Exploring Biodiversity:

A Guide for Educators Around the World

Exploring Biodiversity:
A Guide for Educators Around the World

Exploring Biodiversity is a joint publication of Conservation International (CI) and World Wildlife Fund-US (WWF).

This project was made possible by generous support from the John D. and Catherine T. MacArthur Foundation, the Eastman Kodak Company, and the Singing For Change Foundation.

Text and activities (except *Community Connections, The Rare Scare,* and *The Web of Life*) were adapted with permission from *Biodiversity Basics*, published by World Wildlife Fund as part of *Windows on the Wild*, an international biodiversity education program. (c) 1999. Please visit www.worldwildlife.org/windows/biobasics_credits.html for a complete listing of the original development team.

The Rare Scare was adapted with permission of the National Wildlife Federation. (c) 1999.

For original sources of information found in *Exploring Biodiversity*, please contact education@conservation.org.

WRITING AND EDITING:

Shannon Quesada, Manager, International Environmental Education, CI

Daniela Lerda, Coordinator, International Environmental Education, CI

Judy Braus, Director of Education, WWF

Jeff England, Conservation Education Coordinator, WWF

Haroldo Castro, Vice President, International Communications, CI

Flavia Castro, Senior Producer, International Communications, CI

Gerry Bishop, Editor

Kristen Paratore, Volunteer Editor, Center for Applied Biodiversity Science, CI

SCIENTIFIC REVIEW

Tom Brooks, Ph.D., Center for Applied Biodiversity Science, CI

John Pilgrim, Center for Applied Biodiversity Science, CI

EDUCATOR TESTING AND REVIEW

Amy Higgs, University of Michigan

Patricia Fredericks, CI-Guyana

Region 9 teachers, Guyana

Edy Hendras, CI-Indonesia

Herda Hutabarat, ALAMI Foundation, Indonesia

Monique Pool, CI-Suriname

Ni Putu Sarilani Wirawan-Sundjaya CI-Indonesia

DESIGN AND ILLUSTRATION

Cover and original concept: Fernando Urrea, Graphic Designer, CI

Select illustrations: Stephen Nash, CI

Dear Educator,

No matter what part of planet Earth you call home, you live in the midst of a rich tapestry of life. From the largest animals to the smallest microorganisms, and from the rainforests to the coral reefs, biodiversity is all around us and touches every aspect of our lives.

Yet every day we lose a piece of this tapestry. Forests are cleared, wetlands drained, and species are lost forever. And every day, conservationists from all walks of life work together to try to save our planet's natural treasures for generations to come.

We know that children are our future. An eleven-year-old today will be an adult in ten years, making decisions that impact his or her home, community, or even country. As an educator, you shape the lives of thousands of students, helping them to become active citizens and responsible environmental stewards. Increasing numbers of people seem to be unaware of the wonders of the natural world. Everyday routines demand our attention, leaving little room for any awareness of what's happening right outside our doors—in the soil beneath our feet, the trees in our town, the sky overhead.

At Conservation International (CI) and World Wildlife Fund (WWF), we believe that it's important to nurture an appreciation and understanding of life's natural processes and rhythms. After all, how can people be expected to value or protect something that they've had little or no exposure to and have little or no understanding of?

When people become aware of the fantastic phenomena that routinely take place in the natural world, many experience a sense of awe and appreciation. The intricate dance a honey bee performs when communicating information about a food source, the unexpected appearance of a rainbow, the delicate craftsmanship of a bird's nest—our planet is full of wonders such as these.

This educator's guide was created to help you bring biodiversity to life in your students' lives. With background information for you and hands-on activities to do with students ages 11 to 14, we hope this guide will make it easy to integrate biodiversity into your teaching.

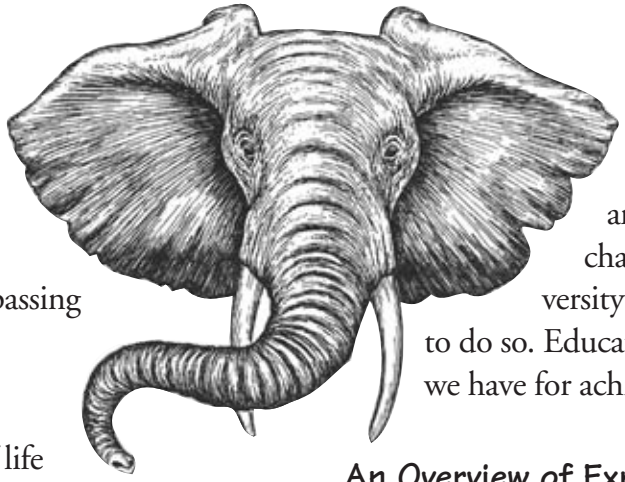
Both CI and WWF are dedicated to conserving our planet's biodiversity for our children's future. We invite you to join us in this effort by guiding your students to learn about, cherish, and care for the life that surrounds and nurtures us all.

Sincerely,

Shannon Quesada, CI
Judy Braus, WWF

TABLE OF CONTENTS

WELCOME TO EXPLORING BIODIVERSITY



Biodiversity! Although the term may seem intimidating to some, you couldn't choose a more engaging and stimulating topic—or one as all encompassing and important for our lives and future.

Biodiversity is the variety of life on Earth. It's everything from the tiniest **microorganisms** to the tallest trees, from creatures that spend their entire lives deep in the ocean to those that soar high above the Earth's surface. The word biodiversity also describes the wealth of **habitats** that house all life forms and the interconnections that tie us together. All of Earth's **ecosystems** and the living things that have evolved within them—including the fantastic range and expression of human cultures—are part of our planet's biodiversity.

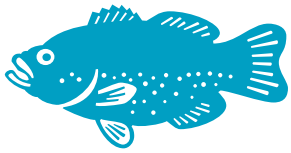
The diversity of life on Earth shapes and nourishes every facet of our existence. But because these connections are seldom obvious, humans don't always know how their actions affect the environment. Many times we pursue short-term interests with limited regard for the well-being of other species and the places they live. At the same time, social and economic inequities have forced some people to overexploit resources to meet their basic needs. As a result, biodiversity is rapidly declining. If we want to ensure the long-term health of the planet, we need to develop an informed and motivated citizenry that understands what biodiversity is and why it's important. We need citizens who have the skills and confidence to rise to the challenge of protecting biodiversity and who feel empowered to do so. Education is one of the best tools we have for achieving this goal.

An Overview of Exploring Biodiversity

Conservation International and World Wildlife Fund developed *Exploring Biodiversity* as a resource for teachers and non-formal educators in priority conservation areas around the world. As an educator, you have an enormous effect on the ways your students learn and develop into the next generation of leaders and decision makers. By helping students develop a sense of stewardship of their local environment, they will be able to act locally while understanding the global context and effects of their decisions, both now and in the future.

Read All About It!

Background text at the beginning of each section will help you learn more about the concepts addressed in each section's activities. With more understanding of biodiversity topics, you'll be better prepared to talk about the issues with confidence, provide examples, and answer students' questions. Don't forget to read before you teach!



Exploring Biodiversity is packed with ideas and information designed to help you explore both the ecological and social dimensions of biodiversity with your students. *Exploring Biodiversity* was designed for use with students aged 11-14, but we've found that many of the activities work well with younger and older age groups too. Most of the activities in this guide can be integrated into many subject areas, not just science. We've also designed the guide for use in both schools and non-formal education settings, such as protected areas, museums, zoos, and other community education settings. In *Exploring Biodiversity* we provide many opportunities for educators to draw out students' natural curiosity and sense of wonder. To help your students learn more about their local environment, we encourage you to spend as much time outside with them as you can—and to make use of the many natural areas that exist in your communities, from the schoolyard to city parks to national protected areas.

This guide is divided into three parts. You'll find a comprehensive overview of biodiversity in the ***Introduction.*** The second part of the guide, ***Activities***, includes ten teaching activities in four sections. Each section will provide you with a short introduction to the issues being discussed. We recommend you read this background information to increase your understanding of the topics before carrying out any of the activities in the section. In addition, each activity includes some background information about the specific topic being covered. Throughout the guide, words in **bold** can be found in the glossary.

The background text and activities in ***Section 1*** define biodiversity and help students explore different aspects of biodiversity. This section provides a base of information that will help students understand the more complex conservation issues discussed in Sections 2-4. ***Section 2*** explores several ways humans are connected to biodiversity and examines different values and perspectives on biodiversity use and conservation. In ***Section 3*** students learn about the state of biodiversity and some principal threats faced by **species** and ecosystems around the world. ***Section 4*** investigates some ways people can help by taking individual or collective action to conserve biodiversity. In this section students also investigate their communities, learning about how connections with nature have changed over time and exploring the status of biodiversity locally.

In the third part of the guide, ***Appendix A: Extention Ideas*** offers a number of suggestions of how you can involve students in learning about the environment through fun and creative activities.

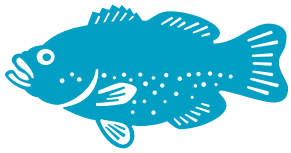
An activity framework on page 3 will assist you in planning your lessons by giving you a quick way

What if I don't know the answer to a question?

When teaching, you might be asked a question that you can't answer. An important part of learning is asking questions. Don't be afraid to tell students, "I don't know. How do you think we could find out?" Then look for the answer together!

ACTIVITY FRAMEWORK

ACTIVITY	SUBJECTS	AGES	TIME (1 session = 45 minutes)	SETTING	PAGE
Section 1: What is Biodiversity?					
1. All the World's a Web	Science, Social Studies, Language Arts	11+	one session	classroom	12
2. The Web of Life	Science, Language Arts	9+	one session	classroom or outside	15
3. BioBlitz	Science, Language Arts	11+	two sessions + home-work	outside	19
Section 2: Biodiversity Connections					
4. The Spice of Life	Science, Social Studies, Language Arts	11+	one session	classroom	28
5. Biodiversity Performs	Science, Art (Drama), Language Arts	11+	one session	classroom or outside	33
Section 3: The State of Biodiversity					
6. The Rare Scare	Science, Art, Language Arts	11+	two sessions + home-work	classroom	46
7. Space for Species	Science, Mathematics, Physical Education	9+	two sessions	classroom + outside	50
Section 4: Biodiversity Conservation					
8. Thinking about Tomorrow	Science, Social Studies, Mathematics	9+	one session	classroom	63
9. Community Connections	Social Studies, Science	11+	three sessions + home-work	classroom + community	69
10. Taking Action	Social Studies, Science	11+	on-going project	classroom + community	72



of selecting activities to do with your students based on learning objectives, subjects, time requirements, and appropriate student age groups. You can work through all the activities in the guide as a unit or select several to do with your students. If you select only a few activities to do, we suggest you try to do at least one activity from each section, starting with an activity like "All the World's a Web" in Section 1.

Our goal for this program is not to teach your students *what* to think about biodiversity but to introduce them to some fascinating topics, raise challenging questions, and guide them to explore, analyse, evaluate, and discuss these issues from an informed position. We're aware that biodiversity issues are both controversial and complicated. Your students may bring many diverse perspectives to the biodiversity-related issues you introduce. However, with your careful guidance, these different points of view can contribute to a dynamic learning environment in which students clarify their own thinking, learn how to listen to others, and gain new insights about these intriguing issues.

In short, we hope this guide opens your students' minds to the wondrous diversity of life around them. We also hope it engages them in thoughtful dialogue about their place on the planet—and about the future of the world we all share. Education should challenge students to think critically and creatively about their world—to question how and why we do things, and how we might do them differently. It should also promote positive change (both personally and within communities), help students envision a better society, increase respect and tolerance for others, and build effective citizenship skills and stewardship.

> ***Exploring Biodiversity*** is built on a set of underlying principles about education. As you read through the activities in this module, you may see some new strategies and approaches to teaching. For example, constructivist education recognizes that people learn by building upon prior experiences and knowledge. Teachers do not transmit knowledge to students, but rather students construct their own understanding of new information and experiences acquired. The activities found here also emphasise group learning, problem solving, teaching a lesson with several subject-area objectives, and learning from experience. Many countries that are currently undergoing education reform are incorporating these educational strategies and approaches into curriculum development, teacher training, and classroom practices.

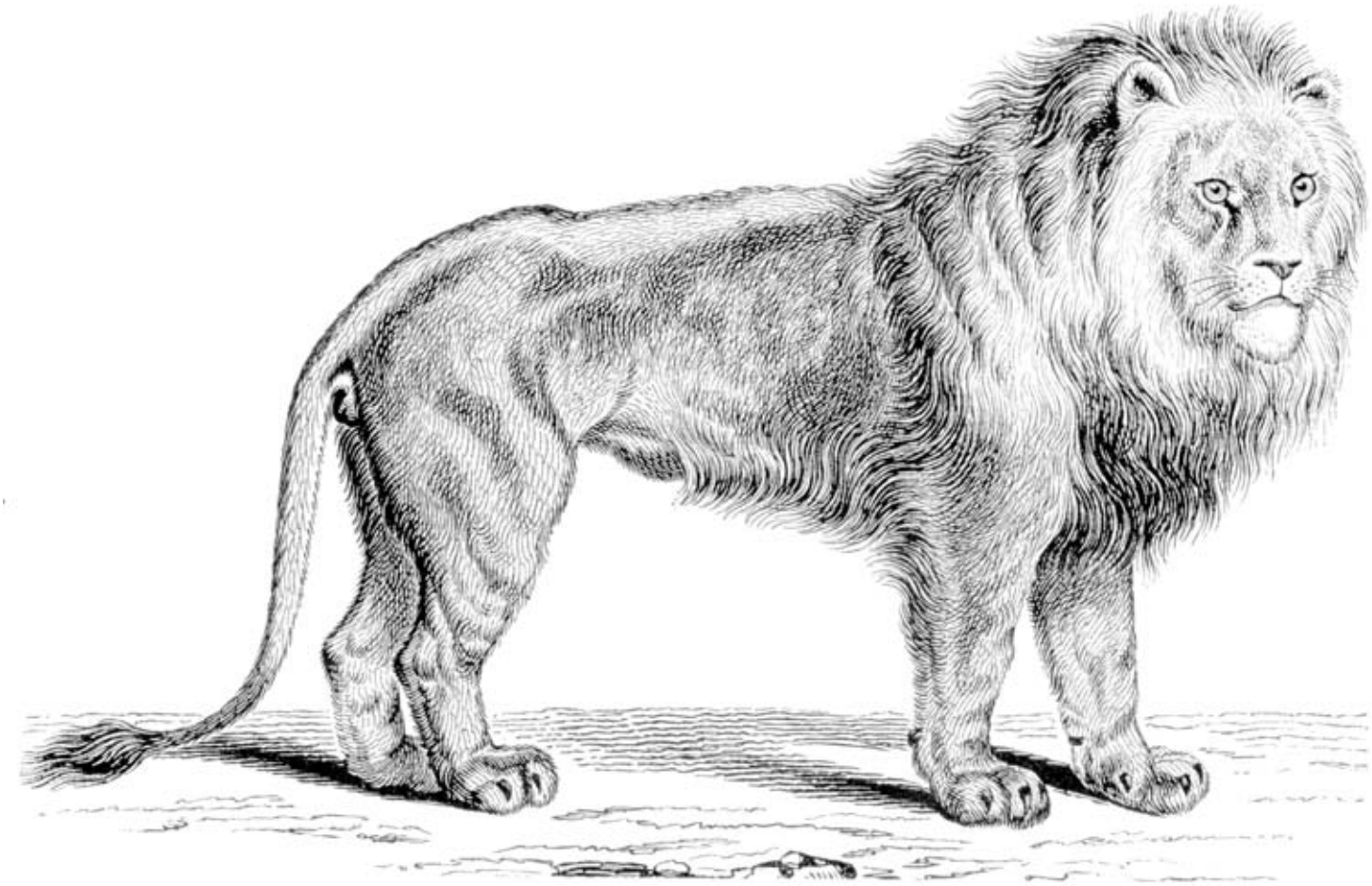
The Building Blocks of Exploring Biodiversity

Exploring Biodiversity addresses biodiversity topics in several ways. In addition to a solid foundation of science that builds knowledge of basic ecology, the guide also specifically explores the connections between humans and the natural systems on which we depend. This basis in environmental education should help students not only gain knowledge and awareness about environmental issues, but should also help students gain the skills they need to become life-long problem solvers and informed decision makers.

Environmental education has five objectives:

- **Awareness** of and sensitivity to environmental problems
- Basic **knowledge** and understanding of how the environment functions
- Positive **attitudes** and values towards the environment
- **Skills** to identify, investigate, and resolve environmental problems
- Active **participation** in environmental protection

The guide also explores pathways to **sustainability**—meeting the needs of the present without compromising our ability to meet the needs of the future. The activities in this guide encourage students to consider the perspective of other individuals, communities, and cultures, and to look forward to assess the way that our actions affect the lives of people and other species all over the world. Students are challenged to think about fairness, individual and community responsibility, and other concerns that are critical to our understanding of sustainability. Specifically, education for sustainability explores the relationships among ecological integrity, economic prosperity, and social equity.



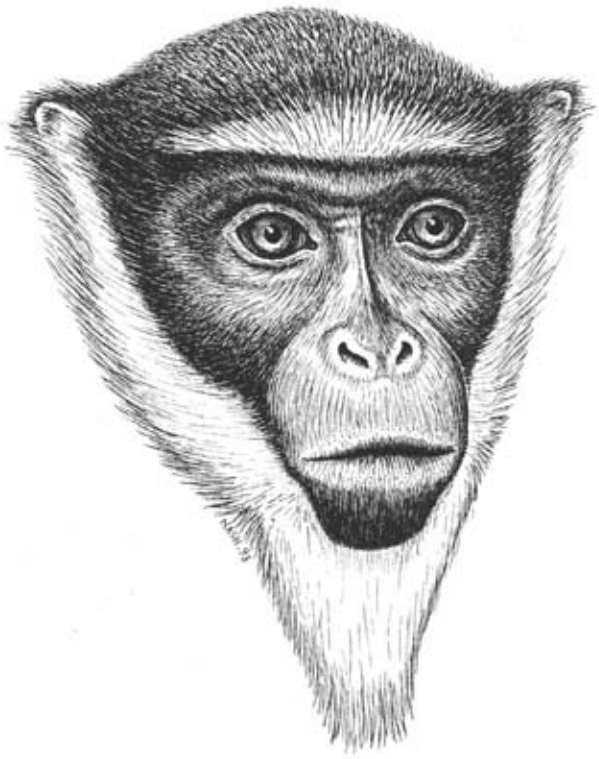
WHAT IS BIODIVERSITY?

WHAT IS BIODIVERSITY?

Our planet is crawling, not to mention swimming and flying, with life. Scoop up a handful of soil from your backyard, and you just might scoop up an impressive collection of biodiversity along with it—everything from **microorganisms**, seeds, and spores to insects, mites, and worms. There could be thousands of **species** right there in the palm of your hand—and many of these might well be unknown to science and unseen to the naked eye. The Earth is so rich with life that scientists don't even know for sure how many different kinds of organisms may exist. So far, they've identified and named more than 1.7 million species, including more than 300,000 plants, a million insects, 25,000 fish, 7,800 reptiles, 4,700 amphibians, 9,700 birds, and 4,600 mammals. The rest includes molluscs, worms, spiders, fungi, algae, and microorganisms. Scientists think that millions more species, mostly microorganisms and **invertebrates**, are yet to be discovered.

Three Levels of Life

The sheer variety of species on Earth—from microscopic bacteria to blue whales a quarter of the length of a football field—is pretty impressive on its own. However, biodiversity isn't limited to the numbers and kinds of organisms that exist. It also includes Earth's **ecosystems**: its savannas, rain forests, oceans, marshes, deserts, and all the other environments where species evolve and live. It includes **genetic diversity**, which refers to the variation within a species, including human variation throughout the world. All three—genetic, species, and ecosystem diversity—are critical to understanding the interconnections that support all life on the planet.



Rich and Unique

Certain ecosystems around the world harbour especially large numbers of species. The most familiar of these are tropical rain forests. The forests of New Guinea near Australia, for example, are home to about the same number of bird species as live in the United States and Canada combined—yet the island covers less than 3 percent of that area. Other incredibly diverse ecosystems include coral reefs, large tropical lakes, and parts of the deep-ocean floor.

Although ecosystems with large numbers of species are important to focus on in the effort to conserve biodiversity, the number of species is just one measure of an ecosystem's importance. Another factor is the uniqueness of an area—from the types of species that live there to the physical landscapes within it. Still another factor is whether the ecosystem performs a key function, such as flood control or water purification.

Where Is the Diversity?

Some areas of the world are uniquely rich in biodiversity, provide important ecological processes, contain species or landscapes that don't exist anywhere else, or are under threat of being damaged or disappearing altogether. By defining these regions, scientists and conservationists can set priorities for where they most urgently need to work.

Scientists study the Earth's biodiversity in terms of **ecoregions**, which are geographically distinct areas such as the Cerrado of Brazil and the Gulf of California in Mexico. Ecoregions are differentiated by climate, vegetation, terrain, altitude, soil type, and the types of plants and animals that exist there. More than 1,000 ecoregions are recognised in the world.

Of those, more than 200 have been identified as being the richest, rarest, and most distinct natural areas on the planet. These outstanding terrestrial, freshwater, and marine habitats require special attention to ensure their protection and to conserve the broadest array of life around the world. In ecoregions such as the Fynbos of South Africa, the Guinean Moist Forests of West Africa, and the Sulu-Sulawesi Seas between Indonesia, Malaysia, and the Philippines, conservation groups are working to protect these special ecoregions and the biodiversity they contain.

Many scientists use the term "**hotspots**" to refer to ecoregions that have a large number of **endemic** species—those that are found nowhere else on Earth. Although hotspots contain high levels of biodiversity, they are given this name because they are also the most threatened places on the planet, having lost more than 70% of their original plant cover (forests, shrublands, or grasslands). Despite this threat, the planet's 25 hotspots contain more than 60 percent of all terrestrial species on just 1.4 percent of the planet's land surface. The Guinean Forests of West Africa, which cover parts of nine countries, are an example of a hotspot.

The Gene Scene

Though not as obvious as Earth's impressive array of species and ecosystems, genes—the basic units of heredity—are an equally important aspect of biodiversity. Many plant and some animal species have as many as 400,000 genes—giving rise to enormous possibilities for genetic variation. Edward O. Wilson, a biologist at Harvard University, describes the importance of genetic diversity in this way:

> Each species is like an encyclopaedia of genetic information, containing billions of genetic letters that give it a unique "code of life." This code allows each species to adapt to the conditions of the ecosystem in which it lives. For example, over hundreds of thousands of years, some plants have developed certain chemicals that make them taste bad, which keeps insects from devouring them. Some animals have developed sharp claws, thick fur, keen eyesight, and other adaptations that help them survive. All of these traits are the result of coded messages in our genes that get passed from one generation to the next. And when a species goes extinct, all that valuable information is lost.

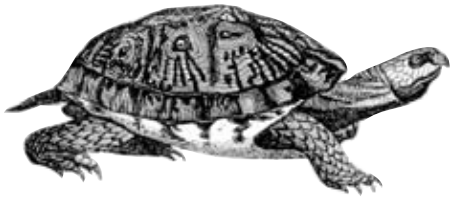
For a vivid portrait of genetic diversity, just look around. It's evident in the different kinds of potatoes in the market, in the different eye and hair colours of mammals, and in the different heights of humans, to name a few examples.

We are still learning about the importance of genetic diversity to the long-term survival of individual species. But we know that most species probably require a great amount of variety to survive over the long run. It is this variety that allows enough individuals to adapt to unexpected changes in their environment and thus to perpetuate the species. Armed with this knowledge, geneticists and conservation biologists are trying to measure and maintain the genetic variation of some **threatened** species, including the red-cockaded woodpecker, Bali starling, cheetah, white rhinoceros, golden lion tamarin, and many plants.

Besides being relevant to the survival of wild species, the genetic aspect of biodiversity also has direct links to humans. For example, we know from experience that genetic diversity in agriculture is important in preventing crop failure. Genetically diverse crop species are much more likely to resist changes in the environment, such as pests or climate change.

The Big Picture

It doesn't make sense to think of the three levels of biodiversity—ecosystems, species, and genes—as separate categories, because each level influences the others in significant ways. If one level is disrupted, the effects can ripple through the others. In Indonesia, for example, the Javan gibbon lives in the tropical rain forests of the island of Java and nowhere else on Earth. As people have destroyed more and more of the Javan gibbon's **habitat**, small populations of Javan gibbons have become separated from each other. Each **population** now lives in a small patch of forest and can't mix with the other populations. Because of this, the Javan gibbons breed only with members of their same group and thus have lost much of their genetic diversity. If the habitat changes any more, or as more patches of forest are lost, the Javan gibbon may not be able to adapt to these changes and avoid extinction. Javan gibbons are important members of the forest ecosystem, since they disperse seeds when they eat fruit, helping tree species reproduce. Without the gibbons the forest ecosystems of western Java will also change, and other species will likely be affected.



Countless Connections

Intricate connections don't exist only among the levels of biodiversity; they also exist among species. These connections are a fascinating and important part of biodiversity. For example, some plants and their pollinators have co-evolved to be extremely well suited to one another: A long-billed bird pollinates a flower that has a long tube, and a night-roving moth pollinates a night-blooming cactus. Some insect parasites have evolved to live in only one host, such as species of wasps that lay their eggs on only one type of caterpillar. Such close partnerships and interrelationships between species mean that if one species becomes extinct, the other could too.

We're just beginning to understand the remarkable interactions among species. We're also beginning to realise that such interactions may be important in ways we don't yet understand—not only to the species but also to entire ecosystems.

RAINING CATS

Malaria once infected nine out of ten people on the island of Borneo, now shared by the countries of Brunei, Malaysia, and Indonesia. In 1955, the World Health Organization (WHO) began spraying dieldrin (a pesticide similar to DDT) to kill malaria-carrying mosquitoes. The program was so successful that the dreaded disease was almost eliminated from the island. However, unexpected things happened. The dieldrin killed other insects, including flies and cockroaches living in people's houses. The islanders applauded. But then small lizards that also lived in the houses died after gorging themselves on dead insects. Then cats began dying after feeding on the dead lizards. Without cats, rats flourished and began overrunning the villages. Now people were threatened by sylvatic plague carried by the fleas on the rats.

On top of everything else, roofs began to fall in. The dieldrin had killed wasps and other insects that fed on a type of caterpillar that either avoided or was not affected by the insecticide. With most of its predators eliminated, the caterpillar population exploded. The larvae munched their way through one of their favourite foods, the leaves used in thatching roofs. The situation was brought under control when WHO parachuted healthy cats onto parts of the island. In the end, the Borneo episode turned out all right; both malaria and the unexpected effects of the spraying program were brought under control. Nonetheless, it shows the unpredictable results of interfering in an ecosystem.

Story adapted from: *Living in the Environment, Fifth Edition*. G. Tyler Miller, Jr. (Wadsworth Publishing Company, 1988).

A Watery World

Diversity doesn't end at the water's edge. In fact, an incredible variety of living things inhabit the world's lakes, rivers, **wetlands**, and oceans. A single **coral reef**, for example, can support more than 3,000 species of fish and invertebrates, such as giant clams, sea urchins, sea stars, and shrimp. Hectare for hectare, there can be more life in a healthy wetland than in almost any kind of habitat. Take **mangroves**, for instance. These rich wetlands, which are found along many of the world's coasts, are nurseries for some of our most commercially important species, including shrimp, crabs, oysters, and fish. They also provide a variety of ecosystem services including flood control, water purification, and food and shelter for a host of aquatic creatures.

Culture and Nature

The diversity of human cultures is also an important part of biodiversity. All humans belong to a single species (Homo sapiens), but within our species are thousands of different cultures. There's evidence to show that the natural world is nearly as important in influencing the development of different peoples as it is in influencing the evolution of different plants and animals. For example, cultural practices are often heavily influenced by environmental conditions. In arid places such as the Sahara or Kalahari Deserts in Africa, people developed nomadic cultures, moving around from place to place in search of resources, rather than settling in one place for a long time. Agricultural communities have stories and proverbs that are passed from one generation to the next that tell when and how to plant crops depending on local climate and other environmental factors.

Activity 1: All the World's a Web

OBJECTIVES: Define **biodiversity** and create a word web that illustrates some of the complex connections in the web of life. Discuss at least one way biodiversity affects people's lives.

SUBJECTS: Science, Social Studies, Language Arts

SKILLS: organising, analysing (identifying components and relationships among components), interpreting, relating

AGES: 11+

TIME: one session

MATERIALS: chalkboard, pencils, container for key words, and key words on separate pieces of paper

BACKGROUND

Biodiversity is the variety of life around us—and much more. It's also everything that living things do—the grand total of interactions of living things among themselves and with their **environment**. These interactions can be as simple as a moth's dependence on one species of plant for food and the plant's dependence on the moth for pollination. At another level, the moth and the plant also depend on all of the elements that make up their **ecosystem**—from clean water to the right climate. At still another level, this ecosystem interacts with other ecosystems to form a huge, global system of interacting parts.

This introductory activity is a great way to start a biodiversity unit because it focuses on connections, which are the heart of biodiversity. By making word webs (see example on page 13) with the words provided, students can begin to consider the complex connections that characterise life on Earth. The activity can also give you an idea of how your students are thinking about biodiversity before you start a unit.

GETTING READY

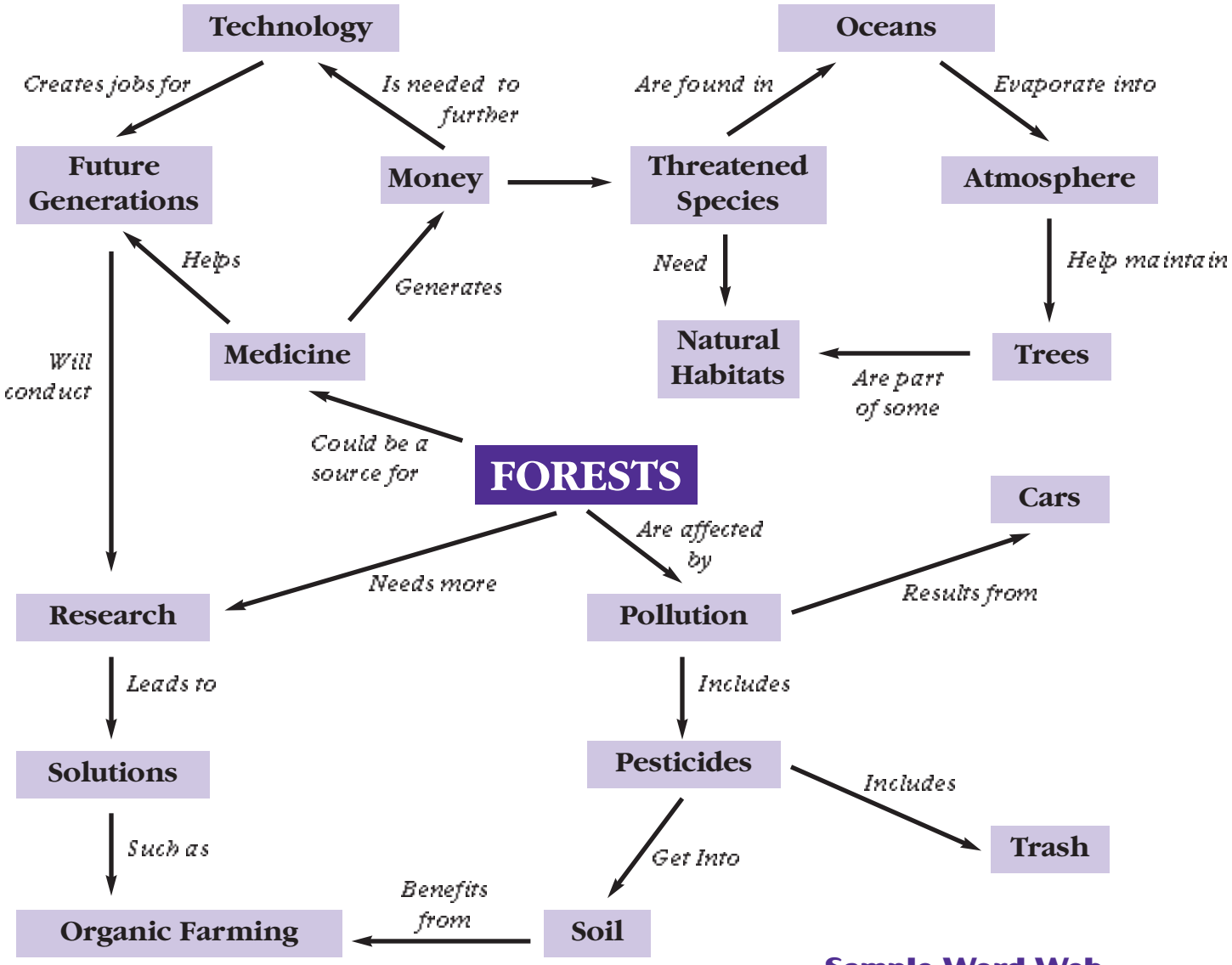
Write each of the key words (see box on page 14) on a separate piece of paper, and put all five key words into a container. Write the web words (see box on page 14) on a chalkboard. Each key word can form the hub or centre of a web. The web words will connect to the key word or to other web words.

Activity adapted with permission from *Biodiversity Basics*, published by World Wildlife Fund as part of *Windows on the Wild*, an international biodiversity education program. ©1999.

WHAT TO DO

1. As a group, create a sample word web.
Use the word "school" as a key word to create a word web on the chalkboard. Ask the students what other words they think of when they think of their school. Some examples might be teacher, student, books, desks, and homework. Make sure you write down the connections between each web word. For example: Students learn from teachers. Teachers give out homework, and so on.

2. Review vocabulary and divide the class into groups.
Go over any key words and web words that the students aren't familiar with, and then have someone from each group pick a key word from the container. Tell the groups to write that key word in the centre of a piece of paper. Next give them time to create a web using as many of the web words as possible. Encourage them to write



Sample Word Web

Key Words:

Earth
animals
plants
people
energy

Web Words:

Earth
animals
plants
people
energy
technology
natural habitats
crops
trash
shopping
soil solutions
pollution
twenty-first century
pesticides
food
oceans
money
water
human population growth
school
cars
threatened species
organic farming
atmosphere
future generations
air
medicine
trees

in words that describe the connections they're creating. Examples include verbs and phrases such as "influences", "affects", "benefits", "is helped by", "can lead to", and "can cause". For example: people benefit from medicine, medicine comes from plants, human population growth can cause loss of natural habitats, pollution can affect threatened species, and so on.

3. Discuss the webs.
Each group should be able to explain the connections that they drew between the key word and the web words, as well as between the different web words. Ask the students if they notice any similarities among different groups' webs and have them work as a group to identify and write down two or more of these similarities. You might also want to have them write down any differences they notice. Use their ideas to start a discussion.

4. Introduce biodiversity.
Write the word "biodiversity" where everyone can see it and ask the students for their ideas on its meaning. Use the glossary and background information to familiarise the students with the word. Explain that biodiversity is the ultimate web because it includes all life on Earth.

5. Create new webs.
Have the same groups try their hand at creating webs as before, but this time use the word "biodiversity" as the key word. They can add any new web words they might think of that may not be on the list. Again, have students share their ideas.

FINISHING UP

This activity can be used as an assessment for other activities. You can have your students create webs after doing other activities in the guide to see if they understand the basic concept of biodiversity and how it is linked to other issues. Try the Web of Life on page 15 for another way to introduce the concept of biodiversity and ecological connections.

Activity 2: The Web of Life

BACKGROUND

An **ecosystem** is a community of plants, animals, and micro-organisms that interact with each other and with their physical environment. Forests, streams, lakes, coral reefs, grasslands, deserts, and rotting logs are all examples of ecosystems. Animals and plants in an ecosystem connect to and depend on each other for food, shelter, pollination and many other things. What happens to one member of an ecosystem can have an impact on the whole system. Although all species are important, some species, called **keystone species**, play critical roles in ecosystems. If a keystone species is removed from or added to an ecosystem, it is likely to cause a major disruption to that ecosystem.

Ecosystem change can be caused by humans or natural processes, such as floods, fires, or drought. Humans can also have a negative effect on ecosystems, for example through clearing forests, over-hunting or over-harvesting plants, or polluting the air, soil, and water. Sometimes disruptions like floods or fires that are part of an ecosystem's natural process can be made more severe or more frequent because of the way humans use the environment. For example, humans use fire to clear land for agriculture, but sometimes if the right precautions aren't taken, fires can get out of control and burn larger areas than were originally planned. Depending on the severity of the disruption and the species affected, ecosystems may adjust to a crisis quickly or may sometimes take a long time to recover, or even be changed forever. It is often hard to know exactly how each species is connected to all the rest and how harming that species may affect the whole system.

OBJECTIVES: Demonstrate understanding of how different parts of an ecosystem are interconnected.

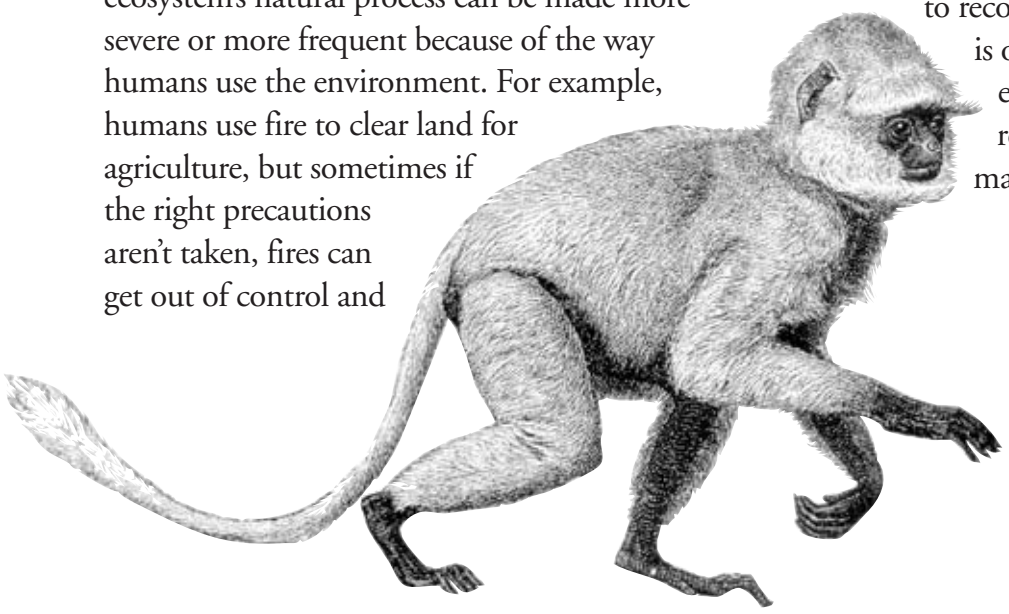
SUBJECTS: Science, Language Arts

SKILLS: creative thinking, oral expression, role-playing, cause and effect, cooperation

TIME: One session

AGES: 9+

MATERIALS: ball of long rope, twine, or heavy-duty string (at least 20 meters)



GETTING READY

Choose a local ecosystem (such as a forest, coral reef, or savanna) and with your students create a list of the various living and non-living things in that ecosystem (see "Sample Forest Ecosystem Members" for ideas of plants and animals from a tropical forest ecosystem). Remember to not only think of common animals, but also to include insects, fungi, fish, plants, microorganisms, and other living things. Assign each student the name of a plant, animal, microorganism, or non-living thing in the ecosystem. If you have time, students can write the name of their ecosystem member and draw it on a piece of paper and tape it to the front of their shirts. Having these signs on their shirts will help the students remember who's who throughout the activity.

Sample Forest Ecosystem Members

sun	water	soil
trees	wild pig	air
frog	snake	log
monkey	hummingbird	
butterfly	lizard	
insect	bee	
parrot	tortoise	
bird of prey	small plant	
large cat	vine	
mushroom	orchid	
snail	alligator	

(Be sure to include a human in the web!)

WHAT TO DO

1. Create an ecosystem.
Ask students to stand in a circle and explain that together they represent an ecosystem and each student represents a part of the ecosystem. Have students look around the circle and think about how plants, animals, microorganisms, and non-living things in their ecosystem are connected. Use "Eco-Connections" on page 17 for ideas.

2. Weave the web.
Ask one student to hold onto the end of the string and toss the rest of the ball of string to another student, explaining his or her ecological connection to that other student. For example, the tree student might say that she is connected to the bird student because she provides shelter for the bird. The bird then might say that he is connected to the snake because snakes eat birds. As each student makes a connection, help wrap the rope around the back of each student's waist, forming a big complicated star-shaped web among the students. It works best if students are connected to others across the circle from themselves, rather than next to each other.

3. Talk about the connections.
When all the students are connected to the web, explain that harming any part of the web can hurt the entire web, sometimes in ways that we don't foresee, because everyone is connected to everyone else in the ecosystem. Have the students imagine what would happen, for example, if the trees were cut down (the tree student can start to shake or tug on the rope), or if the birds went extinct (have the bird student fall to the ground). Ask the other students if they can feel the changes through their string.

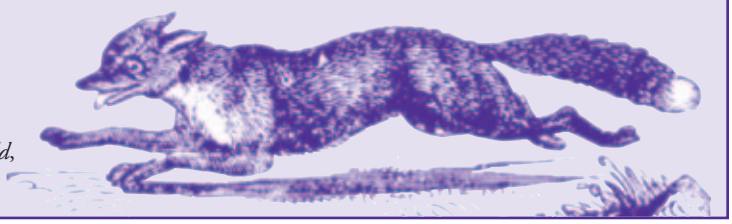
FINISHING UP

After students have played for a while, have them stop and discuss which members of the ecosystem have the most connections to others and why this

ECO-CONNECTIONS

Encourage students to think creatively about the connections and similarities among the different members of an ecosystem. For example, remember to use some of the following connections:

1. a small animal that a bigger animal depends on in some way (insects are food for many animals)
2. a big animal that a smaller animal depends on in some way (fleas and ticks depend on bigger animals such as deer; mosquitoes depend on humans and other warm-blooded animals, some birds get food by eating insects that live on larger animals)
3. a plant that grows on other plants (bromeliads, orchids, moss)
4. an introduced species that has caused problems for native species (a plant that takes over, animals that compete with native animals for food)
5. a wild animal that can thrive in or around people's homes (cockroaches, house flies, house mice, raccoons)
6. an animal that eats dead things (wood beetles, springtails, termites, millipedes, crows, gulls, vultures)
7. an animal home that is in or on a plant (nests and dens in trees, cocoons attached to plant stems and leaves, insect galls)
8. a) a plant that benefits humans in some way (crops, trees [timber, shade trees, food, windbreaks], medicinal plants, plants that provide fibres);
   b) a plant that harms humans in some way (poisonous or stinging plants)
9. a) an animal that benefits humans because of the role it plays in its habitat (bees, bats, butterflies, wasps, and moths pollinate crops; dragonflies and bats eat mosquitoes; earthworms aerate and mix the soil; and some snakes eat rodents that might otherwise eat crops or cause other damage);
   b) an animal that harms humans in some way (mosquitoes, biting ants, rats, poisonous snakes)
10. an animal that looks like a plant (insects such as praying mantids or certain moths that mimic twigs, leaves, bark, and other plant parts)
11. two species that are useful to each other in some way (honey bees and the flowers they pollinate, clownfish and sea anemones, egrets and cows)
12. an animal that spends its life in two different habitats (certain migratory birds, amphibians and insects such as dragonflies that spend part of their life in water and part on land, fish that travel back and forth between freshwater and saltwater habitats)
13. an animal that eats seeds or fruits and then spreads the seeds by passing them as waste (birds, fruit bats, and other large mammals)
14. something that turns into soil (rotting log, crumbling rock, dead leaves)
15. a plant that depends on animals in some way (fruit trees, any plant that is pollinated by animals or that has its seeds dispersed by animals)



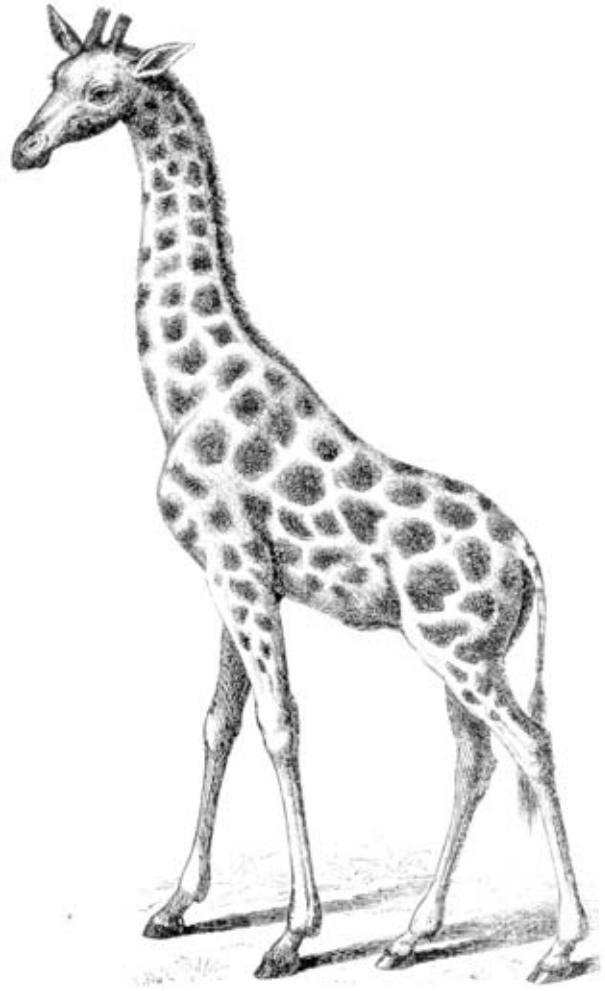
Activity adapted with permission from *Biodiversity Basics*, published by World Wildlife Fund as part of *Windows on the Wild*, an international biodiversity education program. ©1999

might be the case (trees provide food and shelter for many species, for example). What might happen if one of the big animals that eats other animals disappears? With fewer key **predators**, the animals the predators eat become more numerous, which can affect many other interactions in the system. Animals such as large predators that are important to the way the whole ecosystem works are examples of keystone species. What might be a keystone species in your local ecosystem? Discuss the status of ecosystems in your area–are they healthy or has there been some sort of disturbance to the system (pollution, deforestation, over-hunting)?

Have your students choose from one of the following concluding exercises:

- Write a paragraph that describes a connection that they noticed for the first time.
- Write a paragraph that describes one connection they observed during the game. Then have them write a second paragraph that speculates on what the effects might be if one of the "connectors" were to suddenly disappear.
- Write one or more paragraphs either supporting or refuting the following statement: *People are a part of nature*. Have them express their agreement or disagreement with the statement, along with examples that support their view.

If you want, go on an expedition to a natural area near your school. Ask students to see how many kinds of ecological connections they can observe. Use the list from "Eco-Connections" for guidance. After observing local ecosystems, you can play the game again or try it with a different ecosystem.



In Brazil, young people from fishing villages near the Marine Fishing Reserve of Corumbau are part of an environmental team that cultivates oysters to replenish the oyster populations their families depend on. By helping conserve biodiversity, they ensure their own future livelihoods as fishers.

Activity 3: BioBlitz

OBJECTIVES: Name several native plants and animals and describe your local environment. Design and carry out a biological inventory of a natural area.

SUBJECT: Science, Language Arts

SKILLS: gathering (collecting, observing, researching), citizenship (working in a group), reporting

AGES: 11+

TIME: two sessions and homework time

MATERIALS: paper, pencil, chalkboard, plastic bags or containers (nets, sieves, scoops, jars, etc.)

BACKGROUND

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

Activity adapted with permission from *Biodiversity Basics*, published by World Wildlife Fund as part of *Windows on the Wild*, an international biodiversity education program. ©1999.

GETTING READY

Copy the "Ecoregional Survey" questions on the chalkboard.

You should take the survey yourself to generate possible answers. Check with a local naturalist, park guard, or other knowledgeable person in your area for answers if you are unsure.

ECOREGIONAL SURVEY

1. What major **habitat** type do you live in? (*e.g.* **temperate forest, temperate rain forest, grassland, shrubland, desert**)
2. Name 3 **native** trees that grow in your area. Collect a leaf from each one.
3. Name 5 native edible plants that grow in your area and list the seasons in which they are available.
4. Name 1 poisonous plant in your area.
5. Name 10 native animals that live in your area.
6. Name 3 native animals that you can see in your area at any time of the year.
7. Name 3 **migratory** animals that live in your area and list the seasons you can see them.
8. How has your area changed in the past 25 years? (ask your parents or neighbors)
9. What species in your area—if any—are **threatened**?
10. What natural events or processes influence the land around your community? How have they affected the land? (earthquakes, volcanic eruptions, fires, flooding, etc.)
11. Are there any **protected areas** near your community? Why are they protected?
12. Name a non-native species that has created problems in your area.

WHAT TO DO

PART I

1. Give students the ecoregional survey.
Make sure you go over any unfamiliar terms with the class (use the glossary for definitions). Give students about 10 minutes to complete the survey. Afterward ask the students how they think they did. (Ask students not to share their answers at this point.) Collect the completed sheets as a pre-test of the students' knowledge.

2. Divide the group into teams to complete the survey.
Divide your students into teams of about four students each. Ask each team to copy the ecoregional survey questions. Tell the students that the members of each team should work together to complete the survey again as accurately as possible (or assign each team a different set of questions from the survey). Explain that the students can use whatever resources they can find to answer the questions, including interviewing community elders or local park rangers. Stress that they should find the most accurate information they can, and encourage them to create drawings of any animals and plants they list.

3. Set a time limit on research.
Give the students at least two days to find answers to the questions.

4. Go over the survey results.
Once the students have finished the survey, have them share the information they found and compare their answers to the pre-test. Did students find different answers to some of the questions? (For example, how extensive was the group's list

of native plants?) What were their sources? How did the students find these sources? Were they surprised by any of the information they found?

PART II

5. Find an outdoor natural area nearby.
The students will need an outdoor space to conduct a "BioBlitz Survey". School grounds or a nearby park will work. You will need to sketch a quick "site map" of the area on the board. This map should show the boundaries of the study area and roughly where different plants grow. Be sure to have students copy down the "BioBlitz Survey" categories and to provide them with containers for collecting specimens when they go outside.

Bioblitz Survey	
Plants	Insects
Reptiles and Amphibians	Birds
Mammals	Non-Insect Invertebrates (snails, crabs, etc.)

6. Set the stage.
Ask your students to imagine that their school is planning to build a new building. However, before the school goes ahead with the development plans, it needs to know how biodiversity might be affected by the new building. Students have been asked to investigate the area and to create a list, or inventory, of all the major species found on the site.

7. Explain the task.
Explain to the students where their study site is located and show them the "site map" you sketched earlier. Explain each of the different categories that they should investigate on their survey sheet and give some examples of each.

Divide the group into teams of four to five students and explain that the team members have to work together to design a plan for how they will fill out the survey category areas as completely as possible in a relatively short time. Where are they going to look? What are they going to look for? What kinds of questions are they going to ask? How will they record what they find? Are they going to draw sketches of different species, collect specimens, or take very detailed notes? How are they going to divide up the work?

Give students 30 minutes to work at the site to create a plan for their survey and let them know whether they'll be able to bring samples back for identification.

8. Review the study plans.
Once the students have designed their study plans and decided what questions to ask to gather the necessary information for their survey, meet with each group independently and have the group explain its design. Make sure that each group has evenly divided the amount of work to be done among the group members, will be getting to all areas of the study site, and has accounted for inventorying the full range of species types listed on its survey sheet.

9. Conduct the BioBlitz.
Take the students to the study area and give them approximately 30 minutes to conduct their surveys. (This may have to take place on the second study period allocated for this activity if you run out of time). Although identification is not the ultimate goal of this activity, you might want to

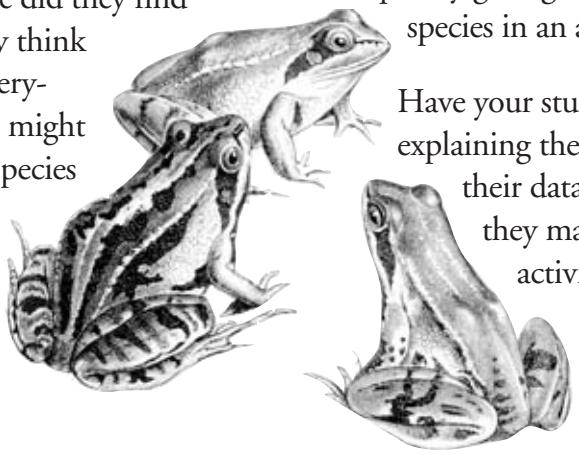
Collection Tips

- Instruct students to collect dead leaves, nuts, or other parts that do not kill or harm the plant. Encourage the students to draw sketches of the plants they want to record or to take small samples from common plants.
- Tell students not to collect bird nests. Sometimes it's hard to distinguish a nest still in use from one that isn't used anymore.
- Encourage students to be gentle when turning over rocks and logs. If they find insects, centipedes, lizards, or other small animals, encourage students to observe closely, but leave the animals in their homes. (Collecting can be stressful for some animals. Plus, they can be very difficult to maintain in the classroom, even for a short period of time.)
- Have students carefully return rocks, logs, and plant matter to their original location.
- Set boundaries and time limits so that students don't scatter or get lost.

help students identify what they are seeing. Students can collect specimens to take back to the classroom, although some things should not be collected: animals (including insects), delicate or rare flowers, dangerous plants, and threatened plants (see "Collection Tips" on pg. 21). Have the students draw sketches of items that should not be collected or that are hard to describe. Pass out plastic bags and any small containers you have for use in specimen collection.

10. Finalise findings.
Give the teams time to review and identify what they found and to consolidate information. Have them make notes and make a sketch of the area they surveyed to indicate where certain things were found or where animals or plants were concentrated. You may even have the students prepare a presentation around any specimens they collected to share with the class.

11. Share results.
Have the groups report on their findings and discuss the processes they used. How many different living things did they find? Where did they find different things? Did they find any native species? Non-native species? Were species evenly distributed across the site or did the students find greater variety in particular areas? If there were distribution differences, where did they find the greatest diversity? Do they think that as a group they found everything out there? What factors might have affected the number of species they found? For example, would they have expected to find the same number and types of species if they'd done their BioBlitz at a different time of year? What if it had been night time? Did one team have a way to complete the investigation that worked particularly well? What was the hardest thing about conducting their BioBlitz? Were they surprised by anything they found or didn't find?



FINISHING UP

Have the students look back at the questions they generated when they created their survey plans. Based on their recent field experience, is there any other information they need to know about the land to make a complete inventory of its biodiversity? What kinds of organisms have they probably missed? Do they think these kinds of rapid assessments are useful? (It's often difficult to find all the species in an area in a short amount of time. Because animals tend to come and go from different areas, they can be missed if the amount of time spent looking for them is too short. Very small or microscopic organisms can be hard to find and identify. Also, there are often seasonal changes in the organisms in an area, so an inventory conducted at one time of year might be very different from an inventory of the same area at a different time of year. However, despite their problems, rapid assessments are often very useful because they are a way to quickly get a good idea of the diversity of species in an area.)

Have your students write an article explaining the process they used to collect their data, including any conclusions they may have drawn during the activity.

BIODIVERSITY CONNECTIONS

BIODIVERSITY CONNECTIONS

Why Is Biodiversity Important?

If you were to ask a dozen biologists or sociologists to explain why a high level of **biodiversity** is important, you'd probably get a dozen different perspectives. However, you'd hear one message loud and clear: The quality of our lives depends on it. Biodiversity does more than provide a variety of products and resources; it also keeps the planet liveable for us and for all other species. Biodiversity helps maintain the **atmosphere**, keep the soil fertile, purify water, and generally keep the world running smoothly. In this section, we'll explore the many ways biodiversity enriches our lives and why we're so dependent on it. In the process, we'll focus on some of the complex ecological interactions that make up life on Earth.

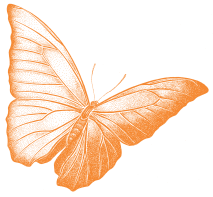
The Power of Plants

There's almost no end to the role plants play in the workings of our planet. For example, besides the essential role of giving off oxygen and thus maintaining a breathable atmosphere, plants keep us cooler by releasing moisture through their leaves and by providing shade. They also remove the main "**greenhouse gas**", carbon dioxide, from the atmosphere.

But that's not all. Scientists are finding more and more examples of the importance of plant communities to overall **ecosystem** vitality. In some parts of Africa and the Middle East, excessive cutting of trees for fuel wood and the destruction of grasses and shrubs by goats and cattle is converting more and more land to desert. In other parts of the world, loss of tree cover has caused massive mudslides, erosion, and flooding. These examples show that when plant communities are damaged or destroyed, so too are important biological services and functions that people and other living things depend on.

Food and Farming

Of about 300,000 known plant species on Earth, only about 7,000 species (about 2 percent) have been used for food by people throughout history. Today, fewer than 20 of those species make up the bulk of the world's food supply. Of all the varieties within these species, very few are commonly used. For example, in India, where 30,000 varieties of rice were once grown, fewer than 10 varieties now make up 75 percent of the country's rice production.



Intensive agricultural production of just a few crop varieties, called industrial farming, is a common practice in much of the world. These crop varieties are attractive to many farmers because they have been bred to produce an optimum yield. In addition, seed companies generate the most profits by producing and selling just a few varieties. Unfortunately, these high-yield varieties (which often lack genetic diversity) tend to be more susceptible to destruction by disease, droughts, floods, and insect pests. Thus, more pesticides and water often have to be used to produce them. In addition, relying on only a few varieties can create serious problems: When a pest or disease attacks an individual plant, it can quickly spread through a large field of plants that are all the same variety. Major crop failures can be attributed to a lack of genetic diversity.

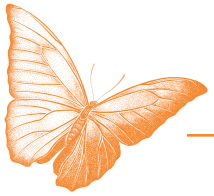
For these reasons, some farmers and agronomists (people who study agriculture) are beginning to recognise the value of growing and maintaining different varieties of crops and seeds. Many are also trying to find economical alternatives to industrial farming–ways to increase yields while protecting diversity. Indigenous and other traditional farming communities are often invaluable sources of genetic diversity for agricultural plants. In these communities, many varieties of native seeds have survived and have been grown and nurtured for generations.

Protected wild places can also be good sources of genetic diversity for crops, since wild relatives of our domesticated plant varieties often still exist in these places. By crossbreeding these wild species with our most popular domesticated crop plants, agronomists can increase crop yields and improve nutritional content, as well as enhance disease and pest resistance. Biodiversity protection, then, has important implications for agriculture: If we protect the places that harbour wild plants, we'll be better able to ensure a continued, reliable source of new genes for agriculture.

The Link to Human Health

- In Ghana, where the tropical forest has been reduced to 25 percent of its original size, approximately 75 percent of the human population depends on wild animals hunted for food to supplement its diet. Forest depletion, along with subsequent reduction in animal populations, has resulted in a sharp increase in malnutrition and disease.
- More than 4.5 billion people—some 80 percent of the world's population—still rely on traditional plant and animal-derived medicines as their primary source of health care.
- Some people have theorised that the loss of tropical forests in Africa, along with other habitat disruptions, is a contributing factor in the emergence of serious viruses and other contagious disease agents in recent years.

Adapted from *Biodiversity, Science, and the Human Prospect* by the Center for Biodiversity and Conservation at the American Museum of Natural History, 1997.



A Diverse Prescription

Go to a pharmacy and you'll likely see a number of products derived from wild plants and animals. In fact, more than 40 percent of the medicines we rely on contain compounds derived from or modelled on substances extracted from the natural world. About 120 useful prescription drugs are derived from 90 species of plants alone. Many of our best drugs for treating cancer are derived from plants. Microorganisms may well be the most well represented species in pharmacies around the world: More than 3,000 antibiotics, including penicillin and tetracycline, were originally derived from these tiny life forms. All species have the potential to provide us with useful or even life-saving products.

Although the use of plants and animals for medicine is one of the strongest arguments for conserving biodiversity, over-harvesting of some species for traditional remedies is also a major threat driving many species to extinction. The demand for certain species, such as tigers and rhinos, used in Traditional Chinese Medicine (TCM), for example, is causing a threatened species crisis throughout Asia.

A Sampling of Free Services from the Wild

- Through photosynthesis, green plants remove carbon dioxide from the atmosphere and replenish the supply of oxygen.
- A diverse group of **bacteria** convert nitrogen in the air into a form that plants can use.
- Dead and decaying organisms are decomposed and recycled by **fungi**, bacteria, insects, and other scavengers and decomposers.
- The flow and quality of water within watersheds are regulated by the biodiversity within the area's soils, waterways, and wetlands.

Adapted from *Biodiversity, Science, and the Human Prospect* by the Center for Biodiversity and Conservation at the American Museum of Natural History, 1997.

Biodiversity and the Economy

A huge number of products derived from wild species also help to boost all levels of our economy. In fact, many businesses and manufacturers have found that biodiversity can make a profit. Here are a few examples:

- Each year, many tourists visit national parks and protected areas to see their unique biodiversity, spending money that strengthens local economies.
- Certain types of bacteria make nitrogen available for use by crops, pastures, forests, and other vegetation. Economists estimate that the value of this activity is US $33 billion annually.
- Bees, butterflies, birds, bats, and other animals pollinate 75 percent of the world's staple crop species and 90 percent of all flowering plants.
- The monetary value of services provided by ecosystems throughout the world is estimated to be US $33 trillion per year. (The value of all human-produced goods and services per year is about US $18 trillion.)

The Nature Connection

The desire of many of us to connect to the natural world is very easy to see. Watch a small child's fascination with animals or the details of a flower. Compare the environment of the countryside with the hectic pace of the city. Although social scientists are still in the early stages of learning about the links between nature and the human mind, we do know that wildlife and wildlands provide a sense of wonder, fascination, and rejuvenation for millions of people, old and young, around the world.

All Species Count

Many people believe that biodiversity should be preserved not just because it is valuable to us in some way, but simply because it exists. Some people who hold this opinion believe that each species should be respected and protected because it is the product of many thousands or millions of years of evolution, and we have no right to interrupt the evolutionary process. They also argue that we have no right to destroy something we did not create and that future generations deserve a natural world that is rich and varied. Because we have the power to destroy species and ecosystems, they say, humans have a moral obligation to be careful stewards of the Earth.

Our children will inherit the planet with whatever biodiversity we pass on to them. The decisions we make as individuals and as a society today will determine the diversity of genes, species, and ecosystems that remain in the future. Many of these decisions are not easy, especially when they involve balancing the immediate needs, rights, and desires of individuals and communities with the measures necessary to protect

nature for the long term. Because people have different values and desires, conflicts over the conservation of biodiversity often develop. Understanding what biodiversity is and how different people value it is an essential first step to designing strategies for long-term conservation.

Some Reasons People Need Biodiversity

- Food
- Medicine
- Economic opportunities (tourism and the use of forests, fish, and other natural resources)
- Pollination
- Clean air and water
- Flood and erosion control
- Natural rubbish removal (decomposition)
- Spiritual, cultural, and aesthetic values

Can you think of others with your students?

Activity 4: The Spice of Life

OBJECTIVES: Explore personal beliefs and values about protecting **biodiversity**. List several reasons it is important to protect biodiversity.

SUBJECTS: Language Arts, Science, Social Studies (Ethics)

SKILLS: organising (prioritising), analysing (discussing), presenting (articulating), citizenship (debating, evaluating a position, taking a position, defending a position)

AGES: 11+

TIME: one session

MATERIALS: chalkboard or large pieces of paper

BACKGROUND

People's feelings about biodiversity issues, including the importance people place on wild species and places and whether they think biodiversity should be protected, do not depend on just their knowledge of these issues and the sciences that relate to them (ecology, biology, sociology, political science, economics, and so on). People's feelings also depend on personal belief systems and values.

This activity is designed to give your students a chance to examine their personal beliefs and values about biodiversity issues. The activity will also help students sharpen their thinking by sharing their opinions and feelings with their peers. The students first discuss their points of view in small groups and then talk about biodiversity **conservation** as a group. We've provided a series of numbered questions to get the students thinking about a range of biodiversity-related concerns, as well as additional guiding questions to help direct the discussions.

GETTING READY

Write each of the six "Why Care About Biodiversity?" statements on page 29 on separate pieces of paper. Also write the word "Other" on a seventh piece of paper. Write large enough so the students can read the statements from all areas of the room. Be sure to also read through and familiarise yourself with the "Valuing Biodiversity" questions on page 30.

WHAT TO DO

1. Review definition of biodiversity.
Ask students what they think biodiversity is. Write their answers on the board. Add other ideas you feel are necessary. Use background information in the beginning of the guide for guidance.

2. Ask your students whether protecting biodiversity is important and why they feel the way they do.
Explain that many people feel that it's important to protect biodiversity and that they have diverse reasons for thinking so. Ask your students how they feel. What reasons can they give to protect biodiversity? Write their ideas on a chalkboard. (It might also help to give them a few minutes to write their ideas before talking.)

Activity adapted with permission from *Biodiversity Basics*, published by World Wildlife Fund as part of *Windows on the Wild*, an international biodiversity education program. ©1999

3. Put up the statements and read each one aloud.
Tape each of the seven statements you copied earlier in different places around the room. Place each one high enough for everyone to see. Explain that the statements represent many of the key reasons people have given for why it is important to protect biodiversity. As a group, go over each of the statements. Compare the ideas represented in the statements with the lists that the students generated.

4. Students choose a statement to stand near.
Ask your students to carefully consider all of the statements. Have each of the students pick one of

WHY CARE ABOUT BIODIVERSITY?

- It is important to conserve the diversity of life for medical and economic reasons. Plants and animals could provide us with additional foods, medicines, and other products that will save lives and benefit society.
- It is important to protect the diversity of life because biodiversity helps maintain important ecological processes such as oxygen production, pollination, and flood control that, in turn, help support all life on Earth.
- Our lives would not be as rich if we lost species such as bears, beetles, hawks, frogs, lizards, and tigers, and the habitats where they live.
- The rich diversity of life also allows for important recreational activities such as hiking, fishing, camping, and bird watching.
- It is important to protect the diversity of life because no generation has the right to destroy the environment and resources on which future generations will depend. It is our responsibility to take care of the diversity of life.
- It is important to protect the diversity of life because biodiversity provides inspiration and provokes curiosity and imagination. Art, music, and poetry are often inspired by the diversity of life. Many of our technological advances, such as flight, have been inspired by examples found in nature.
- It is important to conserve the diversity of life because all species have a right to exist.
- Other

GUIDING QUESTIONS—VALUING BIODIVERSITY

1. **Is it important to conserve the diversity of life for medical and economic reasons?**
   - Do people actually need wild plants and animals for either medicinal or economic reasons?
   - Can people make the medicines they need in a laboratory?
   - If a plant or animal species is not known to have any medical or economic benefit to people, is it then okay to let the species die out?
2. **Does biodiversity help maintain important ecological processes that help support life on Earth?**
   - What sorts of ecological processes does biodiversity help maintain?
   - People have developed an amazing array of technologies to deal with particular problems—everything from water treatment plants that purify sewage water to scrubbers that can take pollutants out of the air from factory smokestacks. Isn't it fair to assume that people will be able to develop technologies that can perform essential ecological processes in place of biodiversity?
   - Are there any down sides to technological solutions?
3. **Would your life be affected in any way if we lost species such as ants?**
   - Is there anything about these species that makes them special?
   - How would you feel if poisonous snakes, biting insects, and other harmful species became extinct?
   - Are there species that you think are more important to protect than others? Which ones? Why?
4. **Do all species have a right to exist?**
   - Do people have the right to use any of the world's resources however they want? Why or why not?
   - Does the right to exist apply to ugly species that are of no use to people?
   - Some species have been around for millions of years—and have survived incredible periods of destruction and change on the planet. Should that influence whether we decide to protect a species?
5. **Some people argue that no generation has the right to destroy the environment and resources that future generations will depend on. Do you agree or disagree with this idea?**
   - Why should people today do without things they want when we don't even know what future generations will need or want?
   - Do you feel that past generations have left you with the environment and resources you need to live?
   - Many species have already become extinct. Has your life been affected in any way by the absence of these species? Will future generations really care about species that disappeared before they were born?
6. **Is the diversity of life important for inspiring inventors and artists and for spurring curiosity and imagination?**
   - What human activities are inspired by nature?
   - What inventions, stories, or works of art can you think of that were inspired by living things? Could these have been produced without the inspiration of nature?

- Will photographs and films that have been made of wild plants and animals be sufficient to provide inspiration to future writers and artists?

7. **Is the diversity of life important for recreational activities?**
   - What kinds of recreational activities rely on wild places or species?
   - Is it right to save an area so people can hike and fish if it means that other people lose their jobs? What types of jobs could be threatened by a **protected area**?
   - Does the fact that someone has done a particular job all his or her life—and perhaps one or more of his or her parents or grandparents also did the same job—give the person a right to keep doing that job even if it means wiping out a species or harming the environment? What kind of jobs could this relate to?
   - Should people be allowed to take part in any recreational activity even if it harms the environment? How do we balance the rights of individuals and the rights of society as a whole?

the statements and then go and stand near it. Explain that the statement the students choose should be one that they feel strongly about—either because they think it is an important reason to protect biodiversity or because they disagree with it. If they don't see a sign that reflects their viewpoint, they can stand at the sign marked "Other". Explain that there is no correct answer and that it's okay to stand either alone or with a group.

5. Discuss the choices that students made. After everyone has made a selection, have the students at each statement discuss among themselves why they chose that particular statement. After about five minutes of discussion, ask one person from each group to summarise the discussion. You might want to record each group's points on a chalkboard, especially any ideas that came from the group who stood under "Other".

6. Open up the discussion to the entire class. After all the groups have given their summaries, use the guiding questions to spur a group discussion of some of the arguments that biologists, conservationists, ecologists, economists, and others have put forth for protecting biodiversity. Read one of the numbered questions in "Guiding Questions" and have the students react to it. You

do not need to ask the class all the guiding questions, and the students do not need to discuss each of the numbered questions in turn.

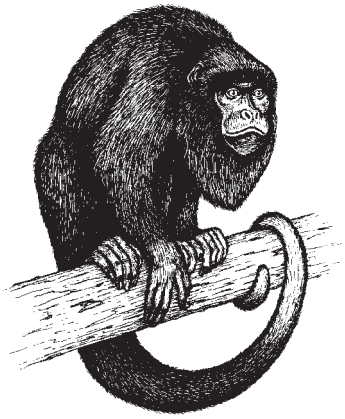
During the course of the discussion, make sure that the students confront the issues highlighted by each numbered question and that they explain why they feel the way they do. Have them give examples whenever they can, and be sure to challenge their ideas—especially when the students reach answers quickly or all of them seem to be agreeing with each other. Allow enough time for the students to fully discuss their points of view. Also give them an opportunity to research issues that come up.

FINISHING UP

Let the students choose between the following two writing activities:

1. Have the students write a personal statement about the importance of protecting biodiversity. Explain that there is no right or wrong answer to this assignment—and that they don't even have to think protecting biodiversity is important at all. However, they should carefully consider everything they've learned about biodiversity as well as all of the points made during their discussion to make a well-reasoned and well-supported statement. Encourage the students to consider medical, economic, and ecological implications of biodiversity protection, as well as recreational activities, artistic inspiration, and any obligations of present generations to future ones. Tell them to use examples to illustrate their points.

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



Every September in Papua New Guinea, students and community members celebrate International Coastal Cleanup day by picking up trash along the beaches of Milne Bay. Milne Bay has some of the world's richest coral reefs, but trash and pollution washing onto beaches, reefs, and waterways are harming biodiversity. By cleaning up their beaches, kids show pride in their environment and community as they work to improve habitat for marine life.

Activity 5:
Biodiversity Performs

OBJECTIVES: Work in teams to act out different **ecosystem** services. Describe several "free" services that **biodiversity** provides to humans and explain how these services make life on Earth possible.

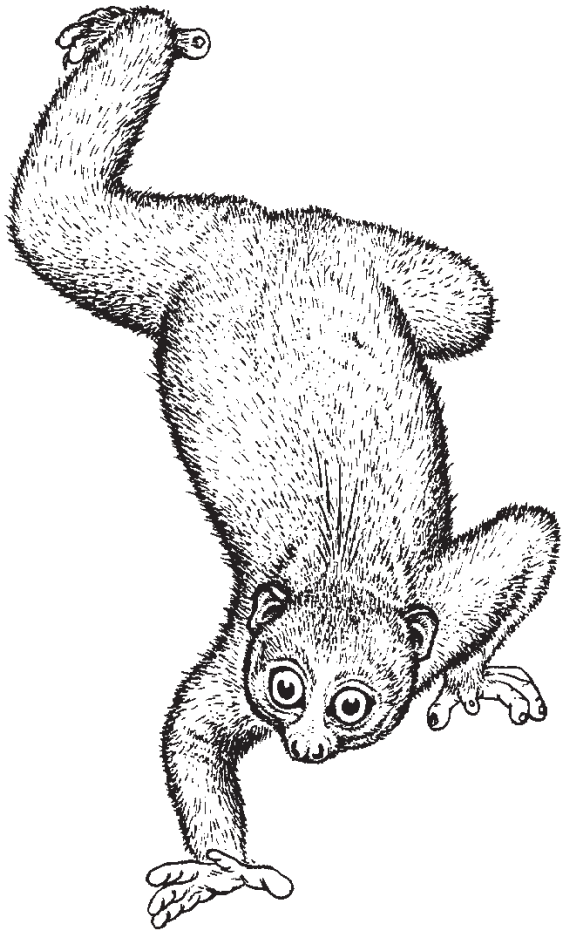
SUBJECTS: Science, Art (Drama), Language Arts

SKILLS: gathering (reading comprehension), analysing (identifying patterns), applying (creating), presenting (acting)

AGES: 11+

TIME: one session

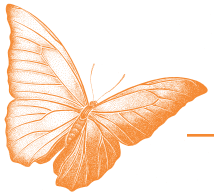
MATERIALS: paper and pen to make "Biodiversity Performs!" cards



BACKGROUND

Whether you realise it or not, ecosystems and the **species** within them perform many jobs that help make human life possible and more liveable. Much of what ecosystems do is difficult to watch or see, so it's easy to take these "secret services" for granted. Just remember, while you're eating, sleeping, working, studying, or playing, forests are helping to clean the air, oceans are regulating the climate, and wetlands are helping to purify water, minimise storm damage, and perform flood control. In this activity, your students can learn about some of the secret services that ecosystems and the species within them provide by creating charade-like performances for their peers.

Activity adapted with permission from *Biodiversity Basics*, published by World Wildlife Fund as part of *Windows on the Wild*,an international biodiversity education program. ©1999.



GETTING READY

Copy down or copy and cut out the following statements as cards.

Insects, birds, and bats help pollinate.

In their daily search for food, bees and other insects, as well as some birds and bats, end up moving pollen from plant to plant. While stopping at a flower for a sip of sweet nectar, the animals get dusted with pollen. When they fly to another flower, some of that pollen brushes off and the pollinated flowers are then able to make seeds. Pollination not only helps wild plants but also is important for crop plants. Most kinds of crops depend on these natural pollinators.

Some species help control potential pests.

Predators often help keep populations of potential pests in check. For example, birds, bats, wasps, and dragonflies are responsible for eating millions of insects that might otherwise gobble up crops, give us itchy bites, or spread diseases.

Some organisms decompose organic matter.

Some living things, called **decomposers**, get the food they need by feeding on dead things. Decomposers not only keep dead organisms from piling up, they also make the nutrients in the dead organisms available to living plants and animals. Any nutrients they use to build their own bodies become available to other animals that eat them. Also, the nutrients that pass through the decomposers as waste end up in the soil in simpler forms that plants can absorb with their roots. Imagine what life would be like without decomposers!

Wetlands help clean water

If you poured dirty water through a filter, you would expect cleaner water to come out. A similar thing happens in nature when water passes through a **wetland**. By slowing the flow of dirty water as it goes by, the vegetation growing in a wetland traps some of the pollutants and sediments. Still, plants aren't the only living things that clean water. Aquatic animals, such as oysters, which pump water through their bodies to filter out food for themselves, also end up cleaning the water they live in. Wetlands are areas that have waterlogged soils or are covered with shallow water either all the time or off and on. Freshwater and salt marshes and swamps, as well as bogs, are all wetlands. Thanks to wetlands, our job of filtering water is so much easier and inexpensive. Imagine how many water filters it would take to filter all the water that we use every day!

Plants help control erosion and flooding.

Have you ever seen rainwater rushing down a hillside that has little plant cover? With little vegetation (plant cover) to slow it down and absorb it, water sweeps away soil at a rapid rate. Plants slow down water, allowing the soil to soak it up. So plants help prevent both erosion and flooding.

Plants convert the sun's energy into energy we can use.

Although the first warm days of spring may make you feel energetic, we humans (and other animals) can't get the energy we need directly from the sun. Instead we rely directly or indirectly on plants. Green plants capture the sun's energy and convert it to starch and sugar through a process called photosynthesis. They store some of the energy in their leaves and stems. When animals eat plants, the animals get the energy that the plants stored and use it or store it. When animals eat animals that ate plants, they then get the energy that's passed along. Without green plants we'd all go hungry!

Plants and animals work together to help maintain the balance of gases in the air.

Plants and animals continuously cycle gases among themselves, the soil, and the air. For example, plants take in carbon dioxide from the air and then release oxygen into the air during photosynthesis. Animals, including humans, use oxygen in respiration and release carbon dioxide into the air.

WHAT TO DO

1. Introduce ecosystem services.
Ask students to give examples of ecosystems (such as **deserts**, **temperate forests**, **wetlands**, **coral reefs**, and so on). If your students aren't familiar with the word "ecosystem", you can lead a discussion that helps them understand that an ecosystem is a community of plants, animals, and other **organisms** that interact with each other and the physical environment. The soil beneath a fallen log, a salt marsh in an estuary, and a Brazilian rain forest are all examples of different-sized ecosystems.

Explain that ecosystems as a whole and the individual species that live within them perform many functions. Through their day-to-day activities aimed at their own survival, individual organisms end up performing jobs that help make life easier for us. The combined efforts of many species in an ecosystem also help make our lives more liveable. To help illustrate this idea, ask your students to explain how plants "help" the environment (produce oxygen, absorb carbon dioxide, reduce erosion, and so on). The students' answers will begin to underscore the important services that ecosystems and the species within them provide. Be sure to emphasise that species don't perform certain activities on purpose to make the planet a better place to live for humans. Rather, the actions that organisms take in order to survive can have beneficial side effects for other living things.

2. Set the stage.
Divide the class into seven groups, with about four students per group, and give each group a card that describes one of the free services that

ecosystems and species provide. If you don't have enough students, you can play the game in two rounds, with each group performing two services. Explain to students that they will have to discuss and practice a performance that gets across the idea described on the card. The audience (members of the other teams) will need to try to figure out what the service is and how it works. Remind the performers to act out the service rather than the words on the card. Some groups may need to divide their performance into several segments to get the full message across. Students may not use words during their performance, but if you would like to make the game less challenging, they can use sound effects and props. Group members can individually imitate an animal, plant, or other object, or the entire group can form an organism or object.

3. Set the students loose.
Give each group a card and allow the groups plenty of time to develop and practice their performances. When the students are ready, call one group at a time to perform. Make sure you know which card each group has. Let the performers finish their skit before the audience guesses. If the students can't guess correctly, you may want to provide additional clues as the performance is repeated. When you feel a correct answer has been given, choose a student to read the card to the class. You may also want to go over some of the services as a group to be sure everyone understands how each service works.

4. Conclude the activity.
Remind your students that whatever we call the important jobs that ecosystems and their species provide—"secret services", "ecosystem services", "nature's services", or "free services"—those services are happening around the clock and help make our lives more liveable. Ask your students to explain any connections they see between the services and **biodiversity**. It's because of Earth's natural diversity that we enjoy these benefits. The free services that ecosystems and species provide make life on Earth possible and are one of the most important reasons we need to protect biodiversity.)

FINISHING UP

Upon completion of the game, have each student summarise the services presented in the various skits and discuss how those services occur in the students' local community.

THE STATE OF BIODIVERSITY

STATE OF BIODIVERSITY

"Biodiversity is out there in nature, everywhere you look, an enormous cornucopia of wild and cultivated species, diverse in form and function, with beauty and usefulness beyond the wildest imagination. But first we have to find these plants and animals and describe them before we can hope to understand what each of them means in the great biological—and human—scheme of things".

—Hugh H. Iltis, botanist

What Is the Status of Biodiversity?

Many scientists think that we are now beginning to witness a spasm, or wave, of **extinction**—the greatest since the dinosaurs and many other organisms died out some 65 million years ago. Scientists estimate that the current extinction rate, due almost entirely to human activity, is more than 1,000 times the natural rate of extinction. They're concerned about the long-term effects of such rapid and massive extinction—not only on natural communities, but also on the planet's ability to sustain large numbers of humans.

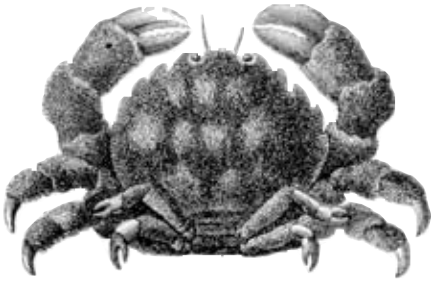
The connection between human activity and extinction seems straightforward enough: Our **population** and rate of resource consumption are growing, causing increasingly serious problems of **pollution** and **habitat** destruction. However, the relationships between human activity and biodiversity loss are often subtle and complex. This chapter explores some of these relationships, focusing not only on their biological and ecological aspects, but also on their political and social dimensions.

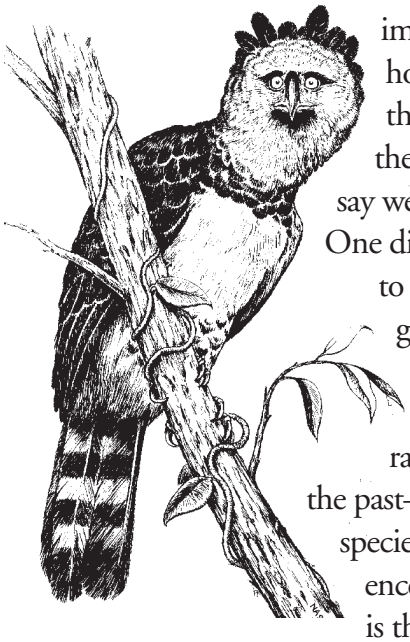
The Nature of Change

There's nothing unnatural about the process of extinction or about disturbance to Earth's ecosystems. More than 99 percent of all species that ever existed have become extinct over a period of more than 3.5 billion years of evolution, and ecosystems have expanded or receded in the wake of climate changes and natural disturbances. For example, areas of tropical forest in Africa and South America gradually gave way to **grasslands** during climate changes associated with the ice ages. As this gradual process occurred, many forest animals and plants died out while others evolved into species more suited to the changing habitat.

Sometimes relatively rapid rates of extinction, called spasms, are brought on by catastrophic natural events. Many scientists believe that such an event—in the form of an asteroid slamming into the Earth 65 million years ago—might have caused the demise of the dinosaurs. They theorise that the asteroid's impact may have created a massive cloud of atmospheric dust and vapour that blocked the sun long enough for many plants to die. This event set off a chain of extinctions (including that of the dinosaurs) that forever changed the composition of Earth's **fauna** and **flora**.

Five mass extinctions have punctuated the history of life on Earth. There are some



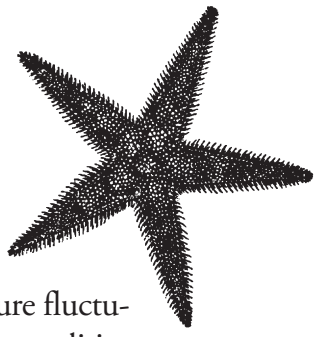


important differences, however, between these extinctions and the one many scientists say we're facing today. One difference, according to conservation biologists, is that today's extinction spasm is occurring more rapidly than those of the past—especially for plant species. Another difference scientists point to is that the potential for species and ecosystems to recover from this episode of extinction is probably far lower than with past episodes. That's because, in the past, certain species have escaped extinction by surviving in pockets of habitat that happened to be relatively unaffected by natural catastrophic events. Species that survived a global extinction episode in these refuges were able to gradually recolonise surrounding areas when conditions became more favourable. But today, many potential refuges are being destroyed or degraded by human activity. Many scientists worry that even if conditions do eventually improve, we have already lost too much habitat and genetic diversity to allow ecosystems to recover. Never before on our planet has one species been responsible for such a massive decline of global biodiversity.

Losing Ground

The loss of habitats—the places where organisms live and get the nutrients, water, living space, and other essentials they need to survive—is the primary reason biodiversity is in decline. When people cut down a forest, fill in a **wetland**, trawl a seabed, or plough a grassland, they change the natural habitat of the species that live there. Not only can such changes kill or force out many animals, **microorganisms**, and plants, but they also can disrupt complex interactions among species.

Often, habitats aren't so much destroyed outright as they are chiselled away little by little. When not carefully planned, agricultural fields, roads, houses, mining operations, and other modifications fragment natural areas, forming a patchwork of habitat islands in a sea of development. For some species, this "sea" is a barrier that isolates them from sources of food or water. It can also isolate species from others of their kind, resulting in inbreeding and a loss of genetic diversity.



Habitat fragmentation can cause other problems too. For example, when a road is built through a forest, areas that were once in the forest's interior become exposed to more light, wind, and temperature fluctuations. Animals that are adapted to conditions inside forests often can't tolerate these changes and are forced to move elsewhere, if they can. Plants, which can't just pick up and move, may die out.

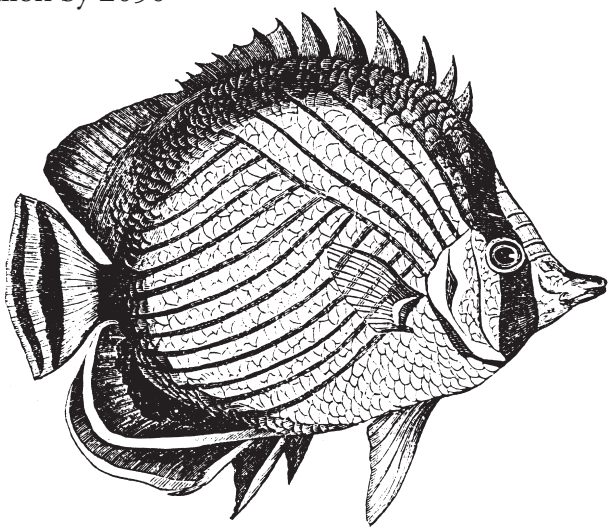
In the long run, habitat destruction can disrupt human communities as well as those of plants and animals. For example, a few people in a community will make money by cutting trees for timber. However, once those trees are gone, the community might face more problems with erosion and flooding, making it more and more difficult to grow food for their families or to sell at markets.

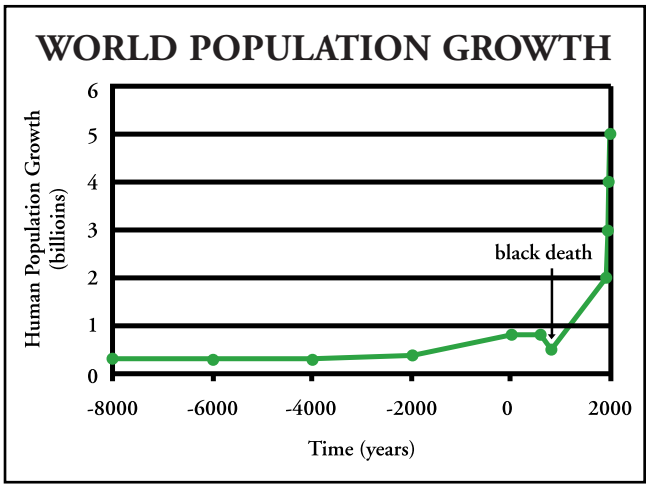
Vanishing Along with their Habitats

While we have a pretty good idea about how many mammals, birds, and other vertebrates are threatened or have already become extinct, we have no idea how many species of **invertebrates** and microorganisms have been or are being lost. What we do know, mainly through recent studies in the tropics, is that vast numbers of unidentified species of invertebrates and microorganisms are adapted to and therefore dependent on localised habitats. Since these habitats are being wiped out by logging, farming, mining, and other human activities, many scientists believe that scores of species, unknown to science, are being extinguished in the process.

A Growing Concern

In 2002, the number of people on Earth is estimated at over six billion—more than twice as many as in 1960. About 77 million more people are added to the planet each year. This annual addition, equivalent to almost twice the population of Colombia, amounts to over 210,000 births every day. Most experts think that human population is likely to reach between 8 and 11 billion by 2050





There is little doubt that our growing population will result in continuing habitat loss and will put enormous pressure on Earth's natural resources. **Non-renewable resources**, such as fossil fuels and certain minerals, could someday become depleted. While some people argue that new technologies could indefinitely extend the use of non-renewable resources and allow the use of alternative ones, many others feel that technology can only delay the time when the Earth loses its ability to sustain us.

Renewable resources, such as trees, won't necessarily run out, but unmanaged use of them can lead to other problems. For example, increasing demands for paper and other wood products could lead to increased plantings of **monocultures**—stands of a single species of tree. Planting monocultures is an efficient way to ensure a steady supply of wood for wood products, and it may allow large areas of high biodiversity, such as tropical rain forests, to be spared. But monocultures can be less resistant to disease than more diverse forests, which often means that they need to be sprayed with more pesticides. They also may require high levels of

chemical fertilisers to remain productive. Perhaps most importantly, they generally support very little biodiversity.

Human Need and Human Greed

Population growth alone doesn't account for the increasing consumption of natural resources that is largely responsible for biodiversity's decline. Patterns of affluence and poverty also have a huge impact. For example, people living in affluent, industrialised nations such as the United States, consume a disproportionate amount of the Earth's fossil fuels, forests, and other natural resources. In less-industrialised areas of the world, people struggling to survive often have little choice but to overuse the few resources available to them.

A few statistics can shed light on the connection between economic status and biodiversity. Consider the consumption patterns of affluent nations, using the United States as an example. The United States uses 3 times as much iron ore, 3.6 times as much coal, and 12 times as much petroleum as does India, but it has approximately one-third the population. A typical Chinese household uses less than 0.03 percent of the energy consumed in the average American home. While many people point out that resource use helps fuel economic growth, others state that the consumption rates of affluent nations run the risk of depleting resources more rapidly than natural processes can replace them. Also, under current consumption patterns, affluent nations are benefiting disproportionately from our planet's limited resources—sometimes at the expense of developing nations. Consequently, some people argue that affluent nations have a responsibility

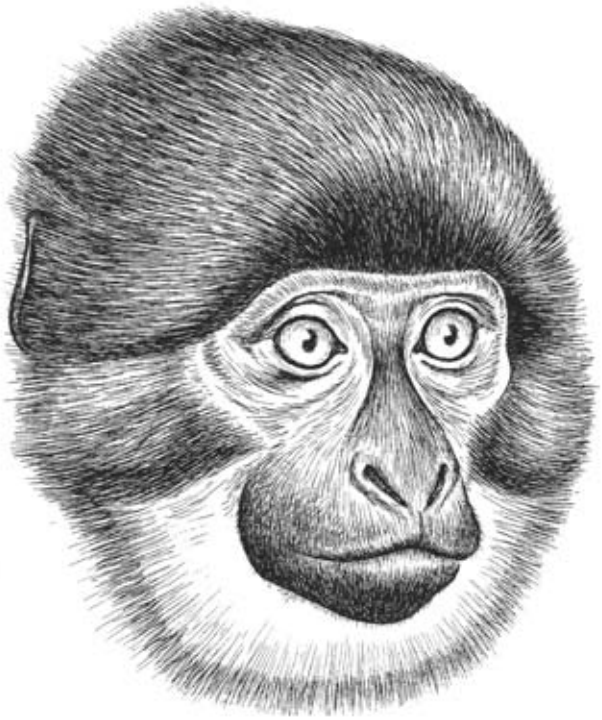
to not only dramatically reduce their consumption of natural resources, but also to help less industrialised nations achieve their economic goals without making the same mistakes as the developed nations have made.

Now consider the connection between poverty and biodiversity loss. Of the more than six billion people in the world, almost five billion live in developing nations. In many of these nations, a handful of wealthy individuals owns a disproportionate percentage of the arable land and other natural resources. The result is that large numbers of poor people are often forced to sustain themselves on land that's not well suited to the task. This situation often degrades the land to such an extent that it can no longer support humans and many other species.

Cycle of Destruction

The destruction of tropical rain forests is one example of how poverty and overpopulation can lead to biodiversity decline. For decades, poor farmers have been chipping away at their forests by clearing land to grow crops. However, rain forest soil is typically shallow and nutrient poor. It doesn't hold nutrients for long; those that are not quickly absorbed by tropical vegetation are leached out of the soil and into streams by the heavy rainfall. Thus, farmers trying to grow crops in rain forest soil can use the area for only a few years before the soil is depleted. When this happens, the farmers must move on and clear another patch of forest.

The land can accommodate this kind of farming up to a point: Historically, nearby species were able to recolonise small patches of spent farmland once the farmers moved on. However, the numbers of poor farmers has greatly increased, and so has the number of acres of degraded land. Tropical forests have not been able to regenerate in many areas because the disturbance has been too severe and widespread. As a result, large areas that once supported lush rain forests are now incapable of supporting much more than a few hardy grasses.



Wildlife for Sale

Trade in wild animals and plants is also a major threat to biodiversity worldwide. Annually, such trade—which encompasses not only wild species themselves, but also products made from them—is worth more than $10 billion. Although most wildlife and wildlife products are legal imports, about one-quarter of this trade is illegal. Driven by consumer demand, people unlawfully take thousands of rare and threatened plants and animals from their native habitats each day. Wildlife trade threatens populations of plants and animals around the world and is especially devastating to those species—such as tigers, parrots, and pandas—that are already vulnerable because of habitat loss, pollution, and other problems affecting their environment.

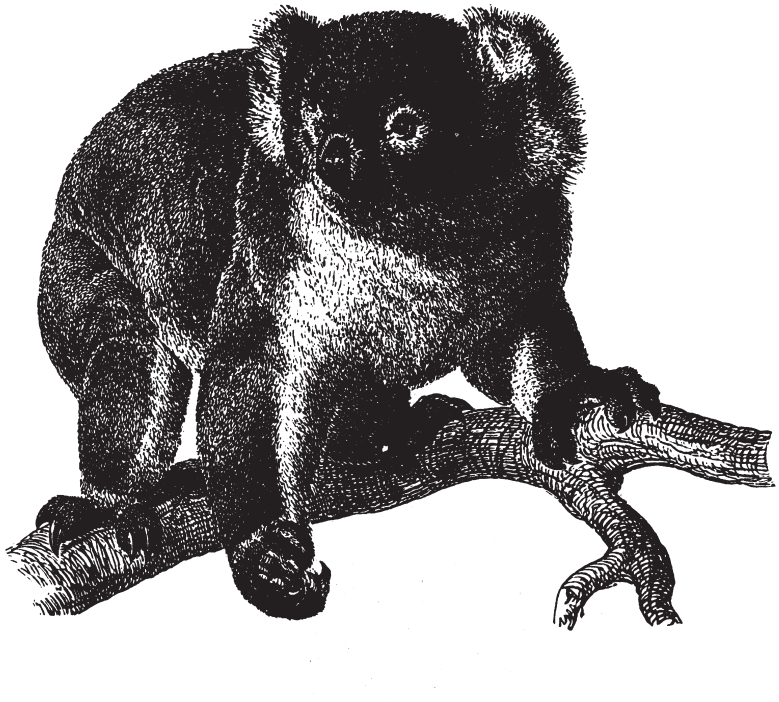
CO_2: An "Innocent" Gas Goes Bad

At first glance, carbon dioxide (CO_2) seems harmless enough. After all, it's non-toxic to people and other living things except in extremely high concentrations. Nonetheless, CO_2 could turn out to be one of the most dangerous pollutants of our time. That's because it's one of the **greenhouse gases**—gases that act as the glass in a greenhouse to keep heat trapped near the Earth's surface.

Ironically, this **"greenhouse effect"** is, in moderate doses, essential to life. Carbon dioxide occurs naturally in our atmosphere—and without a certain amount of this and other greenhouse gases, Earth would be a frigid and potentially lifeless rock. But people have changed the levels of atmospheric greenhouse gases, particularly CO_2. We emit these gases into the atmosphere whenever we burn oil, coal, and other fossil fuels, as well as when we burn forests to make way for agricultural land. All of these activities have increased since the beginning of the industrial era, and so have atmospheric concentrations of CO_2.

Scientists don't yet know exactly what effects the growing levels of atmospheric CO_2 will have. But many computer models now predict that increased concentrations of CO_2 and other greenhouse gases will cause an increase in the overall global temperature, a rise in the sea level, and a change in climate patterns. Most data show that such changes are already under way.

Even a small increase in the overall global temperature could adversely affect biodiversity—especially since the change will probably happen too quickly for many species to adapt to the new conditions or migrate to more suitable habitats. For example, a rise in sea level and coastal flooding could destroy essential feeding grounds for migratory birds. The melting of ice and permafrost in the arctic tundra would change the habitat of polar bears, walruses, and other arctic species. In parts of Antarctica, rising temperatures are already melting sea ice, thus limiting the areas where Adelie penguins can breed.



The HIPPO Dilemma

To understand the role people are playing in biodiversity loss, it helps to think of something called the HIPPO dilemma. This term doesn't refer to hippopotamuses; rather, it's an acronym for the main threats to biodiversity. Presenting the HIPPO dilemma to your students may help them remember the main threats to biodiversity.

Habitat loss

Introduced species

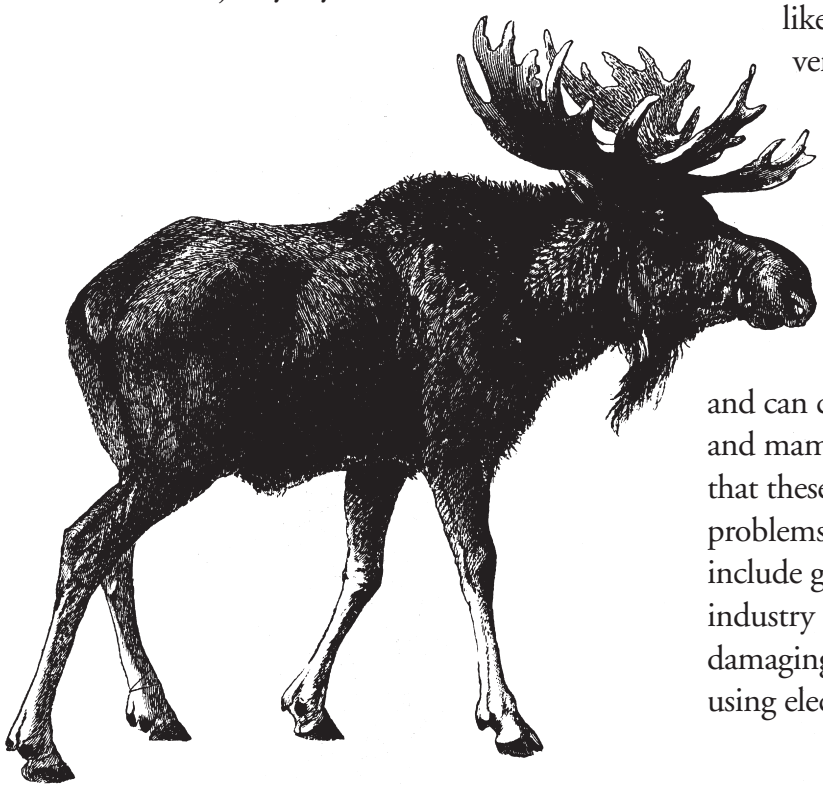
Population growth

Pollution

Over-consumption

Global warming is likely to most severely affect **threatened species** and ecosystems, which already have a tenuous hold on existence. However, it could benefit certain other species and ecosystems. For example, some species might be able to take advantage of the warming temperatures by spreading into areas that were previously too cool for them. Of course, what's good for one species isn't necessarily advantageous to others, or to the ecosystems involved. For example, tropical mosquitoes could be one of the beneficiaries of global warming. As these insects spread into new areas, they'd most likely bring with them the malaria, yellow fever, and other tropical diseases that they routinely carry.

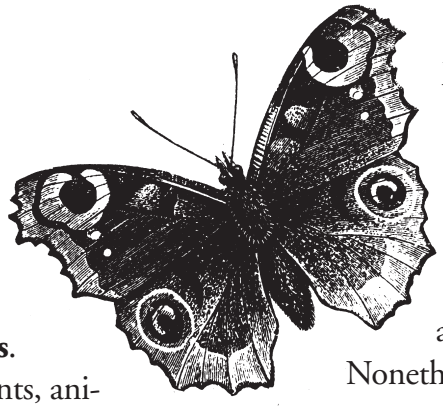
Although most scientists studying the issue agree that global warming is occurring, people are having a harder time agreeing on what to do about it. The majority say we should cut CO_2 emissions now, across the globe. Others say we should do more research before implementing CO_2-cutting policies that could jeopardise the economic health of some nations and bring hardship or at least inconvenience to millions of people. However, many believe that if we cut CO_2 now, we won't necessarily face economic hardships. In fact, some say we could reap many economic and health benefits. The debate is likely to continue for some time to come—but in the meantime, more and more scientists, economists, insurance companies, and others warn that there will be severe consequences if we let current practices continue much longer.



Oil in the Ocean, Gases in the Air

Whether they're renewable or non-renewable, it's safe to say that the more resources our growing population consumes, the more pollution we're likely to create. Pollution's effects on biodiversity can be obvious, such as an oil spill that causes populations of sea life to plummet in the area of the spill. But pollution can also cause problems that, though not visibly dramatic or immediately apparent, are every bit as deadly as an oil spill. Insecticides, for example, reduce food supplies for animals and can cause reproductive failure in fish, birds, and mammals—and research is starting to show that these substances have the potential to cause problems in people. Other dangerous pollutants include gases released into the atmosphere by industry and by everyday activities—the most damaging of which are probably driving cars and using electricity.

Aliens Are Among Us!



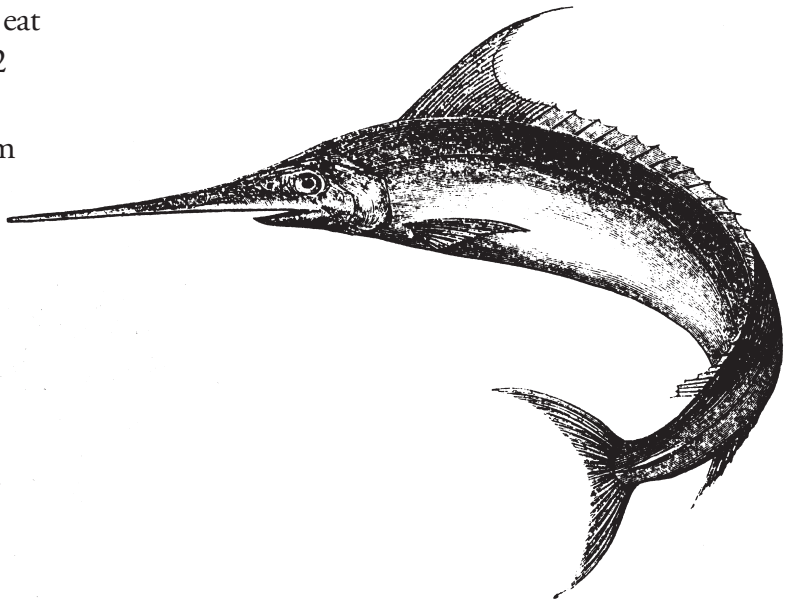
Another contributor to biodiversity decline—and one that is sometimes an indirect result of population growth and consumption—is **introduced species**. When people introduce plants, animals, and other organisms into new areas, either intentionally or accidentally, these organisms can take a toll on **native species**. Also called alien or exotic species, introduced species often have no natural predators or diseases in their new homes. Native species often have no defences against the introduced species or the diseases they carry. As a result, introduced species may thrive—often at the expense of native species. When alien species spread and compete with native species, they are called *invasive*.

For example, the brown tree snake was brought by accident to the island of Guam in the South Pacific in the early 1950s. The snakes, which eat birds and other native species, have caused 12 species of birds to disappear from the island. Since they often use power lines to move from tree to tree, the snakes have also caused more than 600 power outages in Guam since 1978, at an enormous economic cost.

Most experts agree that the accidental introduction of species should be minimised and that deliberate introductions (such as the release of non-native insect predators to control pests) should be undertaken only after careful planning and study of the possible effects. Nonetheless, even under the best conditions, no one can predict with certainty what the effect of introducing an exotic species will be.

Meeting Human Needs

Many biologists, economists, historians, sociologists, and others agree that any plans to preserve biodiversity on a global scale must go hand-in-hand with addressing such critical issues as human poverty, hunger, and health. They warn that failing to do so will ultimately limit the effectiveness of even the best-laid conservation plans. In the end, we must demonstrate that humans can live in harmony with nature.



Activity 6: The Rare Scare

OBJECTIVES: Define the terms **threatened** and **extinct**. Describe several characteristics that make an animal susceptible to extinction.

SUBJECT: Science, Art, Language Arts

SKILLS: critical thinking, art, creativity, working with others

AGES: 11+

TIME: two sessions + homework time

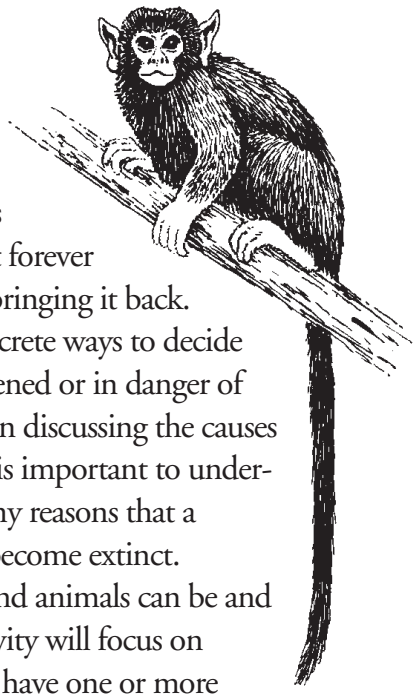
MATERIALS: chalkboard, paper

Describing Your Species

- Where does it live?
- Does it migrate?
- What does it eat?
- How often does it reproduce?
- How many young does it have at once?
- Does it live alone or in groups?
- Does it like warm or cold weather?
- Does it like hills or flat lands?
- Does it like wet or dry conditions?
- Who are its predators?
- What does it look like?

Activity adapted with permission from *Biodiversity Basics*, published by World Wildlife Fund as part of *Windows on the Wild*, an international biodiversity education program. ©1999.

BACKGROUND



Conservationists' main goal is to avoid **species** extinction. Once a species becomes extinct globally, it is lost forever and there is no way of bringing it back. Scientists have very concrete ways to decide when a species is threatened or in danger of becoming extinct. When discussing the causes of species extinction, it is important to understand that there are many reasons that a particular species may become extinct. Although both plants and animals can be and are threatened, this activity will focus on animals. Many animals have one or more characteristics that make them more vulnerable to becoming extinct. For example, an animal may have a low birth rate, a very specialised diet, and inhabit only a particular kind of tree. If changes are made to the environment that provides the food needed by the animal or that threaten its **habitat**, the animal could become threatened or eventually extinct.

GETTING READY

As homework the day before, ask students to interview elders of their family and community about animals that used to be found in their communities but are currently either no longer around or not often seen. Students should record these conversations in enough detail to be able to report back to the class.

On the chalkboard, copy the list of guiding questions given below under "Describing Your Species".

WHAT TO DO

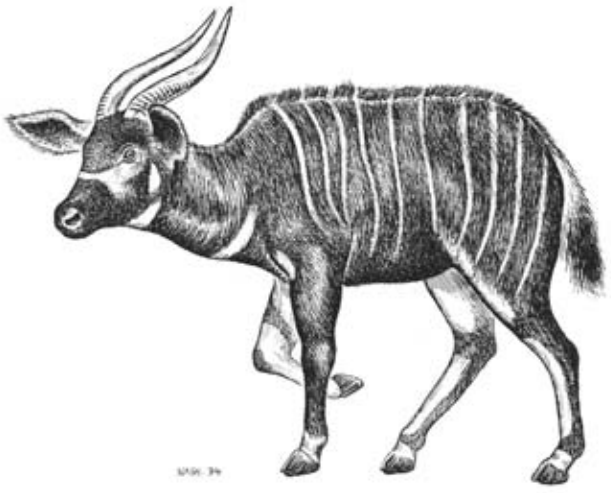
1. Explain what "threatened" means.
Have students present what they found out about animals in their community. Create a list of species that have been identified as either rare or possibly no longer living in your region. Ask your students if they know what threatened means. Ask if anyone can give you an example of a threatened species. Explain that a threatened species is one that has so few of its kind left that it is in danger of becoming extinct. Scientists use specific criteria to decide whether a species is threatened.

2. Talk about why animals might be prone to extinction.
Ask students why they think the animals on their list are rare. Remind students that we might not see some animals because they are active at night or avoid humans. Explain that many species that are threatened share one or more characteristics that make them prone to extinction. Discuss some of these characteristics, using the information from "Species at Risk" on page 48. Make sure students understand the difference between the death of an individual animal (there are still more of its kind that can reproduce) and species extinction (there are no more of that kind of animal anywhere, so it can't ever come back).

3. Break into groups and create a species.
Separate the class into groups of three or four students. Ask each group to create its own imaginary species by listing the characteristics of this species, using the guiding questions you copied on the board earlier. Students can also draw a picture of their species, but first they should make sure that they answer at least six of the guiding questions. (They can answer more questions if they want to as well as provide additional information.) Students should write their answers in large print, as they will have to present them to the rest of the class later.

4. Present each species and vote on the one most likely to become extinct.
Have one person from each group read the information about the group's species to the rest of the class. The students should then hang their answers and/or drawings on the board so the class can refer to them later. After each group representative has presented a species, ask the class to decide which of the species would be the first to become extinct as more and more people move into the area where each species lives. After each person has picked a species, take a tally to see how many students voted for each one.

5. Discuss the students' choices.
Ask the students why they picked these species. Have them discuss the reasons for their choices with the other students in their groups. Refer students to the opening discussion about charac-



SPECIES AT RISK

Animals are more prone to extinction if they:

Are naturally rare. Some animals, including many of the world's large ones, are rare even in the places they normally live. Others live only in a few places and nowhere else. As more people move into the area, many of these already rare plants and animals face habitat loss, competition from introduced species, new diseases, and other problems.

Have small ranges, very specific food or nesting patterns. Some animals are very picky about what they eat or where they live, or both. These specialised animals, which are often adapted to eating only one type of food or living in only one type of area, can become threatened if their food source or nesting site disappears. Animals that can live only in very specialised habitats don't have many areas to retreat to if humans or natural disasters threaten them.

Migrate. Animals that migrate usually depend on several different habitat areas. Because of this, they face many impediments, and habitat destruction can make them especially vulnerable. For example, many songbirds that migrate between **tropical** and **temperate forests** are in trouble because thousands of acres of their habitat have been developed into pastures, farms, towns, and roads.

Live only on islands. Many island animals have adapted to the absence of predators, so they are particularly susceptible to exotic species introduced by humans. For example, a number of flightless island birds such as the dodo have been forced to extinction because, when humans first came to their island, the birds were not afraid of and could not escape the new predators (humans, dogs, and pigs).

Are very sensitive to change. Many animals have a difficult time adapting to changes in their environment. For example, predatory birds and mammals are very sensitive to chemical changes in their habitats, such as the introduction of pesticides. These poisons concentrate in predatory animals from every other animal or insect that they eat.

Produce few offspring and have long gestation periods. Ask the kids if they can think of some animals that give birth to only one or two young every year or every two or three years (elephants, bats, condors, and so on). Explain that when the populations of these animals drop, it takes much more time for their populations to recover because of the low birth rate. These animals sometimes become extinct before they have time to make a comeback.

Are used for food or medicine. In some parts of the world, wild animals are hunted for food or to make traditional remedies. When populations are already small due to habitat loss, or when the trade in these animals reaches a large scale, species can become threatened.

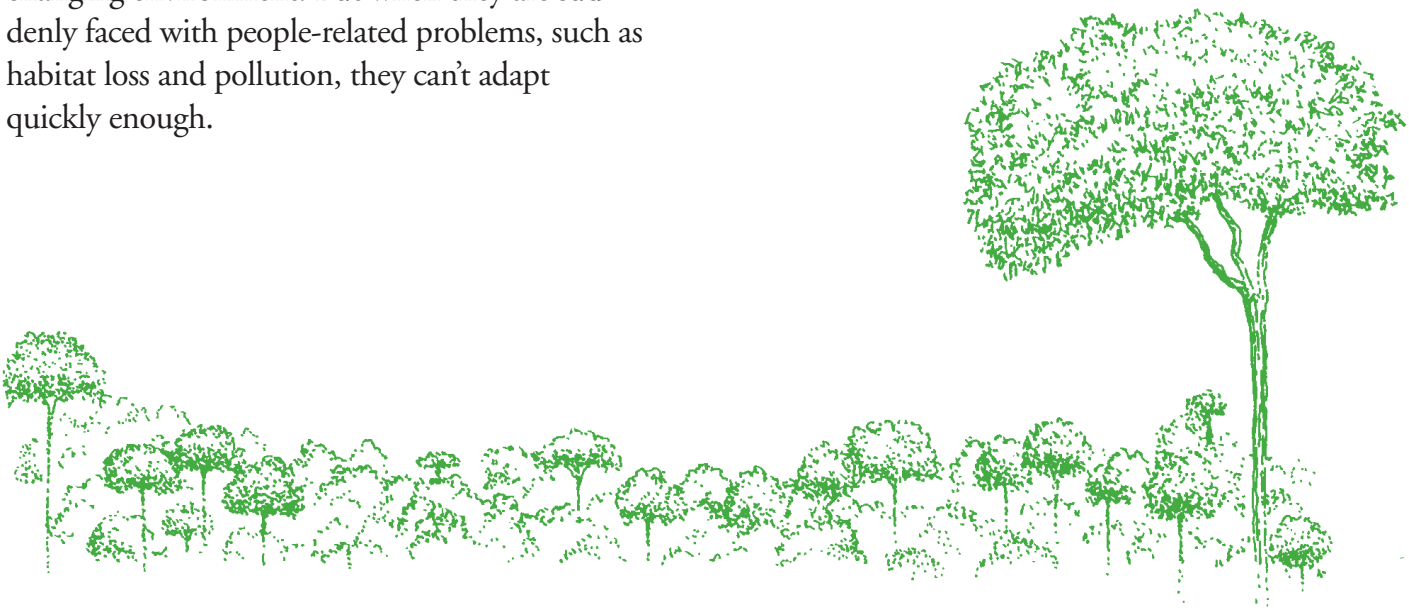
Interfere in some way with people's activities. Some animals, such as jaguars or wolves, may occasionally kill livestock. Because they interfere with human activities, large predators are sometimes killed.

teristics that might make species prone to extinction (see "Species at Risk"). Next, have students from each group read the information about their species again to see if the students agree with their original choices. Then take another tally and compare the results to the first vote.

6. Explain the reasons for the best choice and open the discussion to the class.
Explain which species may become extinct first and why. Explain that species that have one or more of the characteristics that make them vulnerable to extinction usually survive by changing and adapting over thousands of years to a slowly changing environment. But when they are suddenly faced with people-related problems, such as habitat loss and pollution, they can't adapt quickly enough.

FINISHING UP

This could be an oral discussion or a written exercise. Have students talk or write about recent developments in their communities that may have damaged or are damaging a natural **ecosystem**. What could have been done differently to minimise the damage? Why is it important to stop species from becoming extinct? What species are in danger of becoming extinct in your area? How would your life be affected if the (pick a local species) became extinct?



In Ghana, West Africa, more than 75% of the original forest has been cut down for wood or to clear land for agriculture. Children in the capital city of Accra wanted to help, so they planted trees as part of a contest. The school with the best-cared-for trees at the end of the year wins the contest—and the students can continue to watch their trees grow and eventually make their school a cooler, greener place to learn and play.

Activity 7: Space for Species

OBJECTIVES: Describe factors that affect the relationship between **habitat fragmentation** and **biodiversity** loss. Describe strategies for designing **protected areas** that could help lessen the effects of fragmentation.

SUBJECTS: Science, Mathematics, Physical Education

SKILLS: analysing (calculating, identifying patterns), interpreting (inferring), applying (proposing solutions), citizenship (evaluating the need for citizen action, planning and taking action)

AGES: 9+

TIME: two sessions

MATERIALS: four pieces of rope, leaves and small stones, a timer or watch

BACKGROUND

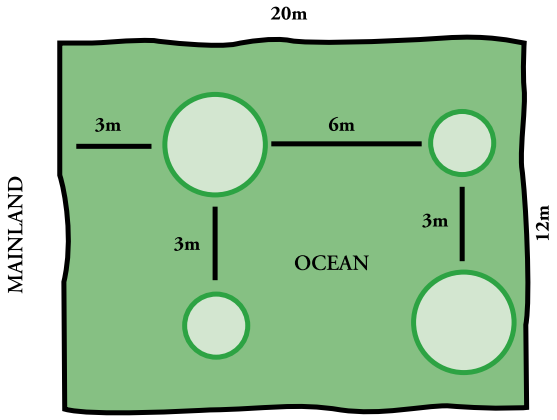
When people build new agricultural fields, homes, and roads, they are trying to help improve lives. However, development can also destroy natural **ecosystems** and habitats. **Habitat** loss is one of the most serious threats to biodiversity. As forests are broken up into smaller areas, "habitat islands" are created, with portions of what used to be part of a large area becoming separated from each other by buildings or fields for human use. Scientists call this breaking up of habitats into smaller chunks **fragmentation**. The problem with these habitat islands is that small habitat areas usually cannot hold as many **species** as large ones.

In this activity, your students will imagine they are species trying to get to different-sized "islands" at different distances from the "mainland". Then they'll apply the concepts they've learned to habitat islands. They'll explore some of the threats facing species in habitat islands and think about ways to reduce those threats by planning development with biodiversity conservation in mind.

GETTING READY

Read "What's the problem with patches?" and familiarise yourself with the rules of the game.

You'll need an open playing area about 20 meters by 12 meters (it may be easier to do this outdoors), with plenty of extra room for students to work in groups outside the playing area. Use four visible markers (such as large rocks or articles of



Activity adapted with permission from *Biodiversity Basics*, published by World Wildlife Fund as part of *Windows on the Wild*, an international biodiversity education program. ©1999.

clothing) to mark the boundaries. Use two 8-metre ropes to make two small islands with diameters of about 2.5 metres. Use two 12-metre ropes to make two large islands with diameters of about 4 metres. Arrange the islands in the playing area as they are arranged in the diagram pg 49.

Next, draw the "Protected Area Design Choices" page 54 on the chalkboard. Make sure you do not include the answers on the chalkboard until you go over the design choices with the class.

What's the Problem with Patches?

Habitat fragmentation is one of the most serious threats to biodiversity. Small, fragmented habitats, called habitat islands, usually can't hold as many species as larger, more continuous ones.

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

Less area, less species: To persist, species need to live in populations of a certain size. If habitat areas are reduced to small fragments, there may not be enough room for a large enough population of the species, making it more prone to extinction. Space is a particular problem for large animals that need large areas in which to find food.

Road blocks: Some species can live in habitat fragments if they can move from one area to another to get everything they need, such as food, shelter, and mates. Unfortunately, many fragments are surrounded by barriers that prevent species from moving between different areas.

Roads are a common barrier that many species can't cross, but buildings, fields, and fences can also keep species from getting where they need to go. When a species is isolated from others of its kind, individuals may breed with relatives, causing a loss of genetic diversity.

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

Fragmentation doesn't affect all species in the same way. Some species are more sensitive than others. Some can even benefit from fragmentation and the edge effect, because they thrive in the kinds of habitats found on the edge.

WHAT TO DO

1. Introduce the activity.
Explain to the students that they will be doing an outdoor activity to study species that travel between islands and the mainland.

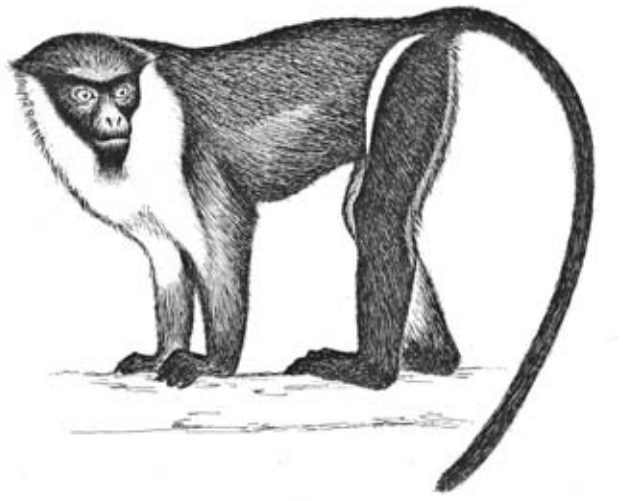
2. Explain the rules.
Familiarise students with the playing area. Show them the islands and their sizes and distances from the mainland. Select three-quarters of the class to be species immigrating to the islands and the rest of the class to represent threats that can cause immigrating species to become extinct. Explain that immigrating species will have one minute to run from the mainland to an island, but when they are between islands they will have to avoid being tagged by the students in the playing area. If they happen to be tagged they will become extinct on the islands and be eliminated from the game. As you select students to be the taggers, you can have them think of (and even act out) some of the causes of extinction (predators, diseases, pollution, severe weather, and so on) they might represent to species immigrating across the ocean.

Explain that once you give the signal, species on the mainland should begin running to the islands. The other students should run after them and try to tag them. Species can be tagged out of the game only when they are out in the open ocean. If they are on an island or the mainland, they can't be tagged. Although they are safe on the mainland, tell students that at the end of the game you'll only count the species that successfully have made it to an island.

Tell the taggers to spread out in the playing field, and make sure they keep moving all the time that students are immigrating. Explain that in nature, threats to species are spread all around the landscape, so the taggers should also be spread out.

3. Play Round 1: Immigrate!
Yell "Immigrate!" to let students know when to begin. Keep time and tell the students to stop after one minute. Ask any students who become extinct to help you monitor the game.

4. Evaluate the results.
Have the students count the number of animal species on each island. Keep track of the results on a piece of paper. Have the students gather around to go over the results of Round 1 and to talk about what they'll do in Round 2. Having them nearby will help them focus on you and not on the many distractions there can be outside. Figure out the percent of students who survived (divide the number of students who made it to an island by the total number of students who started on the mainland, then multiply by 100) and record the percentage on the paper.



Tell the students that the large island close to the mainland should have the most species. Ask the students why this is true. (Those who tried to run to the farthest islands faced many more threats on their journey than those who travelled only to a nearby island.) Regardless of how many students made it to islands at different distances, more students should be on islands that are large than on islands that are small. Ask students why this is true and why the same is true with different species in nature. (Small islands don't have the space or variety of different habitat types to support many different species, just as the small islands in the game were not big enough to hold many students.)

Ask the students who didn't survive why they think they were tagged. Were the extinction taggers faster than they were? Did they have to go to several islands, leaving themselves open to taggers each time? Were they forced out of a small island that was too crowded? Ask them if the same things also affect real species. Species are sometimes forced to travel between many habitat islands to find all the resources they need and are thereby open to threats when they leave their habitat, and many species can be pushed out of overcrowded habitat islands and forced to move to other habitats.

Ask the students why animals need to move between habitat islands. Explain that many islands are too small for all the species living in them, and they can become crowded. Competition for food, water, and living space may force animals to move to find more food or shelter. Some animals need to migrate. Others may be looking for mates.

5. Play Round 2: Habitat island hopping. Round 2 will demonstrate what it's like for species trying to move between habitat islands. Tell students that the playing area now represents habitat islands in a sea of development rather than in an ocean. Have the students think about how the extinction factors might be different in habitat islands as opposed to oceanic islands. (Many animals also become easy targets for predators when they leave their habitat. There may not be enough food in the space between habitat islands. Animals are often killed trying to cross roads.)

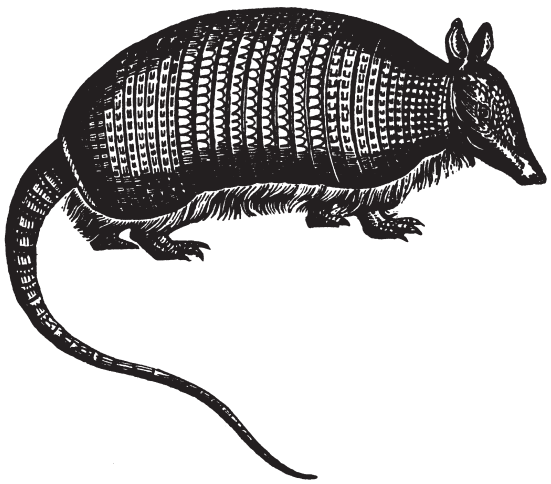
Tell students that the stones and leaves represent some of the things that species need. The leaves may be food and water, and the stones may be space, shelter, and mates. Tell the students that they'll be competing for these resources in the habitat islands. Count out enough stones and leaves so that there is one of each for every student in the habitat islands. Scatter the stones and leaves throughout the four islands so that larger islands, which can hold more resources, have more stones and leaves. State the following rules:

Students must collect at least one stone and one leaf to survive, but they can collect more if they like. Students can pick up only one stone or leaf at a time from any island. So if a student picks up a stone or leaf on the island he or she starts from, the student must run to at least one other island for another stone or leaf. Students can return to their first island for additional stones and leaves if they need to.

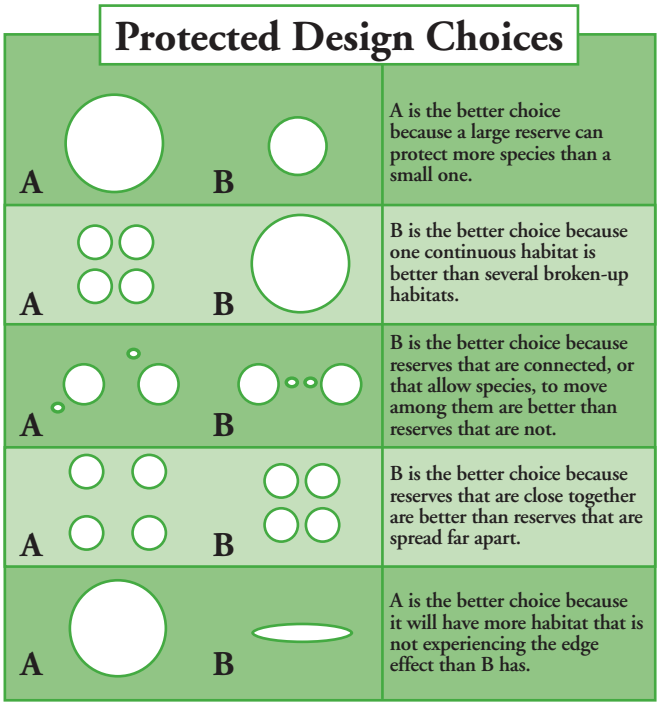
Shout "Immigrate!" to start the game again. This time give students as much time as they need to move between the islands. Stop the game when every student either has been tagged or has collected at least one stone and leaf. After they finish the round, count the number of students who survived and record it.

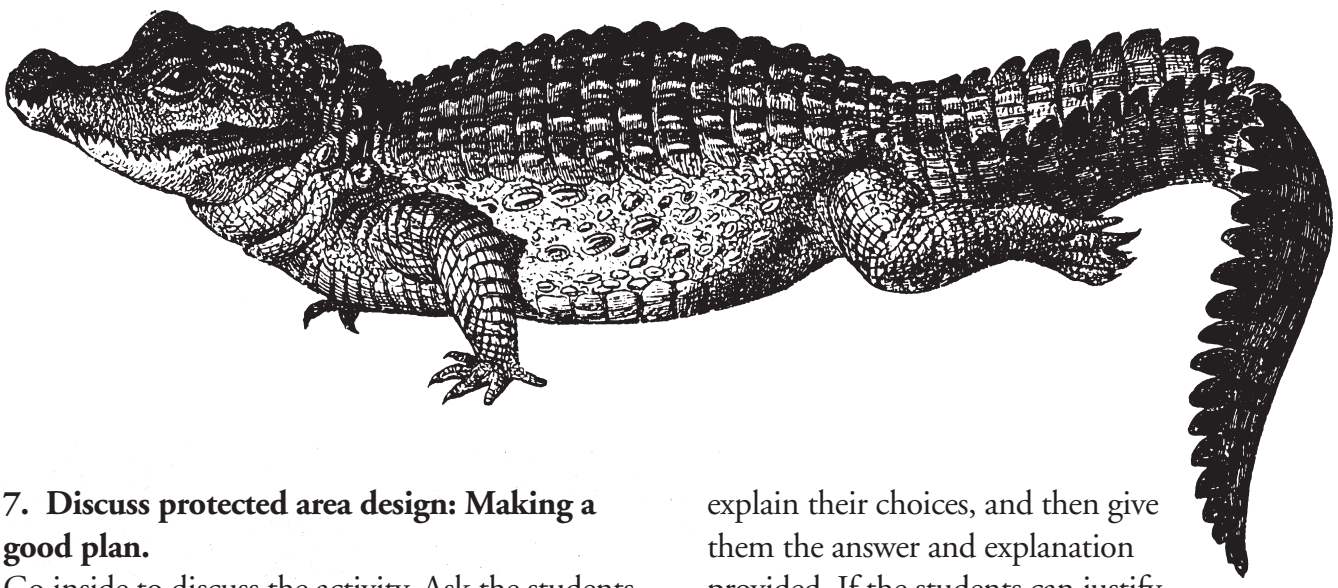
6. Discuss the results.

Have the students gather together to figure out the percent of species that survived. Most likely, a large percent became extinct. Ask students why they think so many species didn't make it. Were the taggers faster than they were? Did they have to go to several islands, leaving themselves open to taggers? Were they forced out of a small island that was too crowded? Ask them if real species face similar threats? What are they? (Species that have to travel to several habitat areas to get resources face many threats, such as lack of food and shelter and nowhere to hide from predators and human hunters.)



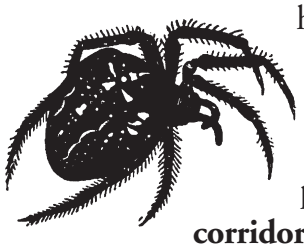
Ask the students who survived why they think they were never tagged. Ask the students if real species can survive in the same way that they did. (Some species can avoid many threats that other species face. For example, birds can fly to escape predators; they can also search for food over large areas. Some species need only a very small amount of space to get what they need, so they might not ever need to leave their habitat island, or they might not have to look far outside their habitat. Still others might not be affected by the main threats in an area. If, for example, there was a predator killing many small animals in an area, a larger species might be too big to be eaten by that predator.)





7. Discuss protected area design: Making a good plan.

Go inside to discuss the activity. Ask the students to think about how we can help wildlife in fragmented areas. One way to make sure that there's enough habitat for species is to set aside land in protected areas. Ask the students if they can think of any potential problems with protected areas. (If they have trouble thinking about problems, lead them back to the concepts they learned in the game. Many protected areas are like habitat islands—they are surrounded by human communities and can become isolated. Some protected areas might be too small to support many species. Wildlife moving between protected areas can face many threats. Your students may come up with other problems not related to the concepts of the game, but be sure that the ones listed here are covered.)



Refer to the diagram "Protected Area Design Choices". Each diagram represents a possible protected area design, but in each set one is a better choice than the other. Ask the students which design in each pair they think is best, based on what they learned in the game. Ask them to explain their choices, and then give them the answer and explanation provided. If the students can justify their answer with an explanation that demonstrates that they understand the material, they're right. Let them know that there are many ways of looking at the problem.

8. Talk about how people can help species in developed areas.

Most animals probably don't live their whole lives in protected areas. Even if they use the protected areas most of the time, chances are they'll need to leave them to find food, mates, or other things at some point. Do your students think wildlife has a good chance of surviving outside protected areas? Are there things we can do to increase the animals' chances and help preserve biodiversity? Many people are working to create **conservation corridors** that link protected areas by involving all of the people who live and work in the area between and around legal parks and reserves. In a corridor, everyone plays a role. Private landowners and communities collaborate to maintain or create safe habitat for species, while still earning a living through sustainable use of the land.

Talk again about the threats that your group discussed in Round 2 of the game and ask students to think of ways we can help reduce them. Some ideas are listed below.

In yards or on farms:

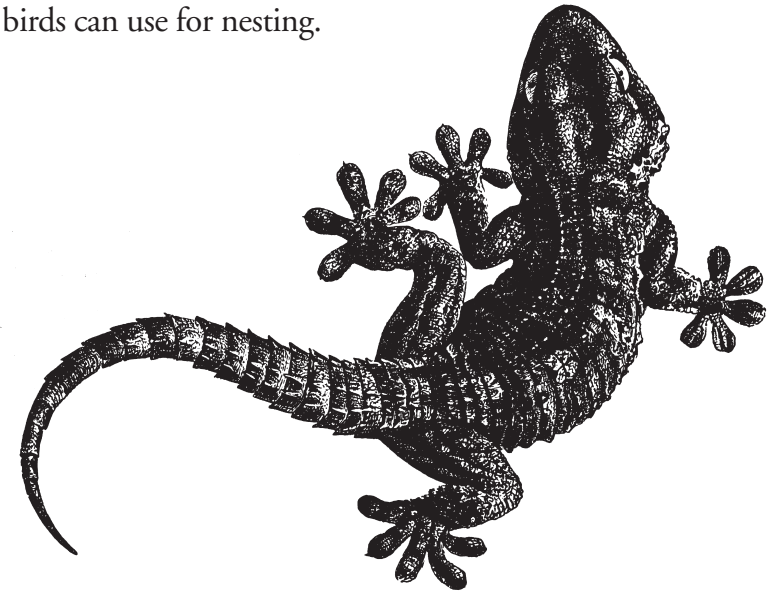
- Plant native plants and trees so that the land is more like wild animals' habitat
- Reduce the use of pesticides so that birds, insects, and other species can use habitats without the threat of being poisoned.

Around the school and other buildings:

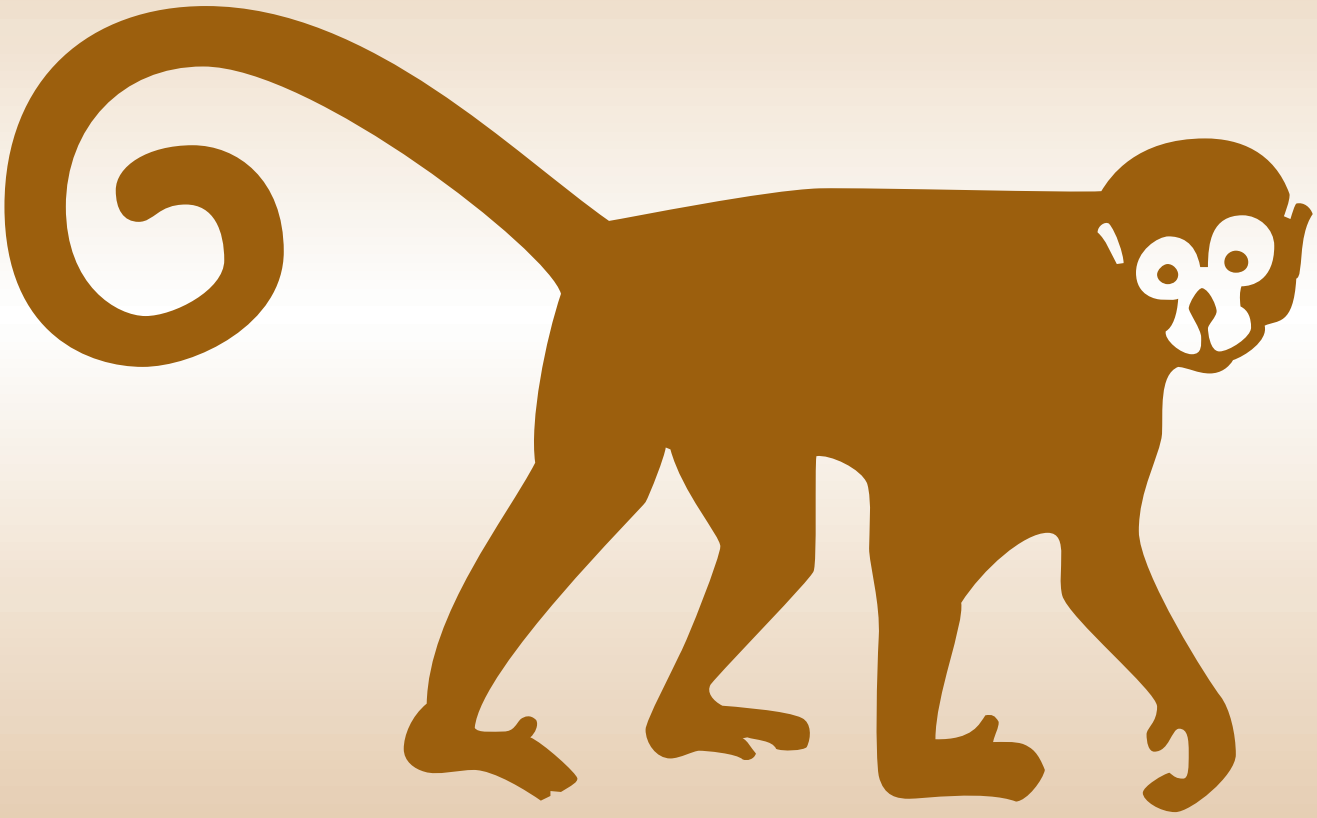
- Convert part of your schoolyard or town park to a wildlife habitat.
- Put up boxes that birds can use for nesting.

FINISHING UP

Have the students write an interview between a journalist for *BioTimes* magazine (or some other title they come up with) and an animal or plant whose habitat has gotten smaller and smaller because of development. The interview could include questions such as these: So, why are you leaving home? Where do you think your travels will take you? What are your special habitat needs? How could people have reduced the damage this development has caused? Afterward, students can share their interviews by taking turns playing the roles of journalists and species being interviewed.



BIODIVERSITY CONSERVATION



BIODIVERSITY CONSERVATION

How Can We Protect Biodiversity?

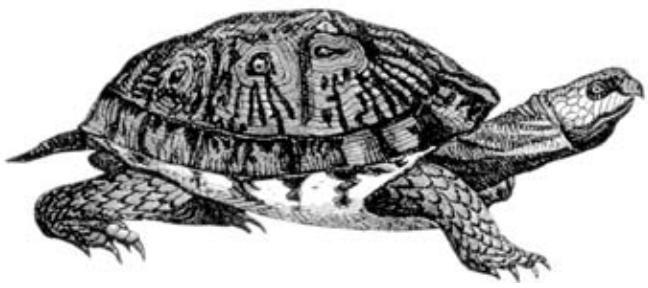
One of the greatest challenges we face in protecting **biodiversity** is how to balance the needs of the present without jeopardising those of the future. We are finding that there's no single way to address this challenge, in part because there is no single reason that we're losing biodiversity. Ensuring the survival of **species**, **genes**, and **ecosystems** will require a combination of approaches and the collective thinking of people from all disciplines and backgrounds.

Protecting Wild Spaces

Today only about five percent of the Earth's land area is designated as parks or reserves, and much of that is weakly protected and managed. Many conservation organisations would like to see at least ten percent of the world's natural areas, including marine areas, protected for the future.

Is the Sustainable Obtainable?

Increasing levels of **pollution** and consumption of **natural resources** are clearly contributing to biodiversity decline and could eventually threaten large segments of the human population. Nobody can avoid using resources and creating waste—it's a necessary part of being alive. However, decreasing our impact on the planet can go a long way toward ensuring that humans and other species can thrive together indefinitely.



Attaining such a state of relative equilibrium with our environment is often described as achieving **sustainability**. A society that reaches sustainability is one that is able to persist for many generations without producing significant amounts of pollution, depleting natural resources, and causing a decline in biodiversity. According to many experts, most of the world's societies are far from sustainable. They also point out that efforts to achieve sustainability must address not only the conservation of biodiversity and other natural resources, but also issues of economic security and social equity. Obviously, we have a long way to go in understanding what a sustainable world would look like and what is required to get us there.

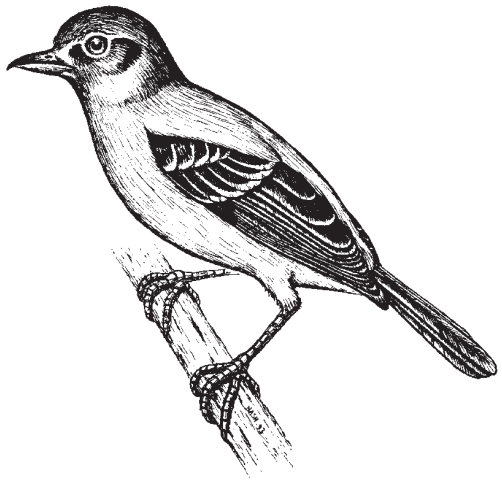
Land for the Future

Many people point out that, in addition to focusing on long-term sustainability, we must also engage in shorter-term projects that address the immediate needs of dwindling species and ecosystems. One such approach is to set aside more land for wildlife. Establishing or expanding **protected areas** such as parks and preserves has been shown to be a very effective way to conserve biodiversity, at least within the boundaries of the protected area.

The Corridor Connection

Creating protected areas can help conserve biodiversity inside protected area boundaries, but what happens to the plants and animals that aren't lucky enough to live in a protected area, or who need to move to other areas to find food, mates, or breeding grounds? A relatively new strategy,

creating **conservation corridors**, attempts to link scattered and diverse protected areas to ensure long-term and effective species protection. In a corridor, conservationists work with landowners to protect the most important land areas between official protected areas. That way everyone takes part in conserving biodiversity by connecting habitats across the landscape.



Bringing Back the Habitats

Around the world, scientists and others have begun to recognise the far-reaching effects that humans have had on the natural world. They are also discovering that many ecosystems no longer can provide the many services that they once did because human activities have severely damaged them. In an effort to recover these ecosystems and the critical services they provide, scientists have begun an important effort called *ecological restoration*. Ecological restoration is the process of returning a damaged ecosystem to a condition as close as possible to what it was before it was disturbed. This process has become an important part of the efforts to protect biodiversity.

Rapid Research

Only a small percentage of the 1.7 million identified species on Earth have been studied in any detail. In some areas of the world, habitat destruction is occurring so fast that species are disappearing before we even know they exist. Conservation biologists agree that we need to find out as much as possible about not only what species are out there, but also about how species depend on their habitats, how people can manage habitats to ensure healthy populations, and which habitats and ecosystems are most at risk. With these points in mind, many of the world's top biologists are forming teams to rapidly assess and catalogue the biological diversity of lesser-known regions all over the globe. Because there's so much work to be done, biodiversity research will need more support—and more scientists to conduct the research itself—in the years to come.

Legal Action

Most countries around the world have environmental protection laws. In the United States, for example, many threatened species owe their continued survival to a law called the Endangered Species Act. In Ecuador, the Special Law for the Galapagos protects these unique islands' biodiversity. CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora) is an international agreement among governments that aims to ensure that international trade in specimens of wild animals and plants does not threaten their survival. These and many other laws and treaties are extremely important parts of the effort to protect biodiversity. In fact, many experts believe that the most important thing we can do to protect biodiversity in the

short term is to implement effective laws and policies that protect natural resources worldwide, and then to enforce them, which is often the most difficult aspect.

However, legislation is just one tool in the conservation toolbox. Others feel that non-policy options, such as promoting **environmental education**, may be as effective in protecting biodiversity as enacting and signing more laws.

Whichever methods of conserving biodiversity we choose, the challenge we face is how to balance the short-term economic interests and rights of individuals with long-term conservation—and how to ensure, in the process, that future generations will inherit a healthy environment.

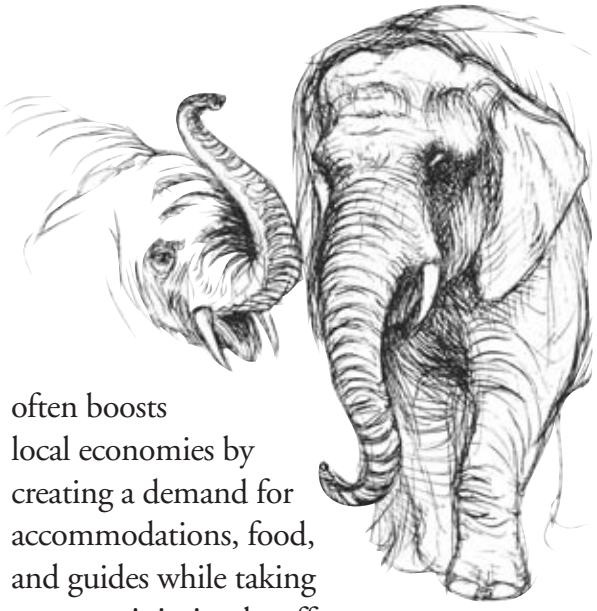
Conservation Biology—A New Field for the Future

Conservation biology is a relatively new, interdisciplinary science designed to explore human effects on biodiversity and to develop practical solutions to the loss of biodiversity. In their efforts to protect species, conservation biologists usually emphasise the protection of entire ecosystems rather than the protection of individual species. This emphasis means considering conservation priorities and human needs. Conservation biologists help determine the best strategies for protecting species, designing nature reserves, and reconciling conservation concerns with the needs of local people. Accomplishing these tasks requires working with many other experts, including anthropologists, botanists, economists, geographers, educators, and zoologists.

Conservation Enterprises

Many times people harm the environment because they have no other choice in how they make their living. Conservation enterprises find new ways to generate income for communities while helping to conserve natural habitats. Sometimes these new ways are actually the way that things used to be done before modern practices began. For example, in Ghana, farmers are growing cocoa under the forest canopy so that animals still have a place to live. Farmers who grow cocoa or coffee without cutting down the forest receive more money for their products than those who clear the land, because many people who drink coffee and eat chocolate are willing to pay more for these products if they know they are helping conservation.

In some areas, **ecotourism** may help protect biodiversity by creating incentives to protect it. Organised "ecology-sensitive" trips to natural areas have been on the rise for the past few years, as have the number of people participating in such trips. From birding tours in Bolivia to elephant research trips in Zimbabwe, ecotourism



often boosts local economies by creating a demand for accommodations, food, and guides while taking care to minimise the effects on local ecosystems.

Not all tourism considers the environment or local people, however. For example, more visitors to natural areas can result in more pollution and disturbance to animals and plants. If enough of the income generated from tourism doesn't end up in the hands of local people, they have little financial incentive to continue to protect the areas that tourists come to see.

The Corporate Connection

Some corporations are taking unprecedented action to integrate stewardship of nature into their decision-making. This is partly due to the desire of the public to use processes or products that are less harmful to the environment. It is also because, in many cases, conserving energy or using alternative industrial processes simply saves money. For example, several large chemical companies have begun to use some of their toxic wastes as a source of inexpensive raw materials for other products—a practice that not only helps prevent pollution but also increases corporate profits.

Employees are also playing a role in the way firms do business, advocating everything from programs for purchasing recycled office paper to programs for reducing pesticide use on company land. Such efforts, along with those of industry leaders, governments, and non-governmental organisations, are reducing the effects of industrial activity on the natural world and its biodiversity. Although we have a long way to go in curbing industry-related damage to the environment, the business community, in working with others, has made many positive efforts in recent years.

Saving Seeds

To help preserve the world's diversity of food crops, medicinal plants, and other plants, people all over the world are storing seeds and other plant parts in **gene banks**. Scientists hope that they'll be able to save rare plants by cultivating them from the seeds and preserved parts. For plants in danger of becoming extinct in the wild, this approach could be a real safety net. Of course, preserving plant parts is not a substitute for preserving the habitat of threatened plants. Also, maintaining seed and gene banks is very expensive.

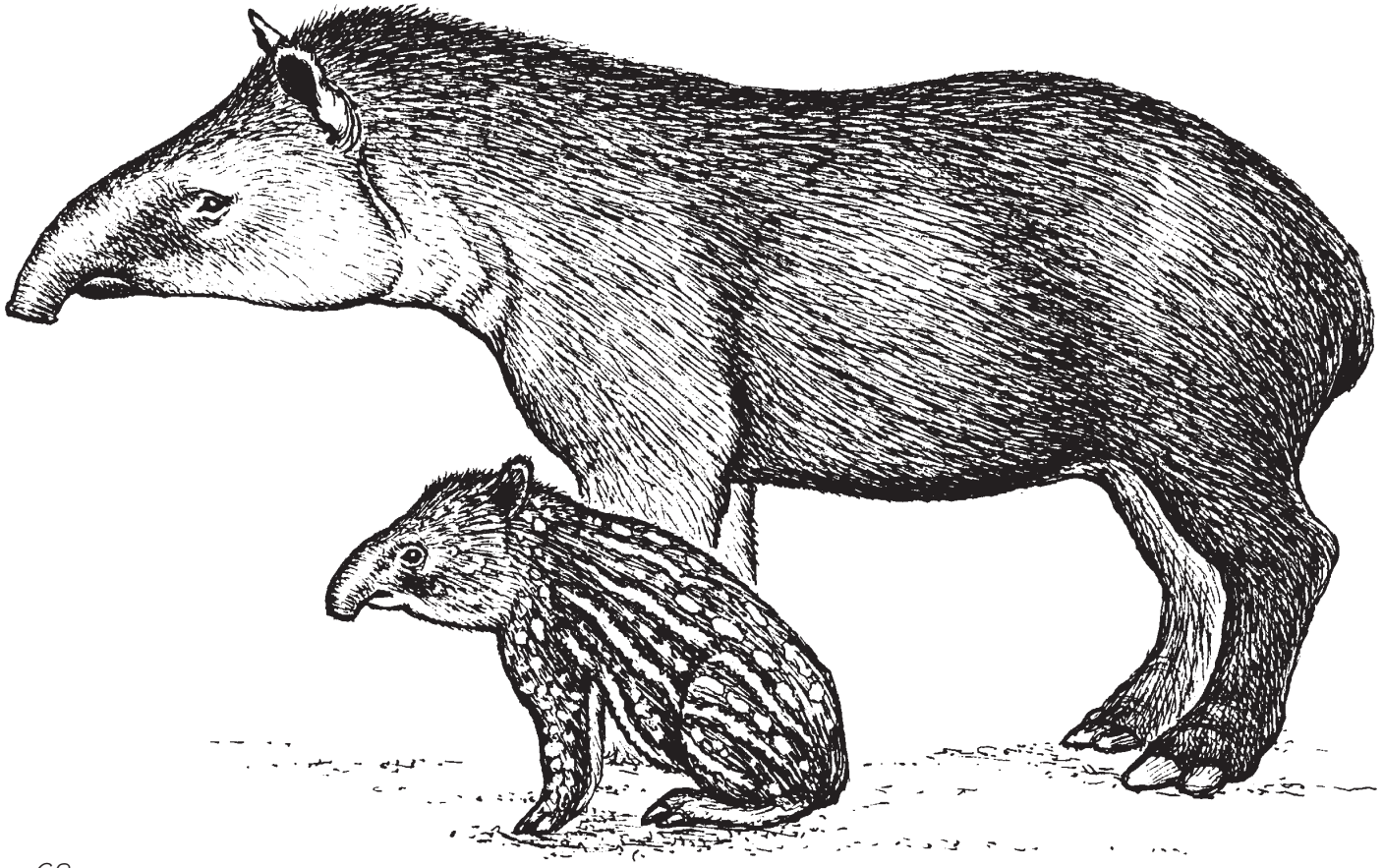
Stewardship, Citizenship, and Democracy

One of the most important things that we can do to conserve biodiversity is to get involved—through our roles as educators, parents, community members, landowners, voters, employees, employers, politicians, and business leaders. For many, that means changing the way we educate our children and ourselves about what it means to be a citizen in a democracy.

There are thousands of examples of individuals, schools, and communities working together to solve biodiversity problems. They're working to try new agricultural techniques that conserve biodiversity, forming citizen groups to restore habitats, writing letters to elected officials, educating their communities, and forming community stewardship committees. By identifying issues in your community and region, and working with others, you can start to make a difference at a local level.

Learning the Three C's

Conserving biodiversity and finding solutions to the intricately connected problems of environmental degradation, social decline, and economic instability will mean feeling about, thinking about, and doing things differently than we have before. It will mean fostering more *compassion* for other species and a kind of reverence for living systems too complex for us ever to understand fully. It will mean educating ourselves about the *connections* among all elements of biodiversity and between a healthy natural environment and a healthy human society. It will mean coming to terms with the *consequences* of our behaviour for other people and other species. Conserving biodiversity will also require us to incorporate the concepts of social equity and ecological integrity into how we do business. It will challenge us, in every aspect of our lives, to work toward creating a more sustainable society—one in which human needs are in balance with the needs of other living things. Above all, it will mean developing not only a conservation ethic but also an entire belief system that honours the integrity of the Earth and of ourselves.



Activity 8: Thinking About Tomorrow

OBJECTIVES: Explore the issue of **sustainable** use of natural resources. Describe several consequences of unsustainable use of **natural resources** for both people and other species. Recognise the difficulty in identifying sustainable ways to use resources when demand and supplies change.

SUBJECTS: Science, Social Studies, Mathematics

SKILLS: reading, comprehension, organising, interpreting (reasoning), planning, problem solving, proposing solutions, presenting (explaining), citizenship (working in a group)

AGES: 9+

TIME: one session

MATERIALS: chalkboard, dry beans, trays or flat containers for beans, a stopwatch or clock

BACKGROUND

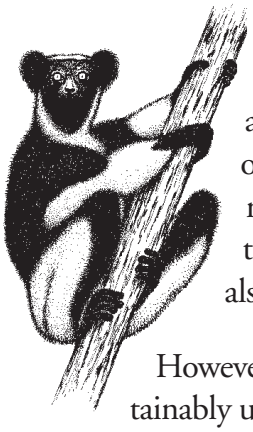
Natural resources are the raw materials that we use every day. That includes everything we eat, as well as the materials we use to build our houses and make our clothes, tools, and many other things. The air we breathe, the water we drink, and the land we use to grow our food are also natural resources. We can therefore say that natural resources are all the things that humans as well as other species depend on for their survival.

Since natural resources encompass so many different things, scientists have created two categories for talking about them. **Renewable resources** are those that can be replenished, either naturally or through human processes. Trees, for example, are a renewable resource since they can either be replanted by humans or naturally reseeded. Sunlight is also a renewable resource because we always have a steady supply of it, no matter how much we use. For a resource to be considered truly renewable, it must either be constantly generating itself (such as sunlight), it has to replenish itself in a couple of generations or less, or we have to be able to replenish it in the same amount of time.

Non-renewable resources, on the other hand, exist only in definitive quantities. This means that once they are used up, they may take millions of years to be replenished, or they may be gone forever. This includes the fossil fuels that our factories, power plants, and vehicles run on and the minerals we use to make metals and other materials. It also includes the topsoil that we need to grow our crops.

Many scientists would agree that we are using our natural resources faster than they can be replenished. Since we rely on natural resources for our survival, we can neither afford to use them all up nor stop using them completely. Between the two extremes, however, is sustainable use. Sustainably

Activity adapted with permission from *Biodiversity Basics*, published by World Wildlife Fund as part of *Windows on the Wild*, an international biodiversity education program. ©1999.

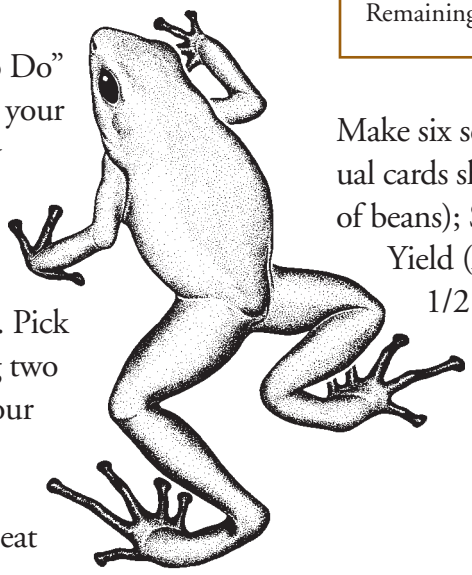


using a natural resources means using the resources in a way that allows people and other species to get what they need today while ensuring that future generations will also get what they need.

However, figuring out how to sustainably use a natural resource is not easy. For example, different kinds of forests have many different uses that require different management techniques. Since the speed with which we consume natural resources is always changing, it is sometimes difficult to tell whether a resource is being used sustainably at any particular moment. Sustainable management also depends on whether a resource is **renewable** or **non-renewable**.

GETTING READY

Make sure you have plenty of room in the classroom. Pour half a bag of beans onto a tray and place the tray on a table in an open area of the room.



Read step 1 in the "What To Do" section and do a trial run on your own to figure out how many beans you'll need for each group. This is how you will find out how many beans you will need for the rounds. Pick up beans from the tray using two of your fingers (the tips of your index finger and thumb) for ten seconds. Make sure you time yourself accurately. Repeat this for the number of people you'll have in each family (usually four or five students). Count the total number of beans you've collected from the tray. If you have four families, you'll need four times as many beans as you have collected to cover the entire class. Playing the game with too many beans won't illustrate the concepts as clearly.

For a family of four, you should start with approximately one cup of beans.

On the chalkboard, copy this chart:

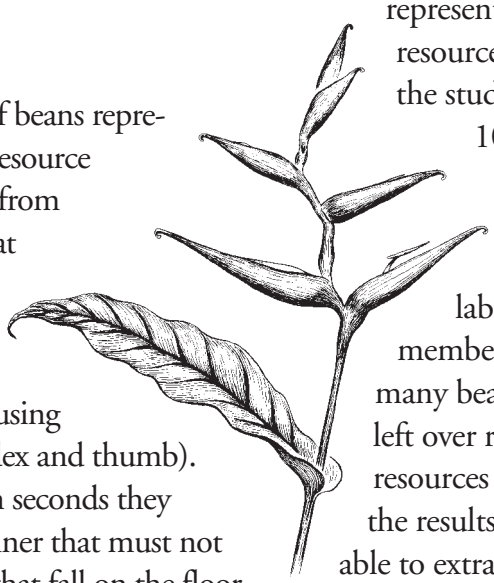
Round 1,2, or 3	**Family Name**	**Family Name**	**Family Name**	**Family Name**
Great-great grandparent	Results	Results	Results	Results
Great-grandparent	Results	Results	Results	Results
Grandparent	Results	Results	Results	Results
Parent	Results	Results	Results	Results
Children	Results	Results	Results	Results
Total beans Remaining	Results	Results	Results	Results

Make six separate "condition cards". The individual cards should read, Drought (Remove 1/2 cup of beans); Surplus (Add 1 cup of beans); Average Yield (Add 1/2 cup of beans); Fire (Remove 1/2 cup of beans); Contamination (Remove 1/2 cup of beans). One card should be left blank.

WHAT TO DO

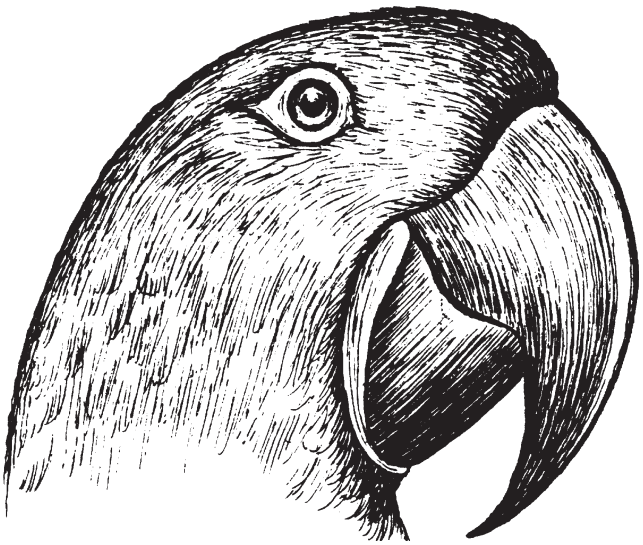
1. Create student groups.
Divide the students into four equal-sized groups (there can be four or five students in each group, but the groups need to be equal in size). Tell the students that each group represents a family. Have each group select a family name and then have each group member select a generation of the family to represent (a great-great-grandparent, a great-grandparent, a grandparent, a parent, and a child). Make sure that each student remembers his/her family name and the generation that he/she represents. Place the tray at the centre of the room on a table and ask each family to form a line at a different side of the tray of beans.

2. Explain the first round.
Tell the students that the tray of beans represents a non-renewable natural resource (petroleum, minerals, or wood from ancient forests, for example) that their "families" rely on. Each family member will have the opportunity to "extract" some of the natural resource (beans) using only the tips of two fingers (index and thumb). As they collect the beans for ten seconds they should place them into a container that must not be lifted from the table. Beans that fall on the floor do not count. They represent wasted resources. When the ten seconds are up, ask students to count the number of beans they have collected and to record their results on the chalkboard.



3. Begin Round 1.
Have the first family member (great-great-grandparent) from each family put one arm behind his/her back and use the other to collect the beans. Remind students of the rules of the game: ten seconds to collect beans, use only tips of index finger and thumb, and at the end of the ten seconds count the beans and record the results on the chalkboard. Next, allow the second family member to repeat the same steps. When they are done ask the third family member to go while the second calculates and records their results. This process should be repeated until all family members have had a chance to "extract resources". The amount of beans remaining represents the amount of natural resource left for future generations.

4. Begin Round 2.
Place all beans back into the tray. Have the beans represent the same non-renewable natural resource as in the previous round. Inform the students that they actually need only 10 beans worth of the natural resource to survive. Repeat the same procedure from round 1. Record the results in a table labelled round 2. After all family members have had their turn, count how many beans are left over. Again, the amount left over represents the amount of natural resources left for future generations. Look at the results to see how many students were able to extract at least 10 beans. (They represent those family members who were able to get enough of the natural resource to survive.) Ask how many students were not able to extract at least 10 beans. (They represent family members who could not get enough of the natural resource to survive.) Ask how many students got 10 beans or more. (They represent family members that used more of the natural resource than needed.)



5. Using the following questions, have the class discuss their observations.

- For both rounds, did each successive generation collect more or fewer beans than the previous generation?

- Compare the number of beans left over after the first round to the number leftover after the second round. Did one round have more left than another? Why? (If the students were taking only enough beans to survive, all students in the second round should have had enough beans, and more beans should have been left over than in the first round.)

- Why might a particular generation consume more natural resources than they need? (People many not realise they are depleting natural resources, or they may think they really need to use them to survive. Or, in other cases, people are indifferent or just greedy.)

- Are there any reasons a particular generation would want to conserve its natural resources? (People may feel it is important to save enough resources for their children or grandchildren to use. They may also feel it's necessary to conserve natural resources for the benefit of their community and culture, the future health of the environment, or for the sake of other species.) Explain to students that using natural resources in a way that protects them for future generations and other species is called sustainable use.

- Who did not survive? How did it feel? Who got too much of a resource? Did it affect whether the next generation of the family got enough of the resource?

- Did knowing how much of a natural resource you need to survive help your students decide how much to collect from the tray? (Students who want to make sure that all of their family members get enough beans might take only as much as they need to survive.)

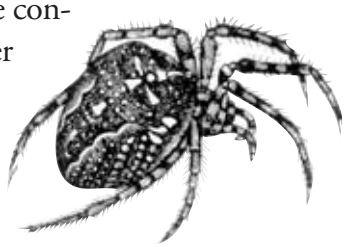
- Did either round produce a lot of wasted resources? What could have been done to reduce the amount of wasted resources? (In rushing to fill their cups, the students will drop many beans on the floor. Designing a community strategy for effectively filling up the containers could decrease the amount of resources wasted.)

6. Explain Round 3.

Rounds 1 and 2 dealt with a non-renewable natural resource. Tell the students that the tray of beans now represents a renewable natural resource. Ask students if they can think of some renewable natural resources that people use (food crops, solar energy, trees, and so on). Each person still represents a member of a family that is part of a community. Using the same rules, play the

next round, but this time introduce a different condition card at the end of each round (for each generation). Explain that most renewable resources have limits to their rate of replenishment. Physical, environmental, and human conditions can change how much a resource is renewed every generation. This round will illustrate sustainability under different conditions.

Place the beans back in the tray. Follow the same procedure for collecting the beans as in rounds 1 and 2. In this round, however, after each generation, adjust the bean amounts according to the five conditions on the cards you prepared earlier: drought, flood, surplus, average yield, or contamination. Two conditions increase the number of beans in the tray: average yield (+1/2 cup)—only an average amount of the resource was replenished; surplus (+1 cup)—more of the resource was replenished than expected. Three conditions remove beans from the tray: drought (-1/2 cup)—lack of available water caused a decrease in the resource; fire (-1 cup)—an uncontrolled fire destroyed some of the resource; and pest/disease (-1/2 cup)—some of the resource was infected to unusable levels. All the conditions represent situations that can affect natural resources. Your students can also create their own situation on the blank card. Shuffle the condition cards. When the ten seconds are up, ask someone to draw a card and add or subtract beans accordingly from their trays. (At each turn in round 3, all families should be following the same condition card that was read out loud.) After each generation's turn, the cards should be replaced in the deck and the deck should be reshuffled. Students should count their beans and record their results. Other family members can begin collecting beans while the previous generation counts and records their results. (Remind the students that they'll still need 10 beans to survive.)

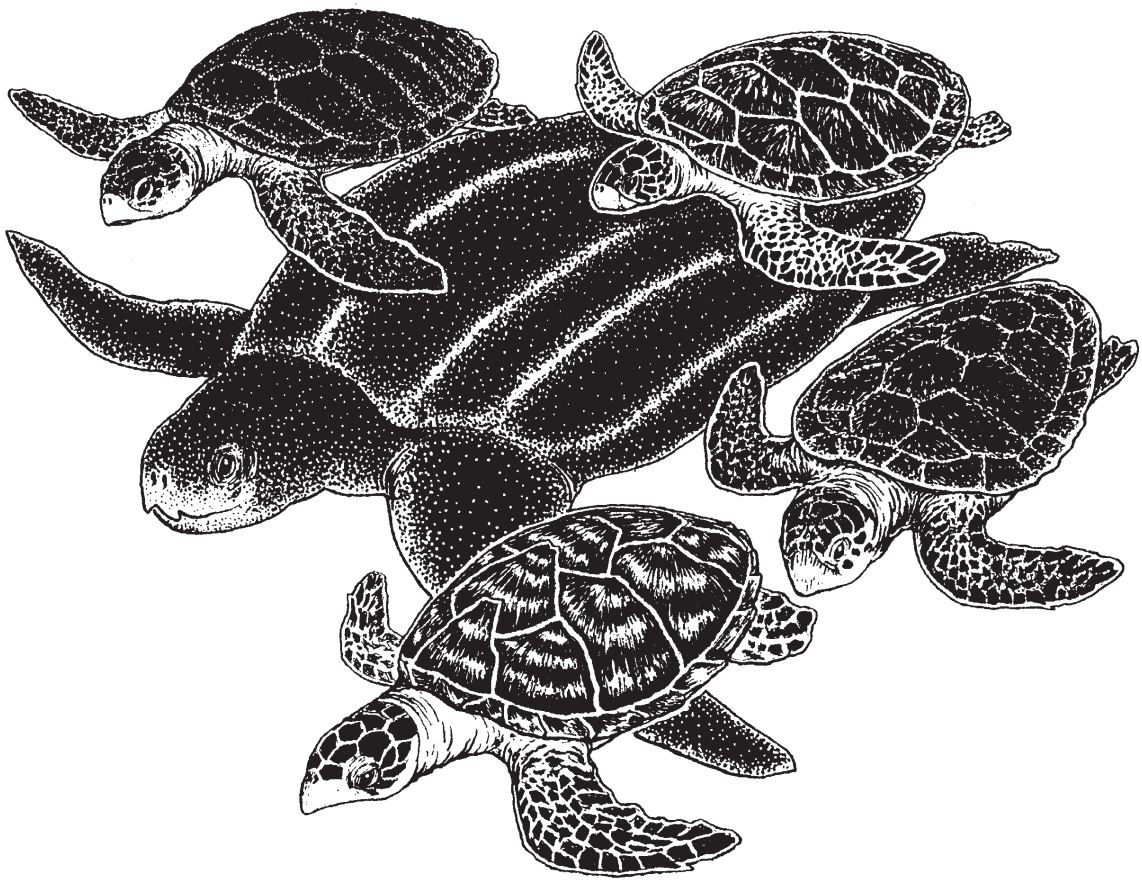


8. Discuss the results of the rounds.
Using the following questions, have the students discuss their observations about the rounds.

- What will happen if we use our natural resources faster than they can be replaced? (They will eventually run out.)
- What happens when generations do not use a cooperative strategy for natural resource use?
- Did the condition cards affect the number of beans you collected? (Some students may have decided not to take so many beans if a drought or a fire card was drawn. Some may have decided to collect more beans after a surplus card was drawn.)
- What are the similarities in strategies for sustainably managing a renewable resource and a non-renewable resource? (Both involve conservation and identification of alternate resources. Even though there are often renewable alternatives to non-renewable resources, a renewable resource can be depleted to the point where it can no longer renew itself.)

FINISHING UP

- Have students select a common issue about resource use to investigate. Some dilemmas might revolve around the following situations: animals that were over-hunted and are now extinct; fisheries that have been reduced in size because of over-harvesting; forests around the world that have been wiped out because trees were cut down without being replaced; grasslands that have turned to desert because of overgrazing; groundwater levels in many parts of the world that have been reduced because of over-consumption and poor management.
- Once students have identified the problem and collected data, they should determine which laws exist to protect the resources they are investigating. You should be able to get information on local resource management issues and laws from your local conservation organisation or government environmental agency.
- Ask students to write an essay on the question of how to balance the use of natural resources with conservation. This is the central issue of sustainability and sustainable development.



Activity 9: Community Connections

OBJECTIVES: Identify components of local natural systems and how human systems interact with the environment.

SUBJECTS: Science, Social Studies

SKILLS: formulating questions, interviewing, observing, researching, organising information, comparing and contrasting, citizenship skills, mapping

AGES: 11+

TIME: varies (approximately three sessions plus homework)

MATERIALS: one large piece of paper for each group, coloured markers or pencils, chalkboard, chalk, notebooks, and pencils

BACKGROUND

In schools and communities around the world, educators are finding that one of the best ways to prepare students for their future role as active citizens is to get them involved in local issues. By addressing a real community need, students can learn about environmental issues, the political process, careers, project planning, and what it means to be a responsible citizen. Every community faces environmental challenges that affect the well-being of both people and wild species: deforestation, pollution, **poaching**, park planning, and so on. By getting involved in a biodiversity-related project, your students will invest energy in their community and see that they can help to improve its condition.

In this activity, students use maps much the way scientists do, to document the current and past states of the environment and to help make complex information easier to understand and analyse. Maps are good tools for understanding how different physical features are related and how an area changes over time. Scientists use maps to show how the land is shaped and how human populations change, as well as to identify patterns of ecological change, where species are found, and many other ecological phenomena.

GETTING READY

Before you start, write the list of questions from "Habitat Query" on page 70 on the chalkboard.

WHAT TO DO

1. Map the present.
Divide the class into small groups of three to five students and give each group a large piece of paper. Each group will work together to create a map of their community. Tell them they should use the questions on the chalkboard to guide them. For example, to map "How is the land shaped?", they can draw the major hills and valleys in their community. Students can write in information or draw pictures or symbols—it doesn't have to be pretty or even accurate, just their best interpretation of where they live. They should have at least 15 to 20 minutes to complete their maps.

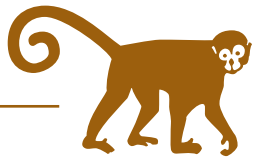
Habitat Query

- Where are the streams, ponds, and rivers?
- How is the land shaped? High/low points?
- What areas stay wet part or all of the year (wetlands)?
- Where does your drinking water come from?
- Where does your wastewater go?
- Where do different kinds of plants live?
- Where do different kinds of animals live?
- Where have humans built things? (streets, buildings, etc.)
- Where does your food grow?

2. Share your maps.
Have each group share their map with the others and compare. Are the maps the same or are there significant differences? Ask the groups what was most difficult about the exercise and how they worked through it. How did it make them think differently about their community?

3. Verify your maps.
Ask students how they could check the accuracy of their maps. If your community is small enough, and if it is safe, students can walk around with their maps (as a class or on their own as homework) and check to see if they forgot or misplaced anything. Alternatively, students could ask their parents or other adults to look at their maps and give their feedback.

4. Think about the past.
Tell students that in the next class they will be drawing new maps. However, this time they will be drawing maps of what their community was like when their grandparents were their age. To create their maps of the past, they will have to gather information from older people in their families or communities. Use the questions from the first part of the activity to develop an interview. Students can add other questions as well, such as: Are there things you like better about the past? The present? Do you think humans are doing a better or worse job at conserving our environment? Why or why not? How have things changed? Ask students to copy down the interview questions. Ask students to interview elders, recording all information collected.



Tips for Interviewing

- Carefully prepare your questions in advance. Limit the number of questions to about ten.
- Before you begin asking questions, explain how you will use the information.
- Ask your questions clearly and give the interviewee time to think and respond.
- Before you end the interview, thank the interviewee for taking the time to help you with your project.

5. Map the past.
In the next class period, students should return to their previous groups. After sharing the results of their interviews, they will create new maps—this time portraying what their community was like in the past. After they have finished, each group should again share their new maps with the class.

6. Make a list of environmental problems.
Explain to the students that they now have maps of their community as it is today and as it was in the past. Ask them if they can think of any changes they have seen since they were younger. What about changes their parents or grandparents mentioned? Were there any changes observed that indicate that the environment in and around their communities has gotten worse? Better? Discuss those changes as a group.

FINISHING UP

Talk with students about what has changed in their communities. As humans try to improve quality of life, sometimes nature is harmed. How do we depend on healthy natural systems to live well? (We need clean water to drink, healthy soil to produce food, and wildlife for balanced ecosystems.) What happens to human quality of life if we don't conserve the life around us?

Ask students how they would like their community to look when they are grown and have children. As a homework assignment, or in class, students can draw a personal map of their vision for the future. If your community has a central place to display the children's work, such as the post office, health clinic, or church, you could create an exhibit with the best maps—past, present, and future.

Indonesia's Gunung Gede National Park has primary rain forest with over 200 species of birds. Since it is very close to the capital city of Jakarta, both tourists and students visit the Bodogol Conservation Education Centre. Youth from communities around the park have been trained as guides to the park, and they help visitors learn about Indonesia's unique forests and wildlife.

Activity 10:
Taking Action

OBJECTIVES: Identify, research, and analyse issues of local importance in a community investigation. Plan and implement an action project.

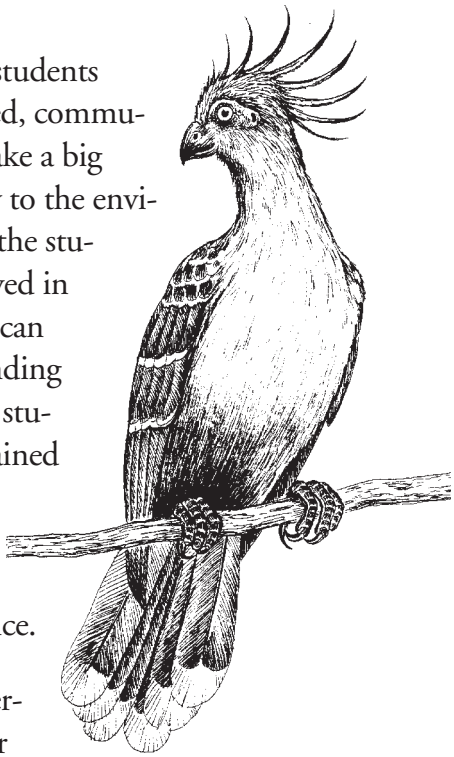
SUBJECTS: Science, Social Studies

SKILLS: formulating questions, observing, researching, organising information, planning, citizenship skills

AGES: 11+

TIME: on-going project

MATERIALS: notebooks and pencils



BACKGROUND

In this activity, which complements "Community Connections" on page 69, students are asked to identify and investigate environmental problems in their community, and then to plan and implement an action project to address one of those issues. Encouraging students to take a community-level approach to biodiversity issues helps them make connections between what they've learned about biodiversity and how they can directly help protect it. Students can participate in conservation projects started by organisations at a nearby protected area, government agencies, or non-governmental organisations (NGO). Your students may even want to come up with a project of their own!

Whatever way your students choose to get involved, community activities can make a big difference—not only to the environment but also to the students. Getting involved in community projects can extend the understanding and knowledge your students have already gained and allow them to experience an increased sense of worth and competence.

There are many different projects that your students might want to tackle that will help them learn more about biodiversity and at the same time address a local or even national problem. Some projects might focus on teaching others about environmental issues. Some might help to physically improve the environment, such as building a trail or cleaning up a park. Other projects might focus on political, consumer, or legislative action or on research or monitoring in the community. Many groups are helping to restore damaged ecosystems or are monitoring species and populations (everything from birds or frogs to butterflies or bats) and the habitats they live in. Your class may even choose to get involved with government agencies, conservation organisations, or universities that have ongoing biodiversity or habitat restoration and monitoring projects.

Activity adapted with permission from *Biodiversity Basics*, published by World Wildlife Fund as part of *Windows on the Wild*, an international biodiversity education program. ©1999.

WHAT TO DO

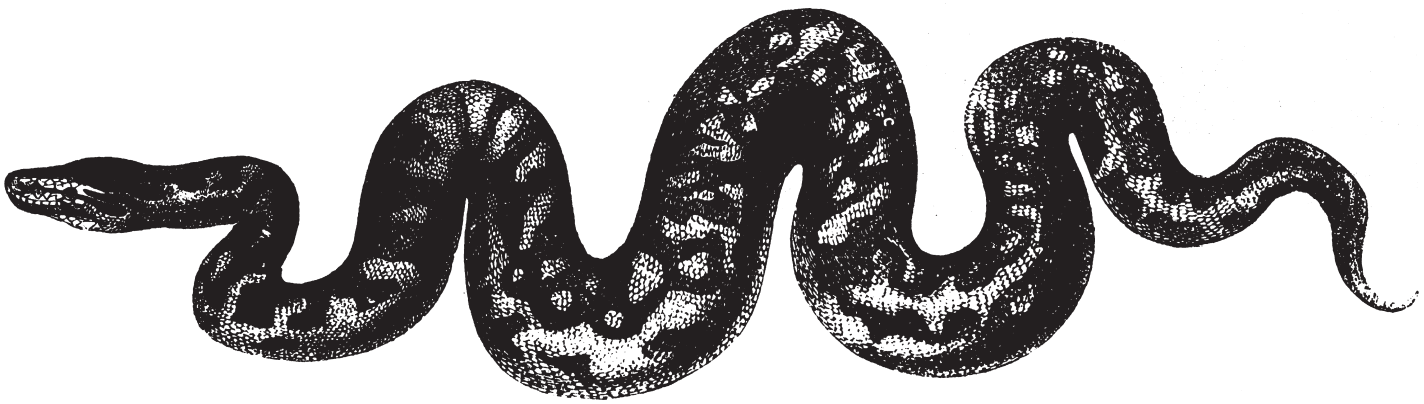
1. Explore project topics and community issues.
Your students can become informed about projects by collecting information from the news, interviewing community members and parents, and contacting organisations that focus on environmental issues. The activity "Community Connections" on page 69 should spark ideas about local problems. If you can, arrange for students to get out and see local environmental problems firsthand.

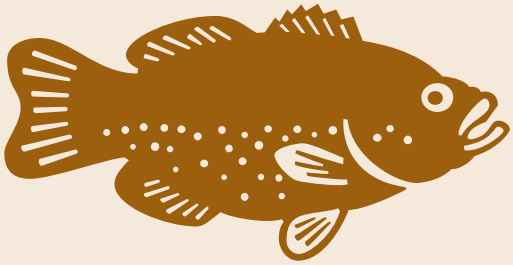
2. Create a list of possibilities.
Once the students have highlighted a number of potential topics, have them work in groups to develop a list of topics that they think are the most interesting or worthwhile. Have students select the topic they most want to tackle and brainstorm specific projects that might help address all or part of the situation. It might be helpful to explain that environmental topics can be very broad and that several project possibilities almost always exist for each topic. For example, if students are concerned about the use of pesticides in their community, they can survey homeowners, launch an education program for pesticide users, collect data on the effects of pesticides on wildlife and people, and so on.

Conservation Consensus

Environmental problems are usually very complicated, and there is seldom an easy solution. Many people, with different perspectives and opinions, need to be involved if we are to try to find solutions. As a teacher, you should maintain a neutral role, helping students to see and understand all sides of a particular issue.

3. Narrow the choices.
For each project listed, ask the students specific questions that will help them think about the process they'll use to accomplish certain tasks. How much time will the project take? How complex is it? What resources are needed? Whom will





Mapping Your Action Project

1. What environmental issue will your project focus on? What is the current status of the issue?
2. Briefly describe the goal of your project and your strategy to accomplish this goal. What would you like to see change as a result of your project?
3. What are the specific objectives that will help you reach your overall goal?
4. What are the approximate starting and ending dates of your project?
5. List the tasks that need to be accomplished to meet each objective. Include a tentative completion date for each task, the names of people responsible for each task, the supplies and equipment required, any funding needed, and ideas about sources for materials and funding.
6. Write down the names of people and organisations that may be able to provide you with useful information, specific skills or expertise, or other help.
7. List ideas for ways to publicize and generate support for your project.
8. Describe criteria for measuring your success.

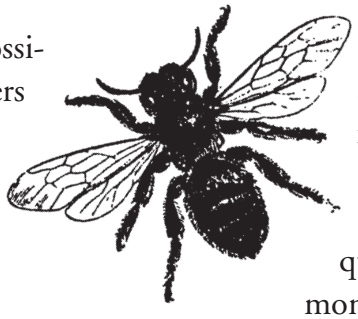
they need to talk to? How will they use the information they gather?

4. Learn more about the issues and pick a project.

Have students choose three to five possible projects, develop a list of questions for each one, and work in groups to research the answers. Give them adequate time to do research, and encourage them to use any sources available (library, Internet, newspaper, TV and radio, local experts). If access to information sources is limited, students can make a list of local people they could interview for more information. For each problem, students should think of people to talk to who are likely to have different opinions on why the problem exists or how to solve it. For example, if the problem is **poaching**, or illegal hunting, students could talk to hunters, park rangers, conservationists, and people who have lived in the community for many years. Afterward, organize presentations or class discussions designed to help students demonstrate their knowledge. Invite experts or resource people to discuss problems, find potential solutions, and help evaluate ideas.

As students approach their final decision about which project to pursue, have each group present a case for one or more of the projects that the group feels strongly about. Then hold a group vote. Or have a large group discussion and try to reach consensus. The important thing is to let students have as much say in the

decision-making process as possible. At the end, group members should have chosen a project that they think is both interesting and doable.



5. Create an action plan.
Help your students get started on their action plan by asking: What do you hope you'll accomplish by doing this project? Guide them in coming up with a goal or vision for the project and specific, concrete objectives that need to be accomplished along the way. Have them reflect on questions such as the following: What is the current status of the problem? What changed to make it become an issue? Do other communities and/or countries experience the same problem? What do other people think about the problem? Are there many different opinions? Are there any conflicts? The students can also use the questions in "Mapping Your Action Project" (on page 74) to help them plan and focus.

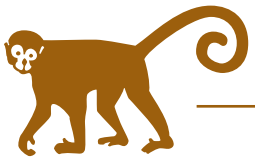
As the students work on their action plan, guide them toward realistic objectives.

One of the most common problems for students is thinking too big. Help them focus and simplify the project by discussing the responses to the questions and by asking them to carefully consider hard questions: How will you raise that much money? How might you tackle a smaller, but more manageable, piece of the problem?

6. Put the plan into action.
As students get started, explain that their projects will work best if they keep track of who's doing what, what they've done, when they did it, whom they've contacted, and so on. It's important that students evaluate the project periodically to see if they're on target and to make modifications if necessary. Remind them that it's OK to rethink their goals and objectives and to revise their plan of action in light of new information or unexpected obstacles.

7. Set a date for project completion and final reports.
Students should be asked to make formal presentations to the rest of the class about their plans, objectives and final results.

In the Páramo region of Colombia in South America, students worked with their teachers, local conservationists, and community members to create a series of 20 radio programs about the local ecosystem, the species that live there, and how local residents can help support conservation. Several local radio stations air the programs, reaching thousands of people.

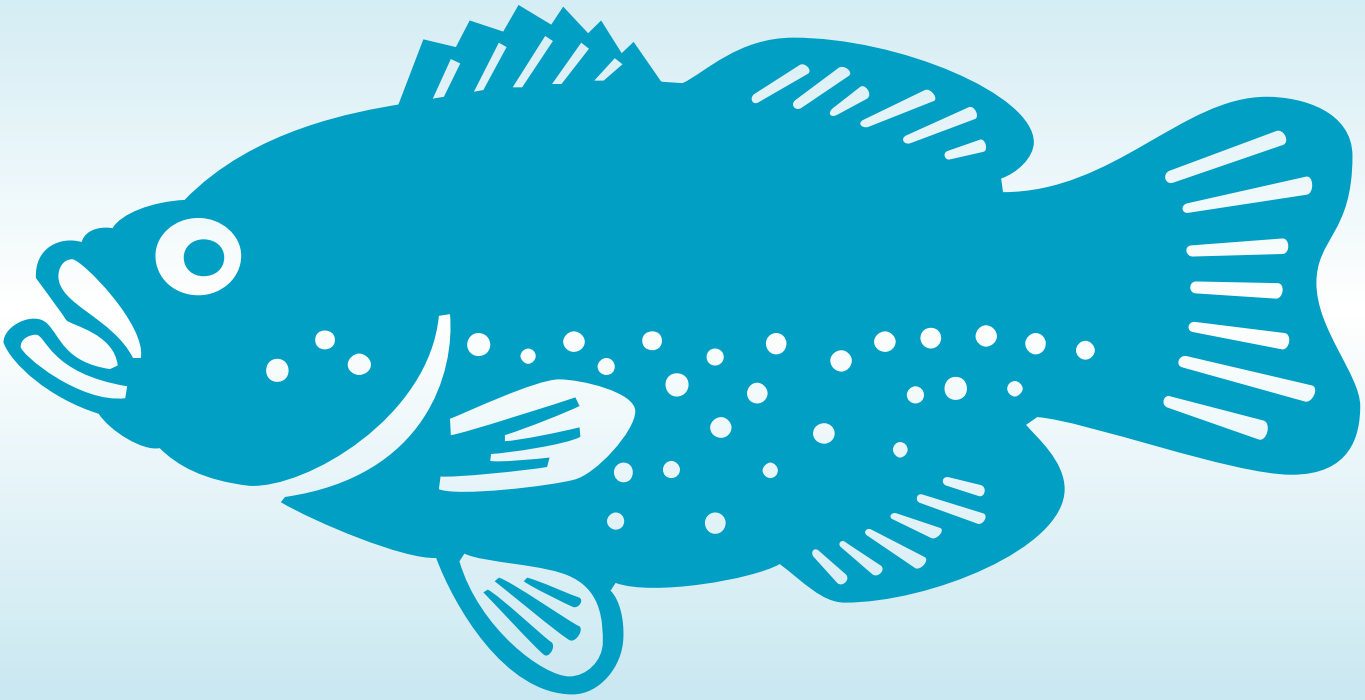


FINISHING UP

As the project draws to an end, guide students in assessing the project itself, the process, and their feelings about the experience. A group discussion will allow students to reflect on their feelings and attitudes by providing the chance to listen to what others say about the project and the experiences they have had. To facilitate the discussion and assess your students' projects, you could ask:

- Did your project accomplish its goal and objectives?
- What was the most successful part of your project?
- What was the least successful part?
- Who was influenced or motivated by your actions?
- Whom might those people influence in turn?
- If you were to repeat the project, what, if anything, would you do differently and why?
- How do you feel about your involvement in the project?
- How did the group work together to accomplish the stated objectives?
- Have your feelings and opinions about the issue you worked on changed since you began the project? If so, how?
- What did you learn during this project that you'll be able to apply to other situations that you'd like to change?
- Would you get involved in another environmental project? Why or why not?
- What advice would you give to other students who are planning an action project?
- Do you think it's important for students to get involved in community issues? Why or why not?

APPENDICES



APEPENDIX A: EXTENSION IDEAS

There are many other ways you can involve your students or community in learning about biodiversity. The following are meant to spark ideas for expanding environmental education throughout your school, protected area, or community. Please contact Conservation International or World Wildlife Fund (see inside back cover) for more information on how to do these activities with your students.

Eco-Clubs

Start an after-school environmental club for students. Ask parents, other teachers, or conservationists to help. Ask students what they want their club to do, or use some of the ideas below to get started.

Contests and forums

Organize art, poetry, essay, songwriting, or knowledge contests about biodiversity. Hold a debate or school-wide forum on biodiversity.

Educator training

Share your knowledge and experience with other educators in your school or district by doing a workshop, demonstrating a lesson during teacher meetings, or co-teaching a class. Invite park rangers or extension agents who do education to participate.

Celebrations

Organize celebrations around special days or weeks, such as World Environment Day (June 5), Earth Week (third week of April), or the anniversaries of protected areas in your region.

Helping Hands

Don't hesitate to ask local businesses, cooperatives, or organizations for help in implementing student conservation projects. Sometimes they can donate supplies, transportation, expertise, or even money to make a project happen. Think of creative ways to solicit their support and explain why your students want to help conserve biodiversity.

Awareness campaigns

Choose an important local environmental issue and design and implement a campaign to raise awareness about that issue. Students can create a logo and key messages and communicate those messages through posters, radio announcements, articles, events, and so on.

Field trips

Organize a visit to a protected or unique natural area. Go on a nature hike in your community.

Youth environmental journalism

Create a student newspaper to report on local or national biodiversity issues.

Conservation projects

Talk with a conservation organization or government agency about how your students can get involved with local conservation efforts. Plan your own project to improve the local environment: clean up a river, park, or beach; plant trees; collect aluminium cans for recycling and find a facility that can recycle them; create a school

organic garden or compost pile; improve animal habitats near your school (plant a butterfly garden, make bird houses); create a nature trail.

Conservation science fair

Organise a science fair at your school or in your district where students plan and present research projects in a competition.

Murals

Paint a biodiversity mural in a central place in the community or at the school. Solicit help from a local artist and private companies for supplies.

Guest speakers

Invite a scientist to speak to your class about his/her work. Hold a career workshop where conservationists talk about the variety of specialties needed to do conservation (science, communications, education, policy, economics). Invite a community leader or elder to talk about his/her views on conservation.

Linking students to students

Work with a secondary school teacher to have older students prepare a lesson or activity for younger students. Set up a letter-writing exchange between students in a school in another part of your country. Bring students from different schools together for an event celebrating the environment.

Involving parents

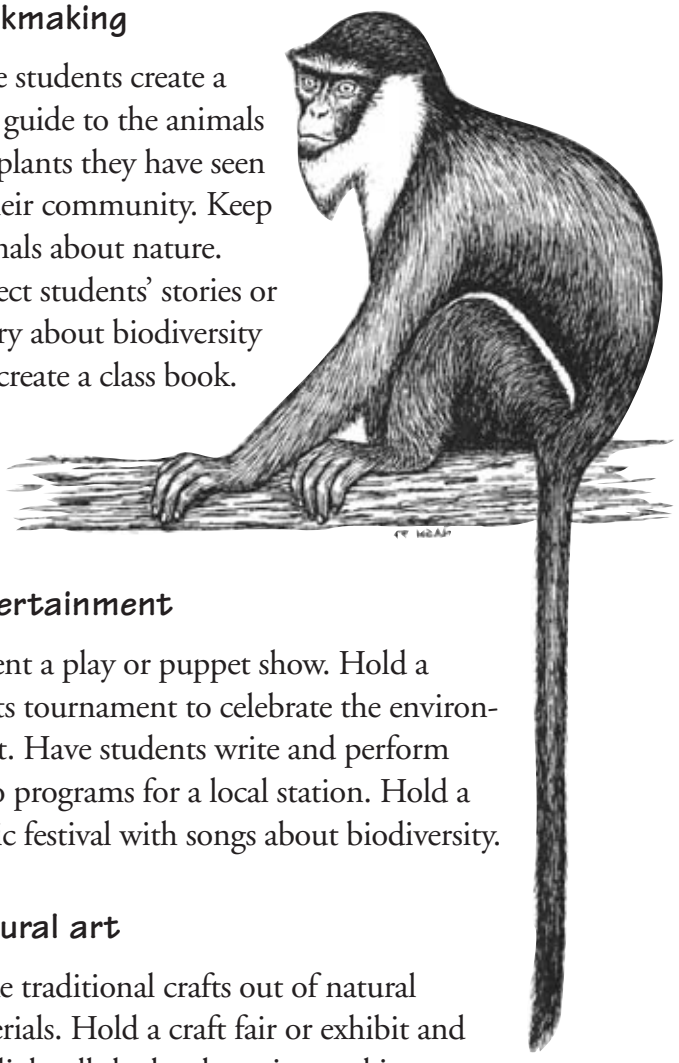
Hold an open house for parents and families to see what your students have been learning. Post their work around the school, have students give a presentation, or create an exhibit.

Conservation camps

Organize a day camp during school vacations. Do some of the activities on this list at the camp.

Bookmaking

Have students create a field guide to the animals and plants they have seen in their community. Keep journals about nature. Collect students' stories or poetry about biodiversity and create a class book.



Entertainment

Present a play or puppet show. Hold a sports tournament to celebrate the environment. Have students write and perform radio programs for a local station. Hold a music festival with songs about biodiversity.

Natural art

Make traditional crafts out of natural materials. Hold a craft fair or exhibit and highlight all the local species used in traditional crafts.

APPENDIX B: GLOSSARY

atmosphere: all of the air surrounding the earth.

bacteria: a large and diverse group of microorganisms that perform many important functions, such as enriching soil fertility. Bacteria are the most successful life forms on Earth, inhabiting almost every conceivable habitat in large numbers.

biodiversity: the variety of life on Earth, reflected in the variety of ecosystems and species, their processes and interactions, and the genetic variation within and among species.

conservation: the protection and planned management of a natural resource to prevent exploitation, destruction, or neglect. Conservationists are people who work to achieve conservation. Conservationists include scientists, teachers, economists, policy-makers, and others.

conservation corridor: an area that connects habitats across the landscape, linking scattered and diverse protected areas to ensure long-term and effective species conservation. In a corridor, conservationists work with governments and landowners to protect species inside and out of legally protected areas.

coral reef: a massive limestone structure formed by the skeletons of small marine animals called corals. As one of the most complex ecosystems on the planet, coral reefs are home to more than 4,000 different species of fish, 700 species of coral, and thousands of other species of plants and animals.

decomposers: organisms such as bacteria, fungi, and earthworms that feed on dead animals and plants as well as other organic wastes and cause them to break down physically and chemically.

desert: a dry area of land with very little vegetation; deserts receive less than 25 centimetres of sporadic rainfall annually.

ecological or ecosystem services: valuable services provided by natural systems. Examples of ecological services include flood control, air purification, and climate control.

ecoregion: a relatively large unit of land that is distinctive in its climate, ecological features, and plant and animal communities. World Wildlife Fund and its many partners have identified over 1,000 terrestrial, marine, and freshwater ecoregions worldwide.

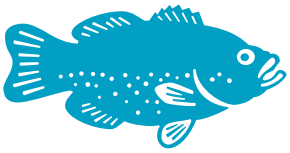
ecosystem: a community of plants, animals, and micro-organisms that are linked by energy and nutrient flows and that interact with each other and with the physical environment. Rain forests, deserts, coral reefs, grasslands, and a rotting log are all examples of ecosystems.

ecotourism: responsible travel that promotes the conservation of nature and sustains the well-being of local people.

endemic: belonging only to one area or region; for example, marine iguanas to the Galapagos Islands.

environmental education: a process of developing a world population that is aware of and concerned about the total environment and its associated problems, and which has the knowledge, skills, attitudes, motivation and commitment to work individually and collectively toward solutions of current problems and the prevention of new ones (UNESCO 1978).

evolution: the process of change in the traits of organisms or populations over time. Evolution, through the process of natural selection, has lead to the formation of every species that has ever lived on Earth.



extinct: refers to a species that no longer exists. Local extinction occurs when every member of a particular population has died. Global extinction occurs when every member of a species has died.

fauna: the animals that live in a particular area.

flora: the plants that live in a particular area.

food chain: a sequence of organisms from producers (plants and some bacteria) to consumers (other plants, animals, and fungi), in which the producers create food energy and all consumers feed on or get nutrients from the producers or other consumers.

fragmentation: the breaking up of large habitats into smaller, isolated chunks. Fragmentation is one of the main forms of habitat destruction, which is the primary reason biodiversity is in decline.

fungi: organisms that use living or dead organisms as food by breaking them down and then absorbing the substances into their cells. Fungi make up one of the five kingdoms of living things on Earth. Mushrooms, yeast, and moulds are types of fungi.

gene: a segment of DNA that includes the coded information in an organism's cells that makes each species and individual unique. Genes contain the hereditary characteristics that are transmitted from one generation to the next and determine how organisms look and behave. Genes are responsible for features such as hair colour and texture and resistance to disease.

gene bank: a facility that stores genetic material. For example, gene banks store seeds and other plant parts for future use.

genetic diversity: the genetic variation present in a population or species. For example, the genetic diversity in the hundreds of varieties of potatoes can be seen by their differences in size, shape, colour, taste, and rate of growth.

global warming: the theory that the average temperature of the Earth's atmosphere is rising mainly because of the release of "greenhouse gases" such as carbon dioxide. These gases are released into the air from burning petrol, oil, coal, wood, and other resources and trap heat in an action similar to that of the walls of a greenhouse. Global climate change is a broader term that describes other changes in the Earth's climate beyond average temperature rise.

grassland: an area of land where mostly grasses grow.

greenhouse effect: the trapping of heat in the Earth's atmosphere by certain gases such as carbon dioxide, nitrous oxide, and methane. Some scientists predict that the rise in atmospheric temperature, sea level rise, and other changes associated with global warming could adversely affect biodiversity.

greenhouse gas: gas that traps heat in the Earth's atmosphere, causing the greenhouse effect.

habitat: the area where an animal, plant, microorganism, or other life form lives and finds the nutrients, water, sunlight, shelter, living space, and other essentials it needs to survive. Habitat loss, which includes the destruction, degradation, and fragmentation of habitats, is the primary cause of biodiversity loss.

hotspot: a region that contains a high number of endemic species and has had much of it's habitat destroyed. Conservation International has identified 25 such areas that contain more than 60% of terrestrial species in just 1.4% of the Earth's surface.

hypothesis: a statement consisting of an action that can be tested and a predicted result. Making a hypothesis is part of scientific inquiry.

introduced species: an organism that has been brought into an area where it doesn't naturally occur. Introduced species can compete with and cause problems for native species. Introduced species are also called exotic, non-native, and alien species. Invasive alien species often spread quickly and take a heavy toll on native species.

invertebrate: an organism that does not have a backbone, such as an insect or snail.

Keystone species: A species whose presence is vital for ecosystem health; the loss of a keystone species has a greater than average effect on other species and the ecosystem as a whole.

mangrove: one of several tropical or sub-tropical tree species that have special stilt-like roots and other adaptations that allow the trees to grow in shallow salt water. Mangroves grow along coasts in dense forests that are important nursery areas for marine life.

microorganism: a living organism too small to be seen with the naked eye. Bacteria, protozoans, viruses, microscopic algae, and some types of fungi are all microorganisms.

migration: the movement of animals in response to seasonal changes or changes in the food supply. Examples of migratory animals include hummingbirds, monarch butterflies, wildebeests, and elephants.

native species: a species that occurs naturally in an area or a habitat. Also called an indigenous species.

natural resource: any aspect of the environment that species depend on for their survival. People depend on natural resources such as forests, minerals, soil, fossil fuels, and fresh water.

natural selection: the process by which detrimental genetic traits are slowly removed from each successive generation. Over time, natural selection helps species become better adapted to their environment. Also known as "survival of the fittest", natural selection is the driving force behind the process of evolution.

organism: any individual life form.

population: (1) the number of people in a country or region; (2) a group of individuals of the same species that live in a specific geographic area.

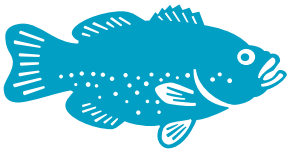
protected area: a location that is important for its landscape, beauty, or biodiversity and that has been protected by national, regional, or local law. National parks, wildlife preserves, and forest reserves are all types of protected areas.

organic: (1) describes matter that is living or was once living; (2) describes agricultural products grown or raised without pesticides or other synthetic chemicals.

pesticides: chemicals that kill or inhibit the growth of organisms that people consider undesirable. Fungicides (which kill fungi), herbicides (which kill plants), and insecticides (which kill insects) are types of pesticides.

photosynthesis: the process by which green plants, algae, and other organisms that contain chlorophyll use sunlight to produce carbohydrates (food). Oxygen is released as a byproduct of photosynthesis.

poaching: hunting, trapping, fishing, or taking wildlife illegally.



pollination: the process by which pollen is transferred from the male part of a flower to the female part of the same or another plant. Insects, birds, mammals, and other creatures, as well as wind and water, can all pollinate plants.

range: the area in which an organism may travel in its lifetime. Range also refers to the geographic distribution of a particular species.

rapid assessment: a quick scientific survey or count that helps measure local biodiversity.

reintroduce: to return members of a species to their historical range. This strategy is sometimes used when a species has become locally extinct or if its population is threatened.

shrubland: an area of land characterised by low-growing woody plants (shrubs).

slash-and-burn agriculture: an agricultural system in which farmers periodically clear land for farming by cutting and burning patches of forest. Traditionally, patches used for agriculture were allowed to revert to forests for a number of years before being replanted, thereby causing minimal impact. Today, however, intensive slash-and-burn agriculture damages many tropical forest ecosystems.

species: (1) a group of organisms that have a unique set of characteristics (such as body shape and behavior) that distinguishes them from other organisms. If they reproduce, individuals within the same species can produce fertile offspring; (2) the basic unit of biological classification. Scientists refer to species using both their genus and species name. The tiger, for example, is called *Panthera tigris*.

sustainable/sustainability: meeting the needs of the present without diminishing the ability of people, other species, or future generations to survive.

symbiotic: refers to an ecological relationship between two organisms. The relationship may be beneficial or detrimental to one or both organisms. For example, termites have a symbiotic relationship with microorganisms that live in their gut and help them digest wood fibre. The microorganisms benefit from food and a safe environment.

temperate rain forest: a type of forest found in only a few places around the world, such as the Pacific temperate rain forest on the west coast of North America. These forests are often dominated by conifers adapted to wet climates and cool temperatures.

threatened species: a species threatened with extinction.

trait: a genetically determined feature or characteristic, such as hair colour or blood type that may be passed on from one generation to the next.

tropical dry forest: a type of forest found near the equator that has distinct rainy and dry seasons. Many tropical dry forest plants are adapted to withstand high temperatures and seasonal droughts.

tropical rain forest: a type of wet forest found near the equator that harbours the richest diversity of terrestrial plant and animal species.

watershed: a geographic area that drains into a single river system and its tributaries.

wetlands: areas that, at least periodically, have waterlogged soils or are covered with a relatively shallow layer of water. Bogs, freshwater and saltwater marshes, and freshwater and saltwater swamps are examples of wetlands.

CONSERVATION INTERNATIONAL

Conservation International (CI) is a global leader in conservation, working to protect threatened ecosystems in over 30 countries. Based in Washington, DC, CI focuses its resources and expertise in parts of the world where the needs are the greatest—biodiversity hotspots, major tropical wilderness areas, key marine ecosystems, and select major wetlands. CI's mission is to conserve the Earth's living natural heritage, our global biodiversity, and to demonstrate that human societies are able to live harmoniously with nature.

The International Environmental Education (EE) Program at Conservation International is part of the International Communications Department in the Field Support Division. The program works with a network of educators in CI field offices to educate youth in priority conservation countries about human connections to their environment in order to promote responsible behavior and commitment to biodiversity conservation. Specifically, the program provides support to field offices in designing locally tailored EE strategies, building the capacity of educators, producing and distributing educational tools, and evaluating the effect of EE programs and activities.

WORLD WILDLIFE FUND

For more than four decades, World Wildlife Fund (WWF) has supported efforts around the world to protect the Earth's endangered wildlife and wildlands. WWF activities include saving critical species such as tigers, pandas, whales, and rhinos; creating and preserving protected areas; providing education programs for all ages; helping people improve their living standards; and helping to tackle global environmental issues such as pollution, deforestation, and over-fishing. WWF works in more than 100 countries and is part of the international WWF network, with organizations in more than 50 countries.

Windows on the Wild, or *WOW*, is an environmental education program of WWF that uses biodiversity as a "window" to explore the incredible web of life and how all living things are interconnected. The goal of *WOW* is to educate people of all ages about biodiversity issues and stimulate critical thinking, discussion, and informed decision making on behalf of the environment. *WOW* also explores the complexity of biodiversity—looking at scientific, social, political, cultural, and economic contexts. Initial funding for *Windows on the Wild* and the program's ongoing support of environmental education in the United States and abroad has been provided through a generous grant from Eastman Kodak Company.

For more information about the *Exploring Biodiversity* educators' guide or education programs at CI or WWF, please contact us:

International Environmental Education Program
International Communications Department
Field Support Division
Conservation International
1919 M Street, NW Suite 600
Washington, DC 20036 USA
Tel: 202-912-1000
www.conservation.org
education@conservation.org

Education Department
World Wildlife Fund
1250 24th Street, NW
Washington, DC 20037 USA
Tel: 1 (202)
www.worldwildlife.org
edmail@wwfus.org