A Teacher's Guide to

Bio*diversity*

Middle School Science in Kentucky

JOAN A. MARTIN

TERRY L. WILSON

Center for Mathematics, Science, and Environmental Education

and

JAMES M. MARTIN

Ogden College of Science, Health and Technology

Western Kentucky University

Bowling Green, Kentucky

Major funding for this initiative was provided by the

KENTUCKY BIODIVERSITY COUNCIL

and

KENTUCKY ENVIRONMENTAL EDUCATION COUNCIL

2000

ACKNOWLEDGMENTS

A special thanks is extended to the following folks who helped in the production of this Guide:

The Kentucky Biodiversity Task Force
whose report "Kentucky Alive!" *is quoted directly and used as a resource for information throughout the* Guide.

and

Jane Wilson Eller *Kentucky Environmental Education Council (1-800-882-5271), for her guidance in the development of this material.*

Tom Foster *Educational Television Graphic Artist, Western Kentucky University, for many of his illustrations used in several activities.*

Walker Rutledge *Assistant Professor, Department of English, Western Kentucky University, for proofreading the entire* Guide.

Rachael Sloan *Student Assistant, Western Kentucky University, for helping to make revisions.*

Jay Webb *Kentucky Department of Fish and Wildlife Resources, for his advice on adapting activities from* Project WILD.

CONTENTS

"My love is watching people learn, rather than teaching."

—Leonard Bernstein
"The Love of Three Orchestras"
Viewed on A&E
August 18, 1996

INTRODUCTION

The diversity of life forms,
so numerous that we have yet to identify most of them,
is the greatest wonder of this planet.

— Edward O. Wilson
Biodiversity, 1988

According to the Report of the Kentucky Biodiversity Task Force *Kentucky Alive!* knowledge of the diversity and importance of our biological resources in Kentucky is insufficient to make proper decisions about their protection and management. The diversity of living things—or biological diversity—is much more than some obscure scientific concept. It is a fundamental aspect of life on our planet; the interdependency among living things is an essential feature that makes life unique and existence possible.

Today, much about what biodiversity is and how it functions is under scientific study. As scientists continue to conduct research on biodiversity, their knowledge will help further define biodiversity and contribute to public understanding of the nature of its importance.

The purpose of these standards-based lessons is to provide your students with a basic understanding of the concept of biodiversity, applied to Kentucky's biodiversity and their schoolyard, and connected to the *Program of Studies for Kentucky Schools*, Grades 6, 7, and 8 in science.

WHAT IS BI0DIVERSITY?

The term *biodiversity* has been derived from a combination of the terms *biological* and *diversity*. It refers to the variety within and among living things and the habitats in which they live. In the section "Turning Chaos into Order," students are introduced to the concept of diversity through an understanding of the classification system of physical characteristics. Four types, or levels, of biodiversity are described in *Kentucky Alive! Report of the Kentucky Biodiversity Task Force:* genetic diversity, species diversity, ecosystem diversity, and landscape diversity. However, this Guide explores only the first three.

Genetic Diversity

According to the Biodiversity Task Force," genetic diversity refers both to the differences in genetic makeup of different, distinct species and the genetic variations occurring within a single species, such as differences among human beings. This diversity took millions of years to evolve. . . . Each individual . . . is . . . unique, [competing with one another to survive and reproduce in a wide range of environmental conditions]. The search for genetic information is the foundation . . . of bioengineering, providing new products in agriculture and medicine. The search for genetic combinations to help humans could be the major science venture of the 21st century." In the section "Diversity Within a Species," students investigate variations within the human species, explore variations within a species that enable it to adapt to change and survive its predators, and grow plants from seeds to select plants with desired characteristics.

Species Diversity

According to *Kentucky Alive!* "Species diversity is perhaps the easiest to understand. Many different kinds of plants, mammals, birds, fish, and other organisms make up our living world. In Kentucky, there are more than 3,000 known species of plants, 230 known fish species, 105 species of amphibians/reptiles, 350 bird species, 75 species of mammals, and an unknown number of invertebrate species." In the section "Diversity Among Species," students compare and contrast characteristics among species.

Ecosystem Diversity

Biodiversity Task Force Report states, "The organization of life and environments on land and in water provides the components of ecosystems. Those most familiar to Kentuckians include forests, wetlands, caves, lakes, and streams. Ecosystem diversity involves the variety of species that live in an area; the soil, water, and air that support them; and the ecological processes that link them together. These linkages are difficult for most nonscientists to grasp. One example that explains them is to imagine an ecosystem as a spider web where each intersection point represents the special role an individual organism plays in the entire community. Each intersection point is connected by several fibers to other points—similar to the way an organism is linked to others in an ecosystem. When a species disappears from an ecosystem, an intersection point is destroyed in the web, potentially weakening another species that relied on that point for support."

Humans Depend On Diversity

Humans take advantage of natural genetic diversity in many ways. All of our staple food crops reflect centuries of work by plant and animal breeders. Many medicines originated as wild species, manipulated by humans. Relatively recently, however, humans have begun to "design" species to meet our "needs," such as consumer tastes, nutritional values, or marketing requirements.

WHAT IS THE FORMAT OF THIS GUIDE?

Sections
The Guide is comprised of five sections. In each section there are several lessons that lead to the understanding of the major concept, which is then applied to students' schoolyard, their region, and Kentucky. Student sheets are grouped together at the end of each section.

Lessons
Each lesson includes performance objectives, materials needed, terms (if appropriate), background information, and step-by-step procedures. Under "Procedure," NOTES offer suggestions for the teacher; if a suggestion is **BOLD**, the authors consider it to be very important. Frequently, idea-starters for reflection are included at the end of the procedures.

Standards
The *Program of Studies for Kentucky Schools* and *Kentucky's Academic Expectations for Science* addressed in each section are listed in a side-bar.

Resources
A listing of recommended resources includes field guides and keys, guides for developing outdoor classrooms, general references, and videos.

1 Turning Chaos Into Order

Wherever we go to observe living things, we come away with an impression of incredible diversity. Biologists have described nearly 3 million types of organisms, and more are discovered every year. There is diversity in every aspect of life—in size, from the smallest microorganism to the largest whale. From the earliest times, humans have tried to find ways to group the many kinds of living things. From those efforts has grown the science of classifying organisms, or taxonomy.

Specialists in taxonomy use a variety of characteristics to classify organisms. One of these characteristics is structure. For example, structures such as skeletal form and reproductive parts of flowers are more constant characteristics than color or size.

In this section, students begin their study of biodiversity by understanding classification systems and two scientists who contributed to the organization of living things.

ORDER IN THE CLASSROOM

Objective — Students will

- develop a system to organize and classify classmates

Materials — *For the class*

- large piece of paper
- marker
- a variety of plant specimens from your area
- plant keys (see Appendices for suggested titles)

For each student

- Student Sheet "Turning Chaos Into Order," Page 14

Terms — **classification:** systematic arrangement in groups or categories according to established criteria

NOTES

Reference to Program of Studies

GRADE 6 SCIENCE
Scientific Inquiry

• *identify and refine questions that can be answered through scientific investigations combined with scientific information.*

Applications/ Connections

• *recognize how science is used to understand changes in populations, issues related to resources, and changes in environments.*

GRADE 7 SCIENCE
Scientific Inquiry

• *identify and refine questions that can be answered through scientific investigations combined with scientific information.*

Life Science

• *investigate unity among organisms.*

Reference to Program of Studies *continued*

GRADE 8 SCIENCE
Scientific Inquiry

• identify and refine questions that can be answered through scientific investigations combined with scientific information.

Life Science

• analyze diversity and adaptations. (e.g., changes in structure, behaviors, or physiology).

• demonstrate the role science plays in everyday life and explore different careers in science.

Reference to Academic Expectations:

2.1 Students understand scientific ways of thinking and working and use those methods to solve real-life problems.

2.3 Students identify and analyze systems and the ways their components work together or affect each other.

hierarchy: a graded or ranked series

Background

For more than 2,000 years, scientists have tried to make order out of the apparent chaos of millions of living organisms on earth. They attempt to do this in two ways that we will explore in this section: a hierarchy of order in a classification system and the universal use of the same scientific names around the world.

In this lesson, students try to make sense of diversity by developing a system to organize and classify classmates.

Procedure

→ Have each student share one thing that is divided into groups (e.g., library books, athletic teams, food in the grocery store, Yellow Pages, etc.). Post the responses.

→ Ask, *Why do you think people organize things into groups? How would you begin to organize things?If you were to organize the students in this class into groups, how might you divide them?*Ask volunteers to develop a system for classifying the rest of the students.

→ When the students have explored this concept, tell them they are going to use one method of classification sometimes used by scientists.

1. Have one student think of a way of dividing the students into two groups based on one specific characteristic, but the student is not to reveal to the class what the characteristic is. After the classifier has divided the students into the two groups, ask the other students to guess the characteristic used by the classifier. *What were the clues?* Ask the classifier to develop a chart that reflects the class being divided into the two groups. Example:

All Students

boys girls

2. Ask another student to select a different characteristic to further divide each group. After the classifier has divided the students into the groups, ask the other students to guess the characteristic used by the classifier. *What were the*

clues? Ask the classifier to continue the chart so that it reflects the two groups being divided into more groups with more specific information. Example:

All Students

boys | girls

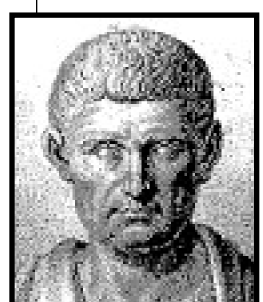
brown hair | not brown hair | brown hair | not brown hair

3. Continue to repeat Step 2—only subdividing groups, not shifting people between groups—until the students are broken down into small subgroups.

4. When this classification has been completed, have students use their positions in the classification chart to identify themselves, For example, Jared is a brown-hair boy; Ashley is a not-brown-hair girl.

5. Repeat Steps 1–4, using different students to choose the characteristics. Thus, each time the system will be new.

OPTION: Have one student leave the area while the groups and subgroups are being formed. Then, ask the student to return and place him or herself in the group where he or she belongs and explain why.



→ Using the sheet "Turning Chaos Into Order," ask students to read the story of Aristotle, an influential Greek scholar.

NOTE: The importance of including the hierarchy of groups is simply to familiarize students with the concept that there are subgroups. Any student interested in taxonomy can access information about it from reference books or on web sites.

→ Discuss the contribution of Aristotle and the role he played in our quest to organize living things. *Why do you think it's helpful to have such systems for everything in nature from insects to trees to aquatic life? How are classification systems useful to you?*

Reflection

What characteristics might you use to develop a classification system for plants? What would the system look like?

What are some possible groupings or classifications of plants outdoors (e.g., plants with woody stems/ plants not having woody stems; flowering plants/ nonflowering plants.)?

FAMILY TIES

Objective

Students will

- sort plants according to physical characteristics
- sort plants according to the structure of the flower
- identify a plant, using a field guide to flowers

Materials

For the class

- an assortment of plant specimens with flowers (e.g., from the classroom, the schoolyard, potted plants, or other source) If possible, include one flowering plant native to your region, which is included in a field guide of flowering plants.

For each small group of about 3 students

- a field guide to wildflowers or other species commonly found in your area (see Appendices for suggested titles)

Background

Classification of living things is based on two principles: some organisms are alike and some organisms are different. By discovering ways in which they are alike, we can put them into categories with those that have the same characteristic. The ways in which organisms are different is the diversity of living things.

In this lesson, students sort flowering plants according to physical characteristic and then according to flower structure.

Procedure

→ Show the class the assortment of plant specimens with flowers. Divide the class into groups of about 3 students, and ask each group to arrange the plant specimens into categories based on physical characteristics (e.g., flower color, number of petals, position of leaves—alternate or opposite, type of stem, etc.). Have groups share their systems with the class and explain the reasons for the systems. As each group explains its system, ask the other students to tell what they liked about the system and any problems they see with the classification. Based on comments made by members of the class, each group is to revise its system.

→ One part of a plant that taxonomists look at is the flower. The number and arrangement of petals is important in the classification system. Look at the plant specimens again and arrange the specimens according to number of petals and arrangement of petals. Is this system of classification similar to any the students developed?

→ Then, help the students use a plant key or field guide to flowering plants to find the name of one plant you used in this lesson.

Reflection

Scientists are learning more and more about biodiversity and the importance of it to our own lives. How does a classification system help in the research?

THE FAMILY NAME

Objective

Students will

- examine the use of scientific words in naming living things

Materials

For each student

- Student Sheet "The Family Name," Page 15

For each small group of about 3 students

- a field guide to wildflowers or other species commonly found in your area (See Appendices for suggested titles.)

Terms

taxonomy: the science of classification

Latinize: to give a Latin form to

Background

To communicate better with one another around the world, scientists follow rules about classifying and naming organisms.

In this lesson, students examine the confusion people in different regions, states, or countries would have if each one called the same species a different name. They also learn the reason the scientific name is in Latin.

Procedure

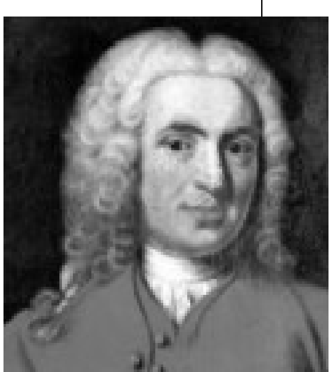
→ Ask for volunteers to tell the class if their families call them names other than the names on their birth certificates. Ask if they have friends who call them by names other than the ones on the birth certificates.

→ If names are not forthcoming from the class, you can use these examples, or one you choose, in order to make the point.

On her birth certificate, her name is "Kathleen." Her family calls her "Kathy." Her friends at school called her "Katie." When she grew up and moved to another state, she called herself "Katn." But whenever she uses her legal name, it is always "Kathleen"—the official name.

William has a similar situation. "William" is his legal name. His family calls him "Billy." His classmates called him "Bill." When he went to college in another city, he called himself "Will." But he always writes "William" on official documents.

Imagine the confusion there would be if everyone—from different regions and different countries—had a different name for each of the millions of species in the world! To make it convenient for the average person, species have a common name in the local language. To help scientists around the world communicate clearly with one another, species also have a scientific name that never changes.



→ Give students a copy of the sheet "The Family Name," and ask them to read about the person who developed the current system of naming plants.

→ Discuss the story about Linnaeus. Help students understand the basic concept of the system. Students may or may not be familiar with this topic. As students use this information throughout the unit, they will become more familiar with it.

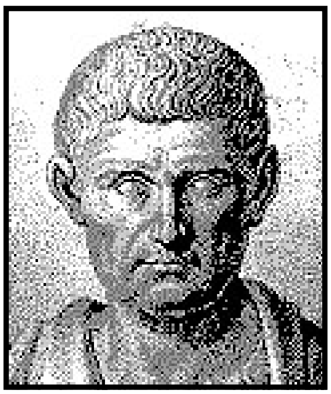
→ Have students revisit a plant key or plant guide and note the Latinized names given to species. Which name is written first? Which word is capitalized? Which word is not capitalized? Are the words in italics?

Reflection	*How does the use of scientific names help in the study of species?* *Why do you think Linnaeus used the number and arrangement of flower petals as one guide to grouping flowering plants?* *Can we use the hierarchal classification system to group animals? Why, or why not?*

STUDENT SHEET Student____________________

Turning Chaos Into Order

If you went into a grocery store to buy canned corn and found it on a shelf between dog food and paper towels, would you wonder, "Why is it there?" You might ask that because one of the ways humans are unique is that we develop systems to organize things in a logical way. From library books to yellow page listings in telephone books, we group things to help us make sense of our world.



More than 2,000 years ago, a great thinker named Aristotle classified all living things into the two groups he studied closely: plants and animals. This classification was not based on genetic information or scientific research as we know it today. It was not modified until the 17th century, when biologists became interested in taxonomy—the science of classification.

Today, after much research, many scientists distinguish five major groups, or Kingdoms. They are plants, animals, fungi (organisms that develop from spores, like mushrooms), protista (mostly microscopic aquatic organisms), and monera (bacteria). Each Kingdom is subdivided into more categories, each category based on more specific similarities in the structure of the organism:

Kingdom
Division (*for plants*) Phylum (*for non-plants*)
Class
Order
Family
Genus
Species

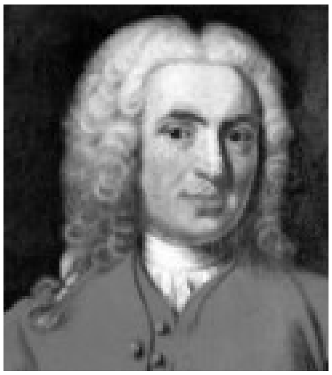
Even now, some scientists want to subdivide one of the Kingdoms into two Kingdoms. Who knows? Maybe one day you will be a scientist who convinces other scientists that one of the five Kingdoms should be divided into two Kingdoms!

Or, maybe you will develop another idea for classification of organisms that no one else has thought about.

STUDENT SHEET Student____________________

The Family Name

Taxonomy is the science of classifying and naming organisms.



Carolus Linnaeus (Li NAY us), was an eighteenth-century Swedish physician and botanist. He helped biologists deal with the mind-boggling task of naming all organisms. He accomplished that by establishing this rule: all organisms are to have a scientific name with two parts: (1) the genus (general group) it belongs to and (2) the species (specific kind).

For example, all maple trees have the first name (genus) *Acer*. The sugar maple is *Acer saccharum*; the red maple is *Acer rubrum* Today Linnaeus is called the Father of Taxonomy because he made the use of this two-name binomial (by NO mee uhl) system so popular.

Sometimes people ask, "Why is the scientific name in Latin? Why not English, German, or French?" The answer is that at the time scientists were trying to make rules about the naming of species, (1) Latin was the language of scholars; (2) Latin was not the language of any one country, so there would be no political jealousy; and (3) Latin doesn't change.

Well, the story doesn't end there! This great botanist was actually born "Karl von Linné." As an adult, he wrote scientific books in Latin, so his own name was written in a Latin form!

What would your name be if you wrote it in a Latin form?

As a botanist, Linnaeus made many more contributions to the scientific world. For example, he distinguished one flowering plant from another largely on the basis of the structure of the flowers, including the number of petals. We still use this system of identification today.

It's easy to count petals, so that's a good way to begin!

“. . . to the degree that we come to understand other organisms, we will place a greater value on them, and on ourselves.”

—Edward O. Wilson
Biophilia, 1984

2 Diversity Within a Species

NOTES

Living things compete with one another to survive and reproduce in a wide range of environmental conditions. Adaptations are features that help living things survive and reproduce in their particular environment. Because there is such a wide range of conditions and potential roles to fill, an incredible diversity of life has evolved on Earth. The diversity within a species results in no two birds, people, tomato plants, or trees being exactly alike. We all have characteristics that are unique to us and distinguish us from the rest of the bunch.

Diversity within a species enables a species to adapt and survive, and it enables humans to select variations of a species that are desirable for our purposes.

In this section, students investigate variations within the human species, explore variations within a species that enable it to survive its predators, and grow plants from seeds to select plants with desired characteristics.

DIVERSITY WITHIN *HOMO SAPIENS*

Objectives: Students will

- classify students by hair color
- count the number of students who have those hair colors
- develop a table or graph to display their findings

Materials: *For each student*

- Student Sheet "*Homo sapiens*: Variation Within the Species," Page 26

Terms:

species (singular or plural word): a classification of plants or animals

***Homo sapiens*:** the scientific name of humans (genus and species)

Reference to Program of Studies

GRADE 6 SCIENCE
Scientific Inquiry

• *identify and refine questions that can be answered through scientific investigations combined with scientific information.*

• *use appropriate equipment (e.g., binoculars), tools (e.g., beakers), techniques (e.g., ordering), technology (e.g., calculators), and mathematics in scientific investigations.*

• *use evidence (e.g., orderings, organizations), logic, and scientific knowledge to develop scientific explanations.*

• *design and conduct different kinds of scientific investigations to answer different kinds of questions.*

• *communicate (e.g., speak, write)*

Reference to Program of Studies, *continued*

designs, procedures, and results of scientific investigations.

• review and analyze scientific investigations and explanations of other students.

Life Science

• investigate how organisms obtain and use resources, grow, reproduce, and maintain stable internal conditions. Examine the regulation of an organism's internal environment.

• analyze internal or environmental stimuli and organisms' behavioral responses. Explore how organisms' behavior changes through adaptation.

Applications/ Connections

• examine the interaction between science and technology.

• recognize how science is used to understand changes in populations, issues related to resources, and changes in environments.

data (plural word): factual information

Background

According to the classification system used by Carolus Linnaeus, humans belong to the genus "*Homo*" and the species "*Homo sapiens*." Diversity within our species includes such characteristics as height, eye color, skin pigmentation and hair color.

Procedure

→ To introduce the concept of diversity within a species, review with students the hierarchy of classifications on Page 14.

OPTION 1. Ask students to research the scientific name for humans (genus and species).

OPTION 2. Tell students the scientific name for humans is *Homo sapiens*.

The genus is capitalized and both words are written in italics.

→ Ask the students to list all the different hair colors *Homo sapiens* have in this classroom (i.e., brown, black, red, blonde, etc.). As the students identify the colors, write the list on the board.

→ Count the number of colors listed (e.g., 4), and write that number under the list.

→ Review what you have done so far: *In this room* (name the room and write it on the board at the top of the list), *there are* (four) *different hair colors*.

→ Next, ask the students to count the number of students that have the hair colors listed (e.g., brown — 7, black — 4, etc.), and write those numbers in a column beside the colors. In this example, there are 7 brown, 4 black, 2 red, and 5 blonde—for a total of 18 individuals.

Room 34

Hair Color		Individuals
Brown	—	**7**
Black	—	**4**
Red	—	**2**
Blonde	—	**5**
4		**18**

→ Give each student a copy of "*Homo sapiens*: Variation Within the Species" to display the data they collected. Have students write the definitions of the terms listed (they can look up the words, or you can tell them the definitions), record the data, and complete the graph.

DIVERSITY AND ADAPTATION

Objectives

Students will

- simulate the predator/prey relationship
- relate the ability to hide from a "predator" to the variation of clothing color

Materials

For each small group

- one blindfold
- area where there are objects behind which students can hide (e.g., outdoor area with trees and shrubs, outdoor area with a variety of objects, library

Terms

adaptation: in natural selection, a hereditary characteristic of some organisms in a population that improves their chances for survival in their environment

natural selection: the individuals that are most adapted to their environment become the parents of the next generation

Background

Diversity within a species enables individuals to adapt to their environment. It is largely because of diverse habitats that the Earth is teeming with a huge assortment of living things. Those individuals best suited, by chance, to meet environmental challenges survive and pass on the successful characteristics to their offspring.

Some adaptations include the color of the animal in response to the season. For example, snowshoe rabbits have a white winter coat that blends with a snowy environment and a tan summer coat that blends with summer ground and vegetation colors. Chameleons change color to blend with their surroundings throughout the year. Young animals have the coloring that hides

Reference to Program of Studies,
continued

GRADE 7 SCIENCE
Scientific Inquiry

• identify and refine questions that can be answered through scientific investigations combined with scientific information.

• use appropriate equipment (e.g., spring scales), tools (e.g., spatulas), techniques (e.g., measuring), technology (e.g., computers), and mathematics in scientific investigations.

• design and conduct different kinds of scientific investigations to answer different kinds of questions.

• communicate (e.g., write) designs, procedures, and results of scientific investigations.

• review and analyze scientific investigations and explanations of other students.

Life Science

• investigate unity among organisms.

• investigate biological adaptation and extinction.

Reference to Program of Studies, *continued*

Applications/ Connections

- *describe the effects of science and technology (e.g., television, computers) on society.*

GRADE 8 SCIENCE
Scientific Inquiry

- *identify and refine questions that can be answered through scientific investigations combined with scientific information.*
- *use appropriate equipment (e.g., barometers), tools (e.g., meter sticks), techniques (e.g., computer skills), technology (e.g., computers), and mathematics in scientific investigations.*
- *use evidence (e.g., computer models), logic, and scientific knowledge to develop scientific explanations.*
- *design and conduct different kinds of scientific investigations to answer different kinds of questions.*
- *communicate (e.g., write, graph) designs, procedures, and results of scientific investigations.*
- *review and analyze scientific investigations*

them well until they are grown. For example, fawns have spotted hair that resembles dappled light on the forest floor on which they lie.

All these adaptations work to "hide" the animals from their predators. In this lesson, students simulate prey hiding from the predator. The color of the students' clothing will help or hurt them in their effort to hide successfully.

Procedure

→ Discuss with the students the various adaptations given in the background section of this lesson. Tell students they will have a chance to use the color of their clothes to successfully hide from a predator.

→ Take the class to the "thicket" of your choice. Establish the parameters of the game area.

→ Blindfold one student, who will play the role of a "predator." The predator slowly counts to 20 while the "prey," or other students, hide.

IMPORTANT: The hiding students must be able to see some part of the predator at all times.

→ After counting, the predator removes the blindfold and looks for prey.

RULES: The predator may turn around, squat, or stand on tiptoe, but may NOT walk or change location. The predator tries to identify as many prey as possible, describing out loud where the prey are. When identified, the prey walk to the predator until the next round.

→ When the time has expired for the first round, give the blindfold to another student. The undetected prey move 10 feet closer to the predator in a new location, and the rest of the students hide. Continue with the rules as in Round One. Depending on your time constraints, repeat the rounds one or two times more.

→ When all the rounds are completed, have any remaining prey that are undetected stand up and identify themselves.

Reflection

What made the predator or prey successful?

What animals have similar characteristics that make them successful?

If the prey that were successful in hiding were to have children with the same color of clothing, and the unsuccessful ones were eaten and unable to have children, what changes would occur in the species?

NOTE: This process is called "natural selection."

What changes could you make to be more successful in your roles?

What survival adaptations are behavioral and which are physical?

Summarize what you have learned.

DIVERSITY AND SELECTION

Objective — Students will

- read about a horticulturist who used selection to develop new, improved plants

Materials — *For each student*

- Student Fact Sheet "The Plant Wizard," Page 27
- Student sheet "Making Comparisons," Page 28

For the class

- packet of Wisconsin Fast Plants seed
  NOTE: Place order about 3 weeks ahead to
  Carolina Science & Math
  1-800-334-5551
  Item #BA-15-8804 (50 seeds) App. $8.75

For each of 7 small groups of students

- Student Sheet "Selecting the Best," Page 29
- marking pen for plastic
- water
- small beverage bottle
- potting soil
- metric ruler
- 3 Wisconsin Fast Plant seeds, or 23 seeds divided among the 7 groups

Reference to Program of Studies, *continued*

and explanations [by] other students.

<u>Life Science</u>

• investigate structure (e.g., cells, tissues, organs) and function (e.g., growth, muscular function, digestion) in living systems.

• analyze diversity and adaptations (e.g., changing physiological activities) and behavior (a set of responses).

<u>Applications/ Connections</u>

• examine the interaction between science and technology.

• recognize how science is used to understand changes in populations, issues related to resources, and changes in environment.

• describe the effects of science and technology (e.g., television, computers) on society.

• demonstrate the role science plays in everyday life and explore different careers in science.

• recognize that science is a process

Reference to Program of Studies, *continued*

that generates conceptual understandings and solves problems.

• explore the importance of scientific discoveries in world history (e.g., new drugs, weapons, transportation).

Reference to Academic Expectations:

2.1 Students understand scientific ways of thinking and working and use those methods to solve real-life problems.

2.2 Students identify, analyze, and use patterns such as cycles and trends to understand past and present events and predict possible future events.

2.3 Students identify and analyze systems and the ways their components work together or affect each other.

2.6 Students understand how living and nonliving things change over time and the factors that influence the changes.

- scissors
- 20-20-20 soluble fertilizer
- sharp-pointed hole puncher
- source of *strong* light
- cotton string (approximately 15 cm long)
- piece of aluminum foil

Terms

horticulturist: a person who works with the science and art of growing fruits, vegetables, flowers, and/or ornamental plants

selection: choosing the best

terrarium: usually a transparent container for growing and keeping plants

Background

Variation does exist within a species. Therefore, in a particular species, one individual may have characteristics that are more desirable than the other individual members of the population. This diversity within the species enables humans to select variations of a species that are desirable for our purposes (e.g., larger flower or more fruit).

In this lesson, students read a short biography of Luther Burbank, a horticulturist who wondered how he might be able to change things to make them better. Then, students sow seeds in mini terrariums to replicate the selection process Luther used to choose the best plant for his purposes.

Procedure

→ PREPARE AHEAD: Order Wisconsin Fast Plants seed 3 weeks ahead of the date you plan to do this activity.

→ Explain to students that diversity within a species is useful for plants as well as animals. Distribute copies of “The Plant Wizard,” and ask students to be prepared to discuss (1) the characteristic of Luther Burbank that enabled him to find the special potato, (2) the characteristic of a potato that Luther Burbank was looking for, and (3) the way he was rewarded for his discovery.

→ When students have finished reading the short biography and the class has discussed the passages, tell students they will replicate the process of selection that Luther Burbank used to identify a **great** potato!

- Divide the class into 7 groups. Each group will prepare one part of the project—a small terrarium. Assembled together, the terrariums will constitute a class project. Give each group a copy of "Selecting the Best." Students are to read over the instructions, and a group recorder is to write the definitions.

  OPTION 1. Ask students to research the definitions of the terms.

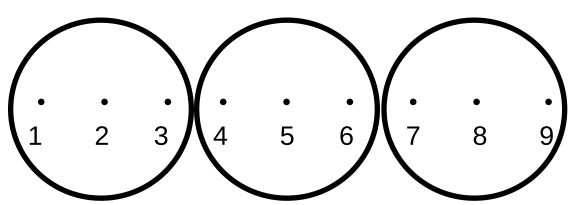
  OPTION 2. Tell students the definitions of the terms.

- Have one member of each group gather the needed supplies.

  NOTE: Wisconsin Fast Plants were developed for the classroom. The good news is that the cycle of this plant—from seed to seed—is approximately 30 days! It was designed that way so students could see the complete cycle in a short period of time. The bad news is that this plant needs very strong light. Provide the best possible light source, and keep it close to the top of the plant as it grows!

- Have a third member of each group read the instructions to the other members and keep them on track.

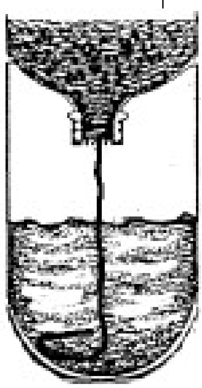
  SUGGESTION: Have each group sow its seeds in a straight line across the middle of the terrarium. When all terrariums are prepared, line them up so that the germinating seeds will closely resemble the drawing on "The Plant Wizard."



  NOTE: If students label their seeds in consecutive order (i.e., 1, 2, 3, 4, 5, etc.), then it will be easier to refer to a specific seedling when making comparisons.

→ Give each student a copy of “Making Comparisons” to complete on appropriate days. Students will use the metric ruler to take measurements.

IMPORTANT: As in any scientific study, the following are critical:



- **Each terrarium must be prepared the same!**
- **Each terrarium must receive the same amount of light!**
- **Each seed must be watered the same!**

Ask students why they think these are so important! (So the only variable is within the seed itself)

→ While they are waiting for the seeds to sprout and the seedlings to grow, have students access information about “natural adaptation” and “selection” on the computer and/or from a local horticulturist, botanist, or community member who grows plants. Invite the the consultant to the classroom, or arrange for students to visit him or her.

→ Have students access information about species in Kentucky that have changed as a result of adaptation. Here are some possible contacts:

- a biologist at the Kentucky Department ofFish and Wildlife Resources at 502/564-4336.
- Kentucky Environmental Education Council at 1-800-882-5271 for names of people in your area.
- Kentucky State Nature Preserves Commission at 502/573-2886
- a biologist at a university

Reflection: *What did you learn in this lesson?*

Did anything surprise you during your investigations? What? Why?

Do plants have predators?

Do plants and animals have anything in common to help fend off predators?(bad smells, spines)

What are some environmental changes that might occur, which would enable a natural selection of survivors? (light changes with the removal of trees, water changes during long periods of climatic change, habitat destruction)

E. O. Wilson, a biologist, says, ". . . to the degree that we come to understand other organisms, we will place a greater value on them, and on ourselves." What do you think he means?

STUDENT SHEET Student______________

Homo sapiens: Variation Within the Species

Homo sapiens **:** ____

species (singular or plural word): ______________________________

data (plural word): ____

We classify things according to ways they are alike or different. When we collect data about living things, we must define the limits of the area we are investigating. Then we count the number of individuals within that area.

1. Complete the chart. Use the data you collected about student hair colors in your class.

____

Defined Area

Hair Color	Individuals
_______	____
_______	____
_______	____
_______	____
_______	____
_______	____
Total _______	___

2. Make a graph of the data you collected.

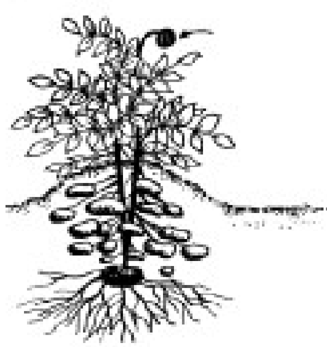
STUDENT FACT SHEET Student______________________

The Plant Wizard

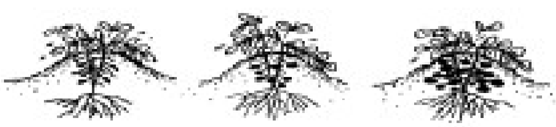
Luther Burbank has been called a plant wizard because he did things with plants that were as surprising as the tricks a magician performs on a stage. He grew a red flower from a yellow one. He grew plums without seeds. He grew a white blackberry. He grew a cherry tree with 500 kinds of cherries on it!

Luther Burbank was the first person to spend his entire time making new plants. He produced more useful new varieties of vegetables, fruits, trees, flowers, and vines than any other horticulturist.

How did he do it? The 13th child in his family, Luther Burbank lived on a farm in Massachusetts. Even before he was 10 years old, he realized that this is a beautiful and wonderful world. He was curious about all the things he saw, and sometimes he would ask “Why?” about the things he saw. Sometimes he wondered how he might be able to change things to make them better.



When Luther Burbank was only 21, he knew that no two plants were exactly alike. He knew that some were more valuable to people. He learned to select those that were the best. That is why he was so excited to discover a seed pod on one of his potato plants! He was sure that if he grew the 23 seeds inside the pod, he would find a new and better variety of potato.



Some plants had small, twisted potatoes. Some had average potatoes. But he was lucky! One had twice the number of good, large potatoes as the kinds farmers were growing then.

A seedsman, Mr. James Gregory, was willing to pay him $150 for his discovery. This was enough money to get him to California. Years later, the Burbank potato became one of the most popular varieties grown, producing as much as $17,000,000 worth of potatoes each year! Maybe someday you could become a plant wizard.

STUDENT SHEET Student ___________________________

Making Comparisons

It's important to keep good records of your activity and your observations.

	Plant ___	Plant ___	Plant ___
Date planted			
Date germinated			
LEAVES Date first leaves appeared			
Date second leaves appeared			
HEIGHT Date and height first week			
Date and height second week			
Date and height third week			
Date and height fourth week			
Date and height fifth week			
FLOWERS Date first flowers opened			
Date and number of flowers fifth week			

STUDENT SHEET Students ____________________________

Selecting the Best

horticulturist: ____

____

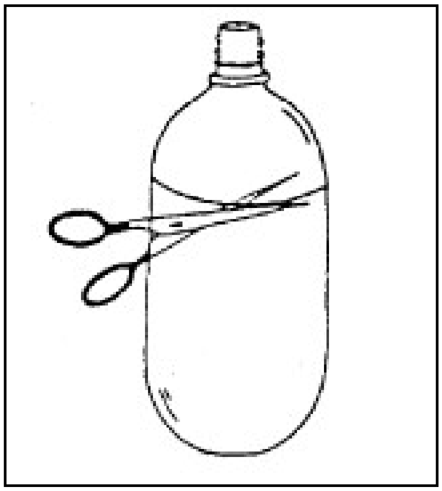
selection: ____

terrarium: ____

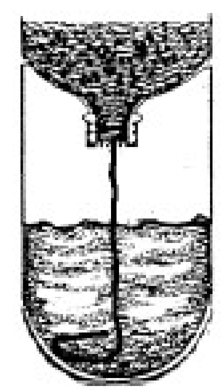
You will need:

- marking pen for plastic
- small beverage bottle
- metric ruler
- scissors
- sharp-pointed hole puncher
- cotton string (15 cm long)
- water
- potting soil
- 3 seeds
- 20-20-20 soluble fertilizer
- source of strong light
- piece of aluminum foil

Make a terrarium:



1. With the lid on the bottle, punch a hole in the lid.
2. Make a line around each bottle just below the bulge at the top.
3. Cut around the bottle on the line.
4. Thread the string through the hole in the lid so that it can serve as a wick.
5. Pour water into the bottom section.
6. Insert the bottle top in the bottom as shown below.
7. Put potting soil in top part and dampen soil with water. Allow the water to drain through the top to the bottom.
9. Label column according to your teacher's instructions.
10. Put 3 seeds on the soil.
    Put just enough soil on top to cover seeds.
11. Place the terrarium in a dark place, or cover with a piece of aluminum foil.



Completed terrarium

- Check the seeds every day. Keep the soil damp.
- As soon as the seeds germinate, place the terrarium in a bright light.
- After about a week, fertilize the plants.

"Ecology sees all species connected in such a mesh of interdependence that one hardly dares step on an ant." 

—Sara Stein

Noah's Garden: Restoring the Ecology of Our Own Back Yards,
1993

3 Diversity Among Species

NOTES

Some biologists estimate that we share this planet with as many as 10 million species, not counting the ones that have become extinct. Biologists classify these organisms into different categories mostly by judging degrees of apparent similarity and difference that they can see. We assume that the greater the degree of physical similarity, the closer the biological relationship.

In this section, students apply what they learned about classification in the section “Turning Chaos Into Order,” by organizing cars in the school parking lot into categories. Then, students learn sampling techniques by working with plants in the schoolyard. Students investigate the diversity of animals in the schoolyard, and they access information about diversity of species in their county and state.

PARKING LOT POPULATIONS

Objective — Students will

- classify cars by make of automobile
- count the number of individual cars in each classification
- develop a table and graph to display findings

Materials — *For the class*

- school parking lot

For each small group of about 4 or 5 students

- Student Sheet “Parking Lot Populations,” Page 40

Terms

species (singular or plural word): a classification of plants or animals

population: a group of organisms of one species that lives in the same place or ecosystem at the same time

Reference to Program of Studies

GRADE 6 SCIENCE
<u>Scientific Inquiry</u>

• identify and refine questions that can be answered through scientific investigations combined with scientific information.

• use appropriate equipment (e.g., binoculars), tools (e.g., beakers), techniques (e.g., ordering), technology (e.g., calculators), and mathematics in scientific investigations.

• use evidence (e.g., orderings, organizations), logic, and scientific knowledge to develop scientific explanations.

• design and conduct different kinds of scientific investigations to answer different kinds of questions.

• communicate (e.g., speak, write) designs, procedures, and

Reference to Program of Studies, *continued*

results of scientific investigations.

• review and analyze scientific investigations and explanations of other students.

Populations and Ecosystems

• observe populations and determine the functions (e.g., decomposers, producers, consumers) they serve in an ecosystem.

•Applications/ Connections

• recognize how science is used to understand changes in populations, issues related to resources, and changes in environments.

GRADE 7 SCIENCE
Scientific Inquiry

• identify and refine questions that can be answered through scientific investigations combined with scientific information.

• use appropriate equipment (e.g., spring scales), tools (e.g., spatulas), techniques (e.g., measuring), technology (e.g., computers), and mathematics in scientific investigations.

data (plural word): factual information

Background

Classification of living things lumps organisms together based on presumed characteristics that emerge from the parent.

In this lesson, students learn to recognize similar characteristics of cars made by the same parent company, with variations among the individual cars.

Procedure

→ Divide the class into small groups of about 4 or 5 students, and give each group recorder a copy of "Parking Lot Populations." Explain that they will be going to the school parking lot—the defined area—to identify different types of cars. Then they will count the number of individual cars of each type. For example, if there is a Ford, they are to write "Ford" under "Cars," and then count the number of individual Ford cars and record the total number in the row "Ford," in the column "Individuals."

Parking Lot

Cars		Individuals
Ford	**—**	**10**
Chevy	**—**	**13**
Nissan	**—**	**15**
Honda	**—**	**5**
4		**43**

Be sure each group understands the instructions.

→ Weather and conditions permitting, have students go outdoors to where the cars are parked and list the makes of cars.

NOTE: Before students go outdoors, make sure they understand, and agree to follow, all safety rules while they are outdoors.

While students are looking at the cars, ask, *What features are the same in cars of the same classification?* (e.g., grill, tail pipe, etc.) *What features of cars in this classification are different from those in other classifications?*

→ Be sure students understand that in the case of hair color in the classroom, different hair colors were examples of variation *within* a species. In

the case of the cars in the parking lot, it was a **simulation** of variation *among* "species."

→ Discuss two essential components of recording diversity:

1. Defined area of any size (e.g., classroom, school, school district, state, nation, world).

2. The number of different species in the defined area.

SAMPLING POPULATIONS

Objective — Students will

- identify and count the number of different plant species in a defined area
- estimate the population of each species by counting or using sampling techniques
- communicate findings of their investigation by displaying the data in tables and graphs

Materials — *For each small group*

- Student Sheet "Sampling," Page 41
- meter stick
- twine
- small stakes or markers
- package of white beans
- Student Sheet "Measuring Populations," Page 42
- Student Sheet "Data Table," Page 43
- Student Sheet "Displaying the Data," Page 44

Terms

sampling: selecting a small part to represent a total population

population: the number of individuals of a particular species in a defined area

Reference to Program of Studies,
continued

• design and conduct different kinds of scientific investigations to answer different kinds of questions.

• communicate (e.g., write) designs, procedures, and results of scientific investigations.

• review and analyze scientific investigations and explanations [by] other students.

Life Science

• investigate unity among organisms.

• investigate biological adaptation and extinction.

GRADE 8 SCIENCE
Scientific Inquiry

• identify and refine questions that can be answered through scientific investigations combined with scientific information.

• use appropriate equipment (e.g., barometers), tools (e.g., meter sticks), techniques (e.g., computer skills), technology (e.g., computers), and

Reference to Program of Studies, *continued*

mathematics in scientific investigations.

• use evidence (e.g., computer models), logic, and scientific knowledge to develop scientific explanations.

• design and conduct different kinds of scientific investigations to answer different kinds of questions.

• communicate (e.g., write, graph) designs, procedures, and results of scientific investigations.

• review and analyze scientific investigations and explanations [by] other students.

Life Science

• investigate and analyze populations and ecosystems.

• analyze diversity and adaptations (e.g., changing physiological activities) and behavior (a set of responses).

• analyze diversity and adaptations (e.g., changes in structure, behaviors, or physiology).

Applications/ Connections

• examine the interaction between science and technology.

random: lacking a definite pattern

herbaceous: without woody tissue

Background

We identify and measure the number of individuals of a particular species in a community of plants to establish the dominant plant. However, it is not always possible to count each individual of a population, such as individual grass plants. In that case, scientific researchers use the technique of sampling as a tool to measure populations.

In this lesson, students apply the tool of sampling to estimate the population of herbaceous plant species in the schoolyard.

Procedure

→ Explain to students that it is not always possible to identify and count the total number of individuals of a species population in a defined area the way they counted cars in the parking lot. For example, could the students count individual grass plants or ants in a lawn? Why? Or why not?

→ Sometimes scientists have to estimate a population by taking a representative sample of individuals in the defined area. This technique is called sampling and is an important tool for collecting data.

→ To familiarize your students with the technique of sampling, use the student sheet “Sampling” as a guide for preparing the students for field research. Instead of sampling populations of plants, use white beans, scattered in the defined area of a square meter—either indoors or outdoors—to represent a species population. Practice the technique as a whole class activity.

→ When students understand the technique of sampling, explain that they will use that tool for estimating populations of herbaceous plants in the schoolyard. Herbaceous plants include colorful annuals, grass, native plants, vegetables, and weeds.

NOTE: Most schoolyards include some species of herbaceous plants. Select the largest area that students can use to estimate populations of herbaceous plants, such as clover, grass, or dandelions.

→ Divide the class into small groups, and give each group a copy of the student sheet “Sampling.” One person in each group will be the recorder. Assign a number (i.e., 1, 2, 3, etc.) to each group, which will become the site number for later recording. Have students write the definitions of terms at the top—either through research or through your telling them the definitions—and follow the instructions on the student sheet.

NOTE: Before students go outdoors, make sure they understand, and agree to follow, all safety rules while they are outdoors.

→ Collect the needed supplies and have students go to randomly selected sites within the parameters you have established. Have students measure a square meter to mark the boundaries for their study.

NOTE: Some students might need help.

→ Students are to draw, name, or describe each species they find in their square meter, and assign each a letter (e.g., A, B, C, etc.).

→ When the time for the investigations has expired, have the groups return to the classroom to record their findings on “Displaying the Data.” Each group shares the data with the other students, providing any explanation needed.

OPTION: Some plants on the school grounds might be woody plants, such as trees, shrubs, or vines. Trees are easy to identify and count in a developed landscape. If the schoolyard includes a wooded or forested area, have students identify and count different tree and shrub species. This activity will provide many teachable moments for the class.

MEASURING DIVERSITY

Objectives Students will

- identify and classify wildlife within the schoolyard or nearby natural area
- document findings of the investigation through writing and sketching

Reference to Program of Studies, *continued*

• recognize how science is used to understand changes in populations, issues related to resources, and changes in environment.

• demonstrate the role science plays in everyday life and explore different careers in science.

• recognize that science is a process that generates conceptual understandings and solves problems.

Reference to Academic Expectations:

2.1 Students understand scientific ways of thinking and working and use those methods to solve real-life problems.

2.3 Students identify and analyze systems and the ways their components work together or affect each other.

2.4 Students use the concept of scale and scientific models to explain the organization and functioning of living and nonliving things

Reference to Academic Expectations: *continued*

and predict other characteristics that might be observed.

2.6 Students understand how living and nonliving things change over time and the factors that influence the changes.

- compile data collected and compare findings with other students

Materials

For each student

- Student Fact Sheets “In a Class of Its Own,” Pages 45–46

For each small group of 2 or 3 students

- Student Sheet “Wildlife in Our Schoolyard,” Page 47
- 4” x 6” plain index card

For the class

- access to a part of the schoolyard or nearby natural area where some form of wildlife (i.e., mammal, bird, insect, reptile, fish, or amphibian) might live
- Sheets “Search for Wildlife,” Pages 48, 49, 50, 51, 52, and 53, copied, cut, and adhered to index cards

Terms

bird: a warm-blooded animal with feathers

mammal: a warm-blooded animal that breathes air, has hair, and produces milk for its offspring

insect: a small invertebrate with 3 body parts, 3 pairs of legs, and typically one or two pairs of wings

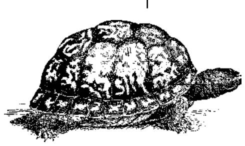
reptile: a cold-blooded animal with scales or plates

amphibian : a cold-blooded animal that lives part of its life in water and part of it on land

fish: an aquatic cold-blooded animal typically with elongated body

Background

The term “wildlife” usually refers to such animals as mammals, birds, fish, reptiles, and amphibians—and in this case, insects—that have not been domesticated. Animals with a backbone are classified as vertebrates.



Different species have different body temperatures, which determine the basic requirements for food and shelter.

Warm-blooded animals maintain a relatively constant body temperature, regardless of the outside temperature. To accomplish this, warm-blooded animals must store food energy on a daily basis and meet their shelter requirements in cold weather.

Cold-blooded animals maintain a body temperature the same as the external temperature.

During the winter months, they are inactive. Some animals cannot survive freezing temperatures, and must hibernate or burrow below the frostline.

Procedure

→ Tell students they are going on a scavenger hunt to find evidence of wildlife in their schoolyard or nearby natural area. But first, they need to become familiar with the *class* of animals to which the species belong.

NOTE: Refer to the classification system on Page 14.

→ Give each student a copy of the two pages of the fact sheet "In a Class of Its Own," and ask them to read the descriptions of six classes of animals. Which ones do they think are found in their schoolyard?

→ Give each pair or small group of students a copy of the student sheet "Wildlife in Our Schoolyard." Do students know of other animals—large or small—that live in the area? If so, they are to write them on the lines below the proper classification of animal. Have students share the names of animals they added.

→ When that is completed, tell the students they are ready to go on the scavenger hunt. Give each group one of the cards you have prepared. Assign a schoolyard site to each group, and label each site "1," "2," "3," and so forth.

NOTE: Students can investigate all classes of animals at the same time, or they can investigate one class of animal at a time.

→ Each pair—or group—is to follow the directions on the card it has been given. Discuss the evidence they might find, for example, nut hulls on the ground, animal scat, footprints, etc. Students use the back of the card to record what they find.

NOTE: Before students go outdoors, make sure they understand, and agree to follow, all safety rules while they are outdoors.

→ Have students go to the assigned sites and begin their investigations. When the time for the investigations has expired, have the groups return to the classroom to share their findings.

Reflection

Were all categories of animals found? If not, why might that be?

What did you discover about your schoolyard as a place that attracts wildlife?

Did anything surprise you while you were searching for wildlife?

DISPLAYING THE DATA

Objectives

Students will

- complete a data sheet of findings as a result of an investigation
- compare results of their findings with other groups
- access information about wildlife in the county and in Kentucky, and compare the animals on the lists with the data collected from their schoolyard

Materials

For each pair of students

- Student Sheet “Compiling the Data,” Page 54
- glue stick

For the class

- masking tape
- a place to display data sheets
- field guides for birds, mammals, insects, fish, amphibians, and reptiles (See Appendix for suggested resources.)
- access to local or regional biologists

- access to the Kentucky Department of Fish and Wildlife Information Systems

  http://www.kfwis.state.ky.us/

- access to the Kentucky State Nature Preserves Commission at 502/573-2886

For each student

- Student Sheet "Documenting the Findings," Page 55

Background

Students need to develop skills in systematic observation and data collection. They also need to think critically about what evidence should be used in displaying the data collected and how the data may best be summarized.

In this lesson, students display the data collected from their schoolyard, compare the results of data collected, and organize data to see the relationships between animals and kinds of habitats. Then, students access information about wildlife in their county and in Kentucky.

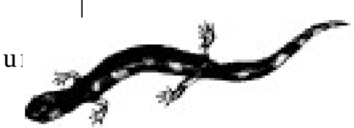
Procedure

→ Distribute a copy of "Compiling the Data" to each pair of students. Ask them to complete the sheet and paste their data card to the sheet.

OPTION: Have students research the scientific name of the animal they observed.

NOTE: If there were no animals found in one or more of the classifications, discuss why that might be.

→ Have students access electronic information about wildlife in their county and in Kentucky (see the Materials section). Students can access information about species in any county and in any classification—except insects. Contact the Kentucky State Nature Preserves Commission (502/573-2886) about a listing of insects in your county.



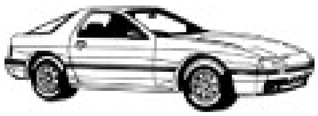
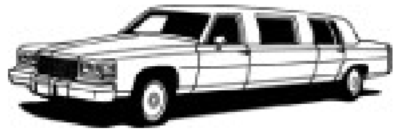
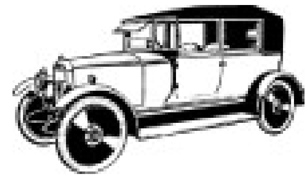
Reflection

How would you summarize the wildlife found in your schoolyard habitat(s)?

How does the wildlife in your schoolyard compare with that found in your county?

How does the wildlife in your county compare with that found in Kentucky?

STUDENT SHEET Group________________________

Parking Lot Populations

We classify things according to ways they are alike and not alike. When we inventory populations of living things, we must define the limits of the area we are investigating—Earth, country, state, county, or schoolyard. In this simulation, the defined area is the school parking lot. Identify the different makes of cars and count the number of individual cars for each make within the defined area.

1. Complete the chart as you collect data about makes of cars in your school parking lot.

____

Defined Area

	Make of Car	Individuals
	_______	____
	_______	____
	_______	____
	_______	____
	_______	____
	_______	____
	_______	____
Total	_______	___

2. Make a graph of the data you collected.

STUDENT SHEET

Group________________

Sampling

sampling: ____

population: ____

random: ____

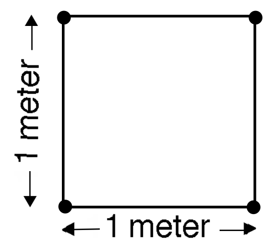
Sometimes it is possible to count every individual of a particular species in a defined area.

However, sometimes it is too difficult to count every individual—such as ants or blades of grass.

When that occurs, we *randomly* select parts of the area to represent the total population.

In other words, we *estimate* the population by taking *random samples* of the area.

Practice taking a random sample:



1, To **estimate** the population of a species, divide the selected square meter into equal units. (In the example there are 25.)

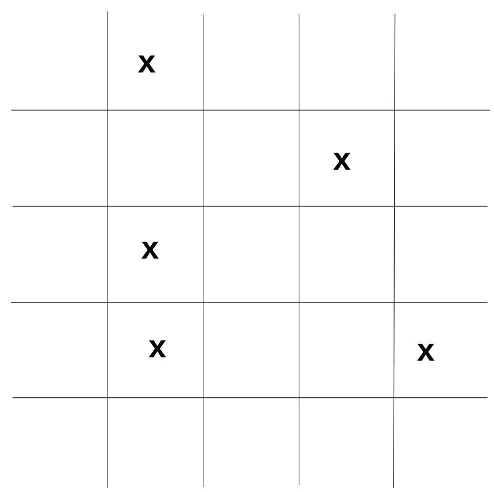
2. To make a **random** selection of units, stand back and toss small items into the square meter. (In the example, 5 objects were tossed.

3. Count the number of individuals of a species in the **randomly** selected units. (In the example the randomly selected spaces are marked with an X.)

4. **Add** the number of individuals in each unit, which gives you a total for the species.

5. Calculate the average. **Divide** the total number of individuals by the number of units you selected. (In the example the number of individuals is divided by 5.)

6. Finally, **multiply** the new total by the number of units. This number is an **estimate** of individuals of the particular species in that square meter—the defined area.



Example of sampling shows square meter divided into 25 parts. In this example, 5 small objects landed in the spots marked with an X.

STUDENT SHEET Group_______________

population: ____

____

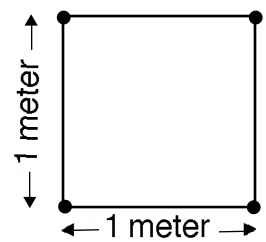
data (plural word): ____

table: ____

1. Now you are going to collect data about populations.
   Create a data table for recording your findings.
   Add as many rows to the table as you need.

Column I = List of different species Column II = Total number of each species

2. Visit the site you will sample.
   Measure a square meter.



3. List all the herbaceous plants you can identify within the square meter. You may name the species, draw a picture of it, or describe it. List each one in **Column I** of your *data table.* Give each species a letter. For example, label them A, B, C, D, and so forth. If possible, collect samples of each species.

4. After you have listed a species, count the number of individuals of each species. Write the total population of each species in **Column II.** (If your location has too many individuals to count, you can estimate the number through the process of *sampling.*)

STUDENT SHEET Group_______________

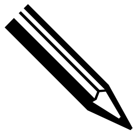
Data Table

Column I = List of different species	**Column II = Total number of each species**

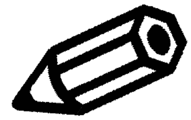
STUDENT SHEET

Students________________________

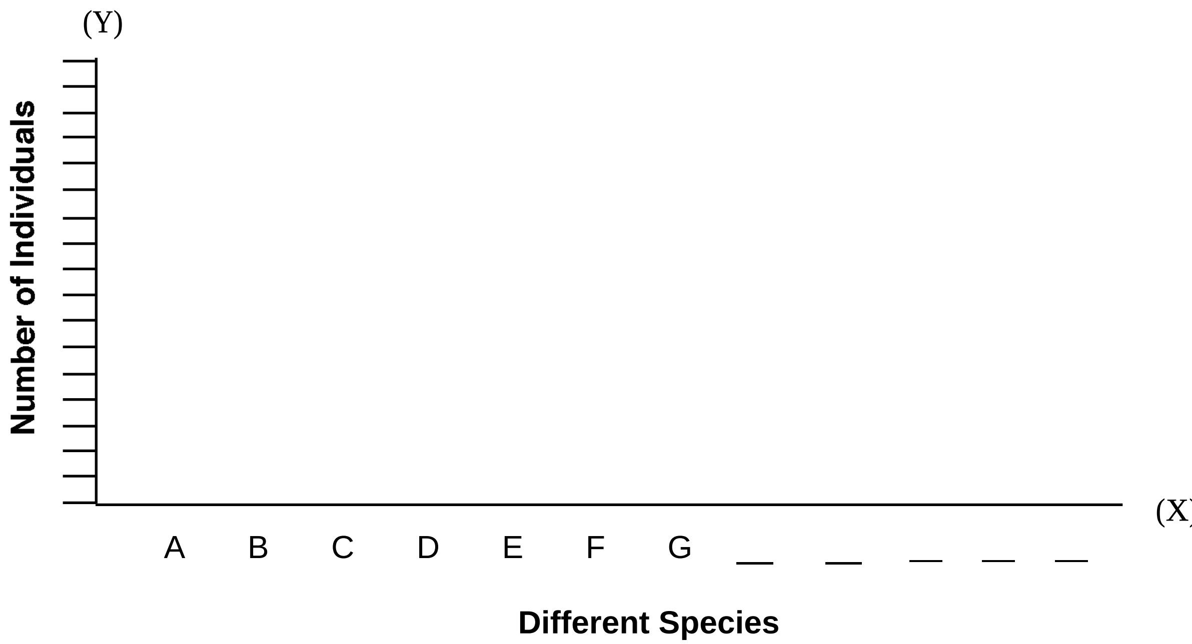
Study Site Number ______



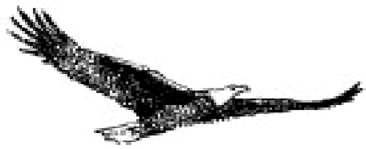
Displaying the Data



Use the data you collected to display your findings on a bar graph. Enter data from Column I on the (X) axis and the data from Column II on the (Y) axis. Establish the value for each line on the (Y) axis—for example, 5 or 50.

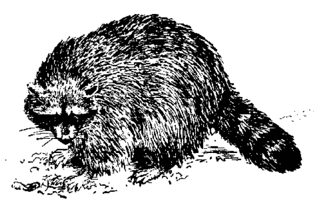


In a Class of Its Own



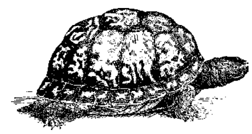
Birds

Birds are warm-blooded animals. All birds have feathers, which provide insulation and usually aid in flight. Birds have no teeth; they have a bill that is adapted for their preferred diet. The bill might be used to pare and crush seeds, seize insects, or protrude into a flower to extract the nectar. Small birds, such as warblers and finches, eat insects, fruits, or seeds. Large predatory birds, such as hawks, eat small rodents or small birds. Most of a bird's behavior is governed by instinct; for example, birds migrate in the fall to warmer temperatures and plentiful food. Shelter includes tall grasses, brush, and a variety of trees at all vegetation layers—from understory (low vegetation) to canopy (tops of tallest trees). Nesting sites, away from human activity, can be supplemented by nest boxes.



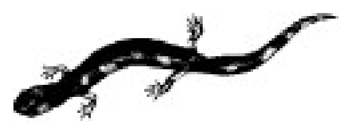
Mammals

Mammals are warm-blooded vertebrates that breathe air, have hair, and produce milk for their offspring. Most mammals, such as deer, produce their young alive and have several different kinds of teeth. Small mammals, such as bats, usually eat insects, fruits, or seeds. Large mammals may eat such plant materials as grass and fruit or small mammals, fish, or amphibians. Some mammals hibernate during cold months to conserve energy. Cover and shelter needs include caves, burrows, brush piles, or hollow tree stumps.



Reptiles

Reptiles are cold-blooded vertebrates which have been on earth longer than any other land vertebrate. Instead of hair or feathers, they have scales or plates, which function primarily to preserve body moisture. Reptiles avoid high and low temperatures by seeking shelter in brush piles and rocks. They usually eat insects or small mammals. Such reptiles as turtles, lizards, and snakes lay eggs on land, or bear living young on land or in the sea.



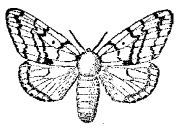
Amphibians

The word *amphibian* is based on Greek words that mean "living a double life." Amphibians, such as salamanders and frogs, are cold-blooded vertebrates with moist skin instead of scales, hair or feathers. Most of them still live the first part of their lives in water. They do not drink, but absorb the moisture they need from water and damp soil. Amphibians absorb pollutants in water and on land, so they are good indicators of habitat quality. The chief item in their diet is mosquito larvae and other

In a Class of Its Own *continued*

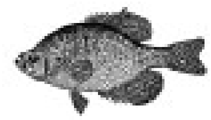
injurious insects. Amphibians need standing bodies of water and covered objects like logs on the ground for protection and shelter.

Insects



Three-fourths of all living animals are insects. Insects are generally small in size, have three pairs of legs, and have bodies divided into three segments. Insects lay eggs that hatch into nymphs or larvae. Some undergo a complete change of life form (metamorphosis)—going through the larvae stage, followed by pupation, and emerging as winged adults. Insects will eat just about anything, including one another. Some are considered harmful such as those that eat grains; some are beneficial, such as those that pollinate flowers. Insects are found in almost any environment that can support life.

Fish



Fish are vertebrate, coId-blooded animals, having gills throughout life, and limbs (if any) modified into fins. A fish's body is designed to move about easily. Fish generally have scales and breathe by water passing over their gills. Some fish reproduce by having the female lay eggs, which are later fertilized by the male. Some fish give live birth and parental care to their young.

STUDENT SHEET

Group______________

WILDLIFE IN OUR SCHOOLYARD

There are many animals that might be in your schoolyard. Here is a list of some common ones. Find out about other animals that are common in your area. Then, go on a search!

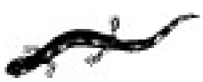
Mammals

Small mammals usually eat insects, fruits, or seeds. Large mammals may eat grass, fruit, small mammals, fish, or amphibians.

- Bat
- Mouse
- Rabbit
- Mole
- Grey squirrel
- Chipmunk
- ____________________
- ____________________
- ____________________
- ____________________

Amphibians

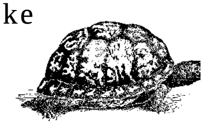
The chief item in their diet is mosquito larvae and other pests.



- Toad
- Salamander
- ____________________
- ____________________

Reptiles

They usually eat insects or small mammals.



- Garter snake
- Turtle
- Lizard
- ____________________
- ____________________

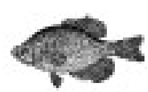
Birds

Small birds eat insects, fruits, or seeds. Large predatory birds eat small rodents or small birds.

- Brown-headed cowbird
- Chickadee
- Crow
- Finch
- House sparrow
- Cardinal
- Mockingbird
- Pigeon
- Robin
- Song sparrow
- Starling
- ____________________
- ____________________
- ____________________
- ____________________
- ____________________

Fish

They eat a variety of plant and animal life, including smaller fish



- Largemouth Bass
- Catfish
- Darters
- ____________________
- ____________________
- ____________________

Insects

Some insects like nectar from the flowers, fruit, and sap. Others like leaves and smaller insects.

- Butterflies/Moths
  - Cabbage white
  - Monarch
  - Painted lady
- Bumblebee
- Cricket
- Firefly
- Grasshopper
- Housefly
- Lady beetle
- Mosquito
- ________________
- ________________
- ________________
- ________________
- ________________
- ________________
- ________________
- ________________
- ________________
- ________________
- ________________
- ________________
- ________________

Go outdoors and find evidence of one INSECT in your schoolyard.

Go outdoors and find evidence of one INSECT in your schoolyard.

Go outdoors and find

evidence of one MAMMAL

in your schoolyard.

Go outdoors and find

evidence of one MAMMAL

in your schoolyard.

Go outdoors and find evidence of one BIRD in your schoolyard.

Go outdoors and find evidence of one BIRD in your schoolyard.

Go outdoors and find

evidence of one REPTILE

in your schoolyard.

Go outdoors and find

evidence of one REPTILE

in your schoolyard.

Go outdoors and find

evidence of one AMPHIBIAN

in your schoolyard.

Go outdoors and find

evidence of one AMPHIBIAN

in your schoolyard.

Go outdoors and find

evidence of one FISH

in your schoolyard.

Go outdoors and find

evidence of one FISH

in your schoolyard.

STUDENT DATA SHEET PAIR_______________________

Compiling the Data

Date __________

Classification ____Bird ____Mammal ____Insect ____Reptile ____Amphibian

____Fish

Identification ____

Species ____________________**Scientific Name** __________________________________

Where was it seen? ____

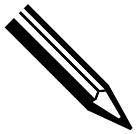
Other information ____

____

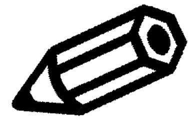
____

Paste the illustration here.

STUDENT SHEET Students________________________



Documenting the Findings



Document your research by entering the name of the resource you used and the information you received. Ask your teacher for an example of the correct format for reference citation or description, or use a reference book.

Resource you used:

____

____

____

____

Information:

____

____

____

____

____

____

____

____

____

____

"The complexity of biological diversity is represented in the biological communities of Kentucky, which form a mosaic that is created and supported by the interaction of various elements— people, climate, geology, mineral resources, soils, wildlife, plants, water, forests, topography, and microorganisms."

—*Kentucky Alive! A Report of the Kentucky Biodiversity Task Force,* 1995
Diana J. Taylor, Editor

4 Diversity of Ecosystems

NOTES

All schoolyards have an ecosystem of biotic (living or once-living) and abiotic (nonliving) factors, such as air, water, and soil. This ecosystem is within a major ecosystem called a biome. Every biome is part of the outer air (atmosphere), water (hydrosphere), and soil (lithosphere) systems where life is found on our earth—the biosphere. Students study the biosphere, biomes, and ecosystems as they relate to the U.S., Kentucky, their county or local region, and their schoolyard.

A healthy, resilient ecosystem results from the complex web of roles played by a diversity of organisms. Plants, for instance, supply food for consumers and help provide our atmosphere's gas mixture, which supports all life on Earth. Animals die, decompose, and provide materials to support plant life. Bacteria recycle nutrients that help to maintain healthy plant life.

When there are many different kinds of organisms in an ecosystem, they don't have to compete as fiercely for resources as they would if they had similar needs and adaptations. For instance, some birds nest in trees and perch on branches, while others nest on the ground and wade in the water. Some pasture plants have tap roots, while others have fibrous root systems.

In this section students view ecosystems in the United States and Kentucky. Then they investigate biotic and abiotic factors of ecosystems in general and their schoolyard particularly.

MAJOR ECOSYSTEMS

Objectives Students will

- compare and contrast different types of biomes
- examine maps to locate and compare different types of biomes in the United States
- identify the major biome in which their school is located

Reference to Program of Studies

GRADE 6 SCIENCE
Scientific Inquiry

• *identify and refine questions that can be answered through scientific investigations combined with scientific information.*

• *use appropriate equipment (e.g., binoculars), tools (e.g., beakers), techniques (e.g., ordering), technology (e.g., calculators), and mathematics in scientific investigations.*

• *use evidence (e.g., orderings, organizations), logic, and scientific knowledge to develop scientific explanations.*

• *design and conduct different kinds of scientific investigations to answer different kinds of questions.*

• *communicate (e.g., speak, write)*

Reference to Program of Studies, *continued*

designs, procedures, and results of scientific investigations.

• review and analyze scientific investigations and explanations [by] other students.

Physical Science

• identify phenomena (e.g., growth of plants, winds, water cycle, ocean currents) on the Earth caused by the Sun's energy.

Life Science

• investigate how organisms obtain and use resources, grow, reproduce, and maintain stable internal conditions. Examine the regulation of an organism's internal environment.

Populations and Ecosystems

• observe populations and determine the functions (e.g., decomposers, producers, consumers) they serve in an ecosystem.

• investigate factors (e.g., resources, light, water) that affect the number of organisms an ecosystem can support.

Materials

For each student

- Student Sheet "Ecological Communities in the U.S.," Page 89

For each small group of students

- Student Sheet "Map of the United States," Page 90
- crayons, different colors
- Student Fact Sheet "8 Major Ecosystems of the United States," Page 91
- Student Fact Sheet "Major Ecological Communities as Biomes," Page 92

Term

biome: all biotic and abiotic factors in a major ecological community

Background

Every schoolyard includes biotic and abiotic factors. Students may be more familiar with the biotic factors (e.g., birds, ants, trees, and squirrels) than with the abiotic factors (e.g., air and its movement, soil, water, temperature, and sunlight). The interrelationship of both biotic and abiotic factors determines the schoolyard ecosystem.

In this lesson, students will see how their special place fits into the "big picture" before studying these factors in the schoolyard.

Procedure

→ To help students construct an understanding of major ecological communities, ask students where they have experienced different types of climates (e.g., warm dry desert, cold snowy mountain, warm humid coast, and others). Or, ask what have they seen on TV or in movies? Post the responses.

→ After discussion and identification of different climates and ecosystems, give each student the sheet "Ecological Communities in the U.S."Ask each student to (1) read the fact sheet and (2) answer the question at the top of the page.

NOTE: The map depicts the contiguous states.

→ Give small groups of students a copy of the "Map of the United States." Have each group locate the eight major ecosystems in the contigouos states of the U.S., using different colors of crayons to mark where they think the regions are on the map.

NOTE: Critical thinking is required to reason the locations of the biomes. Accept all answers at this point.

→ Distribute the fact sheet, “8 Major Ecosystems of the United States.” As a class, discuss the locations of major ecosystems and have students revise their first maps, if necessary.

→ Distribute copies of the student fact sheet “Major Ecological Communities as Biomes,” and have students compare this list with major ecological communities (biomes) in the U.S. Students identify the biomes that are found in the U.S.

→ Have students answer the question at the top of the sheet.

BIOMES AS PART OF THE BIOSPHERE

Objective: Students will

- develop a list of plants and animals that live primarily in the air, in or on water, and in or on land
- describe how the organisms in different spheres are interdependent

Materials: *For the class*

- a world map or a globe

For each small group

- Student Sheet “Plants and Animals of the Biosphere,” Page 93

Term: **biosphere:** the part of the atmosphere, hydrosphere, and lithosphere where life can exist

Background: The biosphere is the world of life. Within this world of life, there are many direct connections between organisms that eat other organisms, and there are indirect connections between any individual organism and the organisms that affect its life. All of this activity takes place in the biosphere.

Reference to Program of Studies, *continued*

<u>Applications/ Connections</u>

• recognize how science is used to understand changes in populations, issues related to resources, and changes in environments.

GRADE 7 SCIENCE
<u>Scientific Inquiry</u>

• identify and refine questions that can be answered through scientific investigations combined with scientific information.

• use appropriate equipment (e.g., spring scales), tools (e.g., spatulas), techniques (e.g., measuring), technology (e.g., computers), and mathematics in scientific investigations.

• use evidence (e.g., measurements), logic, and scientific knowledge to develop scientific explanations.

• design and conduct different kinds of scientific investigations to answer different kinds of questions.

• communicate (e.g., write) designs, procedures, and

Reference to Program of Studies, *continued*

results of scientific investigations.

• review and analyze scientific investigations and explanations [by] other students.

Life Science

• investigate unity among organisms.

GRADE 8 SCIENCE
Scientific Inquiry

• identify and refine questions that can be answered through scientific investigations combined with scientific information.

• use appropriate equipment (e.g., barometers), tools (e.g., meter sticks), techniques (e.g., computer skills), technology (e.g., computers), and mathematics in scientific investigations.

• use evidence (e.g., computer models), logic, and scientific knowledge to develop scientific explanations.

• design and conduct different kinds of scientific investigations to

In addition to living organisms that affect other living organisms, air, soil, and water around the organisms affect them, as well. The biosphere extends from the bottom of the ocean into the air above the Earth. Your schoolyard is a part of the biosphere. And, your students are part of the biosphere.

In this lesson students begin their awareness of living things as part of the biosphere.

Procedure

→ To help students construct an understanding of biosphere, look at a world map or globe and note how land, air, and water are located all around the Earth. The air (atmosphere), the water (hydrosphere), and the land (lithosphere) where all life can exist is called the biosphere.

→ Give each small group of students a copy of the student sheet "Plants and Animals of the Biosphere." Have students read the instructions and complete the work without further instructions.

→ When the work has been completed, have the class compile a listing from the individual sheets. Let the students discuss any discrepancies and reach consensus.

NOTE: Discuss the sphere that contains the most species and the sphere that contains the fewest species.

OUR STUDY SITE WITHIN A MAJOR ECOSYSTEM

Objectives

Students will

- observe biotic and abiotic factors in their schoolyard ecosystem
- organize and interpret observations
- document findings

Materials

For the class

- variety of colored pencils, crayons, etc.

For each small group of about 3 students

- OPTIONAL: camera

- Student Sheet "The Local View," Page 94
- Student Sheet "Making Connections," Page 95

Background

There are many different kinds of ecosystems—woodlands, streams, fields, lawns, and others. Each schoolyard ecosystem is different, and some schoolyards may have several ecosystems. But each schoolyard can provide a small laboratory where students can observe interactions among animals, plants, and the abiotic factors. In this way, students can learn how each organism fits into its environment.

In nearly every schoolyard there is an occasional tree, shrub, and puddle, as well as a bit of vegetation that can be searched for birds, insects, or spiders. Vegetation probably occurs on several layers—the high-branching tree, the medium-high shrub, and the low grass. In this lesson, students record natural features of their schoolyard and describe the study site in poetry, drawings, or photographs.

Procedure

→ Tell students that they are going outdoors to find in the schoolyard the kinds of biotic and abiotic features noted in the previous lesson.

→ Have small groups of about 3 students make observations in assigned parts of the schoolyard. Give each group a copy of the sheet "The Local View." One member of group is assigned the job of recorder, one member of the group selects art materials to sketch and label the features, and a third member of the group completes the student sheet "Making Connections," based on the responses of the other two members. Go over the instructions with the students so that they are clear about what is expected. Tell them how long they have for the investigation.

→ Have colored pencils or crayons available for student use. Each group will also need a pen or pencil for comparing Parts 1 and 2.

NOTE: Before students go outdoors, make sure they understand, and agree to follow, all safety rules while they are outdoors. Review the boundaries of their search areas.

Reference to Program of Studies, *continued*

answer different kinds of questions.

- *communicate (e.g., write, graph) designs, procedures, and results of scientific investigations.*
- *review and analyze scientific investigations and explanations [by] other students.*

Physical Science

- *measure and represent (e.g., graph) forces on objects and motions (e.g., constant speed, changing speed) of objects*

Earth/Space Science

- *investigate the structure of the Earth system (e.g., lithosphere, rock cycle, water cycle, weather, climate).*

Life Science

- *investigate and analyze populations and ecosystems.*
- *analyze diversity and adaptations (e.g., changing physiological activities) and behavior (a set of responses).*
- *analyze diversity and adaptations (e.g., changes in structure,*

Reference to Program of Studies, *continued*

behaviors, or physiology).

Applications/ Connections

• demonstrate the role science plays in everyday life and explore different careers in science.

• recognize that science is a process that generates conceptual understandings and solves problems.

→ When the time has expired, have students share their findings, expressions, and connections. How are the responses alike? How are they different? Have students interpret the findings and writings.

→ Have students compile their findings, descriptions, and thoughts into one schoolyard ecosystem composite of biotic and abiotic factors.

→ Based on the findings of this investigation, each group is to write a question about what else its members want to know about their study site in their schoolyard ecosystem.

Reflection

What surprised you during this investigation?

Which areas of the schoolyard included more biotic factors?

If there were more different kinds of plants, how would they affect wildlife in your schoolyard ecosystem?

Reference to Academic Expectations:

2.1 Students understand scientific ways of thinking and working and use those methods to solve real-life problems.

2.2 Students identify, analyze, and use patterns such as cycles and trends to understand past and present events and predict possible future events.

2.3 Students identify and analyze systems and the ways their components work together or affect each other.

2.4 Students use the concept of scale and

OUR PLACE IN THE BIG PICTURE

Objectives

Students will

- hypothesize about the types of ecosystems that exist in their county, or other defined area
- use a computer to access information about ecosystems in their region

Materials

For each student

- Student Fact Sheet “Kentucky’s Ecosystems,” Page 96
- access to computer and the Internet

Terms

deciduous: trees and shrubs that lose all their leaves once a year

succession: the invasion, establishment, and replacement of a plant and animal species in a more or less predictable fashion over decades of time

mesophytic: plants that grow well in moderate moisture conditions

Background

The natural wealth and beauty of Kentucky has drawn the attention of observers for centuries, and its native flora and fauna have long been the subject of scientific study. The ecosystems that support such a diversity of life include the following:

Forests. Kentucky is in the geographic center of the deciduous hardwood forest of eastern North America. The mixed mesophytic forest region of the Cumberland Plateau and Mountains of eastern Kentucky is the most diverse of Kentucky's communities and ecosystems and widely recognized as a center of the biological diversity of the world's temperate deciduous forest.

Open Lands. Students explore four types of open land in this chapter: barrens, glades, old fields, and agricultural land. The size of these lands varies from small and rare to nearly half of Kentucky.

Caves. These ecosystems have developed over a long period of time, and today almost any change is disruptive to the species that dwell there.

Rivers and Streams. The rivers and streams of the southeastern United States exhibit some of the highest diversity of freshwater aquatic life on this continent and in the world. Only Alabama and Tennessee have more aquatic species than Kentucky.

In this lesson, students learn about the major ecosystems in Kentucky and identify those that exist in their region or county.

Procedure

→ Distribute copies of the student fact sheet "Kentucky's Ecosystems," and ask students to read the brief descriptions of the various ecosystems in Kentucky. Make sure each student understands the categories.

→ Then, give the students the following website and links for the Kentucky Department of Fish & Wildlife Resources to find the person in the area who can help the students identify the ecosystems and species that exist in their county or defined area.

Reference to Academic Expectations, *continued*

scientific models to explain the organization and functioning of living and nonliving things and predict other characteristics that might be observed.

2.6 Students understand how living and nonliving things change over time and the factors that influence the changes.

http://www.kdfwr.state.ky.us/

Link to “Contacts”
Link to Wildlife District Biologists

Then scroll down to your county and to the name of the biologist the students can contact for information.

SUGGESTION: Check out other links on the home page—such as “Nongame”—to see if you want students to access information about the Federal list of endangered species in your area.

→ Have students report their findings to the class, and let students ask questions and make suggestions for further investigation. Ask students to compile the findings into a class report, and then share the report with other classes and with members of the community.

MAPPING THE SCHOOLYARD

Objectives — Students will

- make a base map of their schoolyard

Materials — *For the class*

- property line map

  NOTE: Obtain from your county Property Valuation Administrator, listed in the white pages of the phone book under the name of your county. The cost is approximately $5–$10, depending on whether or not your county produces its own map. Your school property line will be in a section map, so you will need to enlarge the part that includes the boundary of your school site. The location of your building will not be on this property line map.

For each small group of students

- paper
- a measuring tape
- stakes
- string

Background

A map of your schoolyard provides a place for recording features of your ecosystem. It is more important for students to take part in the *process* of making the map than in producing a map that looks like someone else's. This is an opportunity for students to increase their map-making skills, observation skills, and knowledge from many disciplines, as well as critical thinking and problem solving skills.

In this lesson students make individual maps—drawn to scale and depicting different aspects of the site—which are transportable and could be used in presentations to others. Regardless of the final product, each student or small group of students should have an individual base map that can be taken outside when they are collecting data. A base map can be made from a property-line map.

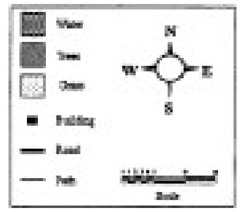
Procedure

→ Determine the scale that will be used—the proportion between the actual size of objects and the representation of those objects on the base map. For example, 1" on the map may equal 4' in the actual outdoor space.

→ Have students make a base map—a simple map onto which other information is added. Information needed for a base map includes the dimensions of the site, location of the school building or buildings, and the compass directions north, east, south, and west.

→ Students are to add permanent features to the map, such as walkways, parking areas, and small buildings. They should include natural features that are easily depicted, such as large trees, ponds, or streams. These features will enable your students to relate the areas of the schoolyard to those on the map.

→ Establish the symbols that will be used in the legend of the maps (the boxed-in area of symbols that appears in a corner of the map). The legend includes the scale of the map. The symbols represent important features so that people will understand the map. For example, students will need symbols for such permanent structures as buildings, recreational facilities, roads, driveways, and parking areas. Students might also need symbols for such natural features as streams, or ponds, or large trees.



→ After students have drawn the base maps, ask someone else in the building to read and use the maps. Students need to be sure their base maps. are clear before they begin adding information. Have students make any revisions necessary as a result of the attempted use of the maps.

Reflection

How might the base map be useful in an investigation of the schoolyard ecosystem?

In what other situations might a base map be helpful?

LITHOSPHERE: THE SOIL BENEATH OUR FEET

Objectives

Students will

- identify and describe soil-forming factors
- collect data about soil in a study site
- identify relationships between soil-forming factors and the resulting soil

Materials

For each student

- Student Sheet “We Make Soil,” Page 97
- Student Sheet “The Soil Beneath Our Feet,” Page 98

For each small group of students

- a small shovel or trowel
- a thermometer
- a plastic container that will hold $^1/_2$ cup of soil
- a hand lens

Background

What makes soil unique to each place on Earth is the way in which the five soil-forming factors work together: climate, topography, plants, animals, parent material of soil, and time. As you look around your site, notice if the effects of the five soil-forming factors are different from one part of the site than another.

Some characteristics that may change from one soil to another include the following:

- the color
- the amount of roots in the soil surface
- the structure of the soil (the arrangement of sand, silt, and clay)
- the texture (percentages of sand, silt, and clay)
- the amount and size of rocks in the soil
- the number of worms or other animals in the soil
- the temperature or moisture (Wet soil will be sticky and clump together, moist soil will feel wet and cool, and dry soil will feel as if it has no water in it.)

No wonder each soil is unique! Soils vary in water-holding capacity. This characteristic depends on many things, among which are the following:

- the force and quantity of precipitation (rainfall, snowfall, sleet, etc.) as it enters (infiltrates) the soil or runs off
- the soil texture (percentages of sand, silt, and clay)
- the organic matter in the soil
- the temperature
- the vegetation

If soil is tightly compacted, as on a well-trodden path, water will not be able to enter the ground as easily as in less-traveled areas. Nature may increase runoff in some areas. For example, in dry climates, “desert pavement” (small rocks laid tightly across the sand like a tile floor) may increase the amount of runoff.

Wind and water may form crusts on some soils that prevent the infiltration of water. Slope also increases the speed at which water runs off the land. Rain will quickly disappear on a steep slope, but collect in puddles on flat ground. The roots of plants help to break up the soil, creating a porous medium in which water can pass. Sandy soils usually let water drain through faster than do clay soils.

Your students might think that there is little variation of temperatures on the school site. However, there may be quite a bit of difference from one place to another. Shade makes the temperature cooler. Shade is found not only under trees but also under rocks or on the north side of buildings away from the sunlight. The soil may be drier in warm places and wetter in cool, shady places.

Providing shade, plants may decrease the evaporation of moisture from the soil. However, plants also contribute to the loss of water by absorbing moisture from the soil.

In this lesson, students will investigate variations in the soils around their school to discover that soil properties, such as moisture and temperature, exhibit considerable variability across a single landscape.

Procedure

→ Ask: *In our part of the world, which side of a slope receives the most sunlight—the north or the south?* (south)

→ *If you were going to hunt for fishing worms (or other soil-dwelling invertebrates), where would you look? Why would you look there?*

Remember, animals need water, air, and nutrients, which are found in various soils.If the soil is compacted, it is more difficult for animals to survive.

→ Ask: *Do more types of plants seem to grow on slopes or in valleys? Why?*

→ Tell students they are going to check out the answers to these questions. Divide the class into groups of 3 to 5 students. Assign groups to different sections of the schoolyard. Each group should have a thermometer, a small shovel or trowel, a plastic container that will hold $^1/_2$ cup of soil, the student sheet "We Make Soil," and a site map. Have students mark the study site location on the base map.

→ Soil types can be described based on five soil-forming factors: climate, topography, plants and animals, parent material (rock) of the soil, and time. Discuss each of these factors with the students. Have groups look for these factors in the assigned site and complete the student sheet "We Make Soil." Then, have groups dig about $^1/_2$ cup of soil (if possible) at their sites, look closely at the soil, and feel it. Have them record what they find on the student sheet "The Soil Beneath Our Feet."

→ When the time for the activity has expired, have students bring their completed sheets and soil samples to the classroom to compare findings. Display the findings.

NOTE: Students will use these soil samples in the next lesson.

→ Have students examine their soil samples and complete the student sheet "The Soil Beneath Our Feet."

→ Compare results. Have students rank the study sites from wettest to driest. Note how the moisture content is affected by the location, the type of plant cover, or other factors of the site.

Reflection

In which parts of the site would you expect soils to be most alike? Which biomes on the map do you think would have similar soils?

How do you think soil factors affect soil moisture content and temperature?

How would the temperature and moisture be different in a sandy soil from a clay soil? How would this affect the way plants grow?

LITHOSPHERE: A SOIL PROFILE

Objectives

Students will

- observe and describe the structure of soil samples
- compare results of their findings with those of other groups

Materials

For each small group of students

- soil sample from the previous lesson
- clear glass jar with lid
- water
- masking tape
- marking pen

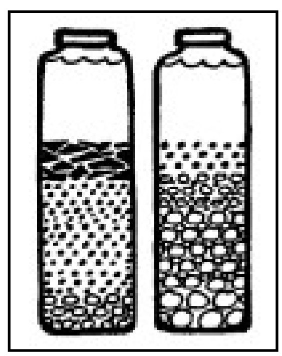
Background

Soils within a small geographic area can show considerable variety. In this lesson, students examine the composition of samples of soil taken from different parts of the schoolyard or study site.

Procedure

→ Have students pour water into a jar until it is about $^2/_3$ full. Then, they should carefully pour their soil sample into the jar, cover the jar tightly with the lid, and shake the mixture for several minutes.

→ Students use masking tape and the marking pen to label each jar according to the study site it represents.



→ Students let the jars sit overnight. When the layers of soil have settled out, place a vertical strip of masking tape the length of the jar. Mark where each layer changes. How do the samples compare? What are the layers composed of?

Reflection

What did you observe?

Do all the jars have the same layers or the same depth of layers?

Why do the layers form in that way?

What surprised you about this investigation? How might you do it differently?

What principle does this layering represent and how might you apply this principle to other situations?

Where did the soil in the schoolyard ecosystem come from? Where will it go?(from erosion by water or wind, or by human activity)

HYDROSPHERE: A MINI WATERSHED

Objectives

Students will

- measure a drainage area
- determine the direction of runoff on their schoolyard base map
- transfer the collected data to the map

Materials

For the class

- overhead transparency of the Student Sheet "A Stream System," Page 99
- 3 locations on paved or black-topped areas
- 3 rolls of making tape
- string
- 3 measuring tapes

  SUGGESTION: Twine or heavy string can be marked at intervals and used as nonstandard measuring tools.
- 3 one-gallon containers of water
- a blank overhead transparency and marker
- the schoolyard base map from the lesson "Mapping the Schoolyard"

Background

A watershed is all the land area that drains water runoff to a particular body of water. In other words, it is a catch basin that guides all the precipitation and runoff into a specific river or lake. It is a dynamic system that affects all living and nonliving things within its boundaries.

All plant and animal life is dependent upon the water within each watershed. Prior to human intervention and use, watersheds tended to be in a state of natural balance with the ecological components of the environment. However, part of the natural process of a watershed is self-destructive. The rivers that give land its form gradually erode and wear down the highlands that contain it. The key here is "gradual," part of a natural, dynamic balance.

Human activity, such as land clearing, farming, and industrial development, increase the rate of erosion. Many of these activities alter the water that is returned back into the water system. Each watershed is a single unit that is connected to other watersheds as they move downstream. Thus, activity that affects the water in one watershed eventually affects other sites downstream.

In this lesson, students map the direction of water runoff on hard-surface areas in the schoolyard mini watershed.

Procedure

→ Prior to the lesson, select 3 sites on hard-surface driveways or parking areas to be used as study sites.

→ Discuss the meaning of "watershed," using examples from nearby streams. Show students the overhead transparency of "A Stream System." Examine the diagram together, noting the boundary of the watershed marked as No. 1. Every place on Earth is part of one watershed or another. Thus, your schoolyard—no matter what size—is part of a mini watershed that is connected to another mini watershed that eventually drains into a river.

→ Ask pairs of students to face one another with their hands extended, palms up, with fingers outstretched and touching. This illustrates two drainage patterns in two watersheds that have a common ridge line.

→ Use a blank overhead transparency to show how the students will investigate a water drainage pattern.

Divide the class into 3 groups and gather supplies: base map, water, string, masking tape, and measurers. Assign each group to one study site. Have each group mark off a square (e.g., 10' X 10' or 15' X 15') and tape the string at each corner.

→ One student in each group stands in the middle of the square and slowly pours the water onto the hard surface. Students note the direction the water runs off the surface.

→ Next, students locate the sites on the base map and indicate the directions of runoff.

NOTE: Students will need to convert the actual measurement to the scale of the map. They may need help with this calculation.

Have students locate the stream into which the water flows.

Reflection

What did you learn?

How is the drainage area we identified like a watershed? How is it different?

How is the water drainage pattern connected with the soil? How is the hydrosphere connected with the lithosphere?

What would you do differently if you were to investigate another drainage pattern?

HYDROSPHERE: HOW MUCH AND HOW FAR?

Objectives

Students will

- measure and calculate the area of the schoolground

- calculate the volume and weight of water falling on the schoolground
- determine specific and annual rainfall and runoff
- trace the course of the runoff to aquatic habitats

Materials

For each student

- the base map from the lesson “Mapping the Schoolyard”
- a 4” x 6” index card
- writing materials

For small groups of students

- a map of your region, which includes the streams and rivers to a lake, gulf, or ocean

For the class

- a rain gauge

Background

Although we may get drenched in a rainstorm, we don’t typically stop to wonder how much rain is falling. The volume and mass of the water in a rainstorm are astounding to those who calculate the values. Developing an understanding of precipitation and runoff is an important part of understanding the water cycle, which is a major factor in ecosystems and biomes.

Rainfall is one way water re-enters aquatic habitats. Once rain falls upon a surface, water begins to move both laterally outward and vertically downward. Lateral movement is runoff, and the water finds its way into streams, rivers, and lakes. Vertical movement seeps into the soil and porous rock and re-charges groundwater supplies. Paving and soil compaction can reduce an area’s water- absorbing ability and therefore increase runoff. Reduced absorption rates can negatively impact vegetation and groundwater recharge.

Runoff is the dominant way that water flows from one location to another. Eventually the water becomes part of an aquatic habitat.

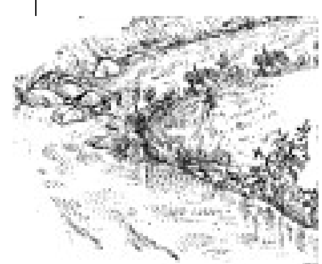
Runoff is responsible for erosion and for the movement and deposition of sediments to aquatic habitats.

On the positive side, runoff waters are necessary to renew many aquatic habitats that are dependent upon inflow for continuity. The inflow prevents lakes from shrinking because of evaporation, and it prevents streams from going below minimum flow levels. Inflow thus helps support aquatic life. Without some runoff, aquatic habitats would suffer.

In this lesson, students calculate both the volume and the weight of rainfall. The measurements and calculations are intended to impress upon students that there are remarkable volumes and weights of water moving through the water cycle. They consider relationships between rainfall and runoff, including effects on wildlife and the environment.

Procedure

→ Ask: *How much rain do you think falls on our schoolyard (or study site) each year?* Post the responses. *How could we find the answer?* Accept all responses, but lead students to (1) accessing information from a local newspaper, a local weather service station, Natural Resource Conservation Service, or website (TV station, weather.com), and (2) using a rain gauge to measure the actual rainfall for half a school year, or (3) measuring the rainfall in a given storm.



NOTE: In Option 1, students access information about precipitation in the community and report the findings to the class. In Option 2, students continue collecting data semester after semester and year after year. These data could become the school's own source of information. In Option 3, students learn to collect, read, and record precipitation in any location.

→ Using the schoolyard base map, students calculate the area:

Area = Length x Width (or A = LW).

Include the entire area—buildings, drives, parking areas, and planted or natural areas, because rain falls on all surfaces.

- Students use collected data to calculate the volume of rainfall on their study site:

  Square feet of site (area) x feet of rainfall (inches converted to feet) = cubic feet (volume) of rain.

- Knowing the volume, students calculate the weight of the rain. Water weighs 62.5 pounds per cubic foot.

  Cubic feet of rain x weight of water = pounds of water, which can be converted to tons.

- All the water that students measure eventually finds its way to a wildlife habitat! A major issue of concern is how humans affect the quality and quantity of water that eventually reaches these habitats.

- Divide students into small groups to trace the water runoff from their site to other sites that are aquatic habitats (e.g., lakes, large streams or rivers, bays, and ocean). Have students report their findings and discuss any differences in the findings.

- Assign the following terms to students:

  precipitation, evaporation, respiration,
  transpiration, ingestion, percolation,
  runoff, and condensation.

  Have them look up the definitions and write them in ink or with markers on 4” x 6” cards. On the back of the card, they are to write in correct style the resource they used to find the definition.

- When the assignment has been completed, have students arrange the cards on a class board in proper sequence to illustrate the movement of water through the water cycle.

- SUGGESTED EXTENSION: On a topographic map, students identify the watershed in which their study site is located and the drainage pattern of the runoff.

Reflection

Where does the water from rainfall go when it leaves the study site?

Where is the location of the nearest wildlife habitat that receives the runoff?

What are some ways people use the water before it reaches the aquatic habitat?

If every place on Earth is part of one watershed or another, what does this mean in terms of the way humans use the water as it drains from the land?

What else would you like to know about the water that falls on your study site?

ATMOSPHERE: BLOWING HOT AND COLD

Objectives

Students will

- design and conduct an experiment to measure the heating and cooling of soil and water
- measure and record data
- organize data in tables

Materials

For each small group of students

- Student Sheet “Blowing Hot and Cold,” Page 100
- the schoolyard base map from the lesson “Mapping the Schoolyard”
- 2 plastic buckets at least 30 cm tall
- a centimeter ruler
- 6 thermometers
- a means of suspending the thermometers over the buckets, such as a string and dowels
- soil
- cool water

Background

The air—or atmosphere—determines our weather, which in turn impacts the biotic factors of a biome, ecosystem, or habitat. One important reason we have different kinds of weather throughout the world is because land and water heat and cool at different rates.

For example, afternoon thunderstorms in Florida often occur as the land heats up faster than the water. In parts of the world that experience monsoons (wind systems that reverse direction seasonally), the rainy part of the monsoon season is characterized by alternating periods of active (rainy) and non-active (not-rainy) weather, depending on whether the land is dry or wet. These are dramatic weather patterns. However, less dramatic effects occur every day all around the world, including in your schoolyard.

Students may have observed a difference in the heating and cooling rates of land relative to water if they have ever run barefoot across a beach or swimming pool deck to the water in the middle of a warm, sunny afternoon. They probably remember how hot the land was and how cool and refreshing the water felt. If they were at the beach or pool until after sunset and walked barefoot across the land to the water, they might remember that at this time of day, it was the land that felt cool, while the water felt warm.

In this lesson, students study this land/water difference by conducting a simple experiment.

Procedure

→ Arrange for using an outdoor area where students can conduct this experiment. The experiment gives the best results on a sunny, warm day.

→ *The third abiotic factor in a biome, ecosystem, or habitat is air. What do we know about air?*(Accept all answers.) *What affects the temperature of air?* (One factor is the heating and cooling of land and water at different rates.)

→ Land and water were the first two abiotic factors of a biome studied in this section. Have students check out the connection between land, water, and air. Give each small group of students a copy of the sheet “Blowing Hot and Cold.” Read over the instructions to be sure everyone understands them. Each group marks on the base map where the group will set up its experiment.

NOTE: Students can investigate the same general area, or they can investigate different areas of the site. You know your students and the best procedure for this investigation.

→ Gather supplies and prepare for the experiment.

NOTE: Before students go outdoors, make sure they understand, and agree to follow, all safety rules while they are outdoors. Review the boundaries of their search areas.

→ When students have completed the readings and recorded them on their student sheets, have them make a graph of the data collected. Were their predictions correct?

→ Have groups compare findings within their own site and among the sites of the different groups.

- Is there a pattern?
- Is the temperature of the soil one centimeter below the surface warmer than it was when students set out the buckets 20 minutes earlier?
- Is the surface temperature of the water warmer now than it was 20 minutes ago? Why?
- Which temperature reading was higher at a depth of 8 cm, soil or water? Why?
- What do students think the results might be if the buckets were left in the sun for 3 hours?
- What conclusions can students draw from this experiment?

Reflection

Did anything surprise you?

How do the variations in temperature affect air movement?

In what ways are land, water, and air connected?

ATMOSPHERE: MOVING RIGHT ALONG

Objectives

Students will

- identify the direction that the wind is moving by using a compass and bubbles

Materials

For the class

- large balloon
- a bottle of bubble formula:

$^2/_3$ cup Joy dishwashing soap
1 gallon of water
2–3 tablespoons of glycerine (from the drugstore)

or

8 tablespoons of liquid dish detergent
3 cups of warm water
8 tablespoons of glycerine
dash of sugar

Gently stir the ingredients together, Let the solution sit in an open container overnight.

For each pair of students

- a small plastic container for the formula
- a device for making bubbles (e.g., bent coat hanger)
- a compass
- schoolyard base map from the lesson "Mapping the Schoolyard"

For each student

- Fact Sheet "Moving Right Along," Page 101

Background

Air always tries to flow from an area of high pressure to an area of lower pressure. (Think of the way air rushes out of a balloon when you open the end. The air from the high pressure area inside the balloon flows to an area of lower pressure outside.) If there is a big difference in air pressure from one area to another, then strong, gusting winds will blow. But if there is only a small difference in pressure, the winds will be light and breezy. The way in which air moves affects biomes, ecosystems, and habitats!

In this lesson, students investigate the way air moves in their schoolyard ecosystem on one particular day. This lesson is more effective on a windy day!

Procedure

→ Ask a student to inflate a balloon, holding the air in the balloon by keeping the end closed. Then ask the students what they think will happen when the student releases the end of the balloon. Ask: *Why does the air rush out?* Let students think about it. (Air moves from a higher pressure to a lower pressure.) *Where else does air move like that?* (wind)

- Ask: *What are some ways in which people use wind?* (e.g., to sail boats, fly kites, power windmills, and windsurf) Post all answers.

  What are some ways in which wind is destructive? (e.g., hurricanes, tornadoes, severe storms, monsoons)

  What are some ways plants and animals use wind? (e.g., seeds, pollen, spores, and spiders move on wind currents; predators and prey smell each other's presence) Post answers.

- Tell students they are going to check the wind in the schoolyard today. Divide the class into pairs of students. Gather supplies: bubble formula, small plastic container for the formula, device for making bubbles, compass, and base map. Explain that while one person releases the bubbles, the partner will need to check the direction the bubbles are moving. Then, the partners change roles.

  NOTE: Before students go outdoors, make sure they understand, and agree to follow, all safety rules while they are outdoors. Review the boundaries of their investigation.

- Tell students they are to note the location of their investigation on the base map. When the time for the activity has expired, have students return to the classroom to share their findings. Discuss any differences in the findings and the reasons for those differences. *Would the findings be the same every day? Why? When weather reporters talk about the direction of the wind, do they refer to the direction in which the wind is going, or the direction from which it came?*

- Give students the sheet "Moving Right Along," and ask them to read it. Divide the class into 4 groups, and assign one topic to each group. Each group should bring to school a map that illustrates the movement of air in North America.

IMPORTANT: They are to correctly reference their source of information so that someone else can find the same information.

Reflection

What did you discover in this lesson?

Do you think the movement of air in your schoolyard ecosystem is the same in another ecosystem? Why? If yes, where?

What else would you like to know about the movement of air (e.g., in your region, or as depicted on weather maps, or in another region of the world, or as it affects biomes and ecosystems)?

SETTING THE SCHOOLYARD BOUNDARIES

Objectives

Students will

- select a study site for identifying biotic and abiotic factors of an ecosystem
- measure the boundary of the study site

Materials

For the class, for each study site

- string
- 4 stakes
- 10-meter measure (string measured and knotted at 10-meter intervals can be used)
- two or three 10 x 10 meter study sites. one of which is in the schoolyard
- a sign or label that identifies the area as a study site

Background

To reinforce students' understanding of the concept of a system, they define the boundaries of a given area. Students will collect data from a 10 x 10 meter study site within the schoolyard ecosystem..

Ideally, the class investigates several different study sites, including their 10 x 10 meter schoolyard site. At each site, students explore a variety of biotic and abiotic factors. The students use the data collected from several sites to compare and contrast the biotic and abiotic factors of the different environments.

In this lesson, students establish the boundaries of the schoolyard study site and two or three other sites for comparison (e.g., athletic field or area near water).

Procedure

→ Obtain permission from school personnel to establish a 10 x 10 meter study site and visit possible sites. Check the sites for any safety hazards. Arrange for someone to accompany students to the sites. Each site will be labeled as a study site, and students will be responsible for any special maintenance of the area for the duration of the study.

→ System boundaries differ, depending upon the question you are asking. When looking at an ecosystem, the question is "What are the biotic (living organisms) and abiotic (nonliving) factors and how are they interdependent?"

→ To establish the defined area—or system boundary—have students identify an area of the schoolyard that is approximately 10 x 10 meters. Locate the site on the school base map.

→ Students can discuss the reasons for selecting the site and reach a consensus on the best location. Choose a site that will be available to the students year-round at approximately the same time of day.

→ **NOTE: Before students go outdoors, make sure they understand, and agree to follow, all safety rules while they are outdoors.**

→ When the site has been selected, have students measure a square 10 meters by 10 meters in the front or side of the school. Place stakes in the corners. Attach the string to the stakes, and identify the site as a "Study Site." Sketch the site, use the sketch to record abiotic measurements at different places within the site.

→ When the system boundary has been established, identify 2 or 3 other sites for comparison. Ideally, the sites should differ in terms of the ecosystems they include (e.g., a shady woodland, a wetland, a well-drained sunny area, etc.). Measure and label each site as noted above.

BIOTIC FACTORS OF A SCHOOLYARD SYSTEM

Objectives

Students will

- record plant and animal life in the study site
- compare and contrast data from several locations within the study site and among other study sites

Materials

For the class

- Class Sheet "Abiotic and Biotic Factors," Page 102

For each of three groups of students:

- pencil and paper

Background

System boundaries are blurred in an ecosystem, for a bird flies from one to another, wind blows from one to another, and sunlight moves from one to another. Thus, all ecosystems are connected to others around them. A stream is linked to a woodland. A woodland ecosystem is linked to the grassland, and so on. In fact, all ecosystems on Earth are connected to each other to form the biosphere.

The flora (plant life) of an ecosystem is affected by the abiotic factors and by the fauna (animal life). The fauna of an ecosystem is affected by the abiotic factors and by the flora. When one part of the system changes, the whole system changes.

In this lesson, students will collect data about biotic factors of their study sites: flora and fauna. Students can conduct the same investigation at the same study sites during different seasons of the year to see a pattern of change.

Procedure

→ Divide the class into the three groups. Each group is divided into three teams to collect data about flora and fauna at three different locations within the study site.

→ Ask the teams to observe the various types of plants at each site, such as large trees, small trees, shrubs, small plants, and grasses. Suggest that they record the most common types of plants found in each location. If possible, have them estimate the population of each plant type. Which plant is the most dominant?

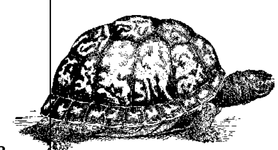
→ Ask teams to note the various kinds of animals (fauna) at each site, such as insects, birds, fish, or reptiles. Students should record *evidence* of animals, such as scat, tracks, burrows, or chewed leaves, in addition to animal sightings. Based on the evidence, they should estimate the population of each animal type. Which is the most dominant?

→ **NOTE: Before students go outdoors, make sure they understand, and agree to follow, all safety rules while they are outdoors.**

→ Each team takes a piece of paper for recording the data. After the teams have had sufficient time to investigate each site, have them report their findings and share what they have learned. After listening to each other's reports, members of the class can complete the biotic section of the class sheet "Abiotic and Biotic Factors" for each site. Use these composites as a basis for discussing similarities and differences within and among the sites.

Reflection

How do the various sites differ in numbers or diversity of species of plants and animals?



Which site had the highest air temperature? The lowest temperature? The most wind? The least wind?

What relationship does light seem to have with air temperature? With plants?

Do you think the findings would be the same on a different day? At a different time of day? In a different season?

As a result of your investigation, what new researchable question can you ask?

ABIOTIC FACTORS OF A SCHOOLYARD SYSTEM

Objectives

Students will

- measure and record temperature, sunlight, and air flow in the study site
- compare and contrast measurements from several locations within one study site and among different study sites

Materials

For one of three groups of students: temperature

- 3 thermometers
- 3 heavy paper cups
- 3 metric measures (meter or half-meter)
- sketch of study site on which to record the temperatures

For one of three groups of students: air movement

- 3 Student Sheets “The Beaufort Wind Scale,” Page 103
- 3 leaves or sheets of paper to hold in the air
- 3 compasses
- sketch of study site on which to record the wind speed

For one of three groups of students: sunlight

- sketch of the study site on which to record the percentage of sunlight on the ground

For the class

- Class Sheet “Abiotic and Biotic Factors,” partially completed in the previous lesson (Page 102)

Background

Data collected about temperature, wind, and sunlight will vary depending upon the physical components of the site, the plant and animal life, the determined boundaries or scale of the study, and the season of the year. This investigation can be conducted with one 10 x 10 meter study site, but opportunity for comparing data will be more interesting if there are several sites to investigate. Also, comparing data from a variety of sites (e.g., woodland, wetland, open field, etc.) will provide more opportunities to understand the concept of diversity.

In this lesson, students will collect data about three abiotic factors of their study site: temperature, air movement, and sunlight.

Procedure → Divide the class into three groups: those studying temperature, air movement, and sunlight. Each team is to collect data at three different locations within the study site.

Temperature. Give the group 3 thermometers, 3 heavy paper cups, a metric measure, and their sketch of the study site. Divide the group into 3 teams. Each team measures the temperature at three locations in the site and at three levels: ground level, 2.5 cm deep in the soil, and at 0.5 m above the ground.

NOTE: To get the temperature of the soil below ground, carefully insert the tip of the thermometer into the ground. To get the temperature at or above ground level, insert the thermometer through a hole in the bottom of an upside-down, heavy, paper cup. The cup acts as a shield around the tip of the thermometer so that direct sunlight and other extraneous sources of heat do not cause inaccurate readings. The thermometer should remain in one location until the temperature does not vary for 1–2 minutes.

Air movement. Give the group three copies of "The Beaufort Wind Scale" for collecting data about air movement. Divide the group into 3 teams. Each team records wind movement at one location in the site. How much air is moving across the sites? Are there leaves shaking in the breeze? Is the wind strong enough to bend small branches? Large branches? Have the students use a piece of paper or a large leaf as a temporary wind sock. One student can hold the paper away from the body, while the others observe whether it hangs straight down or blows out at an angle. Have the students use the compass to determine from which direction the wind seems to be blowing.

Sunlight. Divide the group into 3 teams. Each team records the sunlight at 3 locations within the site. How much sunlight reaches the tops of trees? How much is reaching the ground? What percentage of the ground is in sunlight?

→ After the teams have had sufficient time to investigate each site, have them report their findings and share what they have learned. After listening to each other's reports, members of the class can complete the abiotic section of the class sheet "Abiotic and Biotic Factors" for each site. Use these composites as a basis for discussing similarities and differences within and among the sites.

Reflection

Did the findings in your study site surprise you?

How might you change the study of your schoolyard site?

What else would you like to know about you schoolyard ecosystem?

If you wanted to increase the diversity of your study site, what changes would you make?

 Student______________

Ecological Communities in the U.S.

An ecological community is defined as "all the plants and animals that live together in the same environment." The community is mostly determined by climate and geography. Eight of the major ecosystems are listed below. They are determined by the kinds of vegetation (plants) they have. The plants and animals require a similar physical environment; some depend on one another for their existence.

In which ecological community do you live? ____

---

1. **Sub-tropical and temperate rain forest**
   Cooler temperatures than the tropics, with high humidity all year, often from condensing fog. Lush vegetation (plants) with many ferns and mosses. In the United States, there is one located in the northwest coastal area, where fog and moderate temperatures occur all year long.

2. **Temperate zone broadleaf forest or woodland**
   Woodlands include broadleaf and needleleaf forests. In the United States, diverse forests occupy a large area east of the Mississippi River.

3. **Warm desert and semi-desert**
   Low biological diversity. In the United States, it includes a large area in the hot, dry Southwestern part of the country.

4. **Temperate zone grassland**
   Usually occurs where rainfall is not sufficient for forests to grow. In the United States, this includes the upper Midwest region west of the Mississippi River.

5. **Mixed mountain and highland system**
   A range of vegetation (plant) zones depending on altitude, usually going from forested areas in lower slopes up to alpine meadows and permanent snow on the summits. In the United States, this occurs in the mountain ranges of the western part of the country.

6. **Wetland**
   A swamp, marsh, or bog. One place in the United States where this occurs is in Florida.

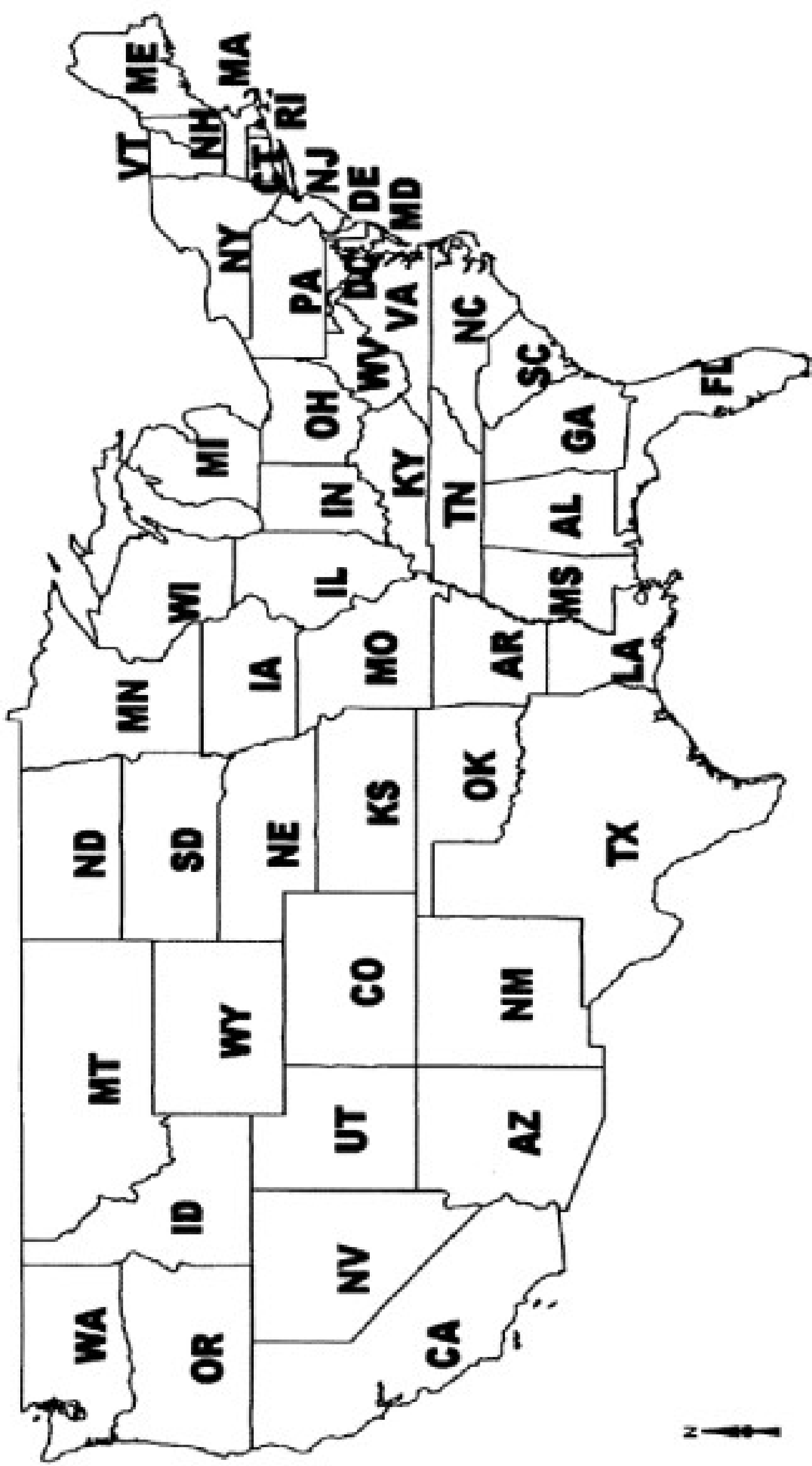
7. **Mangrove**
   Trees and shrubs adapted for life in shallow sea water in tropical and subtropical coastal areas. In the United States, this can be found in the southern coastal region of Florida.

8. **Coral reef**
   Tropical or sub-tropical coastal waters. In the United States, this occurs off the coast of the Florida keys.

Source. World Network of Biosphere Reserves

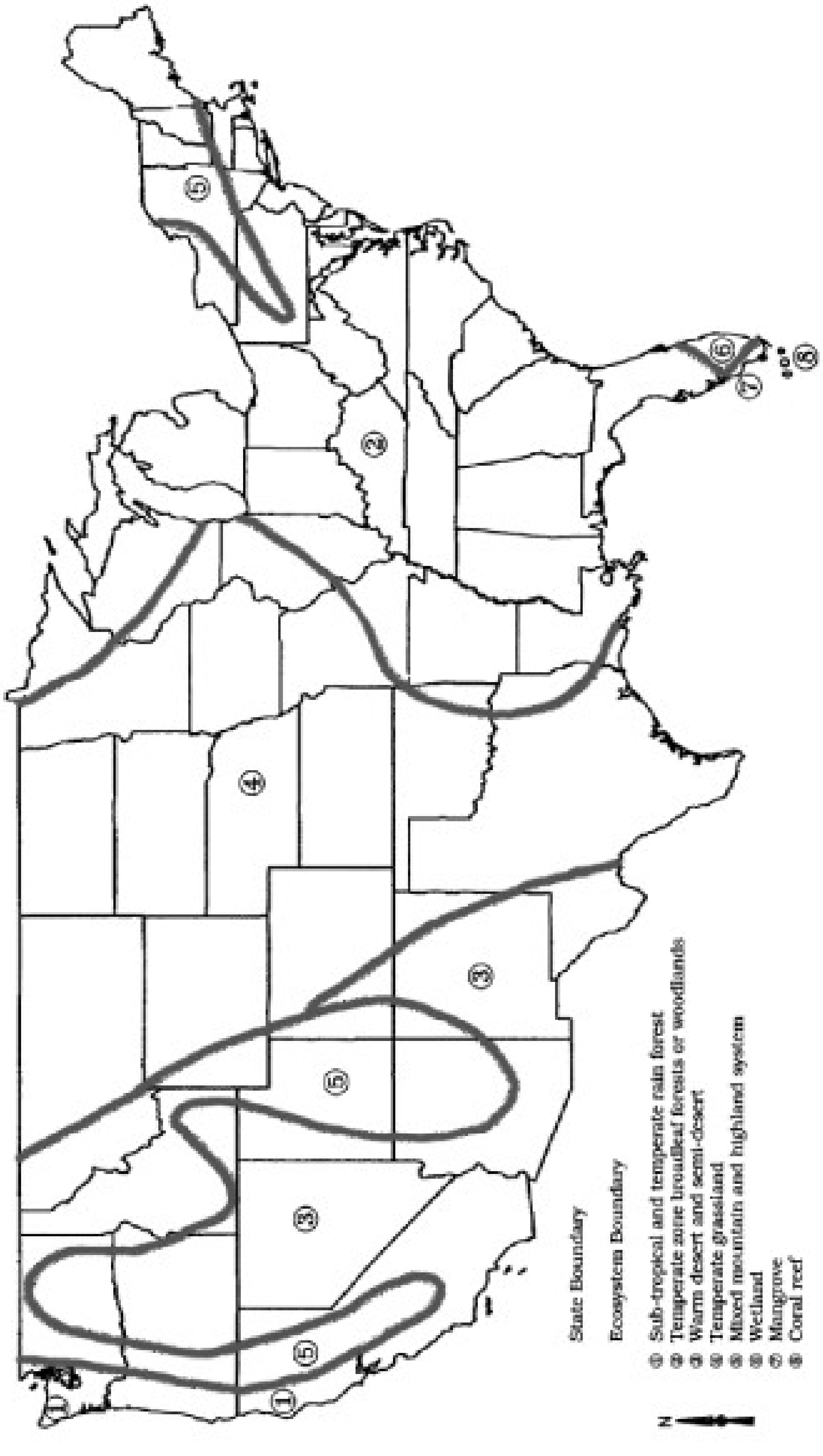
STUDENT SHEET Group_______________

Map of the United States



Source: Barren River Area Development District
This map is not a perfect representation of reality, but it does represent a "model" of the real world.

8 Major Ecosystems of the U.S.



Map Source: Barren River Area Development District. Biome Information: *Student Atlas of Environmental Issues.*

This map is not a perfect representation of reality, but it does represent a "model" of the real world.

STUDENT FACT SHEET Group______________

Major Ecological Communities as Biomes

A **biome** is defined as "all the plants and animals in a major ecological community." The community is mostly determined by climate and geography. Major ecosystems listed here are determined by the kinds of vegetation (plants) growing there. The plants and animals require a similar physical environment; some depend on one another for their existence.

Which biome listed below does the picture represent? ______________________

① **Sub-tropical and temperate rain forest**
Cooler temperatures than the tropics, with high humidity all year, often from condensing fog. Lush vegetation (plants) with many ferns and mosses.

② **Temperate zone broadleaf forests or woodlands**
Woodlands include broadleaf and needleleaf forests.

③ **Warm desert and semi-desert**
Low biological (plant and animal) diversity where it is hot and dry much of the year.

④ **Temperate grassland**
Usually occurs where rainfall is insufficient for forest vegetation.

⑤ **Mixed mountain and highland system**
A range of vegetation zones depending on altitude, usually going from forested areas in lower slopes up to alpine meadows and permanent snow on the summits.

⑥ **Wetland**
A swamp, marsh or bog.

⑦ **Mangrove**
Trees and shrubs adapted for life in shallow salty sea water in tropical and sub-tropical coastal areas.

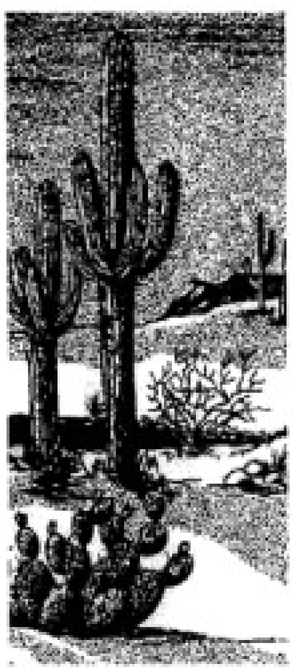
⑧ **Coral reef**
Tropical or sub-tropical coastal waters.

⑨ **Tropical humid forest**
Tropic regions with a very wet season and high biodiversity (many different kinds of plants and animals).

⑩ **Northern coniferous trees (those having cones) in forests or woodlands**
Far northern cold regions with evergreen trees.

⑪ **Tropical dry or deciduous forest (leaves fall in the dry season)**
Marked dry and wet seasons.

⑫ **Small, leathery-leaved evergreen forest, woodland or scrub (low, stunted trees)**
This type of ecosystem is resistant to hot, dry summers.



⑬ **Tropical grassland and savanna**
Mostly only grasses grow naturely.

⑭ **Cold winter desert and semi-desert**
Relatively high biological diversity given the harsh living conditions.

⑮ **Tundra community and barren Arctic desert**
Vast, level, treeless plain in regions so cold the ground never completely thaws, but warm enough that it is not always covered with snow and ice.

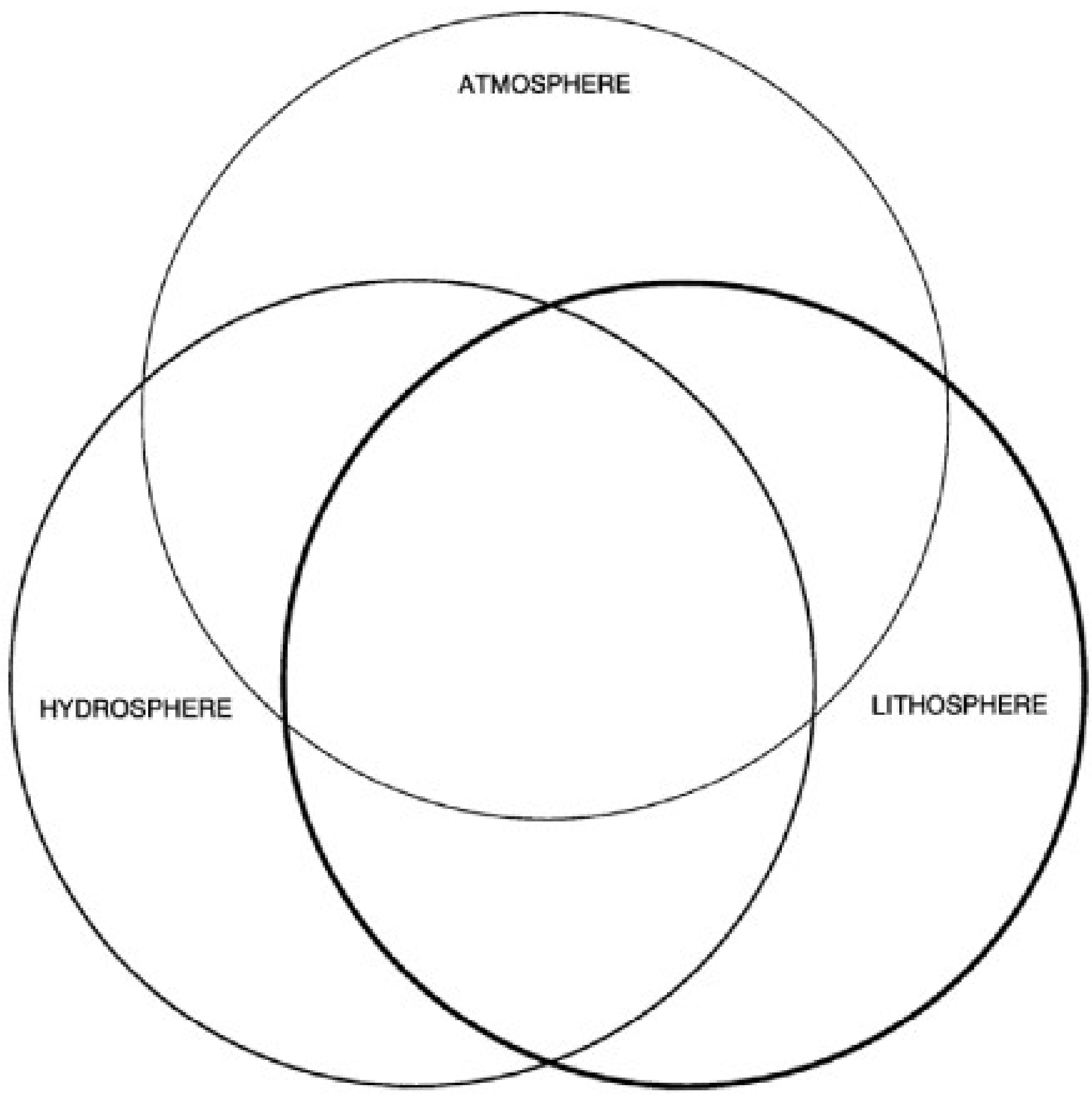
Source: World Network of Biosphere Reserves

 Student______________

Plants and Animals of the Biosphere

The **biosphere** is the region surrounding the earth—including the **atmosphere** (air), the **hydrosphere** (water), and the **lithosphere** (land)—that is inhabited by living things.

On the chart of circles below, list plants and animals that live in the atmosphere, the lithosphere, and the hydrosphere, as well as those that live in two or three spheres. List species that live in different biomes (e.g., dry deserts, cold northern regions).



STUDENT SHEET Group ______________

The Local View

Study Site ____

Part 1. Sit quietly and observe.

What do you see? ____

What do you hear? ____

What do you smell? ____

What do you feel? ____

What do you see when you look up? ____

What do you see when you look near you? ______________________________________

What are the biggest features you see? ____

Part 2. Think about what you observed.

How much of what you observed was made by humans? ________________________

What do you think is beautiful? ____

What do you think is not attractive? ____

What questions do you have? ____

____

Part 3. Express yourself about what you have learned. Do one of the following:

____ Sketch a picture.

____ Write a poem.

____ Take photographs.

____ Write a story.

STUDENT SHEET Group ______________

Making Connections

Study Site ____

What are the CONNECTIONS between the sights, sounds, smells, and feelings your recorder has written in Part 1 of "The Local View?"

Kentucky's Ecosystems

FORESTS

After the last glacial period, the climate warmed in southeastern United States, At that time, oaks, hickories, ash, tulip poplar, beech, sugar maple, and all of the other species of today's deciduous forest began to invade northward from various locations farther south. Today, the forests vary considerably in age and composition due to clearing, logging, burning, and grazing. Our forests comprise the highest percentage of land area occupied by natural ecosystems. Each forest ecosystem contributes cover and food, as well as nesting and breeding habitat for large and small mammals, song birds, reptiles and amphibians.

OPEN LANDS

Barrens are open areas that are dominated by grass. Today, only small scattered remnants exist in areas that are not productive. Among plant species that are indicators of diverse vegetation are several grass species, milkweed, and sunflowers.

Glades are open areas of flat, exposed limestone with shallow or no soil. There are only a few remnants left in Kentucky, and those that do exist are small in area. Plants that grow there are scattered shrubs, eastern red cedar, and a little ground cover.

Old fields are abandoned agricultural lands that are undergoing the natural process of succession. Early plants in this process are grasses and several native annual and perennial herbs. Birds and small animals can be found here. Later, trees and shrubs that exist in sunlight will be followed by trees that grow in shade. Larger mammals, such as white-tailed deer, browse here and contribute to the changing environment.

Agricultural land represents more than 40 percent of Kentucky. This land is dominated by domestic plants and animals, most of which have been imported from other continents. These lands have lower species diversity because of the intended use of selected species, such as corn and tobacco. Pastures support cattle, horses, and sheep.

CAVES

These unique ecosystems—more than 6,700 in Kentucky—are found in 87 counties of our state. There are few species and communities that live in these fragile ecosystems. Caves are more sensitive to change than above-ground ecosystems. Caves are also important to a number of surface organisms that require habitat for hibernating, nesting, raising young, or providing a food source.

RIVERS AND STREAMS

Except for extreme northern Kentucky, the state was not covered by glaciers. The 13 major river basins in Kentucky and a few natural lakes provide many aquatic habitats. These rivers and streams are recognized for a diversity of fish and mussels. More than one-third of these aquatic species are considered rare, threatened, or endangered. Included are large sturgeons, smaller darters, and minnows. Some fish and native mussels are good indicators of water quality.

STUDENT SHEET Group_______________

WE MAKE SOIL

These are five soil-forming factors. How did they impact the soil in your study site?

1. Climate

Is your study site primarily shady or sunny? ___________________________________

What is the temperature of your study site? ___________________________________

2. Topography

Is your study site on a slope or is it flat? ____________________________________

Is your study site at the highest, lowest, or middle level in your schoolyard?

____

3. Plants and Animals

What types of vegetation are on your study site? _____________________________

What evidence of animal life do you see? _____________________________________

What kind of insects are present? ____

How is the site used by humans? (for example, a sports field, a lawn, a natural area, or other use) ____

4. Parent Material (Rock) of Soil

Do you see rocks at the surface that can give you an indication of material from which your site was formed? ____

5. Time (How long has this site been undisturbed?)

Are there grasses, trees, crops, or other plants that have been growing for a long time without being disturbed? ____

Has there been recent building or construction near the site? ____________________

____

STUDENT SHEET Student_______________

THE SOIL BENEATH OUR FEET

Look at your soil sample. Describe the following:

- The color ____

- The texture (the way the soil feels) ____________________________

  ____

- The temperature and moisture (wet soil will be sticky and clump together; moist soil will feel wet and cool; and dry soil will feel as if it has no water in it.)

  ____

  ____

- The kind and amount of vegetation on the soil surface______________________

  ____

- The amount of roots in the soil surface ___________________________

- The number of worms or other animals in the soil ____________________

  ____

- The amount and size of rocks in the soil___________________________

  ____

* The difficulty of digging ______________________________________

  ____

  ____

CLASS SHEET Student________________

A Stream System

The stream system includes four parts:

(1) the surrounding watershed within the dividing line of runoff,
(the total area of land that contributes runoff to a stream)

(2) the stream channel,
(the path created by the runoff)

(3) habitats within the stream, and
(pools, riffles [fast flowing, shallow areas characterized by turbulence], plants, undercut banks, and a variety of substrate materials)

(4) stream banks.
(boundaries of the channel)

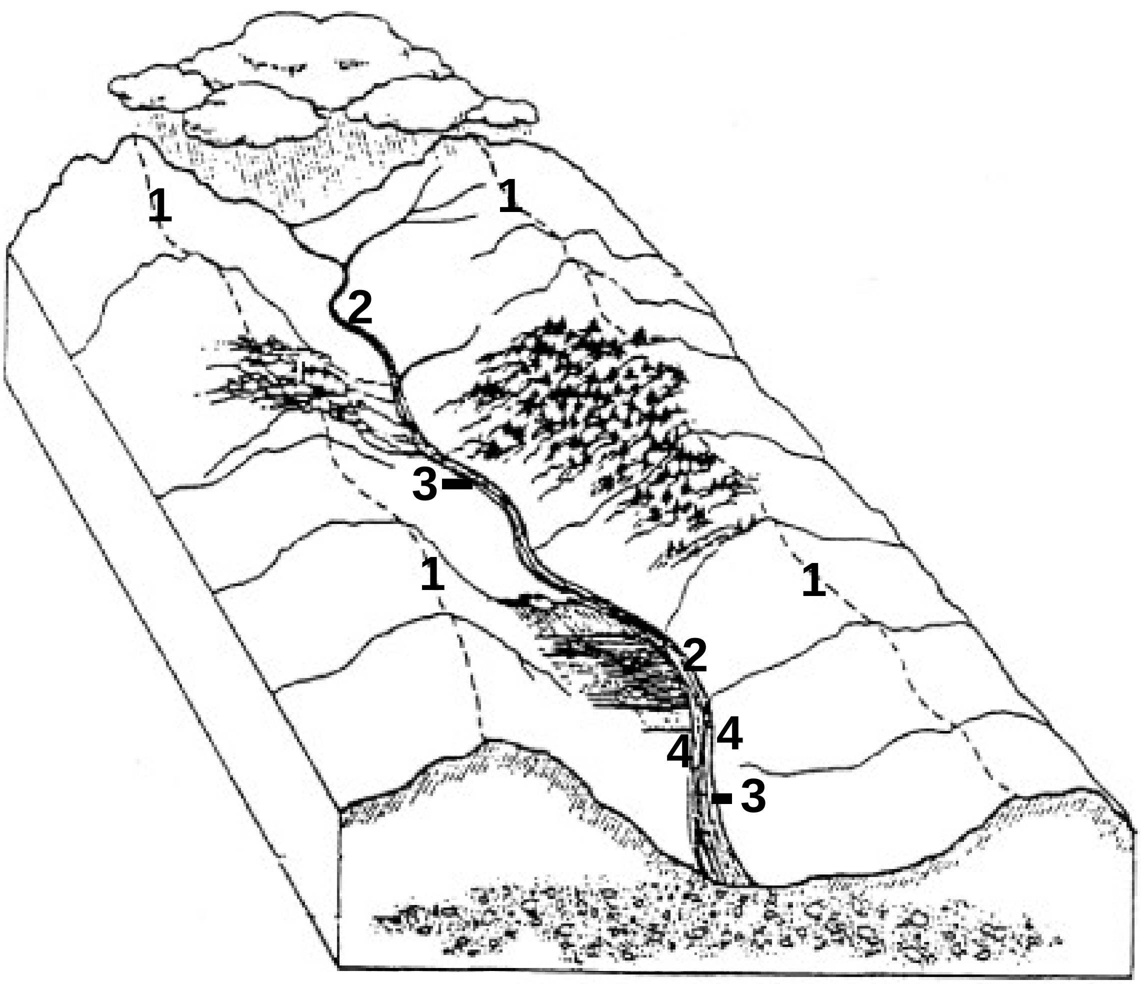


Illustration adapted from *SWEEP*. The SWEEP Project, 1998.

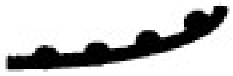
STUDENT SHEET Group_______________

BLOWING HOT AND COLD

You will need:
- 2 plastic buckets
- a centimeter ruler
- 6 thermometers
- a means to suspend the thermometers over the buckets, such as string and dowels
- soil
- a source for cool water

1. Identify the location of your investigation on your school base map.
2. Fill one bucket with soil to a depth of approximately 15 centimeters.
3. Fill the other bucket to the same depth with cool water (as from an outdoor faucet).
4. Set both buckets out in the sun.
5. In each bucket suspend one thermometer one cm above the water or soil surface, a second thermometer one cm below the surface, and a third thermometer eight cm below the surface. Try to position the thermometers so that the sunlight is not shining directly on the bulb or the glass tube. Allow time for the thermometer temperatures to stabilize in their new positions.
6. Predict the highest reading. ______________________________
7. Record the initial thermometer readings.
8. Read the temperature of each thermometer at two-minute intervals for 20 minutes.
9. Create a graph on which to record the readings of the six thermometers.

STUDENT FACT SHEET Student________________________



Moving Right Along

There are many ways in which air moves, affecting biomes, ecosystems, and habitats. This is just a sample of the ways moving air affects our part of the world.

SEA BREEZES AND LAND BREEZES

Near any large body of water you can often feel breezes blowing during the day and night. Here's what happens: when the sun beats down during the day, the land heats more quickly than the water does. The hot land warms the air above it more quickly than the water can. The warmer air is lighter and it rises. Cooler air from over the water moves in to replace the rising warm air and creates a sea or lake breeze. At night, the land loses heat more quickly than the water does. So the wind blows from the cooler land to the warmer water. This is called a *land breeze*.

PREVAILING WINDS

There are some wind patterns in the world that happen over and over, nearly all the time. These winds blow in the same general direction and are called *prevailing winds*. There are three major belts of prevailing winds in the Northern and Southern Hemispheres: Trade Winds, Polar Easterlies, and Prevailing Westerlies.

Prevailing Westerlies

These winds blow more from west to east than from north or south across the middle *latitudes* of the Northern and Southern Hemispheres. States in the contiguous United States and parts of Canada are in the path of the prevailing westerlies, which is why our weather systems usually move from west to east.

JET STREAMS

Jet streams are strong, fast-moving rivers of air high in our atmosphere. They are caused by huge temperature differences in the atmosphere. Jet streams can blow well over 100 miles (160 km) per hour and may cause major shifts in weather patterns.

AIR MASSES

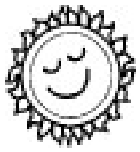
A huge volume of air with about the same temperature and humidity throughout is called an *air mass*. An air mass, which is shaped like a big, upside-down bowl, can be hundreds or thousands of miles across.

Huge waves of air high in the atmosphere are what steer air masses and “push” them along. Just like enormous waves of water in the ocean, these waves of air can be thousands of miles long. As air masses move, they move as a whole body.

CLASS SHEET

Study Site ______________________________

Date __________________________________



ABIOTIC AND BIOTIC FACTORS

Temperature

0.5 m Elevation ____________

Ground Level ____________

2.5 cm Depth ____________

Air Movement

Beaufort Scale ____________

Sunlight

% of Surface Area ____________

Flora	**Population**

Fauna	**Population**

STUDENT SHEET   Group______________

The Beaufort Wind Scale

In 1858, Sir Francis Beaufort (Bo' fert) wanted to to be able to tell how strong the wind was blowing without using an instrument. He decided to observe *what the wind does*. He numbered the force of the wind from 0 to 12–17. Even today you can use these numbers to record the force of the wind.

Wind Speed kmph	mph	Beaufort Number	Wind Description	Observed Effects on Land
<1	<1	0	Calm	Calm, no movement of leaves
1-3	1-3	1	Light air	Slight movement of leaves, smoke, and wind vanes
6-11	4-7	2	Light breeze	Leaves rustling, wind blowing, wind vanes moving
12-19	8-12	3	Gentle breeze	Leaves and twigs in motion, small flags and banners extended
20-29	13-18	4	Moderate breeze	Small branches moving—raising dust, paper litter, and dry leaves
30-38	19-24	5	Fresh breeze	Small trees and branches swaying, wavelets forming on inland water ways
39-49	25-31	6	Strong breeze	Large branches swaying, overhead wires whistling, umbrellas veering
50-61	32-38	7	Moderate gale	Entire trees moving; difficult to walk into wind
62-74	39-46	8	Fresh gale	Small branches breaking, walking difficult, moving automobiles veering
75-87	47-54	9	Strong gale	Roof shingles blown away, structures slightly damaged, branches broken and littering the ground
88-101	55-63	10	Whole gale	Uprooted and broken trees, structural damage
102-116	64-73	11	Storm	Widespread damage to structures and trees, a rare occurrence
>117	>74	12-17	Hurricane	Severe to catastrophic damage

Record the wind movement in three locations within your study site.

Study Site ____

Beaufort Number in Location #1 ________________________________

Beaufort Number in Location #2 ________________________________

Beaufort Number in Location #3 ________________________________

"The earth is to be seen
neither as an ecosystem to be preserved unchanged
nor as a quarry to be exploited for selfish and short-range economic reasons,
but as a garden to be cultivated
for the development of its own potentialities
and the human adventure."

—René Dubos, 1901-1982
Bacteriologist, Pulitzer Prize recipient
Rockefeller University

Entrance to the Land Exhibit, Epcot, Walt Disney World

5 How Humans Depend on Biodiversity

NOTES

Diversity within a species and among species, as well as among ecosystems that support the diversity, is vital to our lives. Finding the balance between a healthy economy and sustainable biological resources is the responsibility of all the citizens of Kentucky.

In the activity "What a Tomato!" students play the role of plant breeders, deciding which characteristics they would like to change in tomatoes. In "Designer Genes," your students grow and compare two plants of the same species that have been bred for very different characteristics. In the final activity, "Finding Out," students access information (1) directly from a local farmer to find out both the benefits and the problems of cross breeding, and (2) directly from an organization or agency to find out about efforts being made to promote biodiversity in Kentucky.

WHAT A TOMATO!

Objective — Students will

- use critical thinking skills to improve a crop

Materials — *For each student*

- 1 slice of tomato
- 1 small paper plate
- 1 section of paper towel

Term — **breeder:** scientist who develops new varieties of plants or animals

Background — Humans take advantage of natural genetic diversity in many ways. The first farmers planted, harvested, and saved their favorite seeds, thus purposely selecting for specific, desirable traits. All of our staple food crops reflect centuries of work by plant breeders. Many medicines originated with the traits of wild species, manipulated by humans. Relatively recently, however, humans have begun to "design"

Reference to Program of Studies

GRADE 6 SCIENCE
<u>Scientific Inquiry</u>

• identify and refine questions that can be answered through scientific investigations combined with scientific information.

• use evidence, logic, and scientific knowledge to develop scientific explanations.

• design and conduct different kinds of scientific investigations to answer different kinds of questions.

• communicate designs, procedures, and results [by] scientific investigations.

• review and analyze scientific investigations and explanations of other students.

<u>Life Science</u>

• investigate how organisms obtain and

Reference to Program of Studies continued

use resources, grow, reproduce, and maintain stable internal conditions. Examine the regulation of an organism's internal environment.

Populations and Ecosystems

• investigate factors (e.g., resources, light, water) that affect the number of organisms an ecosystem can support.

GRADE 7 SCIENCE
Scientific Inquiry

• identify and refine questions that can be answered through scientific investigations combined with scientific information.

• use evidence (e.g., measurements), logic, and scientific knowledge to develop scientific explanations.

• design and conduct different kinds of scientific investigations to answer different kinds of questions.

• communicate (e.g., write) designs, procedures, and results of scientific investigations.

crops to meet our "needs," such as consumer tastes, nutritional values, or harvesting and shipping requirements.

In this activity, students consider why humans might want to develop different types of plants, such as tomatoes.

Procedure

→ Pass around some tomato slices for your students to eat while you play a game called "What Bugs Us About Tomatoes?" Encourage students to use their imaginations as they brainstorm a list of complaints consumers might have about tomatoes. For example, do they make a mess when they are sliced? Are they too small to fit on a hamburger? Is the color unappetizing? Are the seeds too slimy?

→ Post student responses—the more humorous or outrageous, the better!

→ Tell students they have just generated a list of possible reasons some people might want to change the characteristics of tomatoes. People who develop new varieties of crops with different characteristics in response to consumer interest are scientists called "breeders." Some breed animals for better characteristics, and some breed plants for a variety of different characteristics. It is easier to take a closer look at plants, but the concept is the same for animals.

NOTE: Perhaps some students might know of examples of plants or animals that have been developed for certain characteristics.

DESIGNER GENES

Objective

Students will

- compare and contrast two different plants they grow from seed
- observe how different plants can be developed for specific characteristics and uses

Materials

For each small group of about 3 students

- 3 turnip seeds (labeled "A")

- 3 Wisconsin Fast Plants seeds (labeled "B") See Appendix for source. Allow 2–3 weeks for delivery.
- 2 small plastic beverage bottles
- a marking pen for plastic
- potting soil
- water
- cotton string (to use as a wick)
- a piece of aluminum foil
- 20-20-20 soluble fertilizer
- Student Sheet "Designer Genes," Page 111
- Student sheet "Keeping Track," Page 112

For the class

- a good source of strong light
- "Seeds," a video (See Page 119 for source.)

Term

hybridize: to cross-pollinate two distinctly different plants to achieve a mix of desirable characteristics

Background

Advantages to hybridizing plants include the fact that offspring of hybridized plants are often more uniform, earlier, more disease resistant, and higher yielding. People who hold patents on these plants make a lot of money.

However, the benefits of plant breeding do not come without trade-offs. For example, some tomatoes have been bred for toughness to withstand mechanical packing and shipping. However, these same plants have lost flavor and appealing texture. Another problem is that we often lose track of, or discard, varieties that seem not to be "useful" to us. These lost varieties may have great medical or agricultural virtues. Once lost, this valuable genetic information can never be recovered.

To prevent this loss, seed banks collect, store, and save seeds from plants that might otherwise disappear for our use in the future. In this lesson, students grow two plants that were bred for different characteristics.

Reference to Program of Studies
continued

• review and analyze scientific investigations and explanations [by] other students.

Life Science

• investigate traits, heredity, and genes.

Diversity and Adaptations of Organisms

• investigate unity among organisms.

• investigate biological adaptation and extinction.

Applications/ Connections

• describe the effects of science and technology (e.g., television, computers) on society.

GRADE 8 SCIENCE
Scientific Inquiry

• identify and refine questions that can be answered through scientific investigations combined with scientific information.

• use evidence (e.g., computer models), logic, and scientific knowledge to develop scientific explanations.

• design and conduct different kinds of scientific investigations to answer different kinds of questions.

Reference to Program of Studies *continued*

• communicate (e.g., write, graph) designs, procedures, and results of scientific investigations.

• review and analyze scientific investigations and explanations [by] other students.

Life Science

• investigate structure (e.g., cells, tissues, organs) and function (e.g., growth, muscular function, digestion) in living systems.

• analyze reproduction (e.g., asexual, sexual) and heredity (e.g., genetic information, inherited traits).

• analyze diversity and adaptations (e.g., changes in structure, behaviors, or physiology).

Applications/ Connections

• use scientific inquiry and conceptual understandings to design technological solutions (e.g., zippers, ballpoint pens) to problems.

• examine the interaction between

NOTE: This activity will take about six weeks. The seeds must germinate and the seedlings develop. During this time, students keep records of their observations, and they begin the activity “Finding Out.”

Procedure

→ Tell students they will grow seeds from two different plants that are the same species. See Page 14 for the terminology of classification. Plant scientists have specially bred both plants for different characteristics and uses. Tell students they are to try to figure out for which characteristics each plant has been bred.

→ Divide the class into groups of three students and give each group a copy of “Designer Genes.” Students are to follow the instructions on the sheet.

→ Have students record observations on the sheet “Keeping Track.” At the end of six weeks, have students carefully remove plants from the containers so that they can make final observations of the entire plant structures.

→ Ask each group to compare and contrast its results with other groups; then, summarize the findings on a class chart.

NOTE: What are the similarities and differences between both types of plants? What conclusion can your students make?

→ Show the video “Seeds,” a Bullfrog Film

SUGGESTION: Show parts of the video and follow each part with a class discussion.

Reflection

At what stage did you first notice differences between the two plants you grew?

For what characteristics do you think plant breeders may have developed each of these plants? For what use?

Do you think animal breeders look for ways in which they can strengthen certain characteristics of their animals? Why?

FINDING OUT

Objective — Students will

- access information about which seeds farmers use and which animals they raise in their county
- access information about ways in which people in Kentucky promote biodiversity, and why they think it's important

Materials — *For the class*

- access to local or regional farmers
- access to the Kentucky Department of Agriculture—by phone 502/564-4696, or by Internet http://www.kyagr.com—and to your county extension agent

Term — **Thoroughbred:** a member of a breed of horses

Background

According to Kentucky's Biodiversity Task Force, "It is now evident that hybridization can be both beneficial and harmful for the conservation of biological diversity. In certain rare cases, hybridization may be the only possible way to preserve the genes of a rare and endangered group of plants or animals. However, hybridization can also lead to the loss of genetic diversity through the [merging of a] smaller population with a larger one."

In Kentucky, breeders use hybridization to improve traits of animals and plants of economic value, such as Thoroughbred horses and tobacco. At the same time, people are becoming more aware of the value of biodiversity. According to Kentucky's Biodiversity Task Force, "If the state is to successfully conserve its biodiversity . . . citizens of all ages, professions, education levels, and regions [in other words, all of us] must gain a greater understanding of its meaning and value."

In this lesson, students interview (1) local farmers to learn about their use of hybridized seed or crossbred animals, and (2) state agencies and organizations to learn about efforts being made in Kentucky to conserve biodiversity and to use biological resources in a sustainable manner.

Reference to Program of Studies
continued

science and technology.

- *recognize how science is used to understand changes in populations, issues related to resources, and changes in environments.*
- *describe the effects of science and technology (e.g., television, computers) on society.*
- *demonstrate the role science plays in everyday life and explore different careers in science.*
- *recognize that science is a process that generates conceptual understandings and solves problems.*
- *explore the importance of scientific discoveries in world history (e.g., new drugs, weapons, transportation).*

Reference to Academic Expectations:

2.1 Students understand scientific ways of thinking and working and use those methods to solve real-life problems.

Reference to Academic Expectations *continued*

2.2 Students identify, analyze, and use patterns such as cycles and trends to understand past and present events and predict possible future events.

2.3 Students identify and analyze systems and the ways their components work together or affect each other.

Procedure

→ Invite a local farmer to visit the classroom so that students can ask questions related to the topics of hybridization and biodiversity. If there is no farmer nearby, you might invite a nurseryman, orchardist, or greenhouse operator.

NOTE: If students can visit the operation, the direct experience will lead to more teachable moments. In either case, review with your students the expectations you have regarding appropriate manners.

Help students prepare a list of questions beforehand.

OPTION: For a student-directed activity, have small groups of students suggest questions. After they share the questions they have written, students might nee help in wording the questions appropriately. Then, compile a class list of the questions.

OPTION: For a teacher-directed activity, have students develop such questions as *Do you use hybrid seed (or crossbred stock)? What are the benefits of using hybrid seed (or crossbred stock)? Are there any disadvantages? What would you like to see changed in the seed or stock you grow now?*

→ While you are waiting for the visit, have students access information about Kentucky's efforts to promote biodiversity, Assign different organizations, agencies, web sites, and manuals to different students; have them report on their findings, and discuss results,

→ As a final assignment, have each student use the information he or she has gained to answer the following question:

"How can people in Kentucky balance economic considerations with the need to maintain biodiversity?"

NOTE: The purpose of this question is not to have a definitive answer but to have the student *think* about the issue.

STUDENT SHEET Students ___________________________

Designer Genes

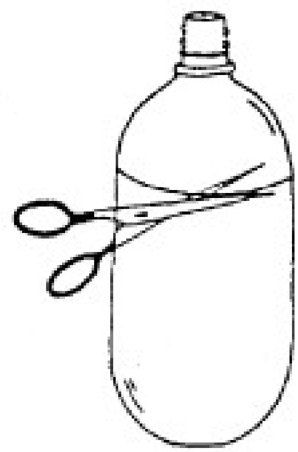
You will need:	marking pen for plastic	water
	2 small beverage bottles	potting soil
	metric ruler	3 seeds of Plant A
	scissors	3 seeds of Plant B
	sharp-pointed hole puncher	source of strong light
	cotton string (15 cm long)	piece of aluminum foil
		20-20-20 soluble fertilizer

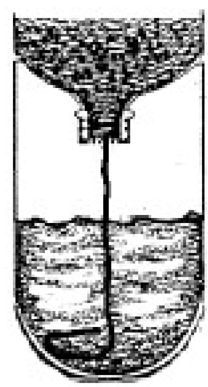
Make 2 identical columns. For each column:

1. With the lid on the bottle, punch a hole in the lid.
2. Make a line around each bottle just below the bulge at the top.
3. Cut around the bottle on the line.
4. Thread the string through the hole in the lid so that it can serve as a wick.
5. Pour water into the bottom section.
6. Insert the bottle top in the bottom as shown.
7. Put potting soil in the top part and dampen the soil with water. Allow the water to drain through the top section to the bottom.
9. Label the column “A”.

---

10. Repeat Steps 1 through 8 for the second column, and label the column “B”.
11, Put 3 seeds of Plant A on the soil of Column A. Put just enough soil on top to cover seeds.
12. Put 3 seeds of Plant B on the soil of Column B. Put just enough soil on top to cover seeds.
13. Place both columns in a dark place, or cover with a piece of aluminum foil.





Completed columns A and B

- Check the seeds every day. Keep the soil damp.
- As soon as the seeds germinate, place the columns in a bright light.
- Select the best seedling in each column to continue growing. Remove the others.
- After about a week, fertilize both plants.
- As Plant A begins to grow, hill up the soil around the stem.

STUDENT SHEET Students ___________________________

Keeping Track

It's important to keep good records of your activity and your observations.

	Plant A	Plant B
Date planted		
Date germinated		
Date first leaves appeared		
Date second leaves appeared		
Date and height first week		
Date and height second week		
Date and height third week		
Date and height fourth week		
Date and height fifth week		
Date and height sixth week		
Date flowered		
Date and sketch of root structure sixth week		

REFERENCES

Abrams, K. S. (1996). *Biodiversity: The Florida story, Issue 1.* Tallahassee, FL: Office of Environmental Education.

Berstein, L. (1996, August 18). *The love of three orchestras*. (nc). Arts & Entertainment.

Biological Sciences Curriculum Study. (1987). *Biological science: An ecological approach* (6th ed.). Dubuque, IA: Kendall/Hunt.

Buzan, T. (1983). *Use both sides of your brain*. New York: E. P. Dutton.

Council for Environmental Education. (1992). *Project WILD Aquatic Education Activity Guide.* Bethesda, MD: Author.

Keeton, W. T. (1973). *Elements of biological science* (2nd ed.). New York: W. W. Norton.

Kentucky Department of Education. (1998). *Program of studies for Kentucky schools: Grades primary–12.* Frankfort, KY: Author.

Leopold, A. (1966). *A Sand County almanac with essays on conservation from Round River.* New York: Ballantine Books.

Lewington, R., & Streeter, D. (1993). *The natural history of the oak tree.* New York: Dorling Kindersley.

Litchfield, M. (1986). *Language arts with an environmental twang*. Murray, KY: Murray State University.

Martin, J. A., Wilson, T. L., & Bartnik, G. (In Press). *Schoolyard ecosystems for eighth-grade science.* Chattanooga, TN: The Tennessee Aquarium.

Martin, J. A. (1996). *Teacher's guide to developing, using & maintaining outdoor classrooms in Kentucky*. Frankfort, KY: Kentucky Environmental Education Council.

National Wildlife Federation. (1989). *NatureScope: Wild about weather.* Washington, DC: Author.

Outdoor Biology Instructional Strategies. (1979). *OBIS*. Hudson, NH: Delta Education.

Pranis, E. & Cohen, J. (1999). *GrowLab: Activities for growing minds.* Burlington, VT: National Gardening Association.

Stein, S. (1993). *Noah's garden: Restoring the ecology of our own back yards.* Boston: Houghton Mifflin.

Taylor, D. J. (Ed.). (1995). *Kentucky alive! A report of the Kentucky biodiversity task force.* Frankfort, KY: Commonwealth of Kentucky.

The Watercourse and the Council for Environmental Education. (1995). *Project WET* (Water Education for Teachers) *curriculum & activity guide*. (nc): Author.

Western Regional Environmental Education Council. (1992). *Project WILD activity guide (Rev. Ed.).* Boulder, CO: Author.

Wilson, E. O. (2000, April–May). Vanishing before our eyes. *Time*. pp. 29–34.

Wilson, E. O. (1999). *Biological diversity: The oldest human heritage.* Albany, NY: The New York State Biodiversity Research Institute.

Wilson, E. O. (Ed.). (1988). *Biodiversity*. Washington, DC: National Academy Press.

Wilson, E. O. (1984). *Biophylia*. Cambridge, MA: Harvard University Press.

RESOURCES

FIELD GUIDES AND KEYS

Bluebirds and Their Survival
Davis, W., Roca, P. (1995). Lexington, KY: University Press of Kentucky.

What Tree Is That?
The National Arbor Day Foundation (nd).
A guide to common trees found in the Eastern and Central United States. Available from The National Arbor Day Foundation, 100 Arbor Avenue, Nebraska City, NE, 68410.

Wildflowers & Ferns of Kentucky
Barbour, R. W., & Wharton, M. E. (1971). Lexington, KY: The University Press of Kentucky.
A unique guide to the herbaceous wildflowers and ferns of Kentucky and Tennessee fields and forests. Contains over 500 full-color illustrations of nearly 500 species. Available from The National Arbor Day Foundation, 100 Arbor Avenue, Nebraska City, NE, 68410.

The Audubon Society Field Guide Series
New York: Alfred A. Knopf. (Dates vary).
Available in most bookstores. (All-color, all-photographic format)

- **North American Rocks and Minerals**
- **Birds** (Eastern Region volume)
- **Butterflies**
- **Insects and Spiders**
- **Mammals**
- **Reptiles and Amphibians**
- **Trees** (Eastern Region volume)
- **Wildflowers** (Eastern Region volume)

The Field Guide to Wildlife Habitats of the Eastern United States
Benyes, J. M. (1989). New York: Simon & Schuster.
Chapters include: What Is a Habitat? Observation Tips, River and Stream, Grassy Field, Transition Forest, and more. Each chapter includes characteristic plants and wildlife that live there.

Nature Study Guild Keys
Nature Study Guild, Box 10489, Rochester, NY 14610.

Flower Finder— spring wildflowers and flower families
Tree Finder— all native and introduced trees
Winter Tree Finder— leafless winter trees
Fern Finder— native northeastern and midwestern ferns
Track Finder— tracks and footprints of mammals
Berry Finder— native plants with fleshy fruits
Winter Weed Finder— dry plant structures in winter
Bird Finder— some common birds and how they live

Peterson Field Guides
Boston: Houghton Mifflin. (Dates vary). Available in most bookstores.
An extensive listing (40) on birds, insects, plants, and more!

OUTDOOR CLASSROOM DEVELOPMENT

Greenways: A Guide to Planning, Design, and Development
Fink, C. A., & Searns, R. M. (1994). Washington, DC: Island Press.
A book that provides community organizations with practical and specific recommendations for creating and preserving natural "green" spaces.

Habitats for Learning
Ohio Environmental Education Fund, Ohio Environmental Protection Agency (1995).
A planning guide for using and developing outdoor classrooms. Available from Ohio Department of Natural Resources, Division of Soil & Water Conservation, Environmental Education Section, 1939 Fountain Square Court, Bldg. E-2, Columbus, OH 43224. Or call 614/265-6878.

Homes for Wildlife
New Hampshire Fish & Game Department (NHF&GD) (1995).
A comprehensive planning guide for habitat enhancement on school grounds. Available from NHF&GD, 2 Hazen Drive, Concord, NH 0330 1. Or call 603/271-3211.

Just Beyond the Classroom
ERIC Clearinghouse on Rural Education and Small Schools, Appalachia Education Laboratory (1996).
Community adventures for interdisciplinary learning, addressing educational reform, outdoor education, and activities for twelve outdoor themes. Available from the publisher at P.O. Box 1348, Charleston, WV 25325.

So you want to start an Outdoor Classroom...
The Oklahoma Conservation Commission (OCC) and The Oklahoma Department of Wildlife Conservation (ODWC) (n.d., no copyright).

A compilation of ideas for developing an outdoor site for primary and intermediate students. Contact the OCC at 2800 North Lincoln, Oklahoma City, OK 73105. Contact the ODWC at 1801 North Lincoln, Oklahoma City, OK 73105.

Teacher's Guide to Developing, Using & Maintaining Outdoor Classrooms in Kentucky
Kentucky Environmental Education Council (KEEC). (1996).

This Guide offers a step-by-step strategy for using the outdoors as a learning tool. It discusses the advantages of using an outdoor classroom and how to organize your school to develop and maintain one. Contact the KEEC at Capital Plaza Tower, Frankfort, KY 40601, or call 502/564-5937.

WILD School Sites
Western Regional Environmental Education Council, Inc. (1993).

A guide to preparing for habitat improvement projects on school grounds. For information, contact Project WILD, 5430 Grosvenor Lane, Bethesda, MD 20814. Or call 301/493-5447.

GENERAL REFERENCES

Backyard Composting
Harmonious Technologies. (1992). Ojai, CA. Harmonious Press. Or call 805/646-8030.

A complete guide to recycling yard clippings.

The Backyard Naturalist
Tufts, C. (1988). Washington, DC: National Wildlife Federation.

An easy-to-read book that blends know-how, common sense, and environmental awareness.

Biodiversity
Wilson, E. 0. (Ed). (1988). Washington, DC: National Academy Press.

A collection of presentations made at the National Forum on biodiversity, held in Washington, DC on September 21-24, 1986. This in-depth discussion addresses our dependence of biodiversity, its value, and ways in which we can help restore biodiversity.

The Bluebird Book
Stokes, D., & Stokes, L. (199 1). New York, NY: Little, Brown & Company.
This book explains how to build a bluebird nest box, how to start a bluebird trail, how to attract bluebirds with appropriate landscaping, and to construct bluebird feeders.

Going Native: Biodiversity in Our Own Backyards
Marinelli, J. (Ed). (1994). Brooklyn, NY: Brooklyn Botanic Garden.
An easy-to-read, colorfully illustrated small book that addresses why biodiversity is needed, how a garden can be made both natural and attractive, and the best plants can be selected for a region.

How to Attract Birds
Burke, K., Wood, J., & McKinley, M. (1983). San Francisco: Ortho.
A beautifully illustrated, easy-to-read book that addresses the basic needs of birds,

Landscape Restoration Handbook
Harker, D., Evans, S., Evans, M., & Harker, K. (1993). Boca Raton, FL: Lewis Pub.
An in-depth guide to naturalizing the managed landscape and maintaining and restoring ecological diversity.

The Natural History of the Oak Tree
Lewington, R., & Streeter, D. (1993). New York: Dorling Kindersley.
A high quality, beautifully and lavishly illustrated visual exploration of oak trees, the organisms that call them "home," and their environment.

Soil Survey Series
National Cooperative Soil Survey. (Dates vary with publication).
Books published for each county in Kentucky include topographical maps for all sections of the county and descriptions of the soil found in each county. Available from the Natural Resources Conservation Service (formerly called the Soil Conservation Service) in your county. Look in the White Pages under US GOVERNMENT, the DEPARTMENT OF AGRICULTURE, then either SOIL CONSERVATION SERVICE (former name) or NATURAL RESOURCES CONSERVATION SERVICE (new name).

VIDEOS

Exploring School Nature Areas
Bethesda, MD: Project WILD. 301/493-5447.
For teachers, it encourages the development of wildlife habitat in school yards.

Habitats for Learning: Ohio Takes a New Look at Land Labs
Columbus, OH: Ohio Department of Natural Resources.
Walks teachers through the process of using and enhancing outdoor learning.

Life in the City Habitat
St. Louis, MO: Missouri Botanical Garden. 1-800-927-9229.
For intermediate-grade students. Explores organisms that have adapted to life in the city. (14 minutes).

Seeds
Oley, PA: Bullfrog Films. 1-800-543-3764.
A concise explanation of the importance of genetic diversity to the world food supply. (26 minutes).

The Puzzle of the Rotting Log
Missouri Botanical Garden. 1-800-927-9229.
For intermediate-grade students. Investigates the process of decomposition of a rotting log in the forest. (12 minutes).

A Teacher's Guide to

Bio*diversity*

Middle School Science in Kentucky

A publication of the

Kentucky Biodiversity Council

and

Kentucky Environmental Education Council