Your students may know people in the community whom they can interview, or they might have ideas about where to start looking. Write their ideas where everyone can see them, then add the following suggestions:

federal, state, regional, county and municipal levels of government

- local offices of federal agencies and departments (such as the U. S. Environmental Protection Agency, the U. S. Forest Service, the U. S. Fish and Wildlife Service and the Natural Resource Conservation Service)
- state agencies (such as the Illinois Department of Natural Resources, Illinois Environmental Protection Agency, Illinois Department of Agriculture, Illinois Department of Commerce and Community Affairs, Illinois Pollution Control Board, Illinois Department of Public Health)
- regional forms of government (such as the Northeastern Illinois Planning Commission)
- county government and agencies (such as forest preserve districts, park districts, Association of Illinois Soil and Water Conservation District offices)
- municipal (such as park and recreation departments, public works offices and recycling centers)

private business, not-for-profit foundations, volunteer groups and professional organizations

- local zoos, aquariums or natural history museums
- nature centers
- local or regional environmental organizations
- professional development organizations related to a particular career
- universities and colleges
- community newspapers
- businesses with a strong environmental focus
- companies or stores that provide alternatives to environmentally harmful products (such as supermarkets that specialize in environmentally-sensitive products)
- organizations that have successfully integrated environmentally-sound programs into their operations (such as office-wide recycling or natural area restoration work)

Have each team write down a list of the people or organizations they'll contact. Tell them to rank the list so that they contact their most likely resources first. (You may want to check their lists to make sure they're on the right track and that several groups aren't planning to contact the same organization.)

[1] An alternative to having pairs of students setting up and conducting the interviews is to invite a professional, or a panel of professionals, to the class. The class as a whole could come up with interview questions in advance, and students could take turns asking the questions.

4. Review how to set up interviews.
Ask your students to describe or act out what they would say on the telephone if they called an organization to get the name of someone to interview. The following is an example of one approach they might take:

> *"Hello, my name is _____. I'm a student at _____, and I'm doing a class project that involves interviewing people about their careers. I'd like to interview a(n) _____. Do you know of somebody I might be able to interview? If not, is there anyone else available who might be able to suggest someone? What is your name, please? Thank you very much."*

Next ask your students to describe or act out how they would ask a particular individual for an interview. Here's one approach:

> *"Hello, my name is _____. I got your name from _____. I'm a student at _____, and I'm doing a class project that involves interviewing people about careers related to biodiversity and the environment. Would you be willing to be interviewed? When would be a good time? Thanks very much for agreeing to talk with me."*

Remind the students that they'll need to discuss a suitable time and place if the person agrees to be interviewed. They should also ask whether he or she would like to have a copy of the questions in advance. If the person does not wish to be interviewed, remind your students to thank him or her for speaking with them.

5. Develop interview questions and review "Tips and Tricks of Interviewing" (page 160).
Write on the board or hand out the "Sample Interview Questions." Have your students brainstorm a list of general questions they think would be appropriate to ask during their interviews. Write their ideas on the board, then help the class organize and edit the list. Encourage the students to come up with open-ended questions rather than "yes or no" questions. The students can use the basic list as a guide when conducting the interviews. Each pair should also come up with additional questions that are specifically related to the career of the person they're interviewing.

Next hand out copies of "Tips and Tricks of Interviewing." Carefully explain each tip while the students follow along.

If you'd like to give your students practice conducting interviews, form groups of four by bringing two pairs together. Then have each pair develop five questions to ask the other pair. You might want to have one person in each pair ask the questions while the other takes notes, or you might have the two alternate so each student can practice asking questions and taking notes. You might also encourage your students to practice by interviewing their parents or neighbors.

6. Conduct the interviews.
Help your students determine the best way to conduct the interviews. In some cases, the interviewees might be able to come to the school. In other cases, they might be able to meet with the students after school at their place of work or another convenient location. Astuh3 geı˝0.03i()Tjı˝T*ı˝(Jı˝T'

harder than they expected? Why? Which careers didn't they know about before? Which careers sounded the most interesting, and why? What did they learn that surprised them?

Some students might have been surprised to find out that a person doesn't need to have a career directly related to the environment to be able to make a difference. Point out that more and more careers include aspects of environmental protection. And many corporations are hiring people with environmental backgrounds. For example, 20 years ago it would have been hard to find an ecologist working for an electric power company, but today many ecologists are helping such companies make sure they aren't harming the environment.

8. Develop and give presentations.
Have each pair put together a brief presentation focusing on the career of the person they interviewed. Encourage the students to create posters, visual aids or use other multi-media techniques to explain and illustrate how the career they're highlighting relates to biodiversity. Make sure that both students in each pair are involved in the presentation. (You might also want the students to write their interview as an article.) Once the presentations are finished, ask students for their reactions to the careers they learned about.

WRAPPING IT UP

Assessment

1. Collect the students' interview notes. Compare the information gathered in the interview with the information included in the presentation.

2. Have the students write up their notes as an interview-style article.

3. Let the students use the following as a journal starter: "The jobs I found most interesting are . . . because . . ."

Portfolio

Interview notes can be used in the portfolio.

Extensions

1. Have the students research other careers that are related to biodiversity conservation or environmental protection. (See the list entitled "Career Corner" for ideas.) They can use their research as a launching pad to write career profiles of people in the community, conduct more interviews, create displays or write reports.

2. Have students investigate the life and career of someone who was instrumental in influencing the fields of science, the environment or technology. Identify how his/her contributions influenced the lives and careers of people today.

Resources

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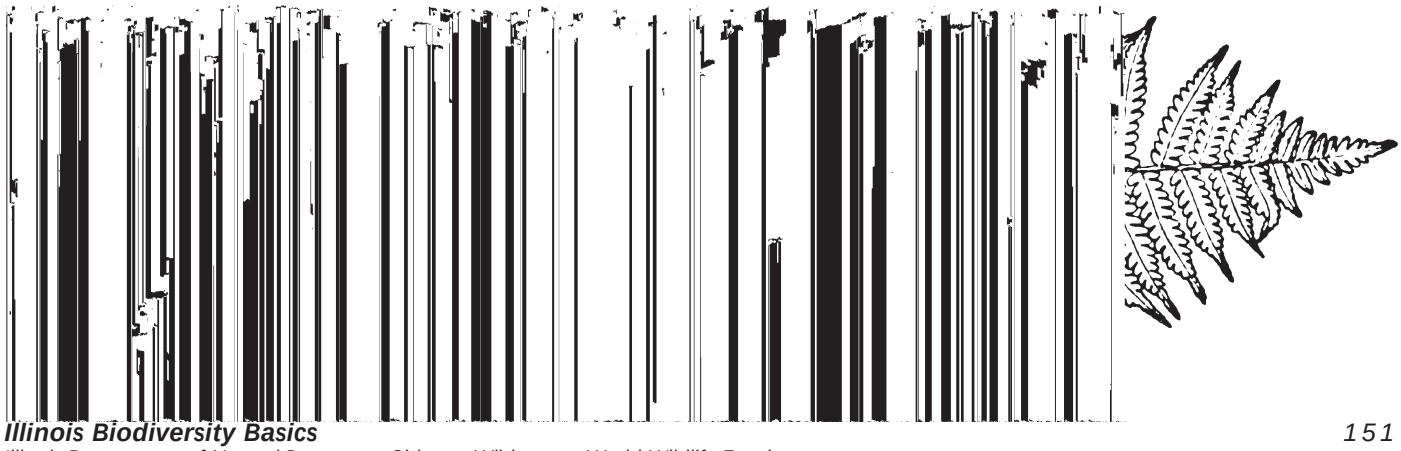


CAREER CORNER

Botanist
Chemist
Community Activist
Conservation Biologist
Conservation Police Officer
Ecologist
Ecotourism Trip Leader
Environmental Educator
Environmental Journalist
Environmental Lawyer
Entomologist
Environmental Specialist at a Foundation
Fisheries Biologist
Forester
Hydrologist
Integrated Pest Management Specialist
Land-Use Planner
Limnologist
Natural History Museum Curator
Naturalist/Interpreter in a Park or a Wildlife Sanctuary
Nature Photographer
Natural Resource Economist
Organic Farmer
Population Expert
Park/Preserve/Refuge Manager
Recycling Coordinator
Research Biologist/Scientist
Soil Conservation Specialist
Solid Waste Manager
Stewardship Volunteer
Toxicologist
Zookeeper
Zoologist

SAMPLE INTERVIEW QUESTIONS

Here are examples of some of the kinds of questions you might want to ask during your interview.

- ✔ *What's a typical day on the job like for you?*
- ✔ *What's your educational background?*
- ✔ *What skills are especially useful in your profession?*
- ✔ *What types of scientific skills or technology do you need to do your job?*
- ✔ *Does your job involve protecting biodiversity? If so, how?*
- ✔ *What's the most challenging aspect of your job?*
- ✔ *What's the most rewarding aspect of your job?*
- ✔ *How did you become interested in your field?*
- ✔ *Did you always want to be involved in a career like the one you're in?*
- ✔

Student Page

Career Profiles

Student Page
Career Profiles (continued)

Bill Kurtis
Journalist with a Passion
Known for his sense of humor and exciting productions, Bill Kurtis, the Emmy award-winning television journalist, has been reporting about world-altering events for more than thirty years. He was among the first Chicago correspondents to travel to world hot spots like Vietnam and Northern Ireland. He has covered numerous special stories about animals, like the endangered black rhino in Africa. Bill Kurtis is also creator and producer of the Peabody Award-winning science-adventure series, The New Explorers.

Bill was born in Kansas and has a background in journalism and law. He has cultivated his professional skills with his personal concerns. Bill demonstrates a responsibility for the environment by participating on the Board of Directors of the National Park Foundation and The Nature Conservancy. He has educated many people with his television productions that often focus on nature and how to protect biodiversity all over the world.

Michael Jeffords
Going Buggy over Bugs
Like many youngsters, Michael Jeffords had a passion for insects at an early age. However, he never knew his calling in life would be to become a scientist in entomology at the University of Illinois in Urbana-Champaign. Michael teaches college students about biodiversity and its preservation. In addition, he is the co-author and photographer of a book on Illinois habitats, called Illinois Wilds, is one of the creators of the habitat monitoring program for Illinois EcoWatch, and is currently helping to develop educational materials on biodiversity.

Michael's educational background is varied, from community college to medical school, to his doctoral degree in entomology. He feels that his specialized knowledge in his field of science and his capacity for integrated thinking has helped him to creatively apply his knowledge to looking at larger problems. His personal efforts have brought him more opportunities than the skills he has gained through academics. He says, "Everything you learn will be helpful to you at some point, so don't limit yourself in whatever you can try or gain knowledge about."

Dennis Dreher

Planning for the Future

Playing in creeks and seeing how water flowed fascinated Dennis Dreher when he was a child. Today, he works with local governments to promote more sustainable communities through improved environmental management. Currently employed at the Northeastern Illinois Planning Commission on a fellowship from Chicago Wilderness, his job requires making presentations, writing proposals and publications, and most importantly, trying to find a common ground between different interest groups for improved ecological practices.

Dennis' college education was in water resources engineering. He finds water issues to be a major part of educating decision-makers about creating more ecologically friendly communities. "The best part of my job is working with committed and passionate people," he says, "especially when I see positive changes in attitudes and practices." His advice to students is to "get a solid but broad analytical background; don't just follow the money ... follow your passion. Do something that will make a difference; and don't be afraid to make changes along the way if you're not happy."

Dave Brandt

The Dirt on Soil

To most homeowners and farmers, soil is a seedbed for plants. To engineers, soil is a construction material. To a parent, soil is something to get out of clothes. For all of us, soil is a natural resource. As a District Conservationist for the Natural Resources Conservation Service (NRCS), Dave Brandt works with individuals, groups and students to promote wise use of soil and all natural resources. "My goal is to make people aware of soil and to teach them why conservation is important."

Dave received his Bachelor of Science degree in Outdoor Recreation and Natural Resources Management from Southern Illinois University (SIU). He found soils so interesting that he took every soils class SIU offered. Dave worked at NRCS offices in Saline, Gallatin and Jasper counties. Now employed in McHenry County, he tackles a mix of urban and agricultural issues. He has found that there are similar natural resource issues throughout the state. "All of the land has been impacted in some way. What is left in the place of native plants are a handful of European invaders, such as buckthorn and reed canary grass."

Dave feels that people who are interested in protecting natural areas need to make a life-long commitment in order to help find solutions. He recommends that students interested in the natural resources fields take a broad spectrum of classes such as biology, botany, geology and water quality rather than focusing on a specific area, so that they will be able to understand the connections among resources.

Shelly Fuller

All Wet and Loving It!

Shelly Fuller first read about Illinois RiverWatch in a newspaper, and her feet have been wet ever since. Originally hired to recruit and train volunteers to conduct stream monitoring, she now finds herself as the Education and Training Coordinator, in charge of all training aspects of this statewide program. There are myriad responsibilities accompanying her position, one of the most important being designing and implementing the training and certification program for EcoWatch trainers. She teaches her field staff the concepts of biological stream monitoring, how to conduct the scientific procedures and identification required by the program, and how to teach the information to Illinois' citizens. RiverWatch has more than 1,500 volunteers collecting data on hundreds of sites each year. One of her favorite things about working for EcoWatch is that it offers conservation-minded citizens across the state the opportunity to contribute to meaningful scientific research.

Shelly's degree is in biological sciences, and she is continuing her education by attending workshops and classes and through self-study under the direction of local naturalists.

Barrie McVey

Planting Forests for the Future

When she was growing up, Barrie McVey's adventures with her family while on vacation throughout the United States led her to develop an appreciation of nature and the interaction of all things within it. She pursued her interest and now works as a District Forester for the Illinois Department of Natural Resources.

Each year foresters plant trees on many acres of land that were once forested but have since been cleared. The tree plantings help to reduce soil erosion, improve water quality, provide homes for wildlife and create future forest products. Foresters also assist private landowners with proper woodland management to improve the quality of their forests. Working on public lands is also part of a forester's job, to ensure that the citizens of Illinois can enjoy healthy forests.

Barrie enjoys being able to work outside in all the different season of the year. She says that the woods can be a completely different place between the summer and the winter. She enjoys going back to a tree planting on old farm ground after a few years and seeing a productive young forest. "It's great to see the trees growing and to see all of the wildlife that moves back in! And it's very satisfying to teach people, both young and old, about the importance of trees."

Wayne Frankie

Rock Detective

As a geologist with the Illinois Natural History Survey, Wayne Frankie has the opportunity to work outdoors, travel and learn about the variety of geology within our state. Wayne says that a geologist is really a scientific detective. One of the most rewarding aspects of his job is working with and meeting people and sharing information with them.

(continued)

Tips and Tricks of Interviewing

Before the Interview

✓ When you call to set up an interview, introduce yourself on the phone. State your name, school, grade level, and the purpose

Appendices
Vocabulary

Each definition is immediately followed by the number of the activity or activities in which it is introduced or to which its meaning is most relevant. For example, (1-2) indicates the second activity in the first section. Vocabulary words may be found in other activities besides those listed below.

abdomen: in arthropods (animals like spiders and insects), the posterior section of the body (1-2)

antenna (singular); *antennae* (plural): paired, flexible, jointed sensory appendage on the head of some arthropods (1-2)

appendage: a part or organ that is joined to the main body of an object or organism; examples include legs and antennae (1-2)

arthropod: organism such as a scorpion, spider, tick, millipede, centipede, insect or crustacean; the body has an external, segmented covering and jointed appendages (1-2)

atmosphere: the gaseous mass surrounding the earth which is held in place by gravity (2-3)

bacterium (singular); *bacteria* (plural): one-celled organism without a true nucleus; some are free-living, and some are parasites (1-2)

biodiversity: the variety of life on earth, reflected in the variety of ecosystems and species, their processes and interactions and the genetic variation within and among species (1-1)

biogeography: the study of living systems and their distribution (3-3)

biosphere: the part of the earth and its atmosphere where living things exist (1-2)

cephalothorax: the joined head and thorax of arachnids (spiders, scorpions, ticks and others) and many crustaceans (1-2)

chromosome: structure that contains DNA in the cell and that is responsible for the determination and transfer of hereditary traits (1-4)

class: a taxonomic category that ranks below phylum and above order (1-2)

classification: grouping organisms into categories based on shared characteristics or traits (1-2)

conflict management: a practice in which disagreeing groups meet with an impartial person to discuss their concerns; each side listens closely to the other side; the impartial person helps clarify what each side is asking for; in many cases, both groups find that their needs can be met without further conflict (4-1)

consensus: collective opinion; general agreement or accord (4-1)

cultural diversity: differences in socially transmitted behavior patterns, arts, beliefs, institutions and other products of human work and thought characteristic of a community or population (4-1)

ecological processes: relationships between organisms and their environments (2-2)

economics: science that deals with the production, distribution and consumption of goods (2-2)

ecoregion: a relatively large unit of land that is characterized by a distinctive climate, ecological features and plant and animal communities (1-3)

Vocabulary *(continued)*

ecosystem: a community of organisms that are linked by energy and nutrient flows and that interact with each other and with the physical environment (1-1)

edge effect: when a habitat is divided into small sections, more boundaries are created between the habitat and its surroundings; these boundaries, or edges, are very different than the conditions in the habitat's interior; edge is often lighter and drier than the interior of the habitat and can change the types of organisms living in the area; in small fragments, edge conditions may compose most of the habitat (3-3)

endangered species: a species threatened with extinction (3-1, 3-2)

Endangered Species Act: legislation enacted to ensure the survival of endangered plant and animal species; habitats critical to their survival may be protected, too (3-1)

evaporation: changing from a liquid state to a gaseous state (2-3)

evolution: the process of change in the traits of organisms or populations over time (1-2, 1-4)

extinct: a species that no longer exists (2-2)

family: a taxonomic category that ranks below order and above genus (1-2)

fragmentation: the breaking up of large habitats into smaller, isolated chunks (3-3)

fungi: organisms that use living or dead organisms as food by breaking them down and then absorbing the substances into their cells (1-2)

gall: an abnormal swelling of plant tissue caused by insects, microorganisms or injury (1-3)

gene: a segment of DNA that includes the coded information in an organism's cells that makes each species and individual unique (1-1, 1-4)

genetic diversity: the genetic variation present in a population or species (1-4)

genus: a taxonomic category that ranks below family and above species (1-2)

global warming: the hypothesis that the earth's atmosphere is warming because of the release of "greenhouse gases" such as carbon dioxide (4-1)

ground-truthing: the process of going to an area to verify information; gives scientists a firsthand look at areas they're interested in and can help guide further studies (1-3)

habitat: the area where an organism lives and finds the nutrients, water, sunlight, shelter, living space and other essentials that it needs to survive (3-1, 3-3)

habitat loss: the destruction, degradation and fragmentation of habitats; primary cause of biodiversity loss (3-2)

heavy metals: natural metallic elements including cadmium, copper, lead and zinc; can be toxic to some organisms (2-3)

immigration: to move into an area (3-3)

impurity: a contaminant or pollutant (2-3)

inherit: to receive genetically from an ancestor (1-4)

introduced species: an organism that has been brought into an area where it does not occur naturally (3-1, 3-2)

invasive species: an organism that has been brought into or spread into an area where it does not occur naturally (4-1)

kingdom: one of the main taxonomic divisions into which natural organisms and objects are classified (1-2)

legislation: the act of making laws; a proposed or enacted law or group of laws (4-1)

lichen: a fungus and an alga or blue-green bacteria growing together in a mutually beneficial relationship often seen as crustlike scaly or branched growths on soil, rocks or tree bark (4-1)

migration: the movement of animals in response to seasonal changes or changes in the food supply (1-1, 1-3)

mineral: a natural inorganic substance with a definite, uniform chemical composition and characteristic crystalline structure, color and hardness (2-3)

native species: a species that occurs naturally in an area or habitat (1-3)

noxious: harmful to health (1-3)

nucleus: complex structure in some cells that contains the cell's hereditary material and that controls metabolism, growth and reproduction (1-4)

order: a taxonomic category that ranks below class and above family (1-2)

organism: a living thing (1-2)

over-consumption: the use of resources at a rate that exceeds the ability of natural processes to replace them (3-2)

pesticide: chemical that inhibits or kills the growth of organisms that people consider undesirable (2-3)

photosynthesis: the process by which green plants, algae and other organisms that contain chlorophyll use sunlight to produce carbohydrates (food) (2-3)

phylum: a taxonomic category that ranks below kingdom and above class (1-2)

pollination: the process by which pollen is transferred from the male part of a flower to the female part of the same or a different flower (2-2, 4-1)

population: all the individuals of one species in one place at one time (1-4)

precipitation: water droplets or ice particles condensed from the atmosphere and heavy enough to fall to earth's surface, such as rain or snow (1-3)

racial justice: equality among ethnic groups (4-1)

range map: graphic representation of the area in which a species lives (3-1)

rapid assessment: a quick scientific survey or count that helps measure local biodiversity (1-3)

recycling: to extract useful materials from; to extract and reuse; to use again or reprocess to use again (4-1)

sampling
uniforms˝/F1alsl tof cstractorlaanic splewhole)

Vocabulary *(continued)*

smart growth: using new methods of building and rebuilding neighborhoods and incorporating long-term planning practices to protect the area's natural resources (4-1)

species: a group of organisms that have a unique set of characteristics that distinguishes them from other organisms; the basic unit of biological classification (1-1, 1-2, 1-4)

stewardship: the management of natural resources (4-1)

sustainable: capable of existing or being maintained (4-1)

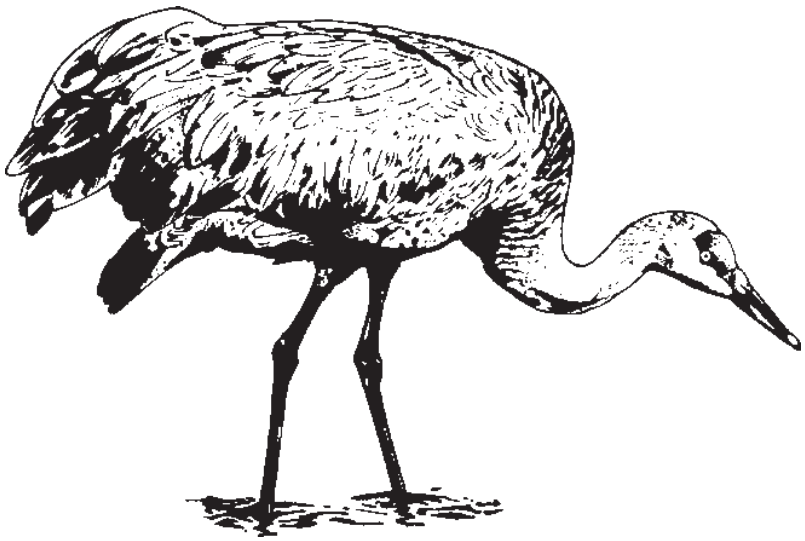
taxonomy: the process and study of classifying organisms (1-2)

toxic substance: one that is harmful, destructive or deadly (2-3)

trait: a genetic feature or characteristic, such as hair color or blood type, that may be passed on from one generation to the next (1-4)

transpiration: the process of giving off water vapor and other products through the stomata of plants (2-3)

wetland: area that, at least periodically, has waterlogged soils or is covered with a relatively shallow layer of water (2-3)



Appendices
Scientific Names

The scientific name is the official name for each organism. A scientific name is assigned after careful research. It is made up of two parts, the genus name (written first) followed by the species name. Your scientific name is *Homo sapiens*. Sometimes a third part, the subspecies name, is also used. The name is always in Latin because when this naming process started, most people everywhere knew Latin. The scientific name is underlined or in italics when written. Often a scientific name tells you something about the species or someone who studied it. Scientific names help scientists to study organisms, especially when working with other scientists.

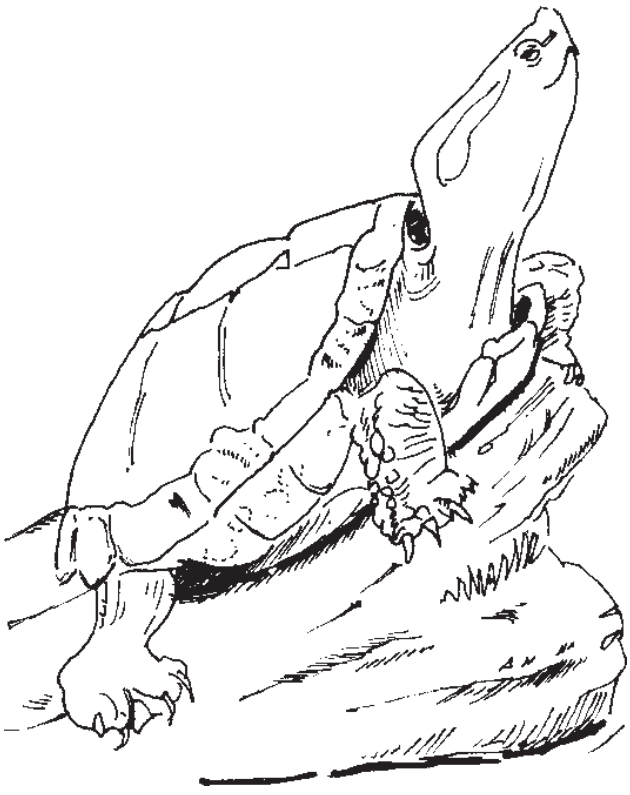
The common and scientific names for most species discussed in this guide (except the list of endangered and threatened species included with Activity 3-1) are listed below. Those species referred to in general terms will not be found in this list.

cow *Bos taurus*

coyote

Scientific Names (continued)

jackal *Canis aureus*
lion *Panthera leo*
little brown bat *Myotis lucifugus*
lynx *Lynx canadensis*
masked shrew *Sorex cinereus*
mayapple *Podophyllum peltatum*
mite *Demodex folliculorum*
mite *Demodex brevis*
mountain lion (puma) *Felis concolor*
mud snake (hoop snake) *Farancia abacura*
multiflora rose *Rosa multiflora*
osprey *Pandion haliaetus*
ovenbird *Seiurus aurocapillus*
paddlefish *Polyodon spathula*
passenger pigeon *Ectopistes migratorius*
pear *Pyrus communis*
peregrine falcon *Falco peregrinus*
pimpleback *Quadrula pustulosa*
plum *Prunus spp.*
potato *Solanum tuberosum*
purple coneflower *Echinacea purpurea*
raccoon *Procyon lotor*
red panda *Ailurus fulgens*
red fox *Vulpes vulpes*
red-tailed hawk *Buteo jamaicensis*
ring-necked pheasant *Phasianus colchicus*
river otter *Lontra canadensis*
ruby-throated hummingbird
Archilochus colubris
sea lamprey *Petromyzon marinus*
short-tailed shrew, northern
Blarina brevicauda
soybean *Glycine max*
spiny water flea *Bythotrephes cederstroemi*
tiger *Panthera tigris*



Appendices

Conceptual Framework and Correlation to *Illinois Biodiversity Basics*

Because the issues surrounding biodiversity can be complex, the topic can be challenging to understand and to teach. The following Conceptual Framework is based on World Wildlife Fund's "A Biodiversity Education Framework" section in the *Windows on the Wild: Biodiversity Basics* educator's guide. The framework in *Windows on the Wild: Biodiversity Basics* is much more extensive than the one shown here and is a general framework for biodiversity education. You may want to reference "A Biodiversity Education Framework" to assist you in teaching about biodiversity.

In this Conceptual Framework you will find the biodiversity topic broken down into small components to help you see, and communicate the relationships among, the different levels of biodiversity, the ecological principles behind it and how we relate to it. We've also linked the concepts to the *Illinois Biodiversity Basics* activities that are designed to teach them. While no single activity can teach the concepts completely, each can contribute to your students' growing understanding. In each activity you will find a section titled "Links to *Illinois Biodiversity Basics* Conceptual Framework." The related conceptual framework topic(s) will be listed there. This section of the guide will explain the framework link in more detail. The concepts are organized under four themes, and the themes are arranged to build on one another, starting with the basic ecological foundation and expanding to include societal issues.

What is Biodiversity?

The concepts within this theme provide students with a fundamental knowledge and appreciation of biodiversity. These concepts also help students understand the characteristics of living systems and the fact that the environment is made up of systems within larger systems.

Biological diversity, also called biodiversity, encompasses the variety of all life on earth, including life on land, in the oceans and in freshwater ecosystems, such as rivers and lakes. People often analyze biodiversity at many levels, ranging from large to small. The three most common levels of analysis focus on ecological diversity, species diversity and genetic diversity. (Activity 1-1)

Species diversity describes the number and variety of species that live on earth. Species diversity can refer to the diversity within specific groups of organisms as well as the total diversity of organisms on earth and the relationships among them. (Activities 1-2, 1-3)

Genetic diversity refers to the variety of genetic information contained in the genes of individuals, species, populations within a species or evolutionary lineages. (Activity 1-4)

A group of organisms that is evolving separately from other groups is called a **species**. For organisms that reproduce sexually, a species can also be defined as organisms that interbreed only among themselves. (Activity 1-2)

Scientists use the terms **endangered, threatened and extinct** to describe the status of species. Endangered species are those species that are in immediate danger of becoming extinct. Threatened species are those whose numbers are low or declining and whose gene pool is becoming too small to ensure variation in offspring. A threatened species is not in immediate danger of extinction but is likely to become endangered if it isn't protected. Extinct species are no longer living. (Activities 3-1, 3-2)

Why is Biodiversity Important?

Concepts in this section can help students investigate how biodiversity affects their lives and supports life on earth. Recognizing the importance of biodiversity increases students' awareness of why and how people's actions affect biodiversity, and why it's important to maintain and restore biodiversity.

Appendices

Conceptual Framework and Correlation to *Illinois Biodiversity Basics (continued)*

Each level of biodiversity is essential to fundamental life processes (life support systems):
Genetic diversity within species allows species to adapt to changes in the environment over time.
Species diversity provides a variety of interactions that contribute to energy flow and nutrient cycling in ecosystems.
Ecological diversity provides habitat for different species, as well as essential services that maintain the biosphere, including water and air purification, microclimate control and soil formation and stability. (Activity 2-3)

The decision to protect biodiversity (or not to protect it) is the result of choices people make as families, community members, voters, consumers, employees, politicians and neighbors. These choices can reflect **values and beliefs**, knowledge of the issues and the consequence of a choice, a need to satisfy basic human needs or other factors. An understanding of biodiversity issues can help us predict future trends and determine the positive and negative effects of our choices and the values they reflect. (Activities 2-2, 4-1)

The ways different **cultures** around the world feel about and use the natural world are expressed through art, architecture, urban planning, music, language, literature, theater, dance, sports, religion and other aspects of their lives. (Activity 2-1)

Human values can be affected by a variety of factors, including wealth, health, religion, ecology and culture. These factors influence the development of lifestyles that may or may not be supportive of maintaining biodiversity. (Activity 4-1)

What's the Status of Biodiversity?

Concepts in this theme can help students understand the status of biodiversity and why it is declining. By learning about causes and consequences of biodiversity loss, students will be able to participate in actions to maintain biodiversity in the future.

The **five major causes of biodiversity decline** are human population growth; loss, degradation and fragmentation of habitat; introduced species; over-consumption of natural resources; and pollution. (Activity 3-2)

The **loss, degradation and fragmentation of habitats**, such as forests and wetlands, is the single most important factor behind species extinction. This large-scale loss is the result of human population growth, pollution and unsustainable consumption patterns. (Activity 3-3)

How Can We Protect Biodiversity?

Concepts in this section help students identify ways to ensure that adequate biodiversity will be maintained for future generations. For students to willingly and effectively take action to protect biodiversity, they must have a thorough understanding and appreciation of what biodiversity is, why it's important, why we're losing it and what people can do to help maintain and conserve it. Students also begin to understand that ecological integrity, social equity and economic prosperity are connected and are important components of a sustainable society.

Because issues related to biodiversity are complex and require the synthesis of information gathered by **investigators in different fields**, biodiversity research involves professionals with backgrounds in science, sociology, demographics, technology, planning, history, anthropology, mathematics, geography and other disciplines. (Activity 4-2)

All sectors of society influence biodiversity to some extent and can work to protect biodiversity through policy initiatives, media campaigns, corporate mission statements and other public activities. (Activity 4-2)

Appendices
Cross-Reference and Planning Chart

Goal: To introduce students in grades five through eight to local biodiversity concepts, issues and conservation.
Objectives: As a result of participating in the unit activities, students will: 1) possess a basic understanding of biological, species and genetic diversity; 2) be able to explain the role biodiversity plays in ecosystem stability and health; 3) be able to report on its current status; and 4) know strategies to employ for its conservation and preservation.

Section 1: What is Biodiversity?

Activity	***At a Glance***	***Conceptual Framework Links***	***Illinois Learning Standards Links***
Activity 1-1: What's Your Biodiversity IQ?	Take a "gee-whiz quiz" to find out how much you know about biodiversity, especially in Illinois.	biological diversity	English language arts: 1.C.2a, 1.C.3a science: 12.B.2a, 12.B.2b, 12.B.3a, 12.B.3b
Activity 1-2: Sizing Up Species	Classify organisms using a classification flow chart, play a team game to find out how many species may exist within different groups of organisms, and make a graph to illustrate the relative abundance of living things.	species diversity, defining "species"	mathematics: 6.C.2a, 6.C.3a, 6.D.2, 6.D.3, 10.A.2a, 10.A.3a
Activity 1-3: Backyard BioBlitz	Answer an ecoregional survey, then take a first-hand look at biodiversity in your community.	species diversity	English language arts: 3.C.2a, 3.C.2b, 3.C.3b, 4.B.2a, 4.B.2b, 4.B.3a, 5.A.2a, 5.A.3b, 5.B.3a, 5.C.2a, 5.C.2b, 5.C.3b science: 13.B.2e, 13.B.2f social science: 16.E.3c
Activity 1-4: The Gene Scene	Play several different games that introduce genetic diversity and highlight why it's important within populations.	genetic diversity	English language arts: 3.C.2a, 3.C.3b, 5.C.2a science: 12.A.2a, 12.B.2b, 12.B.3b social science: 17.C.3a

Appendices

Section 3: What's the Status of Biodiversity?

Section 4: How Can We Protect Biodiversity?

Activity	At a Glance	Conceptual Framework Links	Illinois Learning Standards Links
Activity 4-1: Future Worlds	ote ist Biodiversity?		

Correlation to Subject Areas

What's Your Biodiversity IQ? (Activity 1-1)	x		x		
Sizing Up Species (Activity 1-2)		x			
Backyard BioBlitz (Activity 1-3)	x		x	x	
The Gene Scene (Activity 1-4)	x		x		
The Nature of Poetry (Activity 2-1)	x				
The Spice of Life (Activity 2-2)	x		x	x	
Secret Services (Activity 2-3)	x		x	x	
Endangered Species Gallery Walk (Activity 3-1)	x		x	x	
The Case of the Greater Prairie-Chicken (Activity 3-2)	x		x	x	
Space for Species (Activity 3-3)	x	x	x	x	
Future Worlds (Activity 4-1)	x			x	x
Career Moves (Activity 4-2)	x		x	x	

Appendices
Correlation to Skills

What's Your Biodiversity IQ? (Activity 1-1)			x	x	x			
Sizing Up Species (Activity 1-2)		x	x	x				
Backyard BioBlitz (Activity 1-3)	x	x	x	x	x	x		
The Gene Scene (Activity 1-4)	x		x	x				
The Nature of Poetry (Activity 2-1)	x		x				x	
The Spice of Life (Activity 2-2)		x	x				x	x
Secret Services (Activity 2-3)		x		x			x	x
Endangered Species Gallery Walk (Activity 3-1)	x		x	x	x		x	
The Case of the Greater Prairie-Chicken (Activity 3-2)	x		x		x			
Space for Species (Activity 3-3)	x	x	x	x	x			x
Future Worlds (Activity 4-1)	x	x	x	x			x	x
Career Moves (Activity 4-2)	x		x	x			x	

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Correlation to Time Required

	one class period	two class periods	three or more class periods
What's Your Biodiversity IQ? (Activity 1-1)	***x***		
Sizing Up Species (Activity 1-2)		***x***	
Backyard BioBlitz (Activity 1-3)		***x*** (Part II)	***x*** (Part I)
The Gene Scene (Activity 1-4)			***x***
The Nature of Poetry (Activity 2-1)		***x***	
The Spice of Life (Activity 2-2)	***x***		
Secret Services (Activity 2-3)		***x***	
Endangered Species Gallery Walk (Activity 3-1)			***x***
The Case of the Greater Prairie-Chicken (Activity 3-2)		***x***	
Space for Species (Activity 3-3)	***x*** (Part I)	***x*** (Part II)	
Future Worlds (Activity 4-1)		***x***	
Career Moves (Activity 4-2)		***x***	

Appendices
Resources

The following organizations worked in partnership to produce *Illinois Biodiversity Basics*. Although these groups are not the only sources for biodiversity materials, they can provide you with basic information and educational tools to assist you in implementing this activity guide.

Chicago Wilderness

Education and Communication Team
(312) 665-7444
http://www.chicagowilderness.org

Chicago Wilderness is a regional nature reserve of globally significant rare natural communities in an area encompassing southeastern Wisconsin, the six-county Chicago region and northwestern Indiana. Chicago Wilderness is also a partnership of more than 150 public and private organizations whose goals are to protect, restore and manage these lands. The Education and Communication Team of Chicago Wilderness works to increase and diversify public participation in and the understanding of the region's biodiversity by developing collaborative education programs, events and professional development opportunities. They disseminate existing and newly developed educational materials/ programs/information through training and appropriate channels. Educators may access many biodiversity teaching tools through Chicago Wilderness.

Illinois Department of Natural Resources

Division of Education
One Natural Resources Way
Springfield, IL 62702-1271
217/524-4126
http://dnr.state.il.us
teachkids@dnrmail.state.il.us

The Illinois Department of Natural Resources' Division of Education is responsible for the development, training and dissemination of educational programs and events; and for providing hands-on outdoor education and recreational programming for park visitors. The Division works closely with educators, state agencies and other groups to ensure that environmental education goals are being met. The Division of Education develops and distributes a variety of biodiversity and other environmental education materials. All materials are correlated to the Illinois Learning Standards. For monthly updates on new materials and scheduled workshops visit http://dnr.state.il.us/lands/education/monthly.htm.

World Wildlife Fund

1250 24th Street, NW
Washington, DC 20037
http://www.worldwildlife.org

Working with partners around the world, World Wildlife Fund (WWF) developed a Biodiversity Education Framels a/Eation

Appendices
Action Projects

Many organized action projects to help monitor, maintain and preserve biodiversity are available for you to join. Listed below are a few examples.

Illinois EcoWatch Network
Illinois Department of Natural Resources
One Natural Resources Way
Springfield, IL 62702-1271
217/785-5409
http://dnr.state.il.us/orep/inrin/ecowatch/forest/

Help keep an eye on the environment by becoming a Citizen Scientist with the Illinois EcoWatch Network. Through programs such as RiverWatch, ForestWatch, PrairieWatch, WetlandWatch and UrbanWatch, adult volunteers, high school science teachers and students monitor rivers, forests, prairies and more. Coordinated through the Illinois Department of Natural Resources, the volunteers collect quality data, increase public awareness and promote environmental stewardship. Biological monitoring allows scientists to identify long term changes in the health of ecosystems.

Illinois Environmental Protection Agency
Lake Education Assistance Program
Division of Water Pollution Control
P.O. Box 19276
Springfield, IL 62794-9276
217/782-3362
http://www.epa.state.il.us/org/bow/

The Lake Education Assistance Program is part of the education initiative within the Illinois Lake Management Program Act. Funding is provided through Conservation 2000, an environmental protection program signed into law by Governor Jim Edgar in 1995. The program provides up to $500 for schools or not-for-profit organizations to participate in lake- or watershed-related educational field trips and activities. Projects selected for funding will enhance inland lake or lake watershed education of teachers, students, organizations and/or the community. Recipients are reimbursed for activities and supplies. Application deadlines are September 30 and January 31 annually.

Illinois Middle School Groundwater Project
SIUE
P.O. Box 2222
Edwardsville, IL 62026-2222
309/672-6906 or 618/692-2446
rivers@siue.edu

This cooperative project between many state agencies, local organizations and schools provides opportunities for middle school students to study groundwater through hands-on experiences.

Illinois Resource Watch Program
Illinois Department of Natural Resources
Office of Law Enforcement
One Natural Resources Way
Springfield, IL 62702-1271
217/782-6431

The Illinois Resource Watch program is a joint effort of the Illinois Department of Natural Resources and the Conservation Police Lodge of the Fraternal Order of Police. It is a multi-faceted program which has a single goal of promoting a sense of stewardship toward the natural resources of our state. Resource Watch is targeted on the local needs and problems of an area's natural resources. Local units have a Conservation Police Officer assigned to them to serve as facilitator. Although each unit might have a different goal or current focus, one aspect of the Resource Watch program is the same throughout Illinois: each participant "adopts" an area for the purpose of environmental protection. As a Resource Watch participant, you are asked to monitor an area for environmental threats such

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Appendices
Distribution Information for *Illinois Biodiversity Basics*

Copies of *Illinois Biodiversity Basics* may be obtained free of charge from the Illinois Department of Natural Resources and Chicago Wilderness. *Illinois Biodiversity Basics* is available to educators upon request or through training sessions. Contact either of the following addresses for more information or a copy of this activity guide.

Chicago Wilderness
Education and Communication Team
312/665-7444
http://www.chicagowilderness.org/educators.html

Illinois Department of Natural Resources
Division of Education
One Natural Resources Way
Springfield, IL 62702-1271
217/524-4126
teachkids@dnrmail.state.il.us

Illinois Biodiversity Basics is also accessible at the following Internet address:

http://dnr.state.il.us/lands/educationILBiodiversityBasics/index.htm

Credits

The following people were instrumental in adapting *Illinois Biodiversity Basics* from *Windows on the Wild: Biodiversity Basics*. Their dedication has made this publication possible.

Appendices
Activities (alphabetical order)