4HCCS BU-07706 2002

Name _____

County _____

Reviewed and Recommended
National Collection

Level 3

Exploring Your Environment

Eco-Actions

Youth Activity Guide

Note to Project Helper

Welcome to Eco-Actions

As an adult project helper you have the opportunity to help a young person learn more about the environment through the activities in this project book. You will have the chance to help a youth explore the "wonders" of the natural world. From exploring population pressures and testing erosion prevention methods, to learning how to be a responsible earth steward, this curriculum contains dozens of hands-on, useful and fun projects.

You will be the key individual with whom the young person shares each of the experiences outlined in this activity guide. You will provide encouragement and recognition as the young person develops technical and scientific environmental knowledge and stewardship. In addition, the youth will learn important life skills such as creative thinking, decision making, problem solving and participating as a member of a team.

Your Role

- Review this guide and the *Helper's Guide*
- Support the youth in his or her efforts to set goals and complete the Planning Guide and *Eco-Actions* Achievement Program
- Help select environmental projects to construct, give assistance in doing the activities and answer questions
- Help the young person to think about why something happened the way it did
- Serve as a resource person to help connect the young person with the community, resource materials and others knowledgeable about the environment

The *Exploring Your Environment* Series

This is the third activity guide in the *Exploring Your Environment* Series.

Activity Guide	Level 1	Age	Grade
Eco-Wonders	1	9–12	5–7
Eco-Adventures	2	13–15	8–10
Eco-Actions	3	16–19	11–12
Helper's Guide			

These activity guides may be used by youth at any grade-level based on their environmental skills, knowledge and expertise. The *Helper's Guide* provides additional group activities that can be adapted to the family, classroom or youth group. These activities strengthen understanding of environmental concepts and reinforce environmental skills.

The Experiential Learning Model

The experiential learning model is used in each activity as a means to help the young person gain the most from the experience.

The five steps in this learning model encourage the young person to try to do all, part or some of the activity before being told or shown how. The activity is the experience part of the cycle. Use the questions listed in the *Making Connections* section of each activity to encourage the young person to think about what he or she has learned from the experience. The reflect and application questions ask the youth to:

- **share** what they did
- **process** what was most important about the experience
- **generalize** the life skill and earth stewardship skill practiced to their own lives
- **apply** the life skill or science process skill to a new situation.

To fulfill the experiential learning process, you must complete all the steps, including the review questions in *Making Connections*. The experiential model enhances learning and adjusts to a wide variety of learning styles.

Evaluating the Experience

By asking the questions under *Making Connections* you can evaluate if your youth understands the key concepts and life skills practiced in each activity. Listening to and encouraging consideration of each question, results in conclusions and opportunities for further application. In addition, the *Success Indicator* shown in the introduction of each activity will help you evaluate the experience.

In the *Helper's Guide* you will find an assessment sheet, *Evaluating the Impact*. Use this sheet to help you evaluate your youth's understanding of environmental concepts as he or she completes these activities.

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Hungerford, H.R., Litherland, R. A., Peyton, R. B., Ramsey, J. M., & Volk, T. L. (1996). *Investigating and Evaluating Environmental Issues and Actions: Skill Development Program.* Champaign, IL: Stipes Publishing L. L. C.

Morell, V. (1999). The variety of life. *National Geographic, 195* (2), 6-31.

Thomas, S. (1997). *Movin' the transit way.* Metropolitan Council.

Frequently asked questions about solid waste. Retrieved October 21, 2000, on the World Wide Web: http://www.epa.gov/epaoswer/osw/basifact.htm

Web Connections
www.fourh.umn.edu/exploreyourenvironment

WARNING: Some web sites to which these materials provide links for the convenience of users are not managed by the 4HCCS which does not review, control or take responsibility for the contents of those sites.

Table of Contents

Eco-Actions

Introduction

How this Book Works

Welcome to Eco-Actions

Have you ever wondered...

- What is a biome? And what makes one place a desert and another a rainforest?
- What is the current human population?
- What is biotechnology?
- How does urban sprawl affect wildlife?
- What alien species live in your neighborhood?
- What does biodiversity mean?
- How can I make a difference for the environment?

Your adventures in *Eco-Actions* will help you answer some of these questions and many more! Each section of your project book focuses on an ecological concept and provides activities that will help explain how the environment works. You'll jump right into investigations and explorations to look at real-world issues!

Each activity in *Eco-Actions* has this important information:

Skills – Each activity lists Earth Stewardship Skills, Science Process Skills, Life Skills and a National Science Standard that you will learn and use. You will practice these types of skills when you answer the questions and discuss each activity with your helper.

Success Indicators – You have mastered this skill if you can do what they say. If you have trouble with a skill, keep practicing until you can.

Materials – These are the materials you will need to complete the activity.

Dig In – This is the "do" part of the activity, which you will usually get to share with others.

Making Connections – This is where you and your helper get together to see what you have learned about the environment. You will use these questions to help you discuss what you learned and what you did. You will talk about what was important about what you did, what it meant to you and how you could use what you learned in the future.

- **Talk It Over** – Share with others and talk about what happened in the activity.
- **Let's Reflect** – Questions get you thinking about the most important things you learned.
- **So What?** – Asks you about the activity and how what you learned relates or generalizes to your everyday life.
- **Issues to Discuss** – Helps you use or apply what you learned in a new way.

Here you will find information and tips to help you complete the activity.

These are more activity ideas to help you explore and learn about the environment. Each time you successfully complete one of these, record it on your achievement program page and have your helper initial and date it.

These are vocabulary words found in the activity. The definitions of these words are in the back of your project book.

These are helpful hints to keep yourself safe when exploring the environment.

Here are ideas for science fair or 4-H fair projects.

Here you will find web site links at www.n4hccs.org where you can learn more about the environment.

You will be using an environmental journal throughout your exploration of the environment. This journal could be a spiral notebook, a three-ring notebook, a notepad or a journal you create yourself. A journal is a good place to draw or write ideas, thoughts, feelings, experiments and observations as you do each of the activities.

Your Project Helper

Your *Eco-Actions* project helper is an important part of your overall environmental learning experience. The choice of a helper is yours. This person may be your project leader or advisor, troop leader, teacher, family member, neighbor, friend or anyone who has the interest to work with you on these activities. Involve your helper as you set your goals, discuss the questions following each activity and sometimes work together on an activity. For online help visit: **www.fourh.umn.edu/exploreyourenvironment**

Planning Guide

Eco-Actions

- Select an environmental project helper
- Complete all four steps of the *Eco-Actions* Planning Guide
- Do at least seven activities each year
- Take part in at least two leadership experiences each year
- Keep an *Eco-Actions* journal throughout the project

My Name _____

My Project Helper _____

Helper's Phone Number_____ Helper's E-mail Address _____

1. My Project Goals

I plan to complete my *Eco-Actions* activity book by _____.

2. Leadership Experiences

Participate in at least two of these experiences each year. Put a check mark by the ones you plan to do.

Experience	Plan To Do	Date Completed
Give a demonstration on an environmental topic		
Teach someone something about the environment		
Encourage a friend to be a part of this project		
Attend an environmental workshop		
Give a speech on an environmental subject		
Tour a nature center		
Exhibit an environmental project		
My own activities:		

3. Project Highlights

List and record the date in your journal every time you do and learn something exciting in *Eco-Actions*. Describe what you learned. List the project highlights in this table.

Highlights	Date

4. Project Review

Once you have completed what you planned, arrange to talk with your helper about what you have learned. You will want to have your planning guide, achievement program, journal and the *Making Connections* section of this guide up-to-date.

Achievement Program

Exploring Your Environment - Eco Actions

Guidelines

- Do at least three Required Activities (Dig In) and four Optional Activities (Dig in Deeper) this year and check them off.
- Have your environmental project helper date and initial this log as you complete the activities.

Dig In **Required Activities** **Optional Activities (Dig in Deeper)**

Activity Name	Date Completed	Helper's Initials	Page/No.		Date Completed	Helper's Initials
Biome Basics						
Around the World with Pizza						
What About Water Quality?						
It All Depends						
Population Pressures						
Breaking News with Biotechnology						
Exploring Energy Flow						
Preventing Pollution						
A Changing Climate?						
Changes Over Time						
Catching Our Soil Before It Runs Off						
Transportation Choices						
Developing a Sense of Place						
Insects, A Creature's Features						
Aliens in your Neighborhood						
Investigating Biodiversity						
Knowing the Night						
Working Through Wetlands						

Exploring Your Environment

Eco-Actions

Achievement Program Certificate

I certify that _____

has successfully completed the requirements of the *Exploring Your Environment - Eco-Actions* Achievement Program, Level 3

Project Helper's Signature _____

Date _____

Ecological Themes

The activities in this guidebook will help you discover six important concepts, or ideas, related to ecology while you explore your environment. Each section focuses on one of these ecological concepts, and the activities in each section will help show how the environmental processes and connections work.

Section 1

Four Elements of Life – Sun, Air, Water and Soil

The four elements, or things, needed for life are sunlight, air, water, and soil. The combination of these elements affects all plants, animals and other living things on earth. For example, the amount of sunlight can help determine the kinds of organisms (trees, birds, flowers) that are found in an area because almost all energy comes from the sun. Energy from the sun is captured in the leaves of green plants through the process of photosynthesis to produce food. All animals depend on this process (and the food it produces) for life. The availability of water also determines what creatures, including humans, can live in an area because life cannot survive more than a few days without water. Air and soil are equally important to sustaining any life on earth.

Section 2

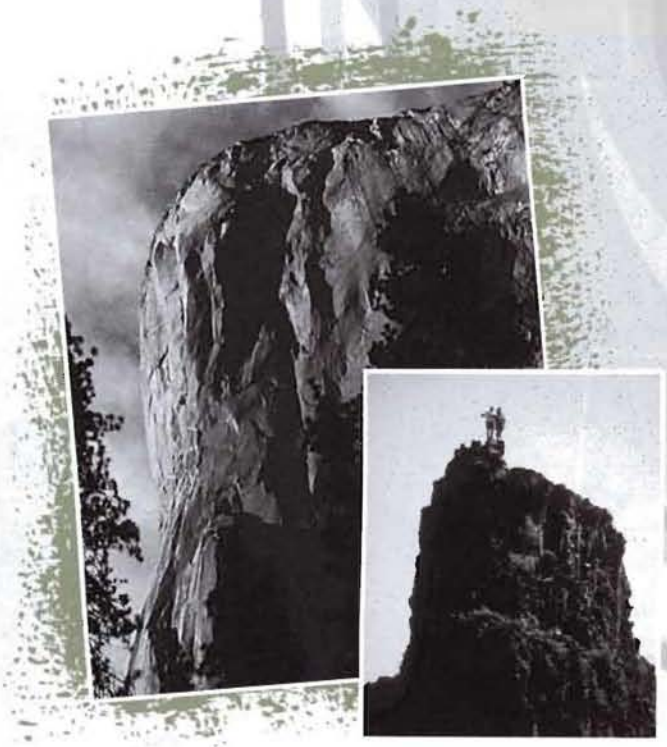
Everything Is Connected To Everything Else

Nature is made up of a network of interconnections. Think of the links in a chain. Things in the environment, like deer or grass, make up each link. In ecology, a food chain is a series of organisms with each feeding on the one before it. For example, grass might be the first link, followed by deer, which might be followed by a wolf. Then these chains are all connected together to make a food web. Just like a spider's web is interconnected, an ecological food web gives a more complete picture of the relationships in an ecosystem. It shows how plants, microorganisms, and animals depend on each other and on the sun, air, water, and soil.

Section 3

Everything Must Go Somewhere

In nature, there is no such thing as "waste." Everything is in a constant change and becoming something else. So where does it go, because there is no "away"? Materials are only moved from one place to another. They are changed from one form to another, as they act on the life processes of any organism in which they're held for a time. Often, what is released by one organism is taken up by another as food. For example, manure (a "waste" product) is a great fertilizer that plants use. In addition, as in the case of harmful pollutants, they may build up in places where they don't belong.



Section 4

There Is No Such Thing As a Free Lunch

For every action we take, there is an effect on the natural community. Despite what humans often think, we are animals, and so our lives depend on the rest of the living world, just like other animals. The materials we use to build our homes, the food that we eat, and even the fuel that we use to get from here to there are tied to the natural world. Every action has a cost. There are no "freebies" in nature because everything is interconnected. Anything taken from it by human effort must be replaced. The payment of this price can only be delayed – it cannot be avoided.

Section 5

All Plants & Animals Are Affected by the M.A.D. Law (Move, Adapt or Die)

If the environment changes, plants and animals must either move or adapt to the new conditions, or they will die. For example, in winter, some ducks and songbirds migrate (move), rabbits, frogs, and turtles adapt, and insects and weak animals may not survive. If an organism can survive, grow and reproduce under certain environmental conditions, we say that it is adapted to that environment. Adaptations are the special characteristics or features that increase an organism's chance for survival and reproduction in that particular environment. So, when the environment changes, organisms must change with it. If they don't, they have to move, or they will die.

Section 6

All Plants & Animals Have a Home

The "home" is made up of two parts: habitat and niche. The place where an individual organism (or population) usually lives is known as its habitat. A niche is the role or specific job that the organism does. For example, a rabbit's habitat may be a field, while its job, or niche, is to eat clover. A plant or animal's habitat is similar to what your home is to you. Here, the organism can get the resources it needs. Some organisms, like fish, whales and crayfish, call the water their home. Others, like earthworms and moles, live in the soil. Still others may live on land in forests, grasslands or deserts.

Section 1

Four elements of life - sun, air, water and soil

Activity 1

Learning about the biomes of the world

Life Skill:
Reasoning – Using logic to draw conclusions

Earth Stewardship Skill:
Recognizing the biomes of the world and their features

Science Process Skill:
Organizing and classifying data

Success Indicator:
You will be able to:

1. Describe the six major biomes of the world
2. Explain what makes biomes different from each other
3. Determine some of the features of the biome where you live

National Science Standard:
The interrelationships and interdependencies of organisms may generate ecosystems that are stable for hundreds or thousands of years.

Materials:

- ☐ topographic and other maps
- ☐ pencil
- ☐ almanac
- ☐ world map or globe
- ☐ topographic
- ☐ climate
- ☐ annual temperature
- ☐ annual precipitation
- ☐ soil and vegetation maps

Biome Basics

Did you ever wonder what makes one area a desert and another a tropical rainforest? It all has to do with **climate**, especially **precipitation** and **temperature**, as they affect the four elements of life.

The earth is divided up into broad regions called **biomes**. Biomes are characterized and described by their dominant vegetation. There are six major biomes around the world: **desert, grassland/savanna, temperate deciduous forest, tropical rainforest, taiga/northern coniferous forest, tundra.**

Biomes are the result of differences in the four elements of life: sun, soil, water and air. These elements are largely determined by **latitude** (the distance from the equator) and **altitude** (the distance, or **elevation**, above sea level), which largely determine the climate of an area. Climate is the average weather for a given region over time.

The two most important climate features are precipitation and temperature. As you move further away from the equator, temperatures usually decrease and as you move up a mountain, the same is true. These precipitation and temperature differences ultimately create differences in vegetation, the defining feature of biomes.

Look at a map of the world. Which biome do you live in? Are you on biome borders?

Record the following information in your journal:

- Record the latitude and elevation of your home.
- Describe the four elements of life where you live:

  Sun: How many hours of sunlight do you receive in July? in December?

  Soil: What are the dominant soil types? Describe these soils.

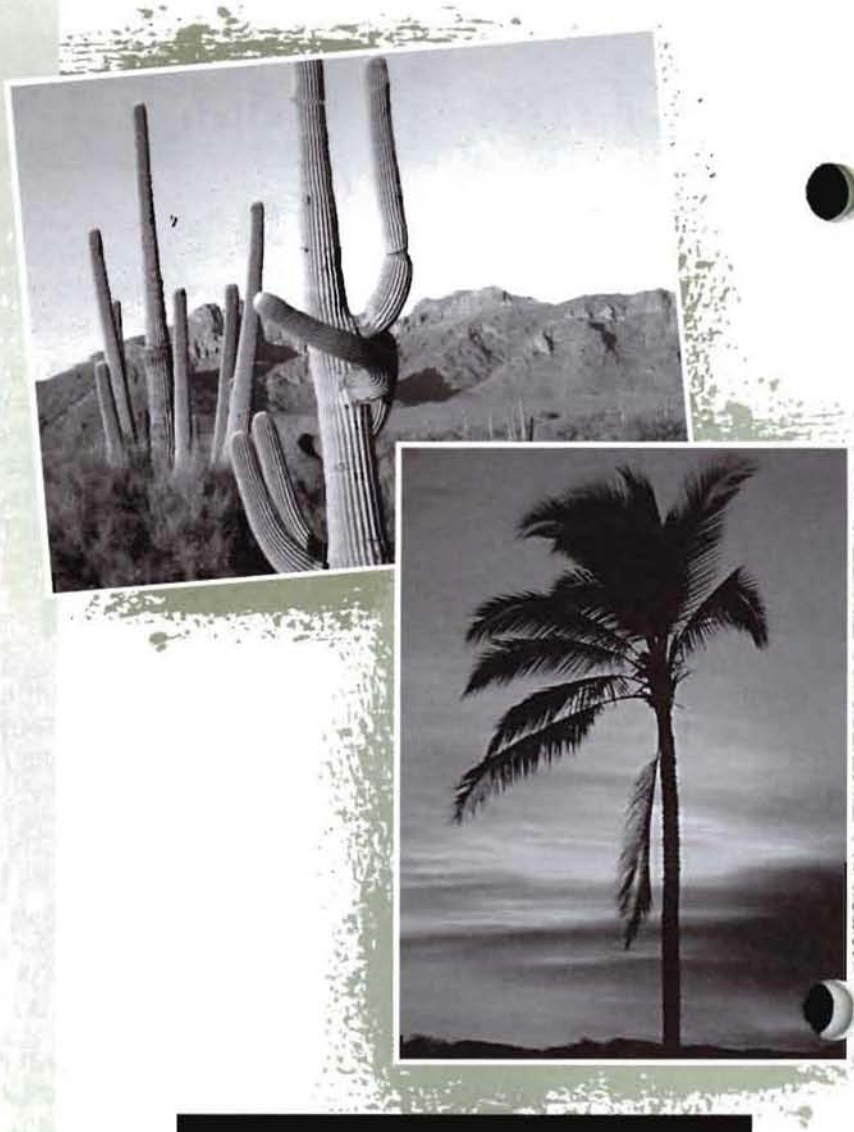
  Water: What is the annual precipitation? How is most of this precipitation received (rain, snow, sleet)?

  Air: What is the average temperature? Extreme temperatures (highs and lows)?

- Describe the climate and seasons where you live.
- Describe the dominant vegetation where you live.
- Describe the types of animals suited for life in the biome where you live. Why are they suited to live in this biome?

Put together a presentation on what you learned about your biome and share it with your helper or your group.

Biomes of the World



Desert

Deserts are areas where evaporation exceeds precipitation and the average amount of precipitation is less than 10 inches per year. Deserts are found throughout the world. Lots of plants and animals are adapted to live in the desert. Some include cacti, acacia, wildflowers, kangaroo rats, Gila monsters and camels.

Grassland and Savanna

Grasslands are found in both temperate and tropical regions. Here, the average annual precipitation is great enough to allow grass to grow, yet so erratic that periodic drought and fire prevent large stands of trees from growing. The tropical grasslands are called savannas. They look similar and are home to large grazers that eat grass, the dominant vegetation.

Temperate Deciduous Forest

The dominant vegetation is made up of broadleaf deciduous trees, like oak and maple. Animals like whitetail deer, rabbits, black bear, squirrels and owls are found in the temperate forest. The weather is very different in this biome from winter to summer.

Tropical Rainforest

This biome is well known for its species diversity, in terms of both plant and animal life. Almost all of the nutrients are tied up in the vegetation, not in the soil. Because rainforests are found near the equator, they have a warm climate, but they have wet and dry seasons too.

Taiga or Northern Coniferous Forest

Conifers are the dominant kind of plant is this biome. There are often long, cold and snowy winters and short, cool summers. A variety of animals, including moose, lynx, wolverines and ravens live here.

Tundra

The tundra is virtually treeless because of permafrost (this means the soil is nearly permanently frozen). Herbaceous plants, like grasses and sedges and moss and lichens grow here. Musk ox, migrating birds and lots of rodents call this place home. The tundra is one of the largest biomes, and also one of the most fragile.

Safety First

It's a good idea to learn about the area that you are going to explore. Learn how to use a compass. Always let someone know when you go out exploring and when you think you'll be back. Also, it is best not to go into strange areas unless you are with a person who knows the area.

Making Connections

Web Connections

For more information on biomes visit www.n4hccs.org and link to:

- National Climatic Data Center

Talk It Over

- Describe the biome that you live in.
- What makes the biome you live in distinct from other biomes?

Let's Reflect

- What influences the climate of the biome you live in (mountains, altitude, slope, prevailing winds, ocean currents, temperature extremes, latitude)?
- How is your lifestyle affected by the biome in which you live? Describe how your lifestyle would change if you lived in a different biome.

So What?

- Why is it important to learn about biomes?
- How can people affect the characteristics of a biome?

Issues to Discuss

- Climate determines the boundaries of biomes. Look at the biome map. Although the biome boundaries look sharp, they are really more gradual and less distinct. Now look at the boundary lines of different countries on a world map or globe. Do biomes cross these lines? How do you think biomes connect people in other countries?
- An environmental education specialist writes lesson plans and teaches others about the environment. How might a unit on biomes of the world teach students about the world we live in?

Words to Explore

Altitude
Biome
Climate
Deciduous forest
Desert
Elevation
Grassland
Latitude
Precipitation
Savanna
Taiga or northern coniferous forest
Temperature
Tropical rainforest
Tundra

Dig In Deeper

1. Think about the major kinds of plants and animals that are found in the biome where you live. Try sketching and describing them.

2. Make a poster promoting the uniqueness of the biome where you live.

3. Learn more about the adaptations that plants and animals have to live in the different biomes.

4. Research why people immigrated to similar types of climates when they moved to the US. Did it have to do with lifestyle adaptations to biomes?

5. Research the differences in the various aquatic biomes. For example, these biomes include running or standing freshwater, marshes and estuaries, intertidal zones, subtidal, oceanic, etc.

Around the World with Pizza

Activity 2

Understand how the four elements of life affect human lifestyles

Life Skill:
Acquiring/Evaluating Information – Obtaining and interpreting information

Earth Stewardship Skill:
Recognizing how human lifestyles are affected by the availability of sun, soil, water and air

Science Process Skill:
Questioning and looking for evidence

Success Indicator:
You will be able to:

1. Discover how the four elements of life vary in three different cities around the world
2. Analyze how this affects people's lifestyles
3. Describe what pizza, using a city's native foods, would look like in the different cities.

National Science Standard:
Human beings live within the world's ecosystems.

Materials:
- ☐ world map or globe
- ☐ pencil
- ☐ reference sources
- ☐ like encyclopedias
- ☐ almanacs
- ☐ recent newspaper/magazine articles

What do the four elements of life have to do with pizza? Well... lots. If there weren't the right amount and conditions of sun, soil, water and air, then we would never be able to grow the ingredients to make pizza in the first place.

Dig In

Think about different places around the globe. How do the amounts and conditions of sun, soil, water and air vary? How do you think that these differences affect the **lifestyles** of the people who live there? Let's check it out.

Look at a world map or a globe. Choose three different major cities in three different countries. Next, find out about the four elements of life in each city.

	City #1	City #2	City #3
How much daylight does the city receive?			
What is the soil like?			
Is the soil fertile?			
What type of freshwater resources does the city have?			
Is the water drinkable?			
Are there lakes, rivers, oceans, or groundwater near the city?			
What is the quality of the air like? (**Hint:** *Read recent articles about the city. Do they mention air problems?*)			

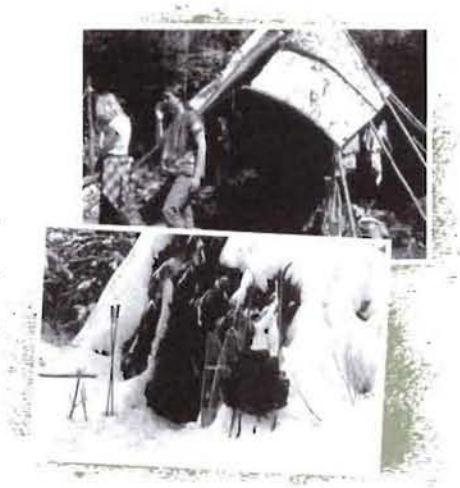
Now that you are familiar with the four elements of life in each city, let's see how this affects the lifestyles of the people that live there.

	City #1	City #2	City #3
Draw or describe common homes of the people.			
Draw or describe common foods that people eat.			
Draw or describe the major forms of transportation.			
Draw or describe common clothing worn by people.			

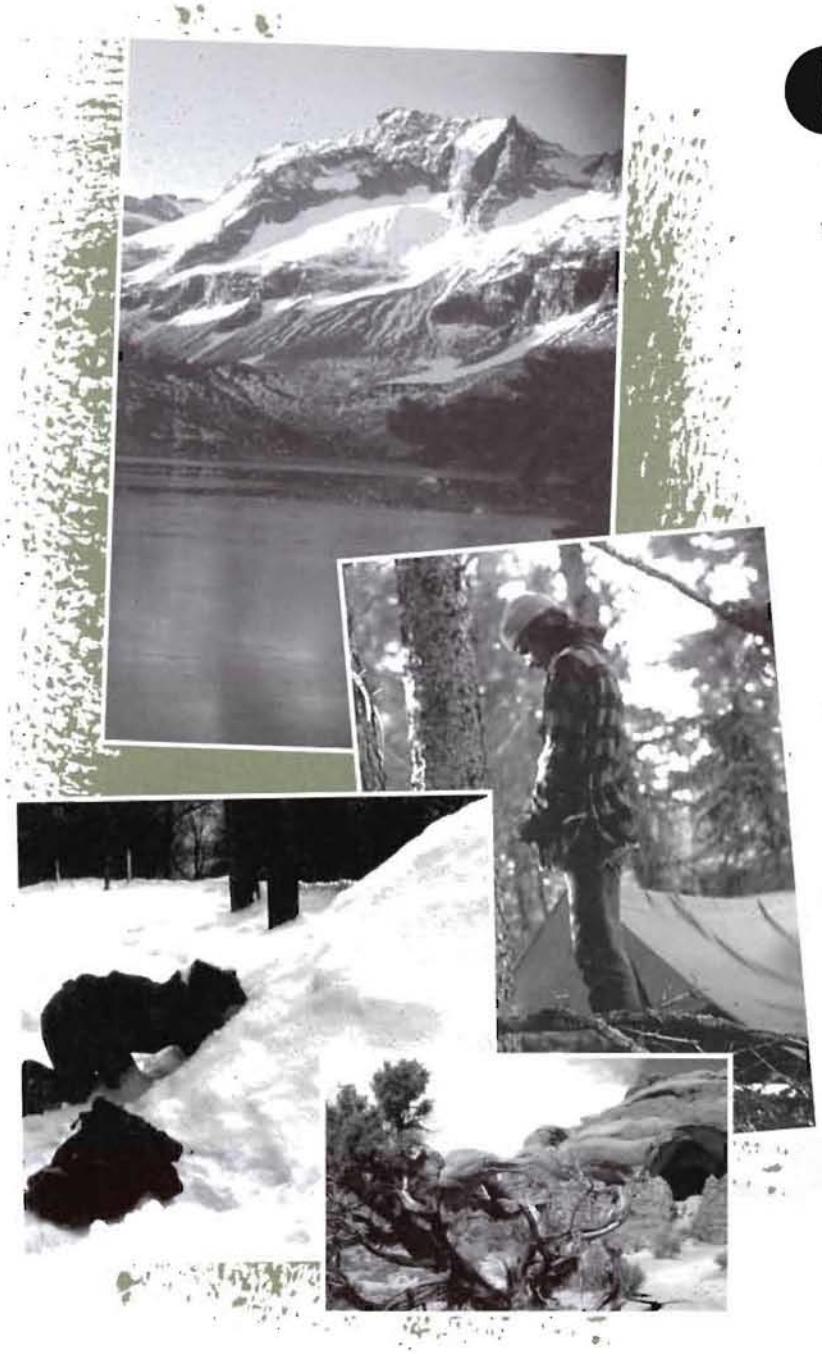
Now let's get back to that pizza. If the cities only used the resources that were available in the area surrounding their city, what would their pizzas look like? Think about what naturally grows near each city. How would pizza be different around the world in these different cities? _____

_____

_____



Make a display of the three cities you chose along with their four elements of life. Include natural resources, homes, clothing, etc. Use descriptions and drawings.



Making Connections

Talk It Over

- What did you see as major differences in the four elements of life between these cities?
- In what type of biome was each city located? How would the features of these biomes affect the availability of the four elements of life in these cities?

Let's Reflect

- How are these cities and their people alike? How are they different?
- How does climate affect the lifestyles of the people living in these different cities? How does climate affect your lifestyle in the area where you live?

So What?

- How can the four elements of life affect the lifestyles of people?
- How can the four elements of life affect plant and animal life?

Issues to Discuss

- International food companies spend time and money in farms, manufacturing plants and markets of other countries. Why would the company's employees need to know about the country's local resources and climate to run a successful business?
- What else, beside the four elements of life, affects the lifestyles of people around the world? (Think about people's access to technology, education, health, industry, development and money.)

Web Connections

For more information on human culture and biomes visit www.n4hccs.org and link to:

- Southampton University's Environmental Database for Schools—main areas: Environment, Engineering

Words to Explore

Lifestyle

Dig In Deeper

1. If you could live in any region of the world, where would it be? Why would you want to live there? What if you could visit any region of the world? Where would that be and why? Share your ideas with your helper.

2. Pick a spot anywhere on the world map or globe. What biome is it in? Draw and describe the type of clothing, food, shelter, etc. you'd have there and explain why. Research to see if you guessed right.

Activity 3

Exploring water quality

Life Skill:
Solving Problems – Identifying the problem and analyzing possible reasons

Earth Stewardship Skill:
Recognizing the need for strict water quality standards

Science Process Skill:
Organizing, gathering and analyzing data

Success Indicator:
You will be able to:

1. State some water quality parameters
2. Make and use equipment for assessing water quality
3. Assess various physical characteristics and biological components of a water body

National Science Standard:
Natural ecosystems provide an array of basic processes that affect humans including the control of the hydrologic cycle. Humans are changing many of these basic processes, and the changes may be detrimental to humans.

Materials:

- ☐ boots or old sneakers
- ☐ life jacket
- ☐ pencil
- ☐ thermometer
- ☐ string
- ☐ stopwatch
- ☐ measuring tape
- ☐ yardstick
- ☐ something that floats like a tennis ball
- ☐ Secchi disk
- ☐ dip net
- ☐ hand lens
- ☐ tweezers or forceps
- ☐ white plastic ice cube trays
- ☐ plastic coffee can lids

What About Water Quality?

If you look at a map of the world (or the globe) you can't help but notice all of the water. It really is everywhere! The surface of planet is over 70 percent water. However, of this total amount, not that much is usable. About 97 percent of the earth's water is saltwater in the oceans and about 2 percent is freshwater in glaciers and icecaps. Less than 1 percent is freshwater that is readily available for human use. These numbers tell us about the quantity of water, but what about its quality?

Most of the water that has been on the planet since the beginning is still here now and it will be the same water that is here long after we are gone. Today's children's children will have the same water. Water is a non-renewable resource. That means that pretty much what's here is what's here—that's about all we get. Because water is one of the four elements of life, we want to be able to assess its quality.

Before you begin your **water quality** investigation, check out under *Water Quality Testing Equipment* (p.14) on how to make observations and use sampling equipment.

Locate a water body of interest to you. Be sure that there is easy access to the site and that there is a level spot for you to put and use your equipment. It's best if the water is shallow—that will make it easier (and safer) to get out into the water. Just throw on some boots or old sneakers and a life jacket for safety. As you explore the water quality parameters below, fill in the Water Quality Worksheet to help summarize your data.

Water Quality Worksheet

Site Location: _____

Name of Water Body: _____

County: _____

Nearest Town: _____

Date: _____

Time: _____

Weather:

Today: _____

Yesterday: _____

Physical:

Temperature: _____

Depth: _____

Current Speed: _____

Turbidity/Clarity: _____

Substrate Composition: _____

Shoreline Conditions
(Eroding? Lots of cover? Pollution present?): _____

_____

_____

What is the land surrounding the water body used for? (forest, cropland, fields, houses, city, yards, parks, industry, feedlot): _____

Other Observations (smell, overall color, etc.):

_____

_____

Overall Physical Appearance: _____

_____

_____

Biological:

Plants: _____

_____

Animals (including fish and insects): _____

_____

How would you rate the overall health of this water body? _____

Water Quality Testing Equipment

Secchi Disk: *Paint a lid from a large can (at least 6-8 inches) white. Paint a large black "X" on top. Drill or punch a small hole in the middle of the "X" and attach a string by using an eye bolt and nut. Mark off one-foot increments on the string with a permanent marker.*

Dip Net: *Use an old metal coat hanger and form the hook into a straight line. Form the rest of the hanger into a D shape so that it sits more flush with the bottom of the water body. Sew some mesh or old nylons onto the loop so that you have a pocket that is about 1 foot deep. The straight end of the hanger should be fastened to an old broom or mop handle or even to a sturdy stick. Use your dip net to collect insects from the water body, gathering along the water edges and on the water's surface.*

Magnifier: *10x or 20x power work well for close-up viewing.*

Safety First

Remember that when you are handling live specimens, be careful with them and return them to where you found them as soon as possible. Also, as you explore the water body, be sure not to damage any of the surroundings or living things.

Words to Explore

Benthic macroinvertebrates
Biological analysis
Chemical analysis
Indicator species
Non-point source pollution
Physical analysis
Point source pollution
Speed of current
Substrate composition
Turbidity (clarity)
Water quality
Water quality parameters

Web Connections

For more information on water quality visit www.n4hccs.org and link to:

- Environmental Protection Agency (EPA)

The World's Water

Water is one of the four elements necessary for life. All living things depend on water and it even makes up a large part of many organisms. Take a second and think about how much we rely on water. We use water for drinking, bathing, cooking, washing, recreation (swimming, boating, fishing), travel and transportation, energy and irrigation of crops. We need water to fight fires and factories need water for manufacturing and cooling processes. We depend on a clean and constant supply of water.

Water quality differs from place to place so there are many ways to assess this quality. Let's look at some **water quality parameters**.

Chemical Analysis

When examining a water body, chemical analysis can offer very important clues as to the quality of the water. However, these kinds of analyses require special equipment and instruction that are beyond the scope of this activity. Chemical factors include things such as pH, alkalinity, dissolved oxygen and total dissolved solids.

Physical Analysis

To determine water quality it is helpful to look at the physical features of a water body, or how it appears. These features include:

- **Water Temperature**

  Water temperature can influence what organisms can and can't live somewhere, the activity level of those organisms and the amount of oxygen the water can hold. The temperature of water varies depending on the position and depth within the water body.

  To assess: *Use a thermometer to measure the temperature of the water at different locations and at different depths. Attach the thermometer to a string, leaving it in the water for about three minutes before you read it.*

- **Water Depth**

  The depth of the water will influence what can live in the water due to the amount of light that reaches plants living in the water.

  To assess: *Use a yardstick to measure water depth in shallow water. In deeper water, use a piece of rope with a weight attached to one end. Measure the height the watermark reached.*

- **Speed of the Current**

  In a stream or river you can measure the speed of the water, or the rate at which the water moves (current). Moving water carries materials, food and organisms with it, and it shapes the bottom of the water body.

  To assess: *Measure out a set distance on the shoreline. Drop an object that floats into the water above the line and use a stopwatch to time how long it takes to travel the set distance. Try using a piece of wood, an orange or a tennis ball.*

  Use the following equation to determine speed and do repeated trials to take an average:

  Distance/Time = Speed *(feet/second or meters/seconds.)*

- **Turbidity/Clarity**

  The amount of silt (soil particles), nutrients and algae in the water affects the water's clarity (turbidity). If the water is very turbid, sunlight is blocked from reaching down into the water. Plants cannot then photosynthesize, insects have a hard time seeing to find food and fish have trouble breathing because the particles clog their gills.

  To assess: *Use a Secchi Disk to measure the penetration of light in lakes and a Secchi Tube for streams and rivers. (Secchi Tube directions see: www.fourh.umn.edu/exploreyourenvironment)*

- **Substrate Composition**

  The substrate includes everything on the bottom or sides of water bodies or projecting out into the water. This is the habitat for all of the living things within the water.

  To assess: *Look around to see what makes up the bottom of the water body. Is it mainly sand, or is it big rocks? Is there submerged wood or leaves?*

Continued on next page.

Biological Analysis

The various forms of life found in or around the water body also indicate the quality of the water.

- **Plants**
  Observe what plants are around the water body and on the water's edge. Use the waterscope to look at the plants in and under the water. Are all of the plants of the same type, or is there a variety in the kinds of plants present? Do they look healthy?

- **Animal**
  Mammals and birds that visit the water body and those that live on the shore, along with the fish and insects that live in the water, are good indicators of the quality of the water. You can also use a waterscope to get a better look at the fish and a dip net to look at aquatic insects.

Use the dip net to scoop along the bottom of the water body to find **benthic macroinvertebrates**, which scientists use to help determine water quality. These creatures are **indicator species** because they help indicate the quality of the water. Benthic macroinvertebrates are organisms that lack an internal skeleton, are large enough to be seen with the naked eye, and are found on the bottom of water bodies. Use the tweezers or forceps to sort out the macroinvertebrates. Are there just a few kinds of insects, or is there a large diversity?

Water Pollution

The amount of usable water can even be reduced through pollution and contamination. There are two main types of water pollution: **point source pollution** and **non-point source pollution**. Point source pollution enters the water from a specific single point. This could be an outflow pipe, an oil spill or a chemical factory leak. Non-point source pollution comes from many sources. It is a diffused type of water pollution that can't be traced to just one single source. Pesticides or manure runoff from agricultural fields, fertilizers from lawns and erosion could all be considered as non-point source pollution.

Making Connections

Talk It Over

- What do you think is the overall quality of the water you investigated? Explain your reasons.
- What was the easiest part of assessing water quality? What was the hardest part?

Let's Reflect

- How do the organisms you observed get the four elements of life?
- What outside factors affect water quality?

So What?

- What are some of the ways that humans can affect water quality?
- What are some ways that you can help prevent water pollution?

Issues to Discuss

- What would be the advantages of using organisms to measure water quality? What would be the disadvantages?
- A biochemist works to protect water quality by studying and analyzing chemical pollutants in the water. Explain the importance of a biochemist's work to human well being.

Dig In Deeper

1. Try sketching some of the plants, fish, animals and benthic macroinvertebrates that you see living in the waters you test.

2. There has been a lot of legislation focused on water. Find out what the following acts did to protect water quality: Federal Water Pollution Control Act of 1972, Clean Water Act of 1977, Water Quality Act of 1987, Safe Drinking Water Act.

3. Visit your community water treatment and wastewater treatment plants. What is the major source of water for the community? What is the process used to treat the water? When is the water released?

4. Photograph local water bodies during different seasons. Make a photographic picture story showing how people and other animals use the area.

5. A water quality standard is the recommended or enforced maximum contaminant levels of chemicals or materials in water. Find out what the water quality standards are in your area.

6. Why do you think it's important to record weather conditions when doing a experiment or investigation outdoors? Try exploring the same water body in different weather conditions. Were your results the same?

Section 2

Everything is connected to everything else

Activity 4

Exploring interactions in an ecosystem

Life Skill:
Acquiring/Evaluating Information – Integrating multiple items of data

Earth Stewardship Skill:
Recognizing the variety of interactions in an ecosystem

Science Process Skill:
Observing and classifying information

Success Indicator:
You will be able to:

1. Make observations of the interactions between plants, animals and the environment
2. Define each type of interaction listed in Table 1 and recognize examples of each in nature

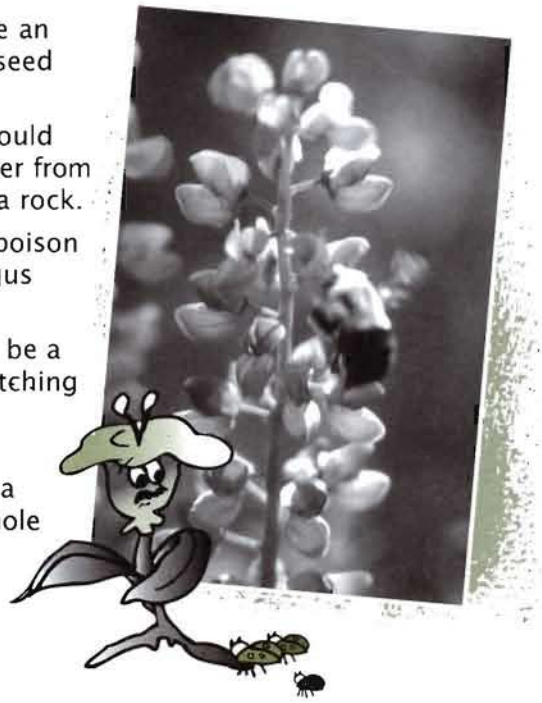
National Science Standard:
Organisms both cooperate and compete in ecosystems

Materials:
- ☐ pencil
- ☐ binoculars (optional)
- ☐ hand lens (optional)

It All Depends

Have you ever noticed how things in nature are all interrelated? There are many kinds of interconnections. Interactions may be between:

- **Plant–Animal** – This could be an insect eating a tree leaf, or a seed getting stuck in a bear's fur.
- **Plant–Environment** – This could be a flower's roots sucking water from the soil, or moss growing on a rock.
- **Plant–Plant** – This could be poison ivy growing up a tree, or fungus growing on a leaf.
- **Animal–Animal** – This could be a bear eating grubs, or a bat catching insects.
- **Animal–Environment** – This could be a duck swimming in a pond, or a gopher digging a hole in the ground.



Dig In

Let's take a look at the interconnections between individuals found in nature. Table 1 lists all of these interactions along with their impacts on the organisms involved.

Table 1: Common Classification of Interactions within Communities.

+ indicates a positive effect, – indicates a negative effect and 0 indicates a neutral effect, neither positive nor negative.

Type of Interaction	Effect on Organism #1	Effect on Organism #2
Mutualism	+	+
Commensalism	+	0
Amensalism	–	0
Predator (Organism #1) Prey (Organism #2)	+	–
Herbivory	+	–
Parasitism	+	–
Competition	– or 0	–

Select some sites for your investigation of interactions. This could be a park near your school, a vacant lot, a field, a wood lot or wherever else you choose. Spend time sitting quietly and observing the interactions and activity around you. Look close to the ground and high in the sky. Check under stones or rotting logs. What do you see going on? What things are connected?

Living Together

Scientists name the kinds of interactions they observe in nature using the following terms:

Mutualism
This in an interaction where both organisms or partners benefit. An example is **mycorrhizae** fungi that live on plant roots. The plant feeds the fungus, but the fungus also provides minerals to the plant roots.

Commensalism
This is an interaction where one partner benefits while the other is little affected. An example is herds of grazing animals that stir up a lot of insects as they graze, so egrets (a type of bird) stay near the herds to eat these insects.

Amensalism
In this interaction one partner is hurt and the other does not benefit. Examples are animal herds trampling down plants or tree branches falling from the treetops and hurting plants in the lower layers.

Predation (Predator-Prey)
In this interaction, one living organism, the predator, kills and eats another living organism, the prey. A spider catching and eating an insect in its web and a cheetah hunting a gazelle are two examples.

Herbivory
In this interaction all or part of a living plant is eaten. Examples include deer eating white pine, or a caterpillar chewing a leaf.

Parasitism
Two species live together, but one (the parasite) gets its nourishment at the expense of the other (the host). The host may be killed. Examples are plant galls, where an insect larvae develops in the plant tissue, or a fluke living in the gut of an animal.

Competition
Competition is the use or defense of a limited resource by one individual that reduces the availability of that resource to other individuals. It is necessary to identify which resources are limiting or being reduced to identify competition. When two organisms interact to get the same resource and both organisms are harmed, competition is involved. Two tree seedlings next to each other on the forest floor, or birds nesting next to each other on the side of a building are both examples of competition.

In nature, because everything is connected to everything else, interactions are almost always more complex than one on one. For example, coyotes are top predators in some ecosystems. Coyotes eat rabbits and mice. What type of interaction is this? Mice eat grass and rabbits eat grass. What type of interactions are these? By eating mice, coyotes may provide more food for rabbits. What type of interaction is this? So, what is the overall interaction between coyotes and rabbits? Do any of your examples help show this complexity as well?

Make a list of interactions you observe. List each organism in the following chart or in your journal. When two organisms interact, each can be affected in one of three ways:

- They might be positively affected (like a bird eating an insect). If this is the case, put a + under that organism;
- They might be negatively affected (like the insect being eaten by the bird). If this is the case, put a – under that organism; or
- They might not be affected at all (like a tree on which the insect was resting). If this is the case, put a 0 under that organism.

Then use the chart below to identify the types of interactions between organisms.

Organism #1	Organism #2	Effect on #1	Effect on #2	Interaction

Amensalism
Commensalism
Competition
Herbivory
Interspecific
Intraspecific
Mutualism
Mycorrhizae
Parasitism
Predation

Making Connections

Talk It Over

- What kinds of interactions did you observe?
- What was the most difficult part of discovering natural interactions? What was the easiest?

Let's Reflect

- Did you notice one kind of interaction more than others? If so, why?
- Why do you think that some interactions were not evident in your area?

So What?

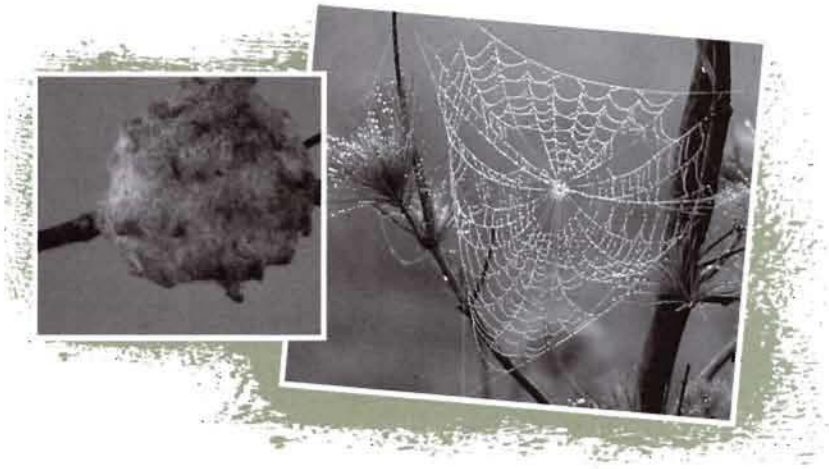
- Why could it be important to know about these interactions and connections between organisms?
- Humans are also connected to the environment. What are some human interactions with plants, animals and the environment? Would they be positive, negative or neutral?

Issues to Discuss

- Wildlife managers care for, maintain and improve natural resources in forests and wildlife reserves. Why would they need to understand the interactions between organisms?
- Think about your typical day. How are you affected by interactions with other people, animals and plants in your environment?

Safety First

Practice safety and act responsibly when you are exploring outdoors. Most accidents can be prevented. Avoid dangerous situations, such as horseplay. Discuss safety with adults, and talk about emergency procedures. Learn how to use a first aid kit.



Web Connections

For more information on relationships found in nature visit **www.n4hccs.org** and link to:

- The Wilderness Society
- National Wildlife Foundation

Dig In Deeper

1. Drawings, sketches and descriptive notes may help you remember more about your observations. As you notice interactions in nature, try to draw or write about them to help you remember the details.

2. Interactions between individuals of the same species are termed **intraspecific** (intra=within). On the other hand, interactions between individuals of different species are termed **interspecific** (inter=between). What interactions did you observe that were intraspecific? Which were interspecific?

Population Pressures

Activity 5

Exploring the effects of human population growth on the environment

Life Skill:
Solving Problems – Identifying the problem and analyzing possible causes

Earth Stewardship Skill:
Understanding the impact of human population growth on the environment

Science Process Skill:
Organizing and analyzing data

Success Indicator:
You will be able to:

1. Think about the impacts of the human population on the environment
2. Use a clustering technique to establish connections between human population and other areas and aspects of life

National Science Standard:
Populations grow or decline through the combined effects of births and deaths, and through emigration and immigration.

Materials:
- ☐ pencil
- ☐ markers
- ☐ old magazine pictures
- ☐ photographs
- ☐ drawings
- ☐ scissors
- ☐ glue

Over six billion people now inhabit the earth. This is about twice as many people as there were in 1960. Global population is increasing, but what are its effects?

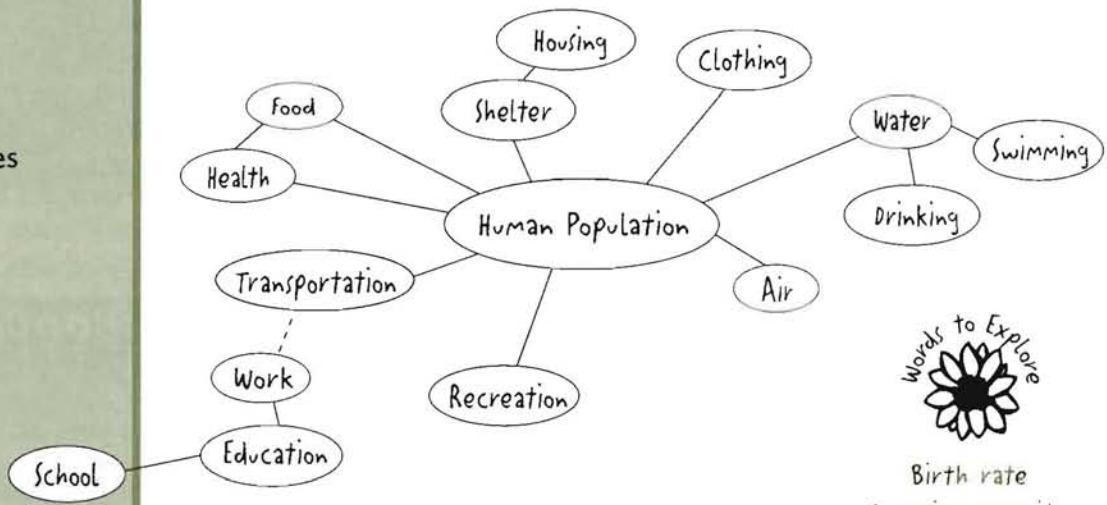
Exponential growth occurs when something increases by a fixed percentage every year. This is what the human **population** is doing. In years past, **birth rates** and **death rates** were about equal, but advances in technology, medicine, sanitation, nutrition and agriculture have lowered death rates and increased birth rates. This has caused a boom in human population.

Dig In

Think about the multiple connections between the environment and the human population.

Journal

Make a mind map of these human population connections in your journal. You can start by adding on to the example below. Put the words 'human population' in the middle and then list words, phrases, interactions, thoughts, feelings and ideas off this as they come to you. This is a clustering technique that is used to make connections between one word and the next. Think about all of the interactions that the human population could have on the environment. Make groupings of your connections.



From your clustering, make a collage of your human population connections. Use whatever materials you choose.

Words to Explore

Birth rate
Carrying capacity
Death rate
Exponential growth
Population
Population density
Zero population growth (ZPG)

People, People Everywhere

Many people think that population is the key environmental issue because it affects so much. It does seem that the human population is connected to everything else. Human population ties into issues of economics, poverty, education, health care, nutrition and so much more.

As human population grows, there are more demands on our natural resources. More energy is needed, as is more land for agriculture, homes, factories, businesses and recreation. There are struggles as to what should be done with the land, producing enough food to feed this growing population, the availability of resources and energy and the production of more waste and pollution. More agriculture and land development could mean more erosion and fewer habitats for wild plants and animals.

Some people think that we are reaching the **carrying capacity** of the earth. This is the number of organisms (in this case humans) that the earth can support because of its limited resources. These people encourage countries to try to reach **zero population growth (ZPG)**. This happens when a population stops growing because the death rate equals the birth rate and the net migration is zero, that is, the number of people entering the country and leaving it are equal.

Others think differently. Some scientists believe that we could survive on earth with 25 billion people. But then still others ask, "At what cost or quality of life?" The size of the human population is important, but **population density** is also important. Certain areas of the world have more people than others in a smaller area of land affecting quality of life.

Web Connections

For more information on population growth visit www.n4hccs.org and link to:

- World POPClock
- The United Nations Population Fund
- Zero Population Growth
- Population Reference Bureau

Making Connections

Talk It Over

- Share your human population cluster with someone. What else do they have to add? How would their cluster look different?
- What were the most crucial problems you predicted from a growing human population? Why did you choose these?

Let's Reflect

- What do you think are the three most important connections in your cluster? Why did you choose these?
- What would be the positive effects of Zero Population Growth? What would be the negative effects?

So What?

- As the global human population increases, what could be the impacts on shared common resources like the air and the oceans? Do you think that these would be more affected or less affected? Why?
- In the United States, farmland continues to be used for building housing developments. How do you think this will affect human populations in the future?

Issues to Discuss

- Do you think the human population is a problem? Why or why not? If so, what do you think should be done to deal with this problem?
- A demographer studies the human population. Why would a demographer need to have a background in statistics to study populations?

Fair Ideas

Display your collage. Make a brochure to go along with the collage to better explain your thoughts and the meaning behind your collage selections.

Dig In Deeper

1. Draw and describe different populations. This could be a population of gazelle on the African savanna, a population of bark beetles on a tree or a population of Native Americans in Minnesota. In what ways are these populations similar? How are they different?

2. A census is taken every ten years in the United States. How has the population of your town or city changed since the last census? Why do you think it has changed?

Activity 6

Learning about biotechnology

Life Skill:
Reasoning – Identifying facts and principles

Earth Stewardship Skill:
Exploring the pros and cons of biotechnology

Science Process Skill:
Gathering and analyzing data

Success Indicator:
You will be able to:

1. Explain what biotechnology is and describe some of the work being done in this area
2. Research some of the benefits and some of the concerns or controversies with biotechnology

National Science Standard:
Individuals and teams have contributed and will continue to contribute to the scientific enterprise. Science is not separate from society but rather science is a part of society.

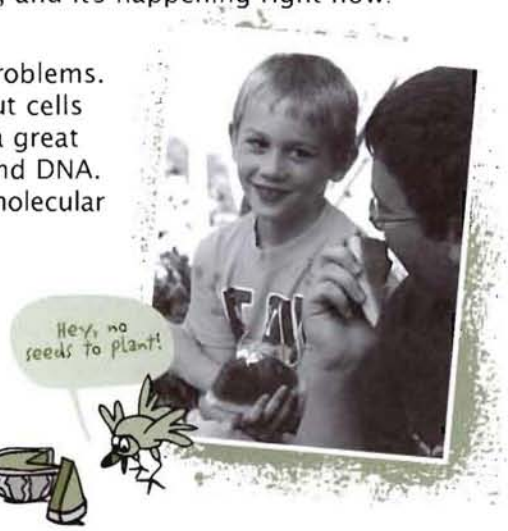
Materials:

- ☐ recent newspapers or magazines
- ☐ pencil
- ☐ access to the Internet

Breaking News with Biotechnology

Microbes eating pollution. Watermelons without seeds. Using DNA to identify criminals. Is this the stuff of fiction? No—it's the news of **biotechnology**, and it's happening right now!

"Bio" means life, and "technology" is applying science to solve practical problems. Biotechnology includes learning about cells to change what they do. It involves a great deal of information about genetics and DNA. Biotechnology uses knowledge from molecular biology, cellular biology and genetic engineering. It also is an area that values creativity. Biotechnology offers a world of possibilities where seemingly crazy thoughts and ideas can one day become reality.



Dig In

Biotechnology is fairly new, and the knowledge is expanding quite rapidly. Some of the best places to look for information on this topic are in recent newspapers, magazines and on the Internet.

- Clip or copy articles that you find relating to biotechnology.
- Check out the following websites for some biotechnology activities and information. There are a ton of experiments to try! Visit www.n4hccs.org and link to:
  - The National Biotechnology Information and click on "Educational Resources."
    There are a lot of activity ideas and information in this website, especially if you look under the heading "Links to Useful Educator Resource Sites," and then click on "Course Materials and Lesson Plans."
  - Outbreak, an interactive web game
  - The National Health Museum and click on "About Biotech"
  - Harvard University's Department of Molecular and Cellular Biology
  - Biotechnology Information Resource (BIC) from the National Agricultural Library of the United States Department of Agriculture

As you search through this new world of biotechnology, seek to answer these questions:

- What are the issues?
- What are the benefits of this new science?
- What are the concerns and controversies?

Then show what you found to others.

- What do they think?
- Do they mention the same benefits?
- What are their concerns?
- Do some people think that potential benefits outweigh any of the concerns?

State your position in response to three of the issues that you discovered. Record reasons to support your positions and opinions in your journal.

Biotechnology

Biotechnology has ties to almost every aspect of our lives. Work of its kind is being done in the fields of medicine, food and agriculture, environmental remediation, fuels and energy and forensics. Biotechnology is where cloning is happening. It is also where the selective breeding of certain livestock or crops with desired characteristics is done.

But with all of these changes has come a lot of controversy too. People are concerned about genetic privacy. There are issues concerning the impact of genetically engineered organisms on the environment, and there are even issues of animal rights. Another area of concern is the long-term effect of this manipulated food and the introduction of foreign genes into what we eat.

On the other hand, there are huge possibilities of discovering cures to illnesses. For example, animals could be engineered that have organs, like hearts and kidneys, which could be fit for transplanting to humans.

All of these possibilities raise enormous moral and emotional questions. Some think that the future won't be guided by the biology or science of it, but instead by ethical questions.

Making Connections

Talk It Over

- What did you learn about biotechnology?
- What are some ways you discovered that you are using biotechnology today? Were you surprised?

Let's Reflect

- What are some of the major benefits of biotechnology?
- What are some of the major concerns or controversies over biotechnology?

So What?

- How does biotechnology connect to your life? How does biotechnology connect to everything else in our environment?
- Describe how biotechnology does or could influence your life.

Issues to Discuss

- Some say biotechnology is "meddling with nature." Others say it is "working with nature in a new way." What do you think?
- Think about technologies that we used today that were once the "new technologies" of their time such as automobiles, the electric light bulb or the cotton gin. These new ideas were often scorned and ridiculed. Why are new ideas often subjects of controversy?

Words to Explore

Biotechnology

Fair Ideas

Make a poster about biotechnology. List its possibilities and concerns. Attach recent news articles and quotes.

Web Connections

For more information on biotechnology visit **www.n4hccs.org** and link to:

- The National Biotechnology Information Facility
- Outbreak
- The National Health Museum
- Harvard University's Department of Molecular and Cellular Biology
- National Agricultural Library of the United States Department of Agriculture

Dig In Deeper

1. Visit a college, university or company that is using biotechnology. Find out about their work. What are some of their major obstacles?

2. Biotechnicians are the people driving these new developments in biotechnology. They often have experience in molecular and/or cellular biology, especially genetic engineering, and are working in the fields of medicine and health care, agriculture, energy and environmental management. Find out more about careers in biotechnology. Put together a pamphlet on careers in biotechnology.

Section 3

Everything must go somewhere

Activity 7

Exploring the flow of energy in an ecosystem

Life Skill:
Acquiring/Evaluating information – Interpreting information and predicting outcomes

Earth Stewardship Skill:
Understanding how energy moves through trophic levels

Science Process Skill:
Questioning and looking for evidence

Success Indicator:
You will be able to:

1. Relate the laws of thermodynamics to energy flow through ecosystems
2. Describe various trophic or feeding levels
3. Explain the pyramid of energy

National Science Standard:
All energy can be considered to be either kinetic energy, which is the energy of motion, or potential energy, which depends on relative position. In all energy transfers, the overall effect is that the energy is spread out uniformly.

Materials:

- ☐ pencil
- ☐ paper
- ☐ 20 oz. soda pop bottles or other narrow-mouth bottles
- ☐ masking tape
- ☐ marker
- ☐ old newspaper
- ☐ big pitcher or empty gallon jug
- ☐ water

Exploring Energy Flow

What do batteries, lightening and a toddler have in common? They are all full of energy!

Energy comes in many forms—heat, light, electricity, sound—and is defined as the capacity to do **work**. Work is performed when an object is moved over some distance. There are two main forms of energy: potential and kinetic energy. **Potential energy** is stored energy, which is energy that is capable of performing work. **Kinetic energy** is energy in motion. It performs work at the expense of potential energy.

Dig In

Think of a particular ecosystem (grassland, temperate forest, freshwater stream, etc.). Brainstorm and make a list of all of the plants and animals you'd find in this environment.

Once you have a large list, put them into categories based on their **trophic level**. Remember that some will fall into more than one trophic level. Does there appear to be more **producers, primary consumers, secondary consumers**, or **tertiary consumers**?

Think about how the energy would flow through these different levels and how that energy would be used.

To demonstrate the flow of energy through a food chain:

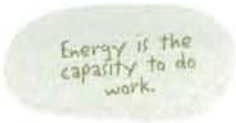
- Pick out a simple food chain from the complex, interconnected food web.
- Take narrow-mouth bottles (like soda pop bottles) and label each as a different member of the food chain with masking tape. Also, record whether the organism is a producer, primary consumer, secondary consumer or tertiary consumer.
- Arrange the bottles on a large table or on the floor into various food chains. Put old newspaper under your area.
- Take a big pitcher or empty gallon jug and fill it with water.
- Start with the producer(s) and fill the bottle up as full as you can with the water. Then, from the producer's bottle, you will try to transfer the water to the primary consumer(s). Then, transfer the water from the primary consumer(s) to the secondary consumer(s) and so on until the water has been transferred to the top of the food chain.

- The trick? You need to do this as fast as you can!

Did the amount of water change as you transferred it from bottle to bottle? Pretend the water represented bits of energy. Was some energy passed on to the top of the food chain? Was some energy lost?

Try to modify this activity so that you could record a high-energy food being introduced into the food chain, or try to introduce a toxin into the food chain.

Record in your journal your experiment, observations and some ideas on how energy could be transformed or lost at each trophic level.



The Laws of Thermodynamics

Thermodynamics is the branch of science that studies the transformation of energy from one form to another. Two laws of thermodynamics govern energy flow in ecosystems:

- **First Law of Thermodynamics**
  (Law of Conservation of Energy)
  Energy is neither created nor destroyed. Energy may change from one form to another or pass from one place to another, but there is no gain or loss in total energy.
- **Second Law of Thermodynamics**
  When energy is transferred or transformed, part of the energy assumes a form that cannot pass on any further. This law is a measure of **entropy**, the degree of disorder in a system. There is a loss in usable forms of energy to unusable forms, mainly as heat.

Let's look at a transformation that follows the First Law of Thermodynamics:

Plant leaves trap radiant energy (light) and produce food through the process of photosynthesis. Then, organisms, like caterpillars, obtain energy by eating the leaf. As the caterpillars crawl and chew, they expend mechanical energy (movement) obtained from the chemical energy of the food.

Within this same example, the Second Law is also depicted because these energy conversions are not 100% efficient—some energy is always lost as heat. Various amounts of usable energy may be lost as the original forms are converted to unusable forms of energy—the heat associated with disorder.

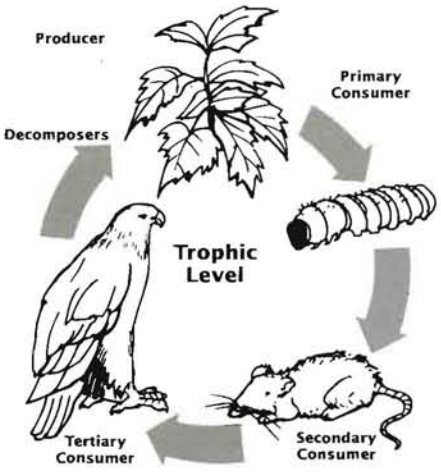
Energy Flow

As you study the flow of energy through ecosystems, it is useful to group organisms according to their source of energy, or their feeding level. Organisms that get their energy from the same source make up a trophic level.

First Level
Plants get their energy directly from the sun. The beginning of the food chain is made up of producers.

Second Level
Animals that eat the plants (herbivores) make up the next trophic level, termed primary consumers. Secondary consumers are those organisms that feed on primary consumers.

Third Level
Tertiary consumers are those organisms that feed on the secondary consumers. However, many organisms get their food from more than one trophic level below them. These organisms are called omnivores. Humans are **omnivores**.



Fourth Level
Decomposers process dead organisms from all trophic levels. They complete the cycle of matter and energy by breaking down organic matter into inorganic organic nutrients that are used by producers.

CONTENT

Pyramid of Energy

A pyramid of energy represents the trophic structure of an ecosystem. There are usually very few tertiary consumers, more secondary consumers, even more primary consumers and a majority of producers, which produces a pyramid shape. Although trophic levels are usually represented by a pyramid, this is not always the case. Some ecosystems might have fewer producers than consumers. For example, in a temperate forest, there might be fewer numbers of trees than there are of insects.

A pyramid represents an energy diagram of an ecosystem because as energy is transferred from one trophic level to another, usable energy is lost in each transfer.

As each organism uses the high-quality food energy to move, grow, breathe, reproduce and to carry out other body functions, this energy is converted into low-quality heat that cannot be used by other organisms. Additionally, sometimes food is not consumed or is not fully digested, and in this case, will be excreted as waste.

The Second Law of Thermodynamics also limits the length of food chains. Food chains usually have no more than four trophic levels because the amount of energy at the top of the trophic structure is not sufficient to support another level. This explains why top carnivores (eagles, tigers) are few in number and are usually the first to suffer when the ecosystem that supports them is disrupted.

Words to Explore

Decomposer
Energy
Entropy
First Law of Thermodynamics
Kinetic energy
Omnivore
Potential energy
Primary consumer
Producer
Pyramids of energy
Secondary consumer
Second Law of Thermodynamics
Tertiary consumer
Thermodynamics
Trophic level
Work

Making Connections

Talk it Over

- In your own words, tell a friend what the two laws of thermodynamics mean.
- How are the laws of thermodynamics at work in the ecosystem found in your own backyard or schoolyard?

Let's Reflect

- Everything must go somewhere. Where does energy go as it moves through different trophic levels?
- Describe some ways that animals and plants conserve energy?

So What?

- What happens to the food you eat? How does your body use this energy?
- What are some examples of energy loss causing pollution? How could this pollution be prevented?

Issues to Discuss

- Where would humans be included in the energy flow pyramid? How could we influence the flow of energy through ecosystems?
- What are some ways that you could use energy more efficiently in your home?

Web Connections

For more information on energy use visit www.n4hccs.org and link to:

- U.S. Department of Energy
- American Council for an Energy-Efficient Economy

Dig In Deeper

1. Watch plants and animals in nature. How do they use their energy? Do they play, travel or look for food? What about humans? What do we do with the energy we have?

2. Try charting the energy flow through a city. What components would you need to include?

3. What kind of energy is used in your home? Where does the energy come from (wood, fossil fuels, wind, etc.)?

4. What countries use the most energy? Where does this energy come from? What other energy sources are available?

Preventing Pollution

Activity 8

Looking at ways to prevent pollution

Life Skill:
Reasoning – Extracting information

Earth Stewardship Skill:
Accepting our responsibility to prevent pollution at its source

Science Process Skill:
Questioning and looking for evidence

Success Indicator:
You will be able to:

1. Explain ways in which pollution can be prevented
2. Analyze products in stores based on their effectiveness in preventing pollution

National Science Standard:
Humans modify ecosystems as a result of population growth, technology and consumption. Human destruction of habitats occurs through pollution, atmospheric changes and other factors.

Materials:
- ☐ pencil
- ☐ various items in a store

Did you know that you can prevent **pollution** before it starts? Waste is any unwanted or discarded material, and when it is released into the environment, it becomes pollution. Pollution can be generated by everyone—homes, schools, churches, clubs, businesses, industries, agriculture and vehicles. Once pollution is generated, it is usually here to stay. When we try to clean up pollution, we sometimes just end up moving it from one place to another. It can move from the air to the soil to the water.

Dig In

To find out more about preventing pollution, take a trip to a grocery store, pharmacy or all-purpose store (like KMart, Wal-Mart or Target) and look at the items on the shelf.

Journal

Look at different products and determine how they rate in terms of **preventing** pollution. Ask these questions and record your answers in your journal:

- How are the products packaged?
- Are their ingredients hazardous? If you were going to buy toothpaste, for example, which product would be the best to purchase if you were trying to prevent pollution?
- What are the short- and long-term consequences of this product or choices you are taking?
- How would or could it affect people and the natural environment?

Make a list of the pros and cons of purchasing an item and weigh your options. What kinds of pollution could arise from this product? How could this pollution be prevented?

Your trip to the store may bring up a lot more questions. Search out as much information as you can about different options. You may want to invite an expert to talk to the group about solid or **hazardous waste**, or you may decide to visit a hazardous waste collection site. Hazardous waste is waste that is toxic, corrosive, flammable, unstable or radioactive. Don't be afraid to get advice from experts.

Words to Explore

Hazardous waste
Pollution
Post-consumer content
Prevention

Fair Ideas

Choose at least three products. Create a display that shows how pollution is or could have been prevented with these products.

Stopping Pollution

In years past, we put a lot of our time, money and efforts into cleaning up pollution. But now, many resources are being focused on preventing pollution. Experts are helping people look at ways they affect the environment, and suggesting ways to reduce the pollution that's produced in the first place. Preventing pollution can save money, protect resources, prevent health problems and improve the quality of life in the long run.

How can you help prevent pollution?

Think before you act. Think about the products you use and the pollution problems associated with various products before you buy them. When shopping for various products, think about the following:

- What is it made of?
  Look for durable products, products that last a long time. Avoid disposables. Are there safer alternatives?
- Where do the ingredients come from and how are they obtained?
  Pay attention to labels and look for key words such as "Caution," "Warning," "Danger," and "Poisonous." Choose the least hazardous product.
- How is the product made? Is it made from recycled materials?
  Buy products in recyclable, returnable or refillable containers. Buy and use paper with at least 20% **post-consumer content** *(made from items that people have used and recycled).*
- How is it packaged?
  Avoid excess packaging. Buy in bulk or in economy-sized containers. Buy concentrates and returnables.
- What happens to the product after it is used?
  How will the product be disposed of? Will it be recycled? Remanufactured? Thrown in a landfill? Incinerated? Sold? How will it be absorbed back into the environment? Are there dangerous toxins in the product?
- Can it be recycled or reused?
  Recycling can conserve natural resources, save energy, protect the environment and even be profitable.

Making Connections

Talk It Over

- What kind of products did you analyze?
- What types of preventable pollution were the most common in the manufacture of the products you analyzed?

Let's Reflect

- What was involved in analyzing the product for pollution prevention?
- How could these products be manufactured differently to make them more environmentally friendly?

So What?

- What kind of product options were available if you wanted to prevent pollution?
- What lifestyle changes could you make to reduce the amount of pollution that you produce?

Issues to Discuss

- What was the most difficult part when analyzing a product for its efficiency at preventing pollution? What was the easiest?
- How could the stores help the community prevent pollution?

Web Connections

For more information on preventing pollution visit www.n4hccs.org and link to:

- United States Environmental Protection Agency's (EPA) Student Center
- Earth Watch Institute
- Environmental Working Group

Dig In Deeper

1. Keep a record of products you see or practices you notice that contribute to pollution. Also, keep a record of products you see or practices you notice that help prevent pollution.

2. Organize an inventory of pollutants often generated by people in homes, yards and garages. Present alternatives.

A Changing Climate?

Activity 9

Exploring climatic changes due to human activity

Life Skill:
Reasoning – Examining information for relevancy and accuracy

Earth Stewardship Skill:
Reflecting upon the controversies associated with environmental issues

Science Process Skill:
Gathering and analyzing data

Success Indicator:
You will be able to:

1. Become more knowledgeable about global climate change
2. Think critically about the issues and positions concerning global climate change
3. Make more informed decisions related to these issues

National Science Standard:
Humans modify ecosystems as a result of population growth, technology and consumption. Human destruction of habitats occurs through pollution, atmospheric changes and other factors.

Materials:

- ☐ recent newspapers
- ☐ magazines
- ☐ books and agency fliers and brochures
- ☐ access to the Internet, pencil
- ☐ paper

Global warming, more accurately described as global climate change, has been a hot topic over the past fifteen years. One of the major questions is: Are humans having an impact on weather and climate above and beyond the normal fluctuation? And the debates begin here.

Let's look at the major issues surrounding **global climate change**. Start collecting articles that deal with global climate change. These may be:

- Proceedings from governmental meetings or international forums
- Stories on weird or extreme weather
- Recent publications, like fliers and brochures from various agencies
- Newspapers, textbooks and other books in the library
- News or special programs discussing this issue
- Weather and climate records from the past
- Internet web sites related to global climate change

Start looking at the different views surrounding global climate change. What do the different sides say? What are their major arguments? What kind of evidence do they use to back up their opinions?

Choose at least three of your different global climate change articles or publications. Think critically about the issues and the various positions within these. Write a paragraph in your journal describing what you now think about global climate change.

Hold a debate about global climate change. One group should take the following topic: "Yes, global climate change is real and humans are causing it." The other group should take this topic: "No, global climate change is not a problem. There is just natural variation in climate." Each group should research and prepare arguments to favor their position.

Critical Thinking

Critical thinking is the ability to separate beliefs (what we think is true) and knowledge (facts supported by accurate observation and valid experimentation). Critical thinking involves:

- **Gathering all of the information you can**. You want to learn as much as you can before you make a decision about something. Look up the definitions of words you don't know.
- **Discerning how the information was discovered or obtained**. Was an experiment carried out? If so, how was it set up? Was it scientifically acceptable?
- **Finding out about the source of the information**. Who is giving the information? Do they have anything to gain by presenting this information?
- **Questioning the conclusions**. Do the facts or the results of the experiment support the conclusions? Are there any other interpretations of the information?
- **Looking at the whole picture**. Look at the whole system and look for multiple causes, effects and interactions. Look for alternative opinions. Avoid thinking that there are only "right" or "wrong" answers.

In life the answers are not always cut and dried or black and white. There is controversy and debate surrounding many environmental issues. Global climate change is one such issue. The point is that you learn to expose yourself to the varying positions and learn to think critically about each side.

Words to Explore

Critical thinking
Global climate change

Global Climate Change

There has always been a natural variability in our weather and even extreme weather like droughts and heat waves. However, many people believe that this extreme weather is becoming more common and is being caused by humans. The chief cause of global climate change is the amount of carbon dioxide we're releasing into the air, largely through the burning of fossil fuels.

This carbon dioxide doesn't just go away. It builds up in the atmosphere. Since carbon dioxide traps heat, many believe that this increase is causing an overall warming of the air around us.

What could be the effects of this increase of carbon dioxide in the atmosphere? We honestly don't know. It could cause weather extremes like tornadoes and hurricanes. It could increase precipitation in some areas, while other areas experience drought. It could increase or decrease the productivity of agriculture fields and forests.

Making Connections

Talk It Over

- Describe what is meant by global climate change to a friend.
- What do scientists think are the causes of global climate change?

Let's Reflect

- Was all of the information you read about global climate change in agreement? Why or why not?
- What are the most controversial issues related to the causes of global climate change?

So What?

- Do you think we should be concerned about climate change? Why or why not?
- Describe another time when you used critical thinking to determine your thoughts on a subject.

Issues to Discuss

- What did you learn from this research that will help you share your viewpoint, ideas or any information in the future?
- What are some of the other suggested ways to slow or prevent global climate change? Why or why aren't they being used or being done?

Web Connections

For more information on global climate change visit www.n4hccs.org and link to:

- The United States Environmental Protection Agency's global warming website for kids
- The Atmospheric Radiation Measurement (ARM) Program's Education Center
- The Beginner's Guide to the United Nation's (UN) Framework Convention on Climate Change for Kids
- Nova Online's website on Warnings from the Ice
- The National Climatic Data Center

Dig In Deeper

1. How do you think that plants and animals will deal with or adapt with global climate change in the future?

2. Some suggest that a way to respond to global climate change is to invest in cleaner, more efficient energy. Alternative energy sources like wind, solar and biomass are suggested. Find out about these other energy forms. Where are they being used? Why aren't they being used in other areas?

3. What role, if any, do you think the government should play in this issue of global climate change?

4. Has the weather in your local area changed so that people have noticed? Talk to or interview some of the older members of your community on this subject.

Section 4

There is no such thing as a free lunch

Activity 10

Discovering how people change land use over time

Life Skill:
Solving Problems – Identifying the problem and recommending an action plan

Earth Stewardship Skill:
Recognizing the impact of human behavior and land use decisions on wildlife populations

Science Process Skill:
Organizing, gathering and analyzing data

Success Indicator:
You will be able to:

1. Think about change over time and how humans can alter landscapes
2. Analyze aerial photographs for changes in habitats and land use over time
3. Make predictions as to wildlife changes as the landscape is altered

National Science Standard:
Humans modify ecosystems as a result of population growth, technology and consumption. Human destruction of habitats occurs through pollution, atmospheric changes and other factors.

Materials:
- ☐ aerial photographs of your neighborhood and surrounding area from various years
- ☐ pencil
- ☐ access to the Internet (optional)

Changes Over Time

Many of the cities in the United States are getting bigger and bigger and are sprawling outward. This phenomenon is known as **urban sprawl**. As human populations and city sizes increase, people move out further from the center. As people move outward, changes to the land take place. Areas that were once fields or forests become housing or shopping complexes. Wild, natural areas are converted to concrete parking lots or well-manicured lawns. People build new homes and then roads to these homes.

Dig In

In this activity you will explore the landscape in your neighborhood and changes that have taken place over the years. Based on what changes have taken place, you will make guesses as to how the wildlife has changed.

Obtain and then look at photographs of your neighborhood and surrounding region. You can get this information (and a great perspective) by looking at aerial photographs. These photographs are available from various years, depending on where you live. You can find these maps at:

- Your local Natural Resources Conservation Service, County Conservation District
- Terraserver web site through the 4HCCS web page. Once online, you search for maps of your town or city. When map choices come up, you can zoom in or out to look at the **landscape**.

Use what you know about the land right now and look for changes in the land through the years. How would you characterize the land now? What about in years past? What is the general habitat like?

Changing Times

For each different year you examine the landscape, try to answer the following questions:

a. How would you describe the landscape of your study site?

- ☐ Urban
- ☐ Suburban/Residential
- ☐ Rural
- ☐ Nature Reserve
- ☐ Agricultural
- ☐ Other

_____

_____

b. How would you describe the ecosystem of your study site?

- ☐ Grassland
- ☐ Forest
- ☐ Agricultural
- ☐ Open Water
- ☐ Marshland
- ☐ Mixed, describe_____

c. How would you describe the land use of your study site?

- ☐ Cropland
- ☐ Pastureland
- ☐ Wild/Left Alone
- ☐ Built up
- ☐ Other _____

_____

_____

d. How would you describe the land use of the area surrounding your study site?

- ☐ Cropland
- ☐ Pastureland
- ☐ Wild/Left Alone
- ☐ Built up
- ☐ Other _____

_____

e. What percentage of each of the following cover types is over your study site?

- ☐ Trees
- ☐ Shrubs
- ☐ Grasses
- ☐ Crops
- ☐ Open space
- ☐ Pavement (parking lots and roads)
- ☐ Buildings

f. Where would wildlife find food?

_____

g. Where would wildlife find water?

_____

h. Where would wildlife find shelter?

_____

i. Where would wildlife find space?

_____

j. What wildlife habitat requirements, if any, are lacking?

_____

_____

_____

After you have answered the above questions for the current landscape condition and in years past, look back through your answers to see how changes have taken place. Share what you have learned with your helper.

Web Connections

For more information on wildlife habitats and land use visit www.n4hccs.org and link to:

- Terraserver
- National Wildlife Federation-Backyard Wildlife Habitat.
- Wildlife Habitat Council

Make a brochure or fact sheet on urban sprawl. If there have been changes in your community over time due to this, describe what some of these changes have been.

Changing Environments

It seems that people have always changed their environment. Why do people do this? We have cleared forests for lumber, agricultural fields, homes or roads. We have drained and filled in wetlands for farms or development. We have built dams on rivers for electricity. Mining operations, overgrazing by livestock, driving off-road vehicles, walking off designated trails and pollution are human practices that have negatively affected natural habitats. People need to grow food, build houses, build roads and lots of these other things, but sometimes we make too many changes and can create problems for the environment and wildlife.

As we alter the landscape, wildlife habitats are affected. All wildlife has four habitat requirements: food, water, shelter and space. Changing any of these four elements will affect the quality of the habitat for different wildlife species. Each affected species will then need to move, adapt or die.

Making Connections

Talk It Over

- How has your neighborhood and the surrounding area changed over the years?
- What was the most dramatic change you discovered? What impact did this change have on the availability of the four elements of life?

Let's Reflect

- How has the availability of wildlife habitat requirements changed in your neighborhood?
- How have habitat changes affected the wildlife populations in your neighborhood?

So What?

- What kind of wildlife do you now see in your neighborhood? Have the kinds of wildlife in the area changed?
- Describe some ways that people can improve their neighborhoods to make them more attractive to wildlife.

Issues to Discuss

- Urban sprawl is a complex issue. Wildlife habitat may be destroyed at the expense of meeting human needs. How do you think that both needs can be satisfied?
- A wildlife manager manages certain areas of land and the inhabiting wildlife. What issues need to be addressed when deciding how to manage wildlife in urban areas?

Dig In Deeper

Words to Explore

Landscape
Urban sprawl

1. Create a wildlife area. You can do this whether you live in a city apartment building, in the suburbs or in a rural area. This could be a city garden, a porch or window box, a rooftop balcony garden, etc.

2. As people move out from the city, they bring their pets with them. Wildlife may not be accustomed to these new animals. What domestic animals might prey on wildlife? Do you think this is a problem? If so, what can be done about it?

3. Talk to people who have made wildlife improvements on their land. What changes did they make? How did they do the work? Have they noticed the presence of more wildlife since the improvements have been made?

4. As humans alter the land, we change the resources available to wildlife. Some wildlife species find it harder to locate food in a sprawling city, but other species may find new supplies of food. For example, many birds take advantage of the garbage from fast-food restaurants. How do you think wildlife react to changes in land use? What benefits are produced by the changes?

There is no such thing as a free lunch

Activity 11
Exploring soil erosion

Life Skill:
Solving Problems—Examining information and analyzing possible causes

Earth Stewardship Skill:
Recognizing the importance of soil

Science Process Skill:
Experimenting and controlling variables

Success Indicator:
You will be able to:

1. State the causes and consequences of soil erosion
2. Explain how eroding soil can damage the environment and reduce farmland productivity
3. Describe some methods used to control soil erosion
4. Experiment with erosion control techniques

National Science Standard:
Some slow and progressive changes can result in problems for individuals and societies. For example, sedimentation in lakes and harbors, and continuing erosion and wasting of soil and landscapes can all negatively affect society.

Materials:
To make the Soil Runoff Table:

- ☐ two 1-gallon plastic containers
- ☐ scissors
- ☐ sod and soil
- ☐ a board
- ☐ 2 liquid measuring cups
- ☐ watering can

To make contour lines:

- ☐ three pieces of wood or bamboo
- ☐ some rope
- ☐ a stone
- ☐ stakes

Catching Our Soil Before It Runs Off

"The nation that destroys its soil destroys itself."
Franklin Delano Roosevelt

"A few inches between humanity and starvation."
Anonymous

"Civilization itself rests upon the soil."
Thomas Jefferson

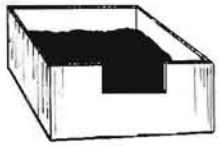
These statements give you a hint of just how precious our soil is. The **carrying capacity** of our planet—that is, the number of people the earth can sustain—depends on the availability and productivity of soil. Soils support food and forest growth. This is why protecting our soil is so important.

Dig In

You will experiment to see how different techniques are used to protect our soils by preventing soil **runoff** and **erosion**—terracing and contour plowing.

Activity 1: Soil Runoff Table

Take either two 1-gallon plastic containers or two cardboard boxes for use in this experiment. Cut the side off of each container like this:



- Fill one container with a piece of sod and one with just soil. It's best to have these from the same area, so that you know your soil is the same.
- Raise both containers on an angle by putting a board underneath them at their ends. Put a liquid measuring cup at the bottom of each of the container's spouts.
- Use a watering can to sprinkle water onto each of the containers. "Rain" the same amount of water on each container and hold the can at the same height as you pour into each of the containers.

What do you see happening? Measure the amount of water collected in the measuring cups. What does the water look like?

Now try the same experiment, but this time, use only soil in both. Make sure you use fresh soil, because the soil you already used has water in it. Instead of leaving the soil alone, make furrows (narrow grooves in the soil – just like rows a farmer would use to plant crops) with your finger. In one of the containers, make the furrows go across, or perpendicular to, the slope. In the other, make the furrows go with the slope.

How much water and soil is washed into the measuring cups?

You can change these experiments by using different kinds of soil or trying it with different slopes (angles).

Activity 2: Making Contour Lines

One of the ways to reduce soil erosion is to contour farm. Surveyors (people who survey the land using linear and angular measures) have special equipment that they use to determine the contours of the land. You can make a simple device to determine land contours too.

Contour lines can be determined using an "A-Frame." The A-Frame is a simple tool that can be made from three pieces of wood or bamboo, some rope and a stone. The A-Frame is level when the plumb line (the rope with the hanging stone) is lined up in the middle of the "A."

Make your A-Frame and then try to map out the contours of a hill. You will need some stakes and maybe some help to do this.

Carrying capacity
Contour farming
Crop residues
Crop rotation
Erosion
Gully erosion/gullying
Nonrenewable resource
Organic matter
Rill erosion
Runoff
Sedimentation
Sheet erosion
Terracing
Weathering
Windbreaks

Making Connections

Talk It Over

- How did the amount of soil runoff differ from your various soil tables in Activity 1?
- How did changing the soil contour affect soil runoff?

Let's Reflect

- How does what you learned in this activity apply to the real world?
- How can plants help prevent soil runoff?

So What?

- Who could use this information? Who would benefit from it?
- Why is soil management so important to maintaining a healthy ecosystem?

Issues to Discuss

- What are the major causes of soil erosion in your area?
- Note the amount of silt in streams, rivers, ponds, lakes and dams after a hard rain. What efforts are being made to reduce this erosion?

Web Connections

For more information on soil erosion visit www.n4hccs.org and link to:

- USDA Natural Resources Conservation Service (formerly called the Soil Conservation Service)
- Board of Soil and Water.

Dig In Deeper

1. Soil erosion is felt all around the world and has constantly been a problem, even in the United States. You may have studied the time in our nation's history called the Dust Bowl days in the 1930s. This time period demonstrated soil erosion at an all time high. Talk to people who lived during this time. Did they directly see the effects of soil erosion? Do they now think differently about soil? Research this time in United States' history.

2. Devise a survey to assess farmers' erosion-control practices.

3. A problem we are encountering with soil is called soil compaction. Soil compaction occurs when the spaces between soil particles become packed down. Soil compaction reduces the amount of water soil can hold, thereby intensifying drought conditions in dry weather and flooding in wet weather. Research this issue and look for ways to reduce this problem.

Saving Our Soil

Soil is the thin upper layer of loose material at the surface of the earth that supports the growth of plants. Soil is not just ground-up rock. It is made up of both living and non-living components such as bacteria, fungi, insects, roots, dead **organic matter**, minerals, gases, air and water. Soil is produced through a process called **weathering**. Weathering is an "in-place" physical and/or chemical change in the make-up of parent material (rock) due to the effects of earth's surface environment. Although soil is continually being formed, it is for practical purposes a **nonrenewable resource** because it takes hundreds or even thousands of years for soil to develop.

Once productive topsoil is removed, it is lost to human use. Currently, soils worldwide are being depleted faster than they are being formed. **Erosion** is the "removal and transport" of soil by wind, water, glaciers and gravity. Deforestation, removing vegetative cover and organic litter, poor agricultural practices, urbanization and construction all expose the soil to these erosive forces. Some types of erosion are:

- **Sheet erosion**
  Sheet erosion is the removal of soil particles in thin layers more or less evenly from an area of gently sloping land. It goes almost unnoticed.
- **Rill erosion**
  Rill erosion is quite visible as distinct channels are carved into the soil by water, wind, glaciers and gravity.
- **Gully erosion/Gullying**
  Gully erosion, the cutting of channels into the landscape by running water, is the most extreme form of erosion and is highly destructive. Often this type begins in wheel ruts made by off-road vehicles, on logging roads and on hiking trails.
- **Wind erosion**
  The wind can carry soil particles in the air for miles, causing breathing problems, illness, air pollution and visibility problems on highways. The wind not only carries the soil, but it carries what is in it (weeds, seeds) as well.

Multiple environmental and economic problems result from erosion. Erosion carries soil into our waterways. **Sedimentation** can choke the water that fish live in; clog dams, reservoirs, rivers and lakes; carry fertilizers and pesticides into waterways; or destroy nesting sites. Plants also suffer because the water is cloudy. Light has more trouble penetrating the water and plants can't harness the sunlight they need to make food. This in turn affects the animals that depend on these plants.

Preventing Erosion

Soil loss is often the number one issue for farmers. We obviously need to continue to grow food and use the land, but how can we act in a way that will reduce soil erosion? Some erosion control practices are:

- **windbreaks** – a row of trees or bushes that absorb the power of the wind or redirect it over an area

- **terracing** – creating flat areas called terraces on sloping ground
- **contour farming** – planting crops perpendicular to the field's slope to follow the contour of the land, rather than up and down the slope – contours will catch water runoff and increase water infiltration

- **crop rotation** instead of monoculture – yearly alternation of soil-depleting crops with soil-enriching crops such as grasses, clover and alfalfa. Row crops, like corn and soybeans, can leave soil vulnerable to runoff
- retaining **crop residues** – leaving stubble of corn, wheat or other crops on the soil surface after harvest

These are just a few techniques. See if you can find out more about some of these and others like alley cropping, riparian buffer strips, grassed ditches and waterways, vegetation restoration, strip-cropping, minimum and no-till and planting strip crops perpendicular to the prevailing wind direction.

Transportation Choices

Activity 12

Exploring how personal decisions affect the environment

Life Skill:
Acquiring/Evaluating Information—Obtaining and analyzing data

Earth Stewardship Skill:
Recognizing how human lifestyles impact the environment

Science Process Skill:
Gathering and analyzing data

Success Indicator:
You will be able to:

1. Explore how your transportation choices have impacts and consequences

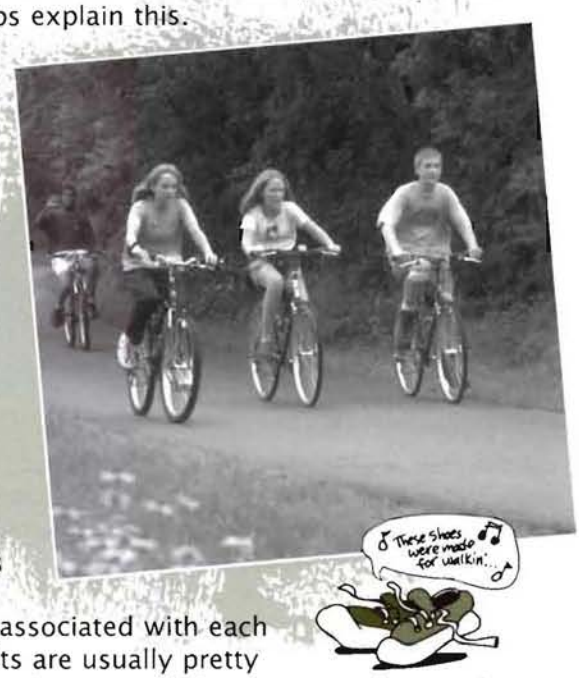
National Science Standard:

Humans have a major effect on other species. For example, the influence of humans on other organisms occurs through land or resource use, which decreases space and resources available to other species.

Materials:

- ☐ pencil
- ☐ calculator (optional)

How do you get from here to there? Do you walk, ride a bike, ride in a car or take a bus? You may not think that the **transportation** choices you make matter, but they do. Individual choices add up quickly to make big impacts. Our choices can affect our own lives as well as others' lives and the overall environment in which we live. The eco-concept, "There Is No Such Thing as a Free Lunch," helps explain this.



Dig In

Do you wonder how your personal transportation choices can have consequences on the environment? Well, let's find out by analyzing where you go and how you get there.

Journal

In the chart below or in your journal, record your mode of transportation and where you go using this form of transportation. Then, analyze the **costs** and **benefits** associated with each transportation choice. The benefits are usually pretty easy to figure out, but the costs can be more subtle. There may be social, financial and environmental costs. Have friends and family help you brainstorm these costs. One or two examples have been filled in for the car.

	Car	Bus	Bike	Walk	Other
Where do you go using this form of transportation?	To the grocery store; to the movies				
What are the benefits of using this form of transportation?	freedom from parents				
What are the costs of using this form of transportation?	Air pollution; requires the building and maintaining of roads				

Put a star next to what you think are the three biggest benefits under each transportation category. Do the same with the costs. Compare these. Then look through all of the benefits and rank your top three. Do the same with the costs. Do the top benefits all fit under one transportation form? What about the costs?

Being an Earth Steward

Every action has a consequence. And just as with everything else we do, transportation has its **trade-offs**. There are costs and benefits to each form of transportation we use. Some of these costs and benefits may be immediate, although some of their effects may not be seen for a long time. Some of these effects are easy to see with our eyes, while others are more inconspicuous.

Our combined transportation choices can impact the world in which we live. Transportation can affect how land is used, the quality of air, water and wildlife habitats and even our global climate. Every form of transportation has some kind of impact. This may be air pollution, energy costs or costs of building and maintaining roads.

Web Connections

For more information on transportation visit www.n4hccs.org and link to:

- Education in Science, Technology, Energy, Engineering, and Math (ESTEEM)

Words to Explore

Benefits
Costs
Trade-offs
Transportation

Making Connections

Talk It Over

- What forms of transportation do you use the most?
- Why do you choose to use these forms of transportation over others?

Let's Reflect

- What impact do the many forms of available transportation have on the environment?
- Why are people in the United States so dependent on transportation? What are the main forms of transportation in countries other than the United States?

So What?

- Which transportation method do you think is best? Would it depend on the weather, the day, where you were going, what you were doing, etc.? Which one balances out the costs and benefits?
- Describe some ways that you could decrease your use of transportation.

Issues to Discuss

- How can your lifestyle influence the type of transportation you use? How can where you live influence the transportation you use?
- How might cities, towns or municipalities work to decrease the negative affects of transportation on the environment?

Dig In Deeper

1. What kinds of transportation options do you think there will be in the future? What will they look like?

2. Talk to your local Department of Transportation (DOT). How many miles of roads are there in your city or state? How many bike trails are there? How many bus routes? Are there any statistics on the number of people who use each form of transportation every day?

3. What forms of transportation, other than those discussed here, exist? What impacts do they have on the environment?

4. How has transportation in your community changed over time? Check out old newspapers in your community library. Also talk to older members of the community to learn how transportation has changed for them.

Section 5

All plants and animals are affected by the M.A.D. law

Developing a Sense of Place

Activity 13

Using observation to better understand nature

Life Skill:
Acquiring/Evaluating Information—Creating data gathering processes

Earth Stewardship Skill:
Learning about the natural world through observation

Science Process Skill:
Observing and communicating

Success Indicator:
You will be able to:

1. Keep a journal of observations and reflections from a special, natural spot
2. Develop a sense of place as you come to know nature and yourself better

National Science Standard:
Creativity, imagination and a good knowledge base are all required in the work of science.

Materials:
- ☐ paper
- ☐ writing utensils
- ☐ contact paper (optional)
- ☐ binoculars (optional)

Do you have a special spot? Is there a place that you know all about down to its last detail? In our fast paced world, you probably don't have much time to sit down, but pausing to smell the flowers, looking into a forest or meadow, or relaxing in nature can be quite helpful. By becoming more intimate with a piece of ground and coming to feel connected to a spot of land, you can actually become more in touch with yourself. Your challenge is to get to know a place so that nature isn't a stranger to you.

Dig In

"Already, by the first of September, I had seen two or three small maples turning scarlet across the pond, beneath where the white stems of three aspens diverged, at the point of a promontory, next to the water. Ah, many a tale their color told! And gradually from week to week the character of each tree came out and it admired itself reflected in the smooth mirror of the lake. Each morning the manager of this gallery substituted some new picture, distinguished by more brilliant or harmonious coloring, for the old upon the walls."

Henry David Thoreau, *Walden*

"...my pines, each with his burden of snow, are standing ramrod-straight, rank upon rank and in the dusk beyond I sense the presence of hundreds more. At such times I feel a curious transfusion of courage."

Aldo Leopold, *A Sand County Almanac*

Nature can be explored in many ways. To help you become personally familiar with the natural world, find a spot in nature where you can be alone and won't be distracted by outside influences. Make it a place that is special. You may choose to sit by a lake or stream, up in a tree, in the middle of a field or under an old oak in a prairie. Wherever you choose, let it become very familiar to you. Go there often. Follow your spot as it changes with the seasons. Pay attention to what you see. Set a goal of going to your special spot for the course of a year. During this time you will become intimately familiar with the location.

Keep a journal to record both observations (details describing the environment around you) and reflections (your personal perceptions and reactions to observations) over the year. In your journal, include the date, time of day, weather, sights, sounds, smells, feels, textures and so on. Record your discoveries.

Look	Look carefully around you. What do you see?
Listen	Listen carefully. What are the sounds you hear?
Feel	Touch what is around you. What does it feel like?
Smell	Take a whiff. What does it smell like?
Taste	Taste the air. Does it remind you of anything?

You can:

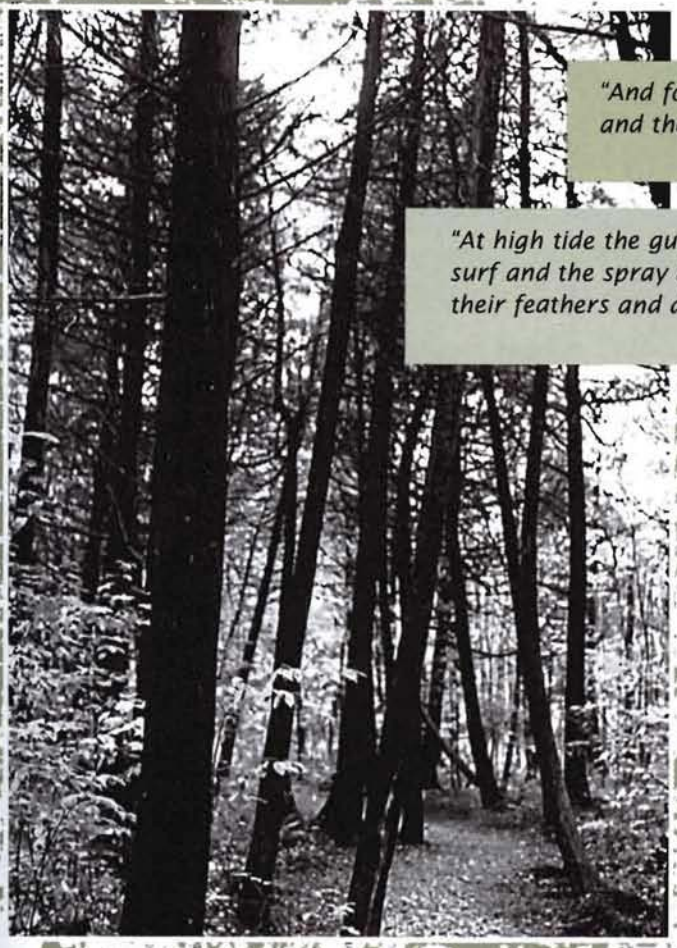
- Try writing and drawing. Sketch plants and animals.
- Keep a booklet of rubbings, pressed flowers and leaves and anything else that is special to you. Use descriptive words to further describe what you are drawing, sketching, rubbing or pressing.
- Take note of things, large and small. Look on the ground, along the shore, in the water and in the sky.
- Take note of the sights and the sounds.
- Try writing poetry, songs or letters to friends describing your thoughts, feelings and observations. Let these words evolve from all of your five senses.

Each time you visit your special spot, you could choose a broad theme for the day. Adaptations, time and space, habitats, cycles, change, designs of nature, colors, comparisons and patterns are all possibilities.

What you do at your spot is totally up to you. This activity is meant to get you more in touch with your surroundings and yourself. And only you know how best to do that.

The beauteous dragonfly's dancing
By the waves of the rivulet glancing;
She dances here and she dances there,
The glimmering, glittering flutter fair.

Heinrich Heine



"And forget not that the earth delights to feel your bare feet and the winds long to play with your hair."

Kahlil Gibran

"At high tide the gulls rest on ledges of rock, dry above the surf and the spray and they tuck their yellow bills under their feathers and doze away the hours of the rising water."

Rachel Carson, *The Edge of the Sea*

Safety First

Practice the basic rules of conservation when you explore outside. Protect the plants and animals that you are studying. Leave all animal homes unchanged. Don't pick or kill plants unless there are many in that area and you have a reason for taking them. Pick up any litter. Take only photos. Leave only footprints. Have a positive impact on the environments you visit.

Metaphors in Nature

To explore nature through the descriptive power of words, try writing some **metaphors** about nature. A metaphor is a word or phrase used to denote the attributes or meaning of something else. Metaphors are used to represent a concept or idea through another concept or idea. For example, "Books are windows of thought," and "A tree is a home" are both metaphors.

"The present never ages. Each moment is like a snowflake, unique, unspoiled, unrepeatable and can be appreciated in its surprisingness."

Gail Sheehy, *The Dragonfly*

"A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community." Aldo Leopold, *A Sand County Almanac*

Making Connections

Talk It Over

- Did you come to feel a sense of place in your chosen spot? How did you feel as you grew to know the area?
- What did you learn about the area that you did not know before?

Let's Reflect

- What may have helped or hindered you from becoming familiar with your spot?
- Why was it important to your understanding of the area to observe it over the course of a year?

So What?

- The M.A.D. Law states that all plants and animals will move, adapt or die. What examples did you see over time in your spot that fit this law?
- Describe another time when you used drawing and writing to describe how you were feeling.

Issues to Discuss

- As you discover nature, you also may discover yourself. What kinds of changes did you notice in yourself, as you became familiar with your spot over time?
- A science or nature writer investigates and writes about the environment. How would this experience in observation help you become a nature writer?

Words to Explore

Metaphor

Web Connections

For more information on habitats visit www.n4hccs.org and link to:

- Earth Watch Institute
- KSE Worldwide (Kids for Saving the Earth)

Dig In Deeper

1. Find a spot in nature or by a natural object and take five minutes to write as many words you can think of to describe that spot or object. Also, record words that describe how you are feeling.

2. Do you know what your spot was like, say 50 years ago? Look around carefully to see if there are any clues as to the area's past. There may be fire scars from a forest fire or twisted trees from a tornado. The forest you are in may once have been a field. Look at aerial photographs of your spot to see how it has changed over time.

Insects, A Creature's Features

Activity 14

Learning about insects

Life Skill:
Reasoning—Applying logic to draw conclusions

Earth Stewardship Skill:
Recognizing the importance of insects to a healthy ecosystem

Science Process Skill:
Observing, organizing and classifying

Success Indicator:
You will be able to:

1. Safely and responsibly collect insects for observation
2. Identify and recognize differences in insect body parts
3. Connect insect structures to functions and adaptations

National Science Standard:
The complexity and organization of organisms accommodates the need for obtaining, transforming, transporting, releasing and eliminating the matter and energy used to sustain the organism.

Materials:

- ☐ forceps
- ☐ small or small Zip Lock bags for collecting insects
- ☐ insect net
- ☐ a beating cloth (large, white poster board or old cloth)
- ☐ stick
- ☐ access to a refrigerator
- ☐ clear plastic containers
- ☐ hand lens
- ☐ labels
- ☐ pencils
- ☐ insect identification guide (optional)

Most insects are small and for the most part, exist in a hidden world. However, soon you will find that insects are **ubiquitous**—they are everywhere! Insects are in the soil beneath your feet, the air above your head, on and in the bodies of the plants and animals around you and maybe even on you. Insects are the largest and most successful group of animals on the planet. **Entomologists** discover new insects every year!

To discover more about insects, you will make an insect collection.

Insect Collection (outdoors)

Take an outdoor trip to a nearby habitat such as a roadside area, the bushes around your schoolyard, a field, a vacant lot, a wetland or a forest. After you have selected a habitat, carefully observe it and prepare to collect the insects that live there. Use one of these methods to collect insects:

- Use forceps to collect insects and place them in small jars or bags. Some good places to look are under rocks, under leaves and under and in rotting logs. Do not pick up bees, wasps, spiders or brightly colored insects with your hands.
- Use a net to sweep across clusters of leaves, branches, flowers and plants in nature. You can make an insect net using a paint strainer (found at hardware stores), an old broom or mop handle, an old clothes hanger and some duct tape. Bend the clothes hanger into a circle and duct tape the paint strainer around the circle to form a pocket. Secure the pocket to the wooden handle and you are ready to go bug hunting!

- Use a stick and beating cloth. The "cloth" should be a white piece of cloth or a white piece of posterboard or cardboard. This should be placed under the branch or bush that you are going to tap with the stick.
- As you look for insects, be sure to look closely for other insect signs. Look for egg cases glued to twigs, irregular blotches on leaves, swellings (galls) in plant stems, empty cocoons, tiny holes and tunnels in tree trunks and branches and nibbled flowers and leaves. Gather any clues as to the types of insects that made these or what kind of features they would need.

As you collect insects, try to leave the area as undisturbed as possible. All of your collected insect samples should be placed in jars or Zip Lock bags with labels that include a description of the habitat where you found the sample(s).

Sorting and Categorizing (indoors)

The labeled containers of your insect collection should be placed in the refrigerator for chilling. To retrieve insects for closer inspection, keep the insects in their containers or bags in the refrigerator for about one hour until the insects fall down to the bottom. Most of the insects will be sluggish from the chill for easier observation. Chilled insects may be placed in clear plastic containers for observation and later released. Use a hand lens to examine your organisms closely.

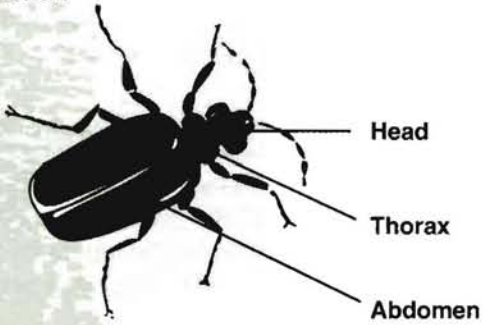
Choose ten different insect specimens from your collection. Use the worksheet "A Creature's Features" information in your journal to help you fill in the data sheet. Although it is not that important to identify the insect classification order to which your insect belongs, you can use an insect identification guide, in addition to your worksheets, to help you figure this out. As you fill in the worksheet, think about the differences in each creature's features that make it unique and adapted to its environment.

Keep insects for only a short time, just so you can observe them and record their characteristics. Return them to where you found them (that's why it is important to label the containers of insects!).

Insect Information

As a group, insects possess an amazing variety of adaptations that allow them to live and survive in many different ecosystems. Insects are found from the tropics to the polar regions, and from high in the sky to caverns deep in the ground. You probably don't really notice them except as pests, but insects are very important to the proper functioning of ecosystems. They serve as decomposers and pollinators and they play an important role in the food web.

Here, you'll get to look at insects up close and personal.



Insects have a special kind of skeleton on the outside of their bodies called an **exoskeleton**. Insects do not have lungs but breathe through holes in their sides called spiracles. Although the body has many segments, or divisions, from front to back, the body itself is divided into three main parts: the head, **thorax** (middle) and **abdomen** (rear). All insects have six legs and most have two pairs of wings. However, some insects only have one pair of wings while a few have none at all. The wings are attached to the thorax.

Insects usually have two sets of jaws, two kinds of eyes (simple and compound) and one pair of antennae. These creature features (number and type of wings, mouthparts, antennae and legs) tell a lot about where and how an insect lives. They are also used to separate the insects into groups (like beetles, butterflies and moths, flies, or bees and wasps).

Data Sheet

Fill out the columns – either with written descriptions or labeled drawings:

Specimen Number	Location Where Found	Body	Legs	Wings	Antennae	Mouthparts	Other Features	Insect Order

A Creature's Features

Body Part	Form and Function	Picture	Some Insects with this Feature
Legs	Swimming		Back swimmers, diving beetles, water boatmen, giant water bug
	Jumping		Grasshoppers, leafhoppers crickets, fleas, katydids
	Walking		Walking sticks
	Digging		Mole crickets, June beetles cicada nymphs
	Running		Cockroaches, tiger beetles, ground beetles
	Grasping		Preying mantis
Wings	Absent		Walking sticks
	Scales		Butterflies, moths
	Membranous		Bees, wasps, flies
	Shell-like		Beetles
Antenna	Segmented		Ants, termites
	Feathery		Moths
Mouthparts	Chewing		Beetles, grasshoppers, crickets, cockroaches, chewing lice, earwigs, silverfish, dragonflies, damselflies, termites, scorpionflies, ants
	Sponging		House flies, blow flies face flies, fruit flies
	Piercing-Sucking		Mosquitoes, true bugs, cicadas, aphids, fleas, sucking lice, scale insects, planthoppers, leafhoppers
	Siphoning		Moths, skippers, butterflies

Making Connections

Safety First

Be sure to use collection materials and safe handling techniques. Some insects are poisonous and you may even have unidentified allergies to insect bites.

Talk It Over

- Did you find that insects really are ubiquitous? Were there many different kinds or just many of the same kind?
- Did you find any spiders or ticks? Are they insects? Why or why not?

Let's Reflect

- Were any of the insect features fairly common?
- What are some of the benefits of insects to people? What are some of the costs?

So What?

- How do you think the insect's structure (features) helps it function? How are these insects adapted to their environment?
- Why would large populations of insects aid in their ability to adapt to a changing environment?

Issues to Discuss

- Entomologists are scientists who study insects. Why would their work be important to such fields as IPM in agriculture or insect transmitted diseases in medicine?
- Issues in agriculture and pest management have raised some concerns. Some insects targeted by pesticides are becoming resistant to the chemicals that are supposed to harm and kill them. Find out what you can about this and discuss the findings with someone.

Web Connections

For more information on insects visit www.n4hccs.org and link to:

- Rainforest Action Network's Kids Corner
- Department of Energy Biological and Environmental Research Program's Educational Sites for All Ages – Top Sites on the Web

Fair Ideas

Make a game about insects. Have people match different parts together to create a real insect. Identify the different body parts and their uses.

Dig In Deeper

1. Try sketching some of the insects you found. What are their most noticeable features?

2. Terry Erwin, an entomologist with the Smithsonian Institution, studies insects in the tropical rain forest. He uses a biodegradable insecticide to collect new insect species. He sprays the chemicals at trees and then insects fall down to white sheets positioned on the forest floor. Erwin fogged one tree in Peru and counted more than 650 beetle species—yes, 650 types of beetles on just one tree (Morell, 1999)! Find out why the study of insects is important to the study of ecosystems?

3. Insects make up many of our pollinators and decomposers. They are very important to the functioning of ecological systems. Look for some of the adaptations these insects have that match them with their function in the ecosystem.

Words to Explore

Abdomen
Entomologist
Exoskeleton
Thorax
Ubiquitous

All plants and animals are affected by the M.A.D. law

Activity 15

Exploring alien species and their influence on an ecosystem

Life Skill:
Acquiring/Evaluating Information—Obtaining and analyzing information

Earth Stewardship Skill:
Understanding how organisms are balanced in an ecosystem

Science Process Skill:
Gathering and analyzing information

Success Indicator:
You will be able to:

1. Explain alien species
2. Discuss alien species' influence on native habitats and native species
3. Identify some local native and alien plant and animal species

National Science Standard:
Organisms both cooperate and compete in ecosystems.

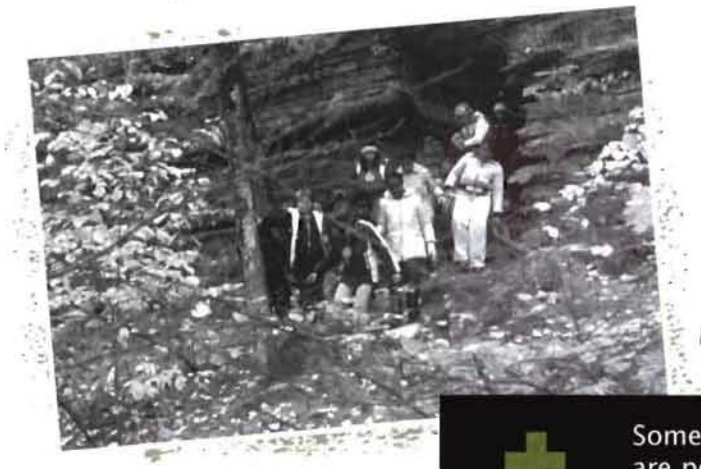
Materials:
- ☐ pencil
- ☐ paper
- ☐ plant and animal identification books

Aliens in Your Neighborhood

When you hear the word "alien," what do you think of? Little green monsters with six eyes and tentacles? One of the definitions of "alien" is used to describe species that are not native to a local area—probably not what you thought of when you first heard the word "alien."

Alien, **nonindigenous**, **exotic** and **introduced species** are the hot topic in many natural resource agencies. They mean about the same thing. For this activity, we will stick with the term "alien."

Do you know which species in your local area are native and which are alien? Find out if there are any alien species that are particularly causing problems. What effects are they having on native populations? What is being done to control them?



Alien species
Exotic species
Introduced species
Invasive species
Native species
Non-indigenous species

You can get help and information from the following places:

- University departments and professors
- United States Fish and Wildlife Service
- United States Department of Agriculture
- United States Geological Survey
- State agencies such as the Department of Natural Resources
- Other groups such as the Nature Conservancy
- Your school and local library

Safety First

Some alien plants are poisonous or dangerous. Learn about any poisonous or dangerous plants and animals in your area. If you don't know what something is, let it be!

Learn how to identify these alien species and watch for them in your local area. Record your findings in your journal.

Once you have identified alien species in your local area, help educate others. Make posters, signs or fliers to hand out or post by lakes, etc. that give pictures of the various alien species. This way people in your community can help identify alien species.

Uninvited and Invited Guests

Species that normally live and thrive in a particular ecosystem are known as **native species**. Others that migrate into the ecosystem, or are deliberately or accidentally introduced into an ecosystem by humans, are labeled alien species. Alien species can now be found in almost every ecosystem of the world. These alien plant and animal species, coming from other parts of the country or world, can invade and disrupt native aquatic or terrestrial communities.

How do these species get from their native areas to these new homes? Sometimes it happens naturally through seed dispersal. And sometimes it happens intentionally. Many of the foods we eat, like beans and rice, are alien. There are many exotics that are used and raised for our well being, like wheat and horses. Many exotic plant species are used widely in agriculture, horticulture and landscaping. Some species were originally introduced as ornamental plants that have now gone out of control.

As the human population increases and as travel between countries and continents also increases, species can 'hitch a ride' accidentally or intentionally to their new home. However, these alien species may have no natural predators or competitors in their new habitat. When left uncontrolled, they can dominate the new ecosystem and cause problems for many of the native species.

The problems of alien species have become widely recognized and they may be a real environmental threat. Many become highly adapted to their new environment and become disruptive or invasive. This means they crowd out or exclude native plants and/or animals and may disrupt the food chain. Without natural predators, they often displace native species and impact recreation, water quality, pollutant cycling and habitat. Introduction of alien species is one of the top reasons for plant and animal extinction because they have no natural predators and thus out-compete other species. When studying alien species, the big question to ask is:

What effects may they have on the native organisms and the physical environment?

Making Connections

Talk It Over

- What are some of the alien species in your local area?
- Describe the positive or negative effects that these alien species have had on your local area.

Let's Reflect

- Are any of these alien species invasive and of particular concern? What is being done to control these alien species?
- What types of pest control might be used to reduce the affects of alien species on an ecosystem?

So What?

- Remember the M.A.D. Law? How are other plant and animal species responding to the alien species? Are they moving, adapting or dying?
- What role can the government play in controlling the introduction of alien species?

Issues to Discuss

- What, if anything, do you think should be done about alien species?
- Describe a time when environmental costs or benefits have affected a decision you have made.

Web Connections

For more information on alien species visit www.n4hccs.org and link to:

- U.S. Fish and Wildlife Service
- United States Geological Survey
- U.S. Department of Agriculture
- Department of Natural Resources
- Nature Conservancy

Dig In Deeper

1. Keep a list of the native and non-native species in your local area. Make sketches and identify key features of the non-natives. Make a note of where and when you see these alien species.

2. Choose one particular alien species. Find out where it originally came from and how it found its way to North America or your state.

3. Find out reasons why animal and plant species would be intentionally introduced to an area. What are some benefits and harmful effects involved in introducing non-native species to an area?

Section 6

All plants and animals have a home

Activity 16

Exploring biodiversity in an ecosystem

Life Skill:
Acquiring/Evaluating Information—Creating data gathering processes

Earth Stewardship Skill:
Recognizing the importance of biodiversity

Science Process Skill:
Organizing, gathering and analyzing data

Success Indicator:
You will be able to:

1. Explain the following terms: biodiversity, richness, evenness
2. Measure species richness and evenness in quadrant plots
3. Compare the biodiversity between two different sites

National Science Standard:
The great diversity of organisms is the result of more than 3.5 billion years of evolution that has filled every available niche with life forms.

Materials:

- ☐ tape measure
- ☐ stakes or tent pegs
- ☐ string
- ☐ field guides to local plants and animals especially insects

Investigating Biodiversity

Did you ever wonder how many different kinds of plants and animals live in a certain area? It's actually not that hard to figure out. You can carry out your own **biodiversity** study to estimate the number of species at a site you choose.

What does biodiversity mean? "Bio" means life and "diversity" means variety, so biodiversity is the variety of life. Biodiversity is defined as the living plants, animals and other organisms that make up a particular region, country, or even the entire earth. Biodiversity has two main components: species **richness**, which is the number of species in an area and **evenness**, the relative abundance of individuals within each species.

Dig In

To measure biodiversity, you will first need to choose a natural habitat to study. An abandoned field, wildlife refuge or overgrown lot would work great.

- Mark off a plot that is 1 meter x 1 meter (a total area of 1 m^2) with stakes and string. This is a quadrant.
- List each plant and animal variety you find on the table, "Natural Habitat."
- Use local field guides to identify plants and animals, especially insects. If you don't know its exact name, describe it in words or with pictures. You can even make up your own names. Just be consistent. You need only to be able to distinguish between different species.
- Make a note if any alien species are found.
- Keep a running total of how many different species of plants and animals there are within your quadrant and count how many individuals of each species there are as well. Repeat the quadrant two more times in the same general area. Were the results from your three quadrant plots similar?

Repeat this investigation in a more controlled or managed habitat like a lawn, garden, park, or schoolyard. For each site you investigate, record the total number of species and individuals. Do the same thing you did with the natural site quadrants, but list your finding on the table "Unnatural Habitat."

Compare the wildlife populations from the two habitats. Record your discoveries and observations in your journal.

Natural Habitat

General location and description of the natural habitat: _____

_____

_____

Date and Time: _____

Weather: _____

Other Observations: _____

_____

_____

_____

Quadrant #1	Species	# of Individuals
Total		

Quadrant #2	Species	# of Individuals
Total		

Quadrant #3	Species	# of Individuals
Total		

Unnatural Habitat

General location and description of the unnatural habitat: _____

_____

_____

Date and Time: _____

Weather: _____

Other Observations: _____

_____

_____

_____

Quadrant #1	Species	# of Individuals
Total		

Quadrant #2	Species	# of Individuals
Total		

Quadrant #3	Species	# of Individuals
Total		

Counting Biodiversity

A community made up of 20 species is more diverse than a community with 10 species because it contains more species richness. On the other hand, if both communities had 10 species, they would be equally rich. But, when comparing two communities with, for example, 5 species each and a total of 20 individuals, the one with abundances of 4, 4, 4, 4 and 4 would be considered more diverse than one with 16, 1, 1, 1 and 1 because the first community is more even. Let's check if this all makes sense

(Each symbol represents an individual; and each different symbol represents a different species.)

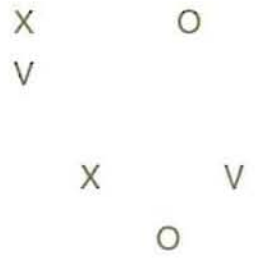
Which community has more species richness? Community A or B?

Community A

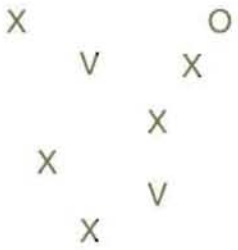
Community B

Which community is more even? Community C or D?

Community C



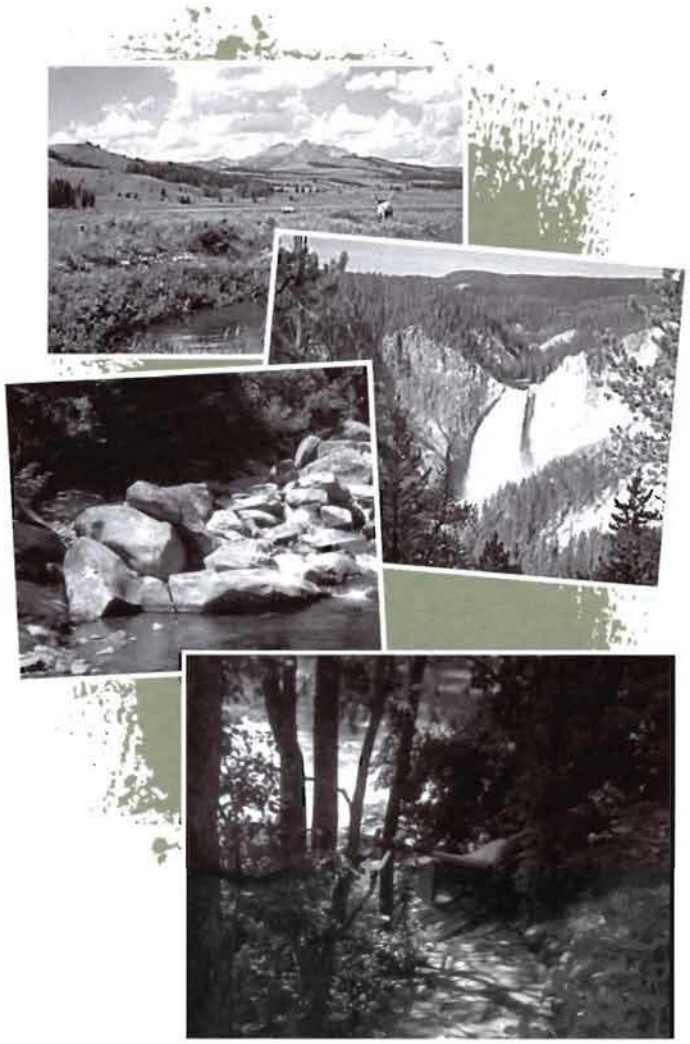
Community D



Why is biodiversity important? Consider Communities C and D. Suppose that 'x' was the major food source. Then suppose a disease came through and killed all of 'x.' What would the area look like? By decreasing the number of species in food webs, ecosystem stability can be impaired. This may give you a hint as to why species biodiversity can be important to community sustainability. Consider this:

Specialists are organisms with restricted use of habitats or resources. Koalas are specialists because leaves from only about five species of Eucalyptus (a type of tree) make up the bulk of their diet. Compare this to **generalists**, species with broad food or habitat preferences. Raccoons are extreme generalists. They will basically eat whatever is available. Their diet includes insects, earthworms, snails, bird eggs, small mammals, carrion, crayfish, frogs, fish, fruits, seeds, berries and nuts. Their success is largely due to their **omnivorous** feeding behavior along with opportunism.

Although raccoons show feeding preferences, availability of food largely determines their selection. Unfortunately, because specialists rely on certain kinds of habitats or food, they are more prone to extinction (the process of ceasing to exist). If their habitat or food resources are destroyed, they may not be able to change their lifestyle to deal with the new conditions. Therefore, it's not just the number of different species that is important but what species are there as well.



Making Connections

Talk It Over

- Which quadrant had the greatest species richness? The least? Which quadrant was the most even? The least?
- What were the abiotic factors featured in each quadrant?

Let's Reflect

- Which of the two habitats you studied seemed to have the highest biodiversity?
- Describe organisms you observed that would be considered generalists or specialists. Explain why you chose these designations.

So What?

- Why do you think certain habitats have more biodiversity than others? (Think about the characteristics of all of your sites, including physical factors such as climate.)
- Monocultures are areas where one primary type of plant grows such as in a corn field, a Christmas tree farm or an aspen stand. Compare this to an area with mixed plants, trees, grasses, etc. What are the advantages and disadvantages of a monoculture vs. a more varied landscape? Why?

Issues to Discuss

- When and why do you think people would want high habitat biodiversity? When and why wouldn't they want it?
- A conservation biologist has training in the sciences related to the conservation of ecosystems globally. Why are social, political and economic issues related to both the recognition and solution of conservation problems?

Words to Explore

Biodiversity
Evenness
Generalist
Omnivore
Regional biodiversity
Richness
Specialist

Web Connections

For more information on biodiversity visit www.n4hccs.org and link to:

- TerraServer
- National Geographic Society

Dig In Deeper

1. Sketch one of the quadrants you study. Make a key to identify the plants and animals within the plot.

2. Figure out the percentage of a particular species relative to the total amount of individuals. For example, if there were 40 dandelion plants and there were 100 total plants, dandelions would make up 40% of the total plants.

40 dandelions/100 plants = 0.4

Then, 0.4 x 100% = 40%

Answer Key: Community A is more species rich than Community B. Community A contains 8 individuals of species X, while Community B only contains 4 individuals of species X. Community C is more even than Community D. Community C has 2 individuals of species X, 2 individuals of O, and 2 individuals of species V. Community D has 5 individuals of species X, 2 of V, and 1 of O. Species X is more dominant in Community D.

Knowing the Night

Activity 17

Learning about animal living patterns

Life Skill:
Acquiring/Evaluating Information—Obtaining and interpreting information

Earth Stewardship Skill:
Recognizing that different organisms are active at different times of the day

Science Process Skill:
Observing and collecting data

Success Indicator:
You will be able to:

1. Explain the difference between diurnal, nocturnal and crepuscular animals
2. Use your senses (including night vision) to explore nature
3. Describe some of the animals that live in the dark
4. Compare day and night observations from the same site

National Science Standard:
The great diversity of organisms is the result of more than 3.5 billion years of evolution that has filled every available niche with life forms.

Materials:

- ☐ flashlight covered with red plastic/cellophane (optional)
- ☐ a blind (old sheet painted green
- ☐ brown blanket or cardboard box (optional)
- ☐ pencil

As you are getting ready to go to bed, many animals are just getting up. There are lots of creatures that sleep during the day and are active at night. These animals are said to be **nocturnal**. On the other hand, **diurnal** animals are active during the day (most humans are diurnal) and **crepuscular** animals are active at dawn and dusk. These various animals can have very different niches within the same habitat.

Dig In

To find out more about these different groups of animals, begin by choosing a habitat to explore such as a field, a forest or a marsh area.

Daytime Exploring
As you explore your area during the day:

- Don't just rely on your eyesight. Vision is just one of our five senses. Try using your other senses—your senses of smell, hearing and touch—to learn about the area, because at night, you won't be able to see as well. Record your observations in your journal.
- Get to know what animals may be around. Try to look for animal signs and tracks. Find a spot along an animal trail that would be a great place to sit when you explore at night if you want a good chance of seeing animals. A watering hole is another good possibility.

Nighttime Exploring

As you explore your area during the night:

- Take along a flashlight, but it is best to cover it in red plastic or cellophane. This allows you to see, but it will not bother animals' eyes. Many night creatures do not even see this red light.
- Practice using your night vision. If you just take some time, your eyes will adjust to the dark. The longer you are outside in the dark and the more often you do it, the better able you will become at developing your night vision. As you are doing this, you should be careful not to look at any bright light or you will spoil your night vision.
- Use your newly discovered night vision to make observations. Check out your surroundings. Take time to see how the branches move in the natural light of night. Watch the shadows move in the forest or across a field. Become familiar with the silhouettes of animals, because in the dark, this may be your best clue as to the animal's identity.
- Take advantage of the time that your eyes are adjusting to the dark to tune into your other senses. As humans, most of us heavily rely on our sight and often neglect our other senses such as touch, hearing and smell. You can develop these other senses with practice.
- Do night hikes with the smallest number of people possible to reduce the amount of noise.

Safety First

The first and most important thing is safety during all of your explorations. Since you will be exploring an area at night here are a few things you should do:

- Make sure the site you choose is relatively safe—an area with steep cliffs would not be a good choice of sites.
- Learn about the area during the day first. Walk through the area during the day to familiarize yourself with the land.
- On your first few night explorations, you will probably want to take an adult with you.
- When exploring by a body of water, be sure to find a safe place to get close to the water.

Sensing the Night

Here are some tips for making the most of your nighttime explorations.

- Try walking with your feet, not your eyes. Feel with and through your feet and shoes. Can you tell when you are walking in certain areas without looking down at the ground? Do you know when you are in moss, in a muddy area or on rocks?
- Feel the objects around you. Use your hands to feel the bark on the trees, the leaves of shrubs and the soil under your feet. Do you feel moss and lichens on rocks? Are there ferns in the area? Do you feel grasses brush against your legs?
- Notice temperature changes. Often it is colder in the valleys as compared to ridges because warm air rises. Also, it is often warmer in the forest because trees act like a blanket trapping in the warm air. What does your skin tell you?
- Be very silent. Walk and talk very quietly. Listen carefully for the sounds of the night. Can you hear hooting owls, the wind blowing through the trees, a mouse scurrying by, a cricket chorus, frogs croaking or the trickle of water?
- Tune into what is going on around you. What do you smell? Use your nose to locate honeysuckle, moist soil, pine trees, or skunk cabbage. To help sharpen your sense of smell, wet your nose or go exploring on a damp night. Moisture helps carry smells.
- Record all of your observations from your night explorations in your journal.

Web Connections

For more information on animal living patterns visit www.n4hccs.org and link to:

- The Wilderness Society
- National Wildlife Foundation (NWF)

Creatures of the Day and Night

Nocturnal, diurnal and crepuscular animals all have characteristics that allow them to live and get along well at the time of day that they are active. For example, nocturnal animals have many adaptations that allow them to be active in the dark. Because it is harder to see at night, they may have large ears to help them hear better and many have good senses of smell to locate food and different territories. Some animals like glowworms and fireflies have body parts that glow in the dark. This helps them to communicate at night.

If you really want to get close to wildlife, you can make a blind to hide behind to observe creatures more closely. This can be a simple structure. You can hide in a teepee made of sticks covered with pine boughs, an old sheet painted to look like the surrounding environment, a green or brown blanket or a cardboard box that is decorated with sticks and leaves to match the environment.

Safety First

Keep in mind that it is often cooler at night. You may want to throw on some extra layers and wear some dark clothing to help you blend in more with your surroundings. Also, it is a good idea to wear a pair of boots to keep your feet dry.

Making Connections

Talk It Over

- How did your observations from your day explorations compare to your observations at night?
- Describe to a friend what it was like exploring in the dark.

Let's Reflect

- By observing this area at different times of the day, did you find out more animals that call this area their home or habitat? Would you have missed some if you only explored during the day? Describe these animals.
- Describe your thoughts and feelings as you explored the night. What did you learn about the area? What did you learn about yourself?

So What?

- Did exploring at night help you become aware of more different niches? How do animals fill these various niches?
- What traits or adaptations do nocturnal animals have to make a living in the darkness?

Issues to Discuss

- Do you think you will explore the night more? Why or why not? If so, what will you change or do differently next time you go out at night?

Words to Explore

Crepuscular
Diurnal
Nocturnal

Dig In Deeper

1. Some common night animals you may encounter are opossums, bats, beavers, porcupines, raccoons, mice, shrews, moles, foxes, wolves, skunks, owls, nighthawks, loons, killdeer, woodcocks, snipes, herons, turtles, geckos, snakes, salamanders, frogs, toads, lamprey, trout, darters, suckers, fireflies, crickets, moths and spiders. Find out how these animals have adapted to living in the dark.

2. Night hikes are a great time to learn about the stars, constellations and the solar system. Take some time to lay down and look up at the star-filled sky.

3. Try observing the same spot at dawn and dusk. Compare your observations to those from your day and night explorations.

4. Bat researchers often have to work at time other than the daytime because many bats are active at dusk and at night. They may want to find out what bats eat, their migration or hibernation patterns, or about how they live in general. Find out more about bats and the work of bat researchers.

Working Through Wetlands

Activity 18

Exploring wetlands and their benefits

Life Skill:
Solving Problems—Identifying the problem and analyzing possible causes

Earth Stewardship Skill:
Recognizing the importance of wetlands

Science Process Skill:
Predicting outcomes and analyzing results

Success Indicator:
You will be able to:

1. Name different kinds of wetlands and their benefits
2. Explain how wetlands capture, store and release water
3. Describe some of the characteristics of a wetland

National Science Standard:
The distribution and abundance of organisms and populations in ecosystems are limited by the availability of matter and energy, and the ability of the ecosystem to recycle materials.

Materials:

For indoor experiments:
- ☐ large light-colored sponges
- ☐ throw-away aluminum trays used for cooking
- ☐ water
- ☐ liquid measuring cups
- ☐ stopwatch
- ☐ books
- ☐ soil

For outdoor observations:
- ☐ life jacket
- ☐ rubber boots or old shoes
- ☐ play clothes
- ☐ shovel
- ☐ net to collect insects
- ☐ pans
- ☐ forceps
- ☐ field guides
- ☐ jars/containers

Imagine the thrill of a variety of ducks—mallards, northern pintails, blue-winged teal—sounding their call and taking wing before your very eyes. Imagine the sound of thousands of frogs singing on a cool moist spring evening. Imagine an array of hundreds of flowers—all with dazzling colors and a beauty that is their own. Where would you be? Why, a wetland of course! Discover these wonders and all of the benefits of **wetlands** as you begin your journey.

Dig In

Experimenting Around (indoors)
What happens to water when it reaches a wetland? This experiment will help show you how wetlands are beneficial.

To demonstrate how wetlands absorb water:

- Pour a shallow layer of water into the bottom of an aluminum tray.
- Place a sponge in the tray. The sponge acts likes a wetland would, absorbing the water.
- Press your finger into the sponge to create a depression. This depression will fill up with water, just like a wetland does.

Experiment #1 Wetland Waters

Now let's compare how much water is absorbed when there is a wetland in a watershed as compared to a watershed without a wetland. To do this:

- Prop one end of the tray up on some books.
- On the down slope end of the tray, poke a hole in the middle of the tray's side, near the bottom of the pan.
- Place a liquid measuring cup underneath the hole to catch the water that will be poured into the tray.
- Make some predictions on how much water will be collected with the sponge in the tray (representing a wetland in a watershed) versus an empty tray (an area without a wetland).
- Place the large sponge into the tray and measure and pour 2 cups of water into the tray on the top end.
- Watch what happens and look to see what the sponge does. Be sure to measure the amount of water collected in the liquid measuring cup. This is the amount of water that passed through your sponge (your simulated wetland).

Try varying the amount of sponges you place into the tray and see how the amount of water collected varies. Keep track of how long it takes for the water to drain. How much water is collected as to the amount poured in?

Experiment #2 Protecting Wetlands

What do you think will happen if the sponges (the wetland) are removed?

- Make some predictions.
- Measure and pour two cups of water into the top end of the empty tray.
- Measure the amount of water collected and the rate it takes to drain. How does the watershed with the wetland compare to the watershed without the wetland? How do you think this experiment is like what happens in real life?
- Then, you can try using water full of soil and watch what happens. Pour water mixed with soil onto your sponges (watershed with wetlands). What happens? What happens to the soil as the water moves through the wetland?

Peat
Saturation
Wetland

Go See the Real Thing (outdoors)

Have you ever visited a real wetland and waded through it? You will need to locate a wetland (any type is fine) and get down and dirty and start exploring. Let your curiosity take you away, but work to find out these things about your wetland as well.

- What is the color of the water in your wetland?
- Do you see any streams that feed into the wetland?
- What is the color and texture of the soil?
- Dig some holes at varying distances from the wetland. How does the soil moisture vary in each? (Remember to fill in your holes when you are done.)
- What animals, plants, insects, birds and fish (or evidence of them) can you find? Why do you think they are found here?
- Are there any hydrophytes (plants that love water)?
- Are there trees present? If so, do they have swollen or flared bases, knobs or bulges on trunk or exposed or shallow roots?
- What do you smell?
- Based on your observations, what type of wetland do you think this is?
- Are there any signs of human activity? Have humans altered the wetland in any way? If so, how?
- Rate the overall health of this wetland (good, intermediate, or poor). Explain why you rated it as such.
- Do you think this particular wetland is important? Why or why not?

Record your answers to these questions and your observations in your journal.

Web Connections

For more information on wetlands visit www.n4hccs.org and link to:

- USDA Natural Resources Conservation Service (NRCS)
- U.S. Fish and Wildlife Service – Wetland Reserve Program (WRP)
- Environmental Protection Agency

What Is a Wetland?

Wetlands are found on every continent except Antarctica. You can find small or large wetlands in a variety of places—along the sides of the highway, in the middle of a field, along the edges of streams and in many other places too. Wetlands basically are areas where **saturation** of the soil during all or part of the growing season determines the types of plants that grow there.

Benefits of Wetlands

- Wetlands provide habitat for many plant and animal species. They serve as nesting, migration and wintering sites for birds. Many endangered or threatened plants and animals in the United States live in or rely on wetlands.
- Wetlands along the coasts serve as fisheries where many of the fish and shellfish that we eat start out. This is a billion-dollar industry.
- Wetlands help control the levels of rivers, streams and lakes. They do this by storing rainfall (and other water like groundwater) and slowly releasing it. Wetlands help to recharge groundwater supplies and help to prevent flooding.
- When water slowly moves through wetlands, it flows over and through soil and filters through particle spaces and around plant roots and vegetative matter. This gives silt and sediments time to settle out. In this way, wetlands trap soil. In addition, they also trap pollutants. In these ways, wetlands help clean polluted and dirty water.
- Wetlands are important areas for recreation. Fishermen, hunters, canoeists, hikers, birdwatchers and others enjoy all of the opportunities wetlands offer.

Even with all of the benefits associated with wetlands, there is a lot of controversy and debate surrounding them. Wetlands are still being destroyed and the threats are many. Farmers drain wetlands to plant crops. Other wetlands are drained and filled in so that developers can build. Decisions about wetland preservation spark heated debate.

Making Connections

Talk It Over

- What did you learn through this activity?
- What role do wetlands play in the water cycle?

Let's Reflect

- What are some new things you noticed about wetlands as you waded through one?
- What animals and plants did you observe as you explored the wetland?

So What?

- What can be learned by doing experiments? What can be learned through making observations? Compare these two methods.
- Are there wetlands in your neighborhood or community? How do you feel about these areas? Did your ideas change after you did this activity? If so, how?

Issues to Discuss

- How do we balance development, agriculture and wetland protection?
- There are wetlands on both private and public land. Who should decide how the land is used?
- If a wetland is or was destroyed, can it be restored or recreated? Can ecological factors be regained? Explain.

Dig In Deeper

Some creatures you may encounter in your explorations of wetlands include turtles, fish, muskrats, beaver, jack-in-the-pulpit, caddisflies, frogs, duckweed, red maple, water tupelos, great blue herons, moose, egrets, osprey, kingfishers, mink, alligators, whooping cranes and wood storks. Find out more about these creatures and how the have adapted to living in wetlands.

Present the activity 'Experimenting Around' to judges. Create a display that coordinates with the activity. Highlight the benefits of wetlands. You could also focus on a wetland in your community.

Words to Explore

Eco-Actions

A

Abdomen – in insects, the posterior or hind part of the body, beyond the thorax

Alien species – species that are not native to a local area

Altitude – the height of a thing above the earth's surface or above sea level

Amensalism – an interaction between two organisms in which one is hurt and the other does not benefit

B

Benefits – positive effect derived from an action; and advantage

Benthic macroinvertebrates – organisms that lack an internal skeleton, are large enough to be seen with the naked eye and are found on the bottom of water bodies

Biodiversity – the variety of life; the living plants, animals and other organisms that make up a particular region, country or even the entire earth

Biological analysis – checking water quality based on the various forms of life found in and around the body of water

Biome – an extensive community of plants and animals whose makeup is determined by soil and climatic conditions

Biotechnology – the use of the data and techniques of engineering and technology for the study and solution of problems concerning living organisms

Birth rate – the number of births per year per thousand of population in a given community, area or group

C

Carrying capacity – the number of people the earth can sustain

Chemical analysis – examining water quality through chemical factors such as pH, alkalinity, dissolved oxygen and total dissolved solids (TDS)

Clarity – the quality or condition of being clear; clearness of water

Climate – the prevailing or average weather conditions of a place as determined by the temperature and meteorological changes over a period of years

Commensalism – a close association or union between two kinds of organisms, in which one is benefited by the relationship and the other is neither benefited nor harmed

Competition – the struggles among individual organisms for food, water, space, etc. when the available supply is limited

Contour farming – characterized by the making of furrows along the natural contour lines so as to avoid erosion, as on a hillside

Costs – negative effect caused by and action; disadvantage

Crepuscular – animals that are active at dawn and dusk

Critical thinking – the ability to separate beliefs from knowledge

Crop residue – leaving plant stubble on the soil surface after harvest

Crop rotation – a system of growing successive crops that have different food requirements, to prevent soil depletion, break up a disease cycle, etc.

D

Death rate – the number of deaths per year per thousand of population in a given community, area or group

Decomposer – an organism that breaks down organic material to forms capable of being recycled

Desert – a dry, barren, sandy region, naturally incapable of supporting almost any plant or animal life

Diurnal – active in the daytime

E

Elevation – height above the surface of the earth

Emissions – something discharged; an issuance

Energy – inherent power; capacity for vigorous action; the capacity for doing work

Entomologist – a person who studies insects

Entropy – a thermodynamic measure of the amount of energy unavailable for useful work in a system undergoing change; a measure of the degree of disorder in a substance or a system

Erosion – to form by wearing away; gradual removal and transport of weathered or unweathered materials by wind, water, glaciers and gravity

Evenness – relative abundance of individuals within each species in an area

Exoskeleton – any hard, external, secreted supporting structure, as the shell of an oyster, cuticle of a lobster, etc.

Exotic species – species that are not native to a local area

Exponential growth – when something increases by a fixed percentage every year

F

First Law of Thermodynamics – the natural law that states that energy is neither created nor destroyed

G

Generalist – species with broad food or habitat preferences

Global climate change – global warming

Grassland – land of region where grass predominates; prairie

Gullying/gully erosion – the cutting of channels into the landscape by running water

H

Hazardous waste – any waste that is toxic, corrosive, flammable, unstable or radioactive

Herbivory – an interaction between an animal and a plant in which all or part of the plant is eaten

I

Indicator species – any organism whose presence helps indicate the quality of the water

Interspecific – between different species

Intraspecific – within a single species

Introduced species – species that are not native to a local area

Invasive species – species that are not native to a local area

K

Kinetic energy – that energy of a body which results from its motion; it is equal to half the product of its mass and the square of its velocity

L

Landscape – an expanse of natural scenery seen by the eye in one view

Lifestyle – way of life of a group of people affected by culture, environment and resources

M

Metaphor – a figure of speech containing an implied comparison, in which a word or phrase ordinarily and primarily used of one thing is applied to another

Mutualism – symbiosis with mutual advantage to both or all organisms involved

Mycorrhizae – an intimate symbiotic association of certain fungi with the root cells of some vascular plants, in which the fungal hyphae often function as root hairs

N

Native species – species that are indigenous to a local area; those that normally live and thrive in a particular ecosystem

Nocturnal – functioning or active during the night

Nonindigenous species – species that are not native to a local area

Non-point source pollution – pollution that enters the water from many sources

Nonrenewable resource – a resource present in a fixed quantity

Northern coniferous forest – a biome dominated by conifers. There are often long, cold and snowy winters and short, cool summers

O

Omnivore – animal that eats any sort of food, especially both animal and vegetable food

Organic matter – material derived from once living organisms

P

Parasitism – a symbiotic association of two kinds of organisms in which the parasite is benefited and the host is usually harmed

Physical analysis – To determine water quality through physical features such as water temperature, depth, speed of current and turbidity/clarity

Point-source pollution – pollution that enters the water from a specific single point

Pollution – decay or corruption through contamination

Population density – the number of a certain organism living in a designated area

Post-consumer content – an item made from items that people have used and recycled

Potential energy – energy in an inactive form that is the result of relative position or structure instead of motion, as in a coiled spring

Precipitation – condensation that causes the fall of rain, snow, sleet or hail

Predation – the act of plundering or preying; the method of existence of predatory animals

Prevention – a means of keeping something from happening; make impossible by prior action

Primary consumer – animals that eat plants; herbivores

Producer – an organism that manufactures food through the process of photosynthesis

Pyramids of energy – a representation of the trophic structure of an ecosystem

R

Richness – the number of species in an area

Rill erosion – distinct channels carved into the soil by water, wind, glaciers and gravity

Runoff – something that runs off, as rain in excess of the amount absorbed by the ground

S

Saturation – filled to capacity; having absorbed all that can be taken up

Savanna – a treeless plain or a grassland characterized by scattered trees, especially in tropical or subtropical regions having seasonal rains

Secondary consumer – organisms that feed on primary consumers

Second Law of Thermodynamics – the natural law that states when energy is transferred or transformed, part of the energy assumes a form that cannot pass on any further

Sedimentation – the depositing or formation of sediment (the matter that settles to the bottom of a liquid)

Sheet erosion – the removal of soil particles in thin layers more or less evenly from an area of gently sloping land.

Specialist – organisms with restricted use of habitats or resources

Speed of current – the rate at which the water moves (current)

Substrate composition – everything on the bottom or sides of water bodies or projecting out into the water. This is the habitat for all of the living things within the water.

Synthetic – produced by chemical synthesis rather than by natural processes

T

Taiga – the coniferous forest in the far northern regions of Eurasia and North America

Temperate deciduous forest – A biome with four distinct seasons and dominant vegetation of broad-leaf deciduous trees

Temperature – the degree of hotness or coldness of anything, usually as measured by a thermometer

Terracing – to form into, lay out in, or surround with any of a series of flat, platforms of earth with sloping sides, rising one above the other

Tertiary consumer – those organisms that feed on the secondary consumers

Thermodynamics – the branch of physics dealing with the reversible transformation of heat into other forms of energy, especially mechanical energy, and with the laws governing such conversions of energy

Thorax – the middle one of the three main segments of an insect's body

Trade-offs – the costs and benefits that result from a choice

Transportation – a means or system of conveyance

Trophic level – of nutrition; having to do with the process of nutrition

Tropical rainforest – a biome found near the equator, with a warm climate and wet and dry seasons

Tundra – any of the vast, nearly level, treeless plains of the arctic regions

Turbidity – muddy or cloudy from having the sediment stirred up

U

Ubiquitous – present, or seeming to be present, everywhere at the same time; omnipresent

Urban sprawl – the outward movement of human populations from urban centers causing changes in suburban and rural land usage

W

Water quality – any of the features that make a body of water what it is; characteristics of a body of water

Water quality parameters – the many factors that affect the quality water including physical, chemical and biological factors

Weathering – the physical and chemical effects of the forces of weather on rock surfaces, as in forming soil, sand, etc.

Wetland – swamps or marshes, especially as an area preserved for wildlife

Windbreak – a hedge, fence or row of trees that serves as a protection from wind

Work – transference of force from one body or system to another, measured by the product of the force and the amount of displacement in the line of force

Z

Zero population growth (ZPG) – when a population stops growing because the death rate equals the birth rate and the net migration is zero

Resources

Eco-Actions

Field guides:

The Audubon Society Field Guide Series. New York: Alfred A. Knopf.

Golden Field Guides. Racine, WI: Western Publishing Co.

Golden Nature Guides. New York: Golden Press. (paperback series)

Peterson Field Guides. Roger Tory Peterson (Ed.). Boston, MA: Houghton Mifflin Co.

Ranger Rick's Nature Scope. Washington, DC: National Wildlife Federation.

For Journaling:

Nature Drawing: A Tool for Learning by Clare Walker Leslie

Finch, R., & Elder, J. (Eds.). (1990). *The Norton book of nature writing.* New York: W. W. Norton Company.

Nicolaides, K. (1941). *The natural way to draw.* Boston: Houghton Mifflin.

Environmental Education Books:

Cornell, J. (1979). *Sharing nature with children.* Nevada City, CA: Dawn Publications.

Cornell, J. (1989). *Sharing the joy of nature: Nature activities for all ages.* Nevada City, CA: Dawn Publications.

Leopold, A. (1966). *A Sand County Almanac.* New York: Ballantine Books. Oxford University Press

Montgomery, S. (1993). *Nature's everyday mysteries: A field guide to the world in your backyard.* Shelburne, VT: Chapters Publishing Ltd.

Sisson, E. (1982). *Nature with children of all ages: Activities and adventures for exploring, learning, and enjoying the world around us.* Massachusetts Audubon Society. Englewood Cliffs, NJ: Prentice Hall.

Watts, M. T. (1957). *Reading the landscape: An adventure in ecology.* New York: The Macmillan Company.

Environmental Organizations

The following organizations can provide you with resources. Many of them are even free. Look for activities, videos, filmstrips, CD-ROMs, audiocassettes, maps, posters, informative articles, technical information, pamphlets, brochures, and fact sheets.

- Alliance for Environmental Organization
- American Forest Foundation
- American Nature Study Society
- Ducks Unlimited
- Izaak Walton League of American, Inc.
- National Audubon Society
- National Geographic Society
- The National Wildlife Federation
- The Nature Conservancy
- North American Association for Environmental Education
- Soil and Water Conservation Society of America
- US Army Corps of Engineers
- US Bureau of Land Management
- US Department of Agriculture
- USDA Natural Resources Conservation Service (NRCS)
- US Environmental Protection Agency
- US Fish and Wildlife Service

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Fax:
612-625-6281

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E-mail:
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Aerospace Adventures

Aerospace 1	BU-06842
Aerospace 2	BU-06843
Aerospace 3	BU-06844
Aerospace 4	BU-06845
Helper's Group Guide	BU-06846
Organizer's Guide	BU-06847
CD-ROM	BU-07605

Arts and Crafts – A Palette of Fun

Helper's Guide	BU-07597

Beef

Beef 1	BU-06351
Beef 2	BU-06352
Beef 3	BU-06353
Helper's Group Guide	BU-06354
Calf Pattern	BU-07332

Bicycle Adventures

Bicycle 1	BU-07503
Bicycle 2	BU-07504
Bicycle 3	BU-07505
Helper's Group Guide	BU-07506
Fix It Video	BU-07507

Cat

Cat 1	BU-06146
Cat 2	BU-06147
Cat 3	BU-06148
Helper's Group Guide	BU-06149

Child Development - Kids on the Grow

Child Development 1	BU-07139
Child Development 2	BU-07140
Child Development 3	BU-07141
Helper's Group Guide	BU-07142

Citizenship - Public Adventures

Citizenship Adventure Kit	MI-07329
Citizenship Guide's Handbook	BU-07330

Clothing Decisions - A Style of Your Own

Discovering Choice 1	BU-07360
Managing Choice 2	BU-07361
Helper's Group Activity Guide	BU-07362

Computer Mysteries

Computer 1 + CD	BU-07509
Computer 2	BU-07510
Computer 3	BU-07511
Helper's Group Guide	BU-07512

Dairy

Dairy 1	BU-06154
Dairy 2	BU-06155
Dairy 3	BU-06156
Helper's Group Guide	BU-06157
Calf Pattern	BU-07332

Dog

Dog 1	BU-06150
Dog 2	BU-06151
Dog 3	BU-06152
Helper's Group Guide	BU-06153

Down to Earth Classroom Gardening

Down to Earth	BU-07714

Exploring Farm Animals

Exploring Farm Animals (K-3)	BU-06350

Electric Excitement

Electric 1	BU-06848
Electric 2	BU-06849
Electric 3	BU-06850
Electric 4	BU-06851
Helper's Group Guide	BU-06852

Embryology in the Classroom

Helper's Guide For Grades 2-5	BU-07595
Helper's Guide For Grades 6-8	BU-07596
Chick Poster	MI-07733

Entomology - Insectiganza of Excitement

Entomology 1	BU-06853
Entomology 2	BU-06854
Entomology 3	BU-06855
Helper's Group Guide	BU-06856

Exploring Your Environment

Environment 1	BU-07704
Environment 2	BU-07705
Environment 3	BU-07706
Helper's Guide	BU-07707

Financial Champions

Money FUNdamentals	BU-07710
Money Moves	BU-07711
Helper's Guide	BU-07712

Fishing for Adventure

Sportfishing 1	BU-07598
Sportfishing 2	BU-07599
Sportfishing 3	BU-07600
Helper's Guide	BU-07601

Foods

Foods A	BU-07144
Foods B	BU-07146
Foods C	BU-07148
Foods D	BU-07150
Helper's Guide	BU-07730

Gardening

Gardening A	BU-07162
Gardening B	BU-07163
Gardening C	BU-07164
Gardening D	BU-07165
Helper's Group Guide	BU-07166
Exhibit Guide	BU-07167

Goat

Goat 1	BU-06162
Goat 2	BU-06163
Goat 3	BU-06164
Helper's Group Guide	BU-06165
Lamb & Kid Pattern	BU-07514

Health... It's Your Choice

Health Exploring	BU-06857
Health A	BU-06858
Health B	BU-06859
Health C	BU-07205
Health D	BU-06861
Helper's Group Guide	BU-06862

Horse

Horse 1	BU-06355
Horse 2	BU-06356
Horse 3	BU-06357
Helper's Group Guide	BU-06358
Horse Pattern	BU-07200

Horticulture

Horticulture 1	BU-07153
Horticulture 2	BU-07154
Horticulture 3	BU-07155
Helper's Group Guide	BU-07156

Lessons and More

CD	CD-07732

Moving Ahead Together

Notebook Lesson Plans	MI-07515
CD-ROM (Posters)	CD-07661

Pet s

Pet 1	BU-06359
Pet 2	BU-06360
Pet 3	BU-06361
Helper's Group Guide	BU-06362

Poultry

Poultry 1	BU-06363
Poultry 2	BU-06364
Poultry 3	BU-06365
Helper's Group Guide	BU-06366

Rabbit

Rabbit 1	BU-06069
Rabbit 2	BU-06070
Rabbit 3	BU-06071
Helper's Group Guide	BU-06072
Rabbit Pattern	BU-07199

Sewing and Textiles

Sewing 1	BU-07179
Sewing 2	BU-07180
Sewing 3	BU-07181
Helper's Group Guide	BU-07182
Let's Sew Book	MI-07198

Sheep

Sheep 1	BU-06367
Sheep 2	BU-06368
Sheep 3	BU-06369
Helper's Group Guide	BU-06370
Lamb & Kid Pattern	BU-07514

Small Engines

Small Engines 1	BU-07324
Small Engines 2	BU-07325
Small Engines 3	BU-07326
Helper's Group Guide	BU-07327

Swine

Swine 1	BU-06158
Swine 2	BU-06159
Swine 3	BU-06160
Helper's Group Guide	BU-06161
Pig Pattern	BU-07201

Theatre Arts

Theatre Arts 1	BU-06870
Theatre Arts 2	BU-06871
Theatre Arts 3	BU-06872
Theatre Arts 4	BU-06873
Helper's Group Guide	BU-06874

Woodworking Wonders

Woodworking 1	BU-06875
Woodworking 2	BU-06876
Woodworking 3	BU-06877
Woodworking 4	BU-06878
Helper's Group Guide	BU-06879

Workforce Preparation

Wild Over Work	MI-06880

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