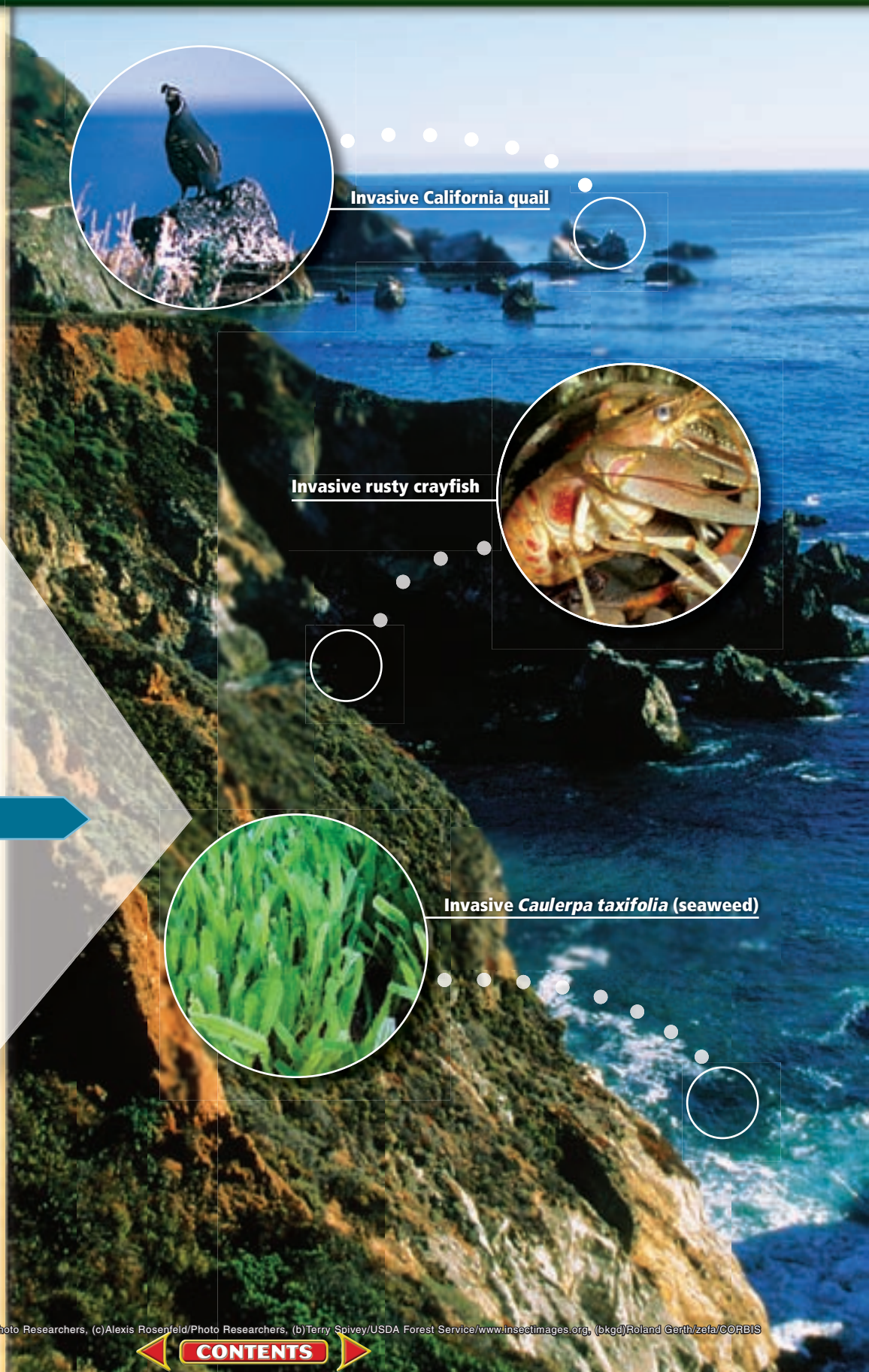
CHAPTER 5

# Biodiversity and Conservation




## Section 1
### Biodiversity
MAIN Idea Biodiversity maintains a healthy biosphere and provides direct and indirect value to humans.

## Section 2
### Threats to Biodiversity
MAIN Idea Some human activities reduce biodiversity in ecosystems, and current evidence suggests that reduced biodiversity might have serious long-term effects on the biosphere.

## Section 3
### Conserving Biodiversity
MAIN Idea People are using many approaches to slow the rate of extinctions and to preserve biodiversity.

## BioFacts

- A hardy, cold-water strain of the tropical algae *Caulerpa taxifolia* was produced for the saltwater aquarium industry.
- Around 1984, an aquarium-bred type of *Caulerpa taxifolia* was placed in the Mediterranean Ocean, where it has negatively affected native plant and animal communities.
- *Caulerpa taxifolia* is invading the waters off the coast of California, where it may harm the local biological communities.





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# LAUNCH Lab

## What lives here?

Some landscapes support more organisms than others. In this lab, you will infer the relative numbers of species that can be found in each environment.

### Procedure

1. Read and complete the lab safety form.
2. Choose three locations in your community that are familiar to you, such as a tree, a group of trees, a drainage ditch, a field, a dumpster, a park, or a pond.
3. Rank the locations in descending order, greatest to least, according to the number of species of animals, plants, etc. you think you would find there.

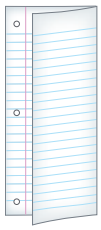
### Analysis

1. **Define** the term *biodiversity* in your own words.
2. **Explain** how you chose to rank the locations in order.
3. **Describe** scientific methods you could use to find out how many species live in each habitat.

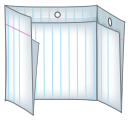

FOLDABLES™ Study Organizer

**Biodiversity** Make the following Foldable to help you understand the three levels of biodiversity and the importance of biodiversity to the biosphere.

**STEP 1** Fold a sheet of paper in half lengthwise. Make the back part about 5 cm longer than the front part.



**STEP 2** Turn the paper so that the fold is on the bottom, then fold it into thirds.



**STEP 3** Unfold and cut only the top layer along each fold to make three tabs. Label the Foldable as shown.


FOLDABLES **Use this Foldable with Section 5.1.** As you study the section, define *biodiversity* under the large tab and explain its importance. Describe each of the three types of biodiversity under the small tabs. Provide an example of each.

Section 5.1

## Objectives

- **Describe** three types of biodiversity.
- **Explain** the importance of biodiversity.
- **Summarize** the direct and indirect value of biodiversity.

## Review Vocabulary

**gene:** functional unit that controls the expression of inherited traits and is passed from generation to generation

## New Vocabulary

extinction
biodiversity
genetic diversity
species diversity
ecosystem diversity

# Biodiversity

**MAIN Idea** **Biodiversity maintains a healthy biosphere and provides direct and indirect value to humans.**

**Real-World Reading Link** Stop for a moment and consider the effect of all the jackrabbits in a food web dying suddenly. What would happen to the other members of the food web? Is the disappearance of one species from Earth important, or will another species fill its niche?

## What is biodiversity?

The loss of an entire species in a food web is not an imaginary situation. Entire species permanently disappear from the biosphere when the last member of the species dies in a process called **extinction.** As species become extinct, the variety of species in the biosphere decreases, which decreases the health of the biosphere. **Biodiversity** is the variety of life in an area that is determined by the number of different species in that area. Biodiversity increases the stability of an ecosystem and contributes to the health of the biosphere. There are three types of biodiversity to consider: genetic diversity, species diversity, and ecosystem diversity.

**Genetic diversity** The variety of genes or inheritable characteristics that are present in a population comprises its **genetic diversity.** **Figure 5.1** shows several characteristics that are shared by the ladybird beetles, such as general body structure. The variety of colors demonstrates a form of genetic diversity. The beetles have other characteristics that differ, but they are not as apparent as their color. These characteristics might include resistance to a particular disease, the ability to recover from a disease, or the ability to obtain nutrients from a new food source should the old food source disappear. The beetles with these characteristics are more likely to survive and reproduce than beetles without these characteristics.

Genetic diversity within interbreeding populations increases the chances that some species will survive during changing environmental conditions or during an outbreak of disease.

PSU Entomology/Photo Researchers

**Figure 5.1** These Asian ladybird beetles, *Harmonia axyridis,* demonstrate some visible genetic diversity because of their different colors.

OSF/R. Packwood/Animals Animals

**Figure 5.2** Many species gather at this watering hole, making it a habitat rich in species diversity.

**Species diversity** The number of different species and the relative abundance of each species in a biological community is called **species diversity.** As you look at **Figure 5.2,** notice how many different species of organisms are in this one area. This habitat represents an area with a high level of species diversity because there are so many species present in one location. However, species diversity is not evenly distributed over the biosphere. As you move geographically from the polar regions to the equator, species diversity increases. For example, **Figure 5.3** shows the number of bird species from Alaska to Central America. Use the color key to see how diversity changes as you move toward the equator.

**Reading Check** **Compare and contrast** genetic and species diversity.

FOLDABLES
Incorporate information from this section into your Foldable.

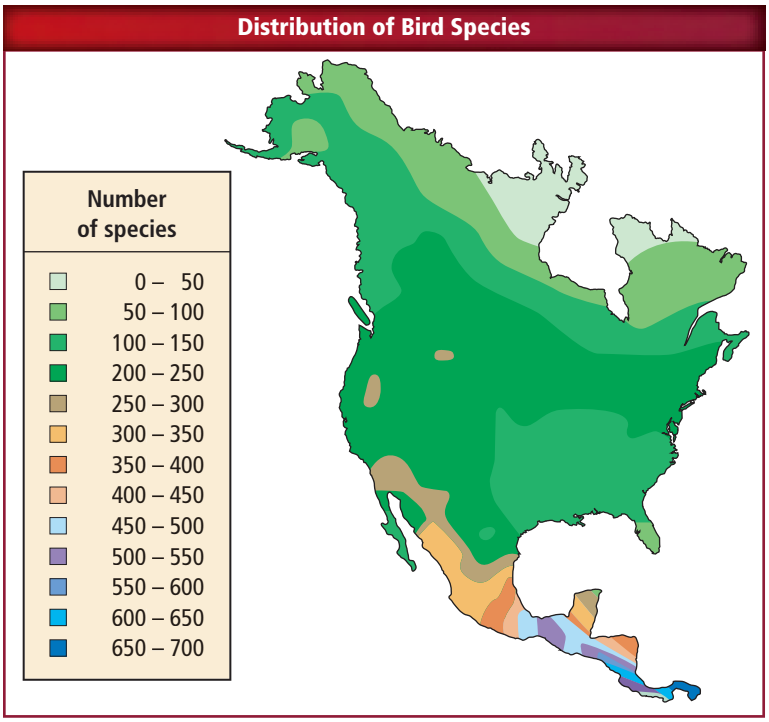



**Figure 5.3** This map shows the distribution of bird species in North and Central America. As you move toward the tropics, biodiversity increases.
**Identify** *the locations with the highest and lowest amounts of species diversity.*

Alaska

Peru

(l)Stefan Meyers/Animals Animals, (r)Michael and Patricia Fogden/Minden Pictures

**Figure 5.4** The biosphere contains many ecosystems with diverse abiotic factors that support a variety of organisms.

**VOCABULARY**

**ACADEMIC VOCABULARY**

**Diverse:**
Made of different qualities.
*The colors and shapes of flowers are very diverse.*

**Ecosystem diversity** The variety of ecosystems that are present in the biosphere is called **ecosystem diversity.** Recall from Chapter 2 that an ecosystem is made up of interacting populations and the abiotic factors that support them. The interactions of organisms affect the development of stable ecosystems. Different locations around the world have different abiotic factors that support different types of life. For example, an ecosystem in Alaska has a set of abiotic factors that supports Dall sheep, which are shown in **Figure 5.4.** An ecosystem in Central America has a different set of abiotic factors that supports tropical birds, also shown in **Figure 5.4.** All of the ecosystems on Earth support a diverse collection of organisms.

**Reading Check** **Explain** why ecosystem diversity results in species diversity in a healthy biosphere.

## The Importance of Biodiversity

There are several reasons to preserve biodiversity. Many humans work to preserve and protect the species on Earth for future generations. In addition, there are economic, aesthetic, and scientific reasons for preserving biodiversity.

**Direct economic value** Maintaining biodiversity has a direct economic value to humans. Humans depend on plants and animals to provide food, clothing, energy, medicine, and shelter. Preserving species that are used directly is important, but it also is important to preserve the genetic diversity in species that are not used directly. Those species serve as possible sources of desirable genes that might be needed in the future.

The reason there might be a future need for desirable genes is that most of the world's food crops come from just a few species. These plants have relatively little genetic diversity and share the same problems that all species share when genetic diversity is limited, such as lacking resistance to disease. In many cases, close relatives of crop species still grow wild in their native habitat. These wild species serve as reservoirs of desirable genetic traits that might be needed to improve domestic crop species.

**CAREERS IN BIOLOGY**

**Plant Pathologist** A plant pathologist studies the symptoms, causes, damage, spread, and control of plant diseases. For more information on biology careers, visit biologygmh.com.

**Teosinte plant**

**Domestic corn plant**

■ **Figure 5.5** The teosinte plant contains genes that are resistant to several viral diseases that affect domesticated corn plants. These genes have been used to produce virus-resistant domestic corn varieties.

The distant relative of corn shown on the left in **Figure 5.5** is resistant to the viral diseases that damage commercial corn crops. Using this wild species, plant pathologists have developed disease-resistant corn varieties. If this wild species had not been available, this genetic diversity would have been lost, and the ability to develop disease-resistant corn varieties would have been lost as well.

In addition, biologists are beginning to learn how to transfer genes that control inherited characteristics from one species to the other. This process, sometimes referred to as genetic engineering, is discussed in Chapter 13. Crops have been produced that are resistant to some insects, that have increased nutritional value, and that are more resistant to spoilage. Most wild species of plants and animals have not been evaluated for useful genetic traits. The opportunity to benefit from these genes is lost forever if wild species of plants and animals become extinct. This increases the importance of species that currently have no perceived economic value because their economic value might increase in the future.

**Reading Check** **Explain** why preserving biodiversity is important for the human food supply.

**Connection to Health** Many of the medicines that are used today are derived from plants or other organisms. You probably know that penicillin, a powerful antibiotic discovered in 1928 by Alexander Fleming, is derived from bread mold. Ancient Greeks, Native Americans, and others extracted salicin, a painkiller, from the willow tree. Today, a version of this drug is synthesized in laboratories and is known as aspirin. **Figure 5.6** shows a Madagascar periwinkle flower, which recently was found to yield an extract that is useful in treating leukemia. This extract has been used to develop drugs that have increased the survival rate for leukemia patients from 20 percent to more than 95 percent.

Scientists continue to find new extracts from plants and other organisms that help in the treatment of human diseases. However, many species of organisms are yet to be identified, especially in remote regions of Earth, so their ability to provide extracts or useful genes is unknown.

■ **Figure 5.6** Drugs developed from an extract from Madagascar periwinkle, *Catharanthus roseus*, are used to treat childhood forms of leukemia.

**Summarize** ***Why is it important to maintain biodiversity for medical reasons?***


**Figure 5.7** An economic study determined that restoring the biodiversity in the ecosystem that filtered the water supply for New York City was less expensive than using technology to perform the same service.

**Infer** *What type of human activities could affect a watershed and lower water quality?*

**Indirect economic value** A healthy biosphere provides many services to humans and other organisms that live on Earth. For example, green plants provide oxygen to the atmosphere and remove carbon dioxide. Natural processes provide drinking water that is safe for human use. Substances are cycled through living organisms and nonliving processes, providing nutrients for all living organisms. As you will soon learn, healthy ecosystems provide protection against floods and drought, generate and preserve healthful fertile soils, detoxify and decompose wastes, and regulate local climates.

It is difficult to attach an economic value to the services that a healthy biosphere provides. However, some scientists and economists have attempted to do just that. In the 1990s, New York City was faced with the decision of how to improve the quality of its drinking water. A large percentage of New York City's drinking water was supplied by watersheds, shown in **Figure 5.7.** Watersheds are land areas where the water on them or the water underneath them drains to the same place. The Catskill and Delaware watersheds did not meet clean water standards and no longer could supply quality drinking water to the city.

The city was faced with two choices: build a new water filtration system for more than $6 billion or preserve and clean up the watersheds for approximately 1.5 billion dollars. The economic decision was clear in this case. A healthy ecosystem was less expensive to maintain than using technology to perform the same services.

## MiniLab 5.1

### Investigate Threats to Biodiversity

**What are the threats to natural habitats in your local area?** Investigate these threats and brainstorm possible remedies with which you can educate others.

**Procedure**

1. Read and complete the lab safety form.
2. With your lab group, choose one factor that is threatening the biodiversity in your community and study how it has affected the climax community.
3. Brainstorm ways that this threat could be reversed.
4. Organize this information about threats and possible solutions with your classmates.

**Analysis**

1. **Evaluate** What are the most important pieces of information the public needs to know about this threat?
2. **Infer** Imagine you have implemented one plan to reverse a threat you studied. Now it is 100 years later. What does the ecosystem look like? What changes have occurred? What species are there now?

Adam Jones/Photo Researchers

**Figure 5.8** It is difficult to attach an economic value to the aesthetic qualities of healthy ecosystems and biodiversity.

This example shows that nature can provide services, such as water that is safe for human consumption, at less expense than using technology to provide the same service. Some scientists believe the natural way should be the first choice for providing these services. Research indicates that when healthy ecosystems are preserved, the services the ecosystems provide will continue to be less expensive than performing the same services with technology.

**Aesthetic and scientific value** Two additional considerations for maintaining biodiversity and healthy ecosystems are the aesthetic and scientific values that they provide. It is difficult to attach a value to something that is beautiful, such as the ecosystem shown in **Figure 5.8,** or something that is interesting to study. Perhaps it is best to consider how life would be if all that was present on Earth was a barren and desolate landscape. The value of biodiversity and healthy ecosystems would be more obvious to us then.

## Study Tip

**Biojournal** Some of the vocabulary words in this chapter include the term *species*. Review the definition of *species*. Use your knowledge of the term *species* to help remember the meanings of new vocabulary words.

# Section 5.1 Assessment

### Section Summary

- Biodiversity is important to the health of the biosphere.
- There are three types of biodiversity: genetic, species, and ecosystem.
- Biodiversity has aesthetic and scientific values, and direct and indirect economic value.
- It is important to maintain biodiversity to preserve the reservoir of genes that might be needed in the future.
- Healthy ecosystems can provide some services at a lesser expense than the use of technology.

### Understand Main Ideas

1. MAIN Idea **Explain** why biodiversity is important to the biosphere.
2. **Summarize** the three types of biodiversity.
3. **Generalize** why maintaining biodiversity has a direct economic value to humans.
4. **Differentiate** between the direct and indirect economic value of biodiversity.
5. **Evaluate and discuss** the importance of maintaining biodiversity for future medical needs.

### Think Scientifically

6. *Design a course of action* for the development of a building project in your community, such as a shopping mall, housing development, city park, or highway, that provides for the maintenance of biodiversity in the plan.
7. WRITING in Biology Write a short report explaining the desirability of maintaining genetic diversity in domesticated animals such as dogs, cats, pigs, cattle, and chickens. Include the advantages and disadvantages in your report.

# Section 5.2

## Objectives

- **Describe** the biodiversity crisis.
- **Explain** the factors that threaten biodiversity.
- **Describe** how the decline of a single species can affect an entire ecosystem.

## Review Vocabulary

**food web:** a model representing the many interconnected food chains and pathways in which energy and matter flow through a group of organisms

## New Vocabulary

background extinction
mass extinction
natural resource
overexploitation
habitat fragmentation
edge effect
biological magnification
eutrophication
introduced species

# Threats to Biodiversity

**MAIN Idea** **Some human activities reduce biodiversity in ecosystems, and current evidence suggests that reduced biodiversity might have serious long-term effects on the biosphere.**

**Real-World Reading Link** Have you ever built a structure with blocks, and then tried to remove individual blocks without causing the entire structure to collapse? Similarly, if you remove one species from a food web, the food web can collapse.

## Extinction Rates

Many species have become extinct and paleontologists study fossils of those extinct species today. The gradual process of species becoming extinct is known as **background extinction.** Stable ecosystems can be changed by the activity of other organisms, climate changes, or natural disasters. This natural process of extinction is not what scientists are worried about. Many worry about a recent increase in the rate of extinction. Some scientists predict that between one-third and two-thirds of all plant and animal species will become extinct during the second half of this century. Most of these extinctions will occur near the equator.

Some scientists estimate the current rate of extinction is about 1000 times the normal background extinction rate. These scientists believe that we are witnessing a period of mass extinction. **Mass extinction** is an event in which a large percentage of all living species become extinct in a relatively short period of time. The last mass extinction occurred about 65 million years ago, as illustrated in **Table 5.1,** when the last of the surviving dinosaurs became extinct.

CLICK HERE

**Table 5.1** **Five Most Recent Mass Extinctions**

Interactive Table To explore more about mass extinctions, visit biologygmh.com.

| | Ordovician Period | Devonian Period | Permian Period | Triassic Period | Cretaceous Period |
|---|---|---|---|---|---|
| Time | about 444 million years ago | about 360 million years ago | about 251 million years ago | about 200 million years ago | about 65 million years ago |
| Example |  Graptolites |  *Dinichthys* |  Trilobite |  Cynognathus |  Ammonite |



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CLICK HERE

**Table 5.2** **Estimated Number of Extinctions Since 1600**

**Interactive Table** To explore more about mass extinctions, visit biologygmh.com.

| Group | Mainland | Island | Ocean | Total | Approximate Number of Species | Percent of Group Extinct |
|---|---|---|---|---|---|---|
| Mammals | 30 | 51 | 4 | 85 | 4000 | 2.1 |
| Birds | 21 | 92 | 0 | 113 | 9000 | 1.3 |
| Reptiles | 1 | 20 | 0 | 21 | 6300 | 0.3 |
| Amphibians* | 2 | 0 | 0 | 2 | 4200 | 0.05 |
| Fish | 22 | 1 | 0 | 23 | 19,100 | 0.1 |
| Invertebrates | 49 | 48 | 1 | 98 | 1,000,000+ | 0.01 |
| Flowering plants | 245 | 139 | 0 | 384 | 250,000 | 0.2 |

*An alarming decrease of amphibian populations has occurred since the mid-1970s, and many species might be on the verge of extinction.

**Connection to History** The accelerated loss of species began several centuries ago. **Table 5.2** shows the estimated number of extinctions that have occurred by group since 1600. Many of the species' extinctions in the past have occurred on islands. For example, 60 percent of the mammals that have become extinct in the past 500 years lived on islands, and an 81 percent of bird extinctions occurred on islands.

Species on islands are particularly vulnerable to extinction because of several factors. Many of these species evolved without the presence of natural predators. As a result, when a predator, such as a dog, cat, rat, or human, is introduced to the population, the native animals do not have the ability or skills to escape. When a nonnative species is introduced to a new population, it can be a carrier of a disease to which the native population has no resistance. The native population often dies off as a result. In addition, islands typically have relatively small population sizes and individual animals rarely travel between islands, which increases the vulnerability of island species to extinction.

**Reading Check** **Explain** why organisms found on islands are more vulnerable to extinction than other organisms.

**VOCABULARY**

**WORD ORIGIN**

**Native**
from the Latin word *nativus;* means to be born.

## Factors that Threaten Biodiversity

Scientists point out that today's high rate of extinction differs from past mass extinctions. The current high rate of extinction is due to the activities of a single species—*Homo sapiens*. After a mass extinction in the past, new species evolved, and biodiversity recovered after several million years. This time, the recovery might be different. Humans are changing conditions on Earth faster than new traits can evolve to cope with the new conditions. Evolving species might not have the natural resources they need. **Natural resources** are all materials and organisms found in the biosphere, including minerals, fossil fuels, nuclear fuels, plants, animals, soil, clean water, clean air, and solar energy.

Ocelot

White rhinoceros

■ **Figure 5.9** The ocelot and all species of rhinos, including the white rhinoceros, are in danger of becoming extinct, due in part to overexploitation.

■ **Figure 5.10** Cleared land often is used for agricultural crops or as grazing land for livestock. Planting large expanses of crops reduces the biodiversity of the area.

Natural tropical rain forest

Cleared tropical rain forest

**Overexploitation** One of the factors that is increasing the current rate of extinction is the **overexploitation,** or excessive use, of species that have economic value. For example, the great herds of bison that once roamed the central plains of North America were hunted to the brink of extinction because their meat and hides could be sold commercially and because they were hunted for sport. At one time, it is estimated that there were 50 million bison. By 1889, there were less than 1000 bison left.

Passenger pigeons are another example of a species that has been overexploited. At one time, there were huge flocks of these birds that would darken the skies of North America during their migration. Unfortunately, they were overhunted and forced from their habitats. By the early 1900s, they had become extinct.

The ocelot, shown in **Figure 5.9,** is found from Texas to Argentina and is in danger of becoming extinct. The increasing loss of their habitat and the commercial value of their fur are reasons for their declining numbers. The white rhinoceros, also shown in **Figure 5.9,** is one of five species of rhinos, all of which are in danger of becoming extinct. They are hunted and killed for their horns, which are then sold for medicinal purposes. Historically, overexploitation was the primary cause of species extinction. However, the number one cause of species extinction today is the loss or destruction of habitat.

**Reading Check** **Explain** the term overexploitation as it relates to species extinction.

**Habitat loss** There are several ways that species can lose their habitats. If a habitat is destroyed or disrupted, the native species might have to relocate or they will die. For example, humans are clearing areas of tropical rain forests and are replacing the native plants with agricultural crops or grazing land.

**Destruction of habitat** The clearing of tropical rain forests, like what is shown in **Figure 5.10,** has a direct impact on global biodiversity. As mentioned earlier, the tropical latitudes contain much of the world's biodiversity in their native populations. In fact, estimates show that more than half of all species on Earth live in the tropical rain forests. The removal of so much of the natural forest will cause many species on Earth to become extinct because of habitat loss.





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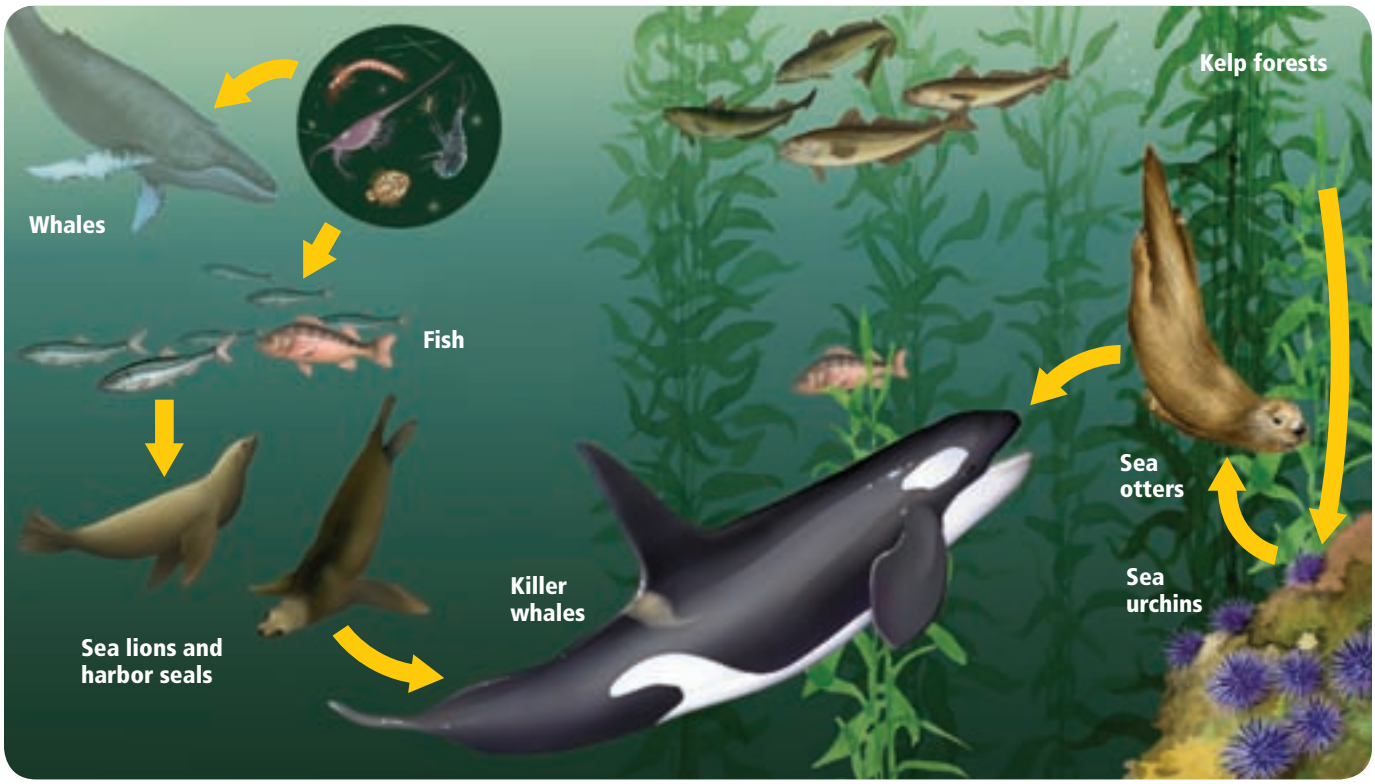



**Figure 5.11** A declining population of one species can affect an entire ecosystem. **Explain** *how killer whales adapted to their environment when their primary food source began to disappear.*

**Disruption of habitat** Habitats might not be destroyed, but they can be disrupted. For example, off the coast of Alaska, a chain of events occurred in the 1970s that demonstrates how the declining numbers of one member of a food web can affect the other members. As you can see from the chain of events shown in **Figure 5.11,** the decline of one species can affect an entire ecosystem. When one species plays such a large role in an ecosystem, that species is called a keystone species. A decline in various fish populations, possibly due to overfishing, has led to a decline in sea lion and harbor seal populations. Some scientists hypothesize that global warming also played a role in the decline. This started a chain reaction within the marine ecosystem that affected many species.

**Reading Check** **Summarize,** using **Figure 5.11,** how the decline in the number of sea lions and harbor seals caused the kelp forests to decline.

**Fragmentation of habitat** The separation of an ecosystem into small pieces of land is called **habitat fragmentation.** Populations often stay within the confines of the small parcel because they are unable or unwilling to cross the human-made barriers. This causes several problems for the survival of various species.

First, the smaller the parcel of land, the fewer species it can support. Second, fragmentation reduces the opportunities for individuals in one area to reproduce with individuals from another area. For this reason, genetic diversity often decreases over time in habitat fragments. Smaller, separated, and less genetically diverse populations are less able to resist disease or respond to changing environmental conditions.

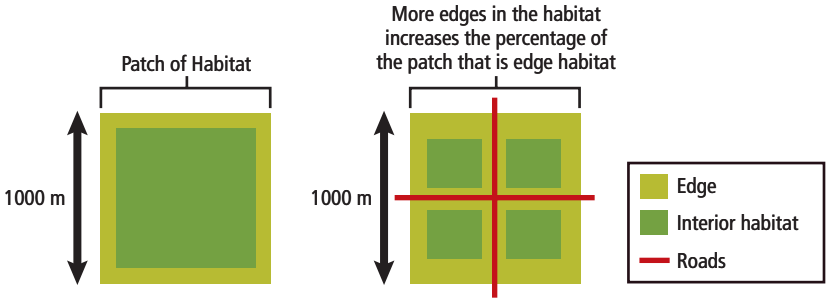
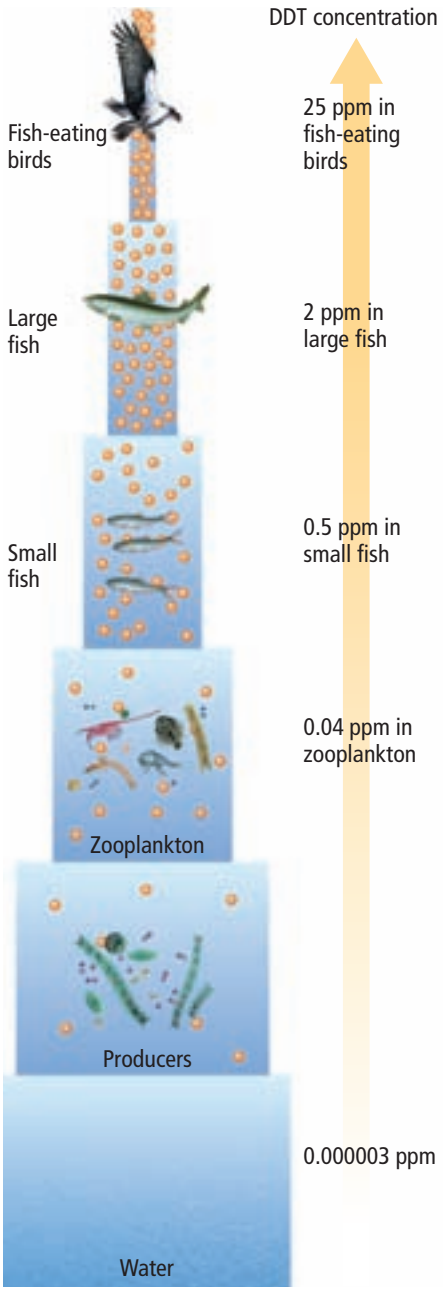



**Figure 5.12** The smaller the habitat size, the greater percentage of the habitat that is subject to edge effects.

Third, carving the large ecosystem into small parcels increases the number of edges—creating edge effects, as illustrated in **Figure 5.12.** **Edge effects** are different environmental conditions that occur along the boundaries of an ecosystem. For example, edges of a forest near a road have different abiotic factors, such as temperature, wind, and humidity, than the interior of a forest. Typically, the temperature and wind will be higher and the humidity lower on the edges in a tropical forest. Species that thrive deep in the dense forest might perish on the edges of the ecosystem. Predators and parasites also thrive on the boundaries of ecosystems, which makes the species in these areas more vulnerable to attack. Edge effects do not always create a disadvantage for all species. Some species find these conditions favorable and they thrive.

**Reading Check** **Explain** how an increasing percentage of land is affected by edge effects when the piece of land is small.

**Figure 5.13** The concentration of toxic substances increases as the trophic level in a food chain increases.




**Pollution** Pollution and atmospheric changes threaten biodiversity and global stability. Pollution changes the composition of air, soil, and water. There are many types of pollution. Substances—including many human-made chemicals that are not found in nature—are released into the environment. Pesticides, such as DDT (dichloro-diphenyl-trichloroethane), and industrial chemicals, such as PCBs (polychlorinated biphenyls), are examples of substances that are found in food webs. These substances are ingested by organisms when they drink water or eat other organisms that contain the toxic substance. Some substances are metabolized by the organism and excreted with other waste products. However, other substances, such as DDT and PCBs, accumulate in the tissues of organisms.

Carnivores at the higher trophic levels seem to be most affected by the accumulation because of a process called biological magnification. **Biological magnification** is the increasing concentration of toxic substances in organisms as trophic levels increase in a food chain or food web, as shown in **Figure 5.13.** The concentration of the toxic substance is relatively low when it enters the food web. The concentration of toxic substance in individual organisms increases as it spreads to higher trophic levels.

Current research implies that these substances might disrupt normal processes in some organisms. For example, DDT might have played a role in the near extinction of the American bald eagle and the peregrine falcon. DDT is a pesticide that was used from the 1940s to the 1970s to control crop-eating and disease-carrying insects. DDT proved to be a highly effective pesticide, but evidence suggested that it caused the eggshells of fish-eating birds to be fragile and thin, which led to the death of the developing birds. Once these toxic effects were discovered, the use of DDT was banned in some parts of the world.



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(t)Michael Gadomski/Earth Scenes, (b)Kirtley-Perkins/Visuals Unlimited

**Acid precipitation** Another pollutant that is affecting biodiversity is acid precipitation. When fossil fuels are burned, sulfur dioxide is released into the atmosphere. In addition, the burning of fossil fuels in automobile engines releases nitrogen oxides into the atmosphere. These compounds react with water and other substances in the air to form sulfuric acid and nitric acid. These acids eventually fall to the surface of Earth in rain, sleet, snow, or fog. Acid precipitation removes calcium, potassium, and other nutrients from the soil, depriving plants of these nutrients. It damages plant tissues and slows their growth, as shown in **Figure 5.14.** Sometimes, the acid concentration is so high in lakes, rivers, and streams that fish and other organisms die, also as shown in **Figure 5.14.**

**Eutrophication** Another form of water pollution, called eutrophication, destroys underwater habitats for fish and other species. **Eutrophication** (yoo troh fih KAY shun) occurs when fertilizers, animal waste, sewage, or other substances rich in nitrogen and phosphorus flow into waterways, causing extensive algae growth. The algae use up the oxygen supply during their rapid growth and after their deaths during the decaying process. Other organisms in the water suffocate. In some cases, algae also give off toxins that poison the water supply for other organisms. Eutrophication is a natural process, but human activities have accelerated the rate at which it occurs.

**Forest damage**

**Fish kill**

**Figure 5.14** Acid precipitation damages plant tissues and can kill fish if the acid concentration is high.
**Infer** ***Which areas of the United States would most likely have acid precipitation problems?***

## MiniLab 5.2

## Survey Leaf Litter Samples

**How do you calculate biodiversity?** It is not possible to count every organism in the world, which makes calculating biodiversity difficult. Scientists use a sampling technique to do this. They calculate the biodiversity in a certain area and use that number to estimate the biodiversity in similar areas.

### Procedure

1. Read and complete the lab safety form.
2. In the **leaf litter sample** your teacher has provided, count and record the species in a section that are visible to the eye. Look up any unknown species in a **field guide.**
3. Record your observations in a data table.
4. Calculate the index of diversity (IOD), using this equation (unique species is different species observed; total individual is the total of every individual observed):

$$\text{IOD} = \frac{\text{\# of unique species} \times \text{\# of samples}}{\text{\# of total individuals}}$$

### Analysis

1. **Classify** which observed species are native and nonnative to your area.
2. **Infer** from your survey the effects, if any, the nonnative species have on the native species. Are these nonnative species invasive? How do you know this?
3. **Hypothesize** whether the IOD has changed in your area over the last 200 years. Explain.

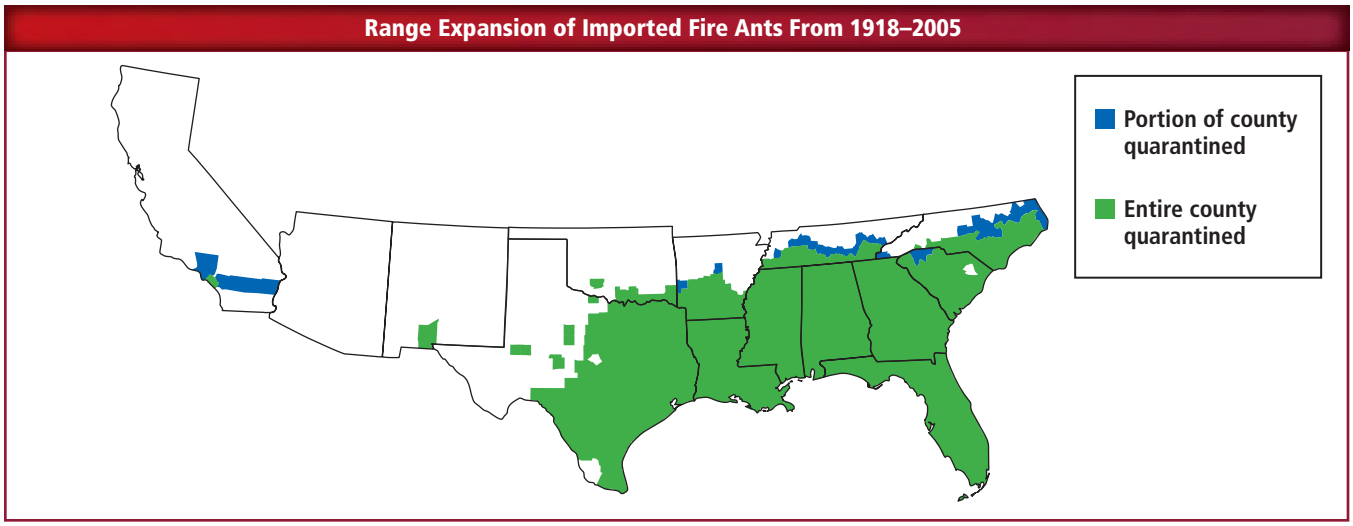


**Figure 5.15** Fire ants were transported by ship accidentally to the port of Mobile in Alabama. The ants spread throughout the southern and southwestern United States.

**LAUNCH Lab**

**Review** Based on what you've read about biodiversity, how would you now answer the analysis question?

**Introduced species** Nonnative species that are either intentionally or unintentionally transported to a new habitat are known as **introduced species.** These species are not a threat to biodiversity in their native habitats. Predators, parasites, and competition between species keep the native ecosystem in balance. However, when these species are introduced into a new area, these controlling factors are not in place. Introduced species often reproduce in large numbers because of a lack of predators, and become invasive species in their new habitat.

Imported fire ants are a species that is believed to have been introduced to the United States through the port of Mobile, Alabama in the 1920s by ships from South America. The fire ants spread throughout the southern and southwestern United States, as illustrated in **Figure 5.15.** Fire ants attack and feed on some wildlife, such as newborn deer and hatching or newly-hatched ground-nesting birds.

Introduced species are a worldwide environmental problem. An estimated 40 percent of the extinctions that have occurred since 1750 are due to introduced species, and billions of dollars are spent every year in an effort to clean up or control the damage caused by introduced species.

## Section 5.2 Assessment

### Section Summary

- The current rate of species extinction is abnormally high.
- Species on islands are particularly vulnerable to extinction.
- Historically, overexploitation of some species by humans has led to their extinction.
- Human activities, such as release of pollutants, destruction of habitat, and the introduction of nonnative species, can result in a decrease in biodiversity.

### Understand Main Ideas

1. MAIN Idea **Explain** three ways that humans threaten biodiversity.
2. **Summarize** the biodiversity crisis.
3. **Choose** one of the factors that threatens biodiversity and suggest one way in which biodiversity can be preserved in a real-life scenario.
4. **Summarize** how the overharvesting of a single species, such as a baleen whale, can affect an entire ecosystem.

### Think Scientifically

5. *Design* a planned community that preserves biodiversity and accommodates the human population. Work in small groups to accomplish this task.
6. *Survey* your community to identify at least five threats to biodiversity and suggest ways in which biodiversity can be preserved.



Self-Check Quiz biologygmh.com

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# Section 5.3

## Objectives

- **Describe** two classes of natural resources.
- **Identify** methods used to conserve biodiversity.
- **Explain** two techniques used to restore biodiversity.

## Review Vocabulary

**natural resources:** materials and organisms found in the biosphere

## New Vocabulary

renewable resource
nonrenewable resource
sustainable use
endemic
bioremediation
biological augmentation

# Conserving Biodiversity

**MAIN Idea** **People are using many approaches to slow the rate of extinctions and to preserve biodiversity.**

**Real-World Reading Link** Have you ever broken a decorative item and repaired it? You probably carefully searched for all the pieces and then carefully glued the item together again. Repairing a damaged ecosystem is a similar process. Scientists carefully search for all the pieces of the ecosystem, repair the damages, and secure the location to protect the ecosystem from future damage.

## Natural Resources

The biosphere currently supplies the basic needs for over six billion humans in the form of natural resources. The human population continues to grow and the growth is not evenly distributed throughout the world. An increase in human population growth increases the need for natural resources to supply the basic needs of the population.

The consumption rate of natural resources also is not evenly distributed. **Figure 5.16** shows the consumption of natural resources per person for selected countries. The natural resource consumption rate is much higher for people living in developed countries than for people in developing countries. As developing countries become more industrialized and the standard of living increases, the rate of natural resource consumption also increases. Because of the rising human population growth and an increased rate of consumption of natural resources, a long-term plan for the use and conservation of natural resources is important.

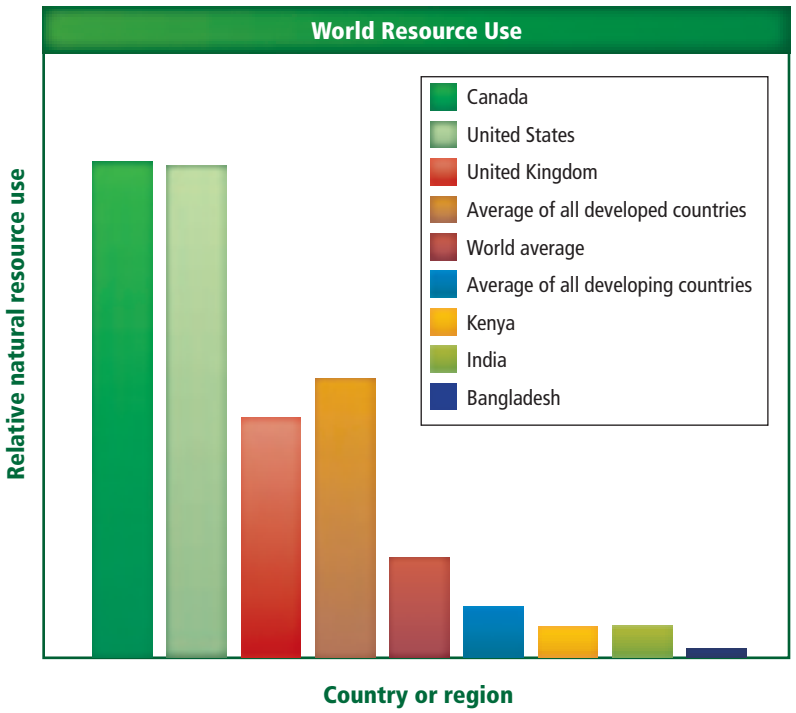



**Figure 5.16** This graph shows the consumption of natural resources per person for selected countries based on the equivalent kilograms of oil.

**Explain** *Why is the use of natural resources high for Canada and the United States and so low for India and Bangladesh?*

**Figure 5.17** This cleared forest is considered a nonrenewable resource because there is not enough of the forest intact to provide a habitat for the organisms that live there.

**Renewable resources** Plans for long-term use of natural resources must take into consideration the difference between the two groups of natural resources—renewable and nonrenewable resources. Those resources that are replaced by natural processes faster than they are consumed are called **renewable resources.** Solar energy is considered a renewable resource because the supply appears to be endless. Agricultural plants, animals, clean water, and clean air are considered renewable because normally they are replaced faster than they are consumed. However, the supply of these resources is not unlimited. If the demand exceeds the supply of any resource, the resource might become depleted.

**Renewable v. nonrenewable resources** Those resources that are found on Earth in limited amounts or those that are replaced by natural processes over extremely long periods of time are called **nonrenewable resources.** Fossil fuels and mineral deposits, such as radioactive uranium, are considered nonrenewable resources. Species are considered renewable resources until the last of a species dies. When extinction occurs, a species is nonrenewable because it is lost forever.

The classification of a resource as renewable or nonrenewable depends on the context in which the resource is being discussed. A single tree or a small group of trees in a large forest ecosystem is renewable because replacement trees can be planted or can regrow from seeds present in the soil. Enough of the forest is still intact to serve as a habitat for the organisms that live there. However, when the entire forest is cleared, as shown in **Figure 5.17,** the forest is not considered a renewable resource. The organisms living in the forest have lost their habitat and they most likely will not survive. In this example, it is possible that more than one natural resource is nonrenewable—the forest and any species that might become extinct. If a species is found only in this forest, this species might become extinct if it loses its only habitat.

**Sustainable use** One approach to using natural resources called sustainable use is demonstrated in **Figure 5.18.** Just as the name implies, **sustainable use** means using resources at a rate in which they can be replaced or recycled while preserving the long-term environmental health of the biosphere. Conservation of resources includes reducing the amount of resources that are consumed, recycling resources that can be recycled, and preserving ecosystems, as well as using them in a responsible manner.

**Figure 5.18** Replacing resources preserves the health of the biosphere.
**Explain** *Why is this process considered a sustainable use of a resource?*




CONTENTS

# Protecting Biodiversity

In Section 2, you learned how human activities have affected many ecosystems. Many efforts are underway worldwide to slow the loss of biodiversity and to work toward sustainable use of natural resources.

**Protected areas in the United States** Conservation biologists recognize the importance of establishing protected areas where biodiversity can flourish. The United States established its first national park—Yellowstone National Park—in 1872 to protect the area's geological features. Many additional national parks and nature reserves have been established since 1872.

**International protected areas** The United States is not the only country to establish national parks or nature reserves. Currently, about seven percent of the world's land is set aside as some type of reserve. Historically, these protected areas have been small islands of habitat surrounded by areas that contain human activity. Because the reserves are small, they are impacted heavily by human activity. The United Nations supports a system of Biosphere Reserves and World Heritage sites. Costa Rica has established megareserves. These reserves contain one or more zones that are protected from human activity by buffer zones—an area in which sustainable use of natural resources is permitted. This approach creates a large managed area for preserving biodiversity while providing natural resources to the local population.

**Reading Check** **Explain** the advantages of megareserves.

## DATA ANALYSIS LAB 5.1

**Based on Real Data***

### Use Numbers

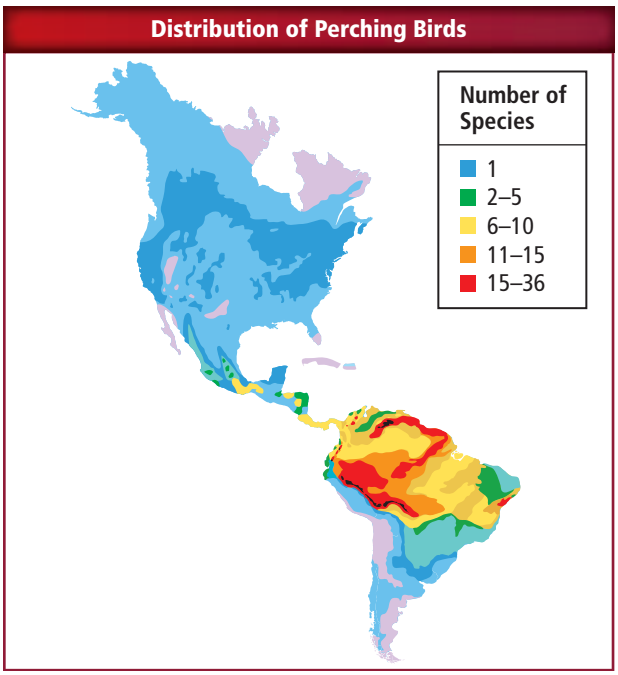
**How is the biodiversity of perching birds distributed in the Americas?** The distribution of birds, like other species, is not even. Perching birds appear to be more concentrated in some areas of the Americas than others.

#### Data and Observations

Use the maps to answer the following questions about the biodiversity of perching birds.

#### Think Critically

1. **Determine** the location of the highest concentration of perching birds.
2. **Generalize** the trend in the number of perching birds as you move from Canada to South America.
3. **Infer** Why does the number of perching birds change as you move toward the southern tip of South America?

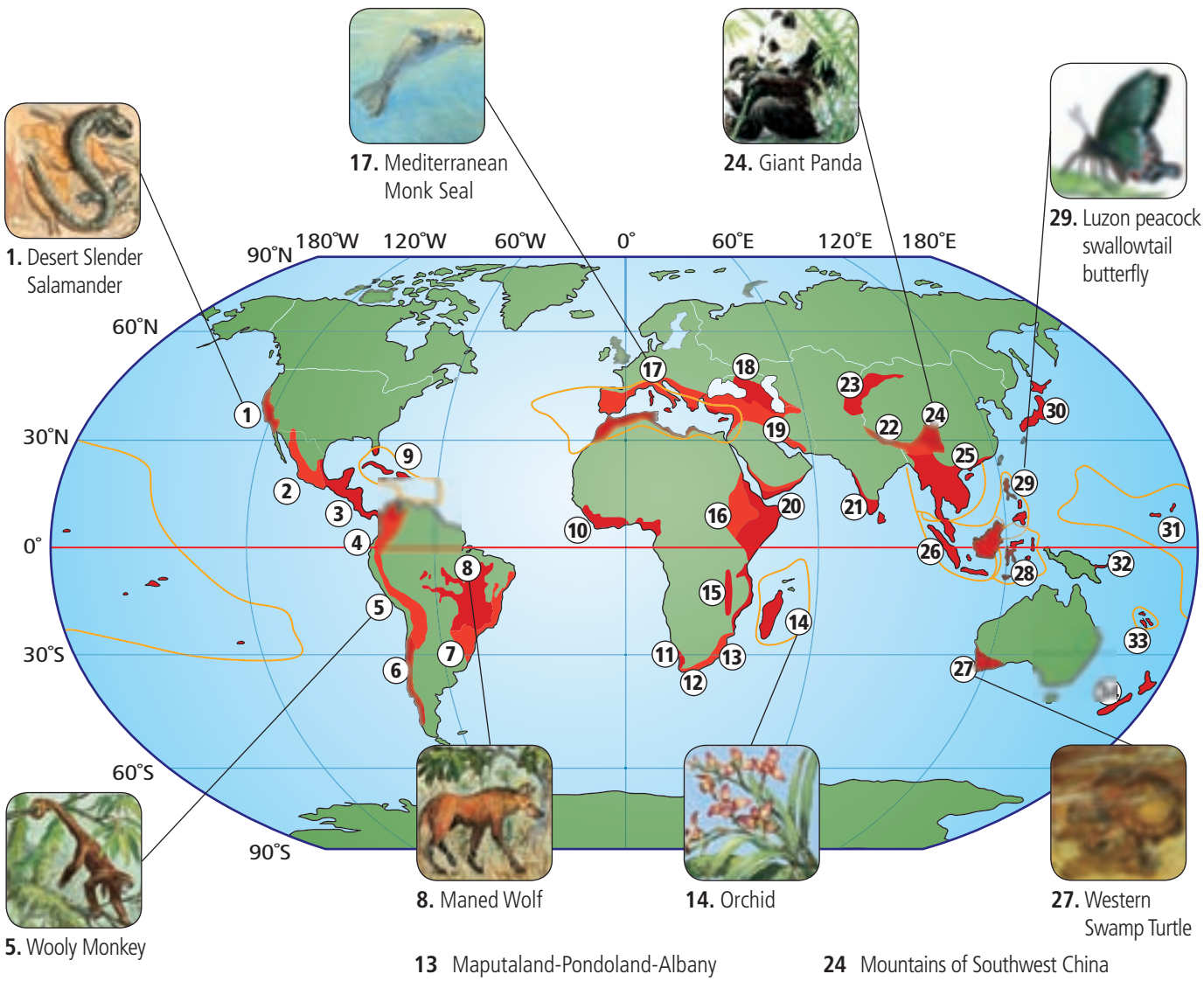



*Data obtained from: Pimm, S.L. and Brown J.H. 2004. Domains of diversity. *Science* 304: 831–833.

NATIONAL GEOGRAPHIC

# Visualizing Biodiversity Hot Spots

**Figure 5.19** Biodiversity hot spots, highlighted in red on the map, are ecosystems where endemic species are threatened. If these species become extinct, biodiversity will decrease.




1 California Floristic Province
2 Madrean Pine-Oak Woodlands
3 Mesomerica
4 Tumbes-Chocó-Magdalena
5 Tropical Andes
6 Chilean Winter Rainfall-Valdivian Forests
7 Atlantic Forest
8 Cerrado
9 Caribbean Islands
10 Guinean Forests of West Africa
11 Succulent Karoo
12 Cape Floristic Region
13 Maputaland-Pondoland-Albany
14 Madagascar and the Indian Ocean Islands
15 Coastal Forests of Eastern Africa
16 Eastern Aforomontane
17 Mediterranean Basin
18 Caucasus
19 Irano-Anatolian
20 Horn of Africa
21 Western Ghats and Sri Lanka
22 Himalayans
23 Mountains of Central Asia
24 Mountains of Southwest China
25 Indo-Burma
26 Sundaland
27 Southwest Australia
28 Wallacea
29 Philippines
30 Japan
31 Polynesia-Micronesia
32 East Melanesian Islands
33 New Caledonia
34 New Zealand

**Interactive Figure** To see an animation of biodiversity hot spots, visit biologygmh.com.

**Biodiversity hot spots** Conservation biologists have identified locations around the world that are characterized by exceptional levels of **endemic** species—species that are only found in that specific geographic area—and critical levels of habitat loss. To be called a hot spot, a region must meet two criteria. First, there must be at least 1500 species of vascular plants that are endemic, and the region must have lost at least 70 percent of its original habitat. The 34 internationally recognized hot spots are shown in **Figure 5.19.**

Approximately half of all plant and animal species are found in hot spots. These hot spots originally covered 15.7 percent of Earth's surface, however, only about a tenth of that habitat remains.

Biologists in favor of recovery efforts in these areas argue that focusing on a limited area would save the greatest number of species. Other biologists argue that concentrating funding on saving species in these hot spots does not address the serious problems that are occurring elsewhere. For example, saving a wetland area might save fewer species, but the wetland provides greater services by filtering water, regulating floods, and providing a nursery for fish. These biologists think that funding should be spent in areas around the world rather than focused on the biodiversity hotspots.

**Corridors between habitat fragments** Conservation ecologists also are focusing on improving the survival of biodiversity by providing corridors, or passageways, between habitat fragments. Corridors, such as those shown in **Figure 5.20,** are used to connect smaller parcels of land. These corridors allow organisms from one area to move safely to the other area. This creates a larger piece of land that can sustain a wider variety of species and a wider variety of genetic variation. However, corridors do not completely solve the problem of habitat destruction. Diseases easily pass from one area to the next as infected animals move from one location to another. This approach also increases edge effect. One large habitat would have fewer edges, but often a large habitat is hard to preserve.

## Vocabulary

### Science usage v. Common usage

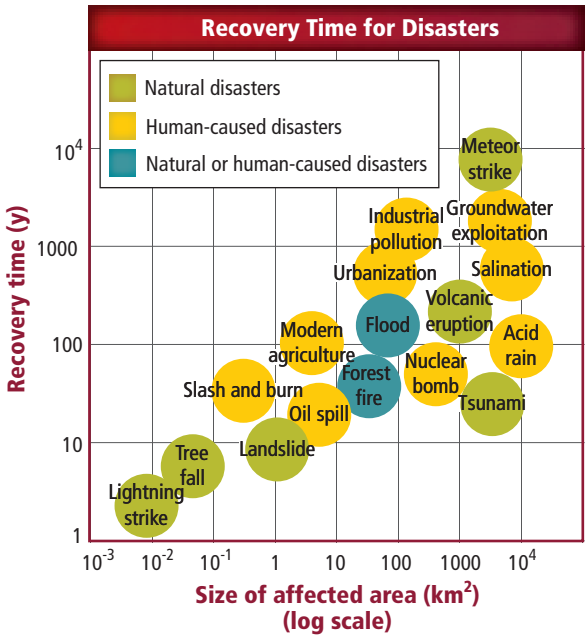
**Corridor**

***Science usage:*** a passageway between two habitat fragments.
*The deer uses the corridor to safely travel between the two habitat fragments.*

***Common usage:*** a passageway, as in a hotel, into which rooms open.
*The ice machine is in the hotel corridor by the elevators.*

Alan Sirulnikoff/SPL/Photo Researchers

■ **Figure 5.20** Corridors between habitat fragments allow safe passage for animals.
**Describe** ***What are the advantages and disadvantages of corridors?***




■ **Figure 5.21** The recovery time for disasters is not dependent upon whether or not it was a natural or human-made disaster, but on the size of the area affected and on the type of disturbance.

**Determine** *What is the approximate recovery time for a landslide?*

# Restoring Ecosystems

Sometimes biodiversity is destroyed in an area such that it no longer provides the abiotic and biotic factors needed for a healthy ecosystem. For example, the soil from cleared tropical rain forests becomes unproductive for farming after a few years. After mining activities are completed, the land might be abandoned in a condition that does not support biodiversity. Accidental oil spills and toxic chemical spills might pollute an area to such a degree that the native species cannot live there.

Given time, biological communities can recover from natural and human-made disasters, as illustrated in **Figure 5.21.** The length of time for recovery is not related directly to whether the disaster is natural or human-made. The size of the area affected and the type of disturbance are determining factors for recovery time. In general, the larger the affected area, the longer it takes for the biological community to recover. Ecologists use two methods to speed the recovery process of these damaged ecosystems—bioremediation and biological augmentation.

**Bioremediation** The use of living organisms, such as prokaryotes, fungi, or plants, to detoxify a polluted area is called **bioremediation.** In 1975, a leak from a fuel-storage facility in South Carolina released about 80,000 gallons of kerosene-based jet fuel. The fuel soaked into the sandy soil and contaminated the underground water table. Microorganisms that naturally are found in the soil break down these carbon-based fuels into carbon dioxide. Scientists found that by adding additional nutrients to the soil, the rate at which the microorganisms decontaminated the area was increased. In a few years, the contamination in the area had been greatly reduced. These microorganisms can be used in other ecosystems to remove toxins from soils that are contaminated by accidental oil or fuel spills.

Some species of plants are being used to remove toxic substances, such as zinc, lead, nickel, and organic chemicals, from damaged soils, as shown in **Figure 5.22.** These plants are planted in contaminated soils, where they store the toxic metals in their tissues. The plants then are harvested, and the toxic metals are removed from the ecosystem. Bioremediation is relatively new, but there appears to be great promise in using organisms to detoxify some ecosystems that have been damaged.

■ **Figure 5.22** Chemical waste from an industrial complex is being treated using reed beds. Bacteria and fungi in the reed beds transform a wide range of pollutants into harmless substances.



Robert Brook/Photo Researchers

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**Biological augmentation** Adding natural predators to a degraded ecosystem is called **biological augmentation.** For example, aphids—very small insects—eat vegetables and other plants, which can result in the destruction of farm crops. Aphids also can transmit plant diseases. Some farmers rely on ladybugs to control pests that eat their crops. Certain species of ladybugs eat aphids, as shown in **Figure 5.23,** and can be used to control aphid infestation. The ladybugs do not harm the crops, and the fields are kept free of aphids.

## Legally Protecting Biodiversity

During the 1970s, a great deal of attention was focused on the destruction to the environment and maintaining biodiversity. Laws were enacted in countries around the world and many treaties between countries were signed in an effort to preserve the environment. In the United States, the Endangered Species Act was enacted in 1973. It was designed to protect legally the species that were becoming extinct or in danger of becoming extinct. An international treaty, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), was signed in 1975. It outlawed the trade of endangered species and animal parts, such as ivory elephant tusks and rhinoceros horns. Since the 1970s, many more laws and treaties have been enacted and signed with the purpose of preserving biodiversity for future generations.

Anthony Bannister/Gallo Images/CORBIS

**Figure 5.23** Ladybugs can be introduced into an ecosystem to control aphid populations.

## Section 5.3 Assessment

### Section Summary

- There are two classes of natural resources—renewable and nonrenewable.
- One approach to using natural resources is sustainable use.
- There are many approaches used to conserve biodiversity in the world.
- Biodiversity hot spots contain a large number of endemic species that are threatened with extinction.
- Two techniques used to restore biodiversity in an ecosystem are bioremediation and biological augmentation.
- Since the 1970s, many forms of legislation have been passed to protect the environment.

### Understand Main Ideas

1. MAIN Idea **Describe** three approaches used to slow down the rate of extinction or to preserve biodiversity.
2. **Identify and define** the two classes of natural resources.
3. **Choose** a human-caused disaster from **Figure 5.21.** Discuss the methods that could be used to restore biodiversity.
4. **Compare** the advantages and disadvantages of large and small nature reserves.

### Think Scientifically

5. *Create* a script of dialogue that could occur between a conservationist and a person that lives in a biodiversity hot spot. The local person wants to use the natural resources to provide a living for his or her family. The dialogue should include a compromise in which both sides are satisfied with the use of resources.
6. MATH in Biology If Earth has 150,100,000 $km^2$ of land area, how much land area is included in the biodiversity hot spots?

NATIONAL GEOGRAPHIC

# In the Field

## Career: Conservationist

### Wangari Maathai: Planting Seeds of Change

Living and working in her homeland of Kenya, Wangari Maathai was disturbed by the plight of women in rural areas of the country. Limited firewood, scarce water resources, and poor soil made it difficult for rural women to meet their families' needs. Maathai's solution? Plant trees, and teach other women to do the same.

What began with planting trees evolved into the Green Belt Movement, with Maathai as its energetic leader. This grassroots, non-governmental organization involves Kenyans in reducing the environmental and social effects of deforestation. While tree planting is the focal activity, the movement also focuses on promoting environmental consciousness, volunteerism, conservation of local biodiversity, community development, and self-empowerment, particularly for Kenyan women and girls. Maathai was awarded the Nobel Peace Prize in 2004 for her contribution to sustainable development, democracy, and peace.

**Positive change in Kenya** As a leader for environmental change in Kenya, Maathai's work has helped Kenyans achieve a deeper understanding of their role in environmental conservation. Today, there are more than 600 community networks throughout Kenya that oversee about 6000 tree nurseries. These nurseries are staffed primarily by Kenyan women, and provide an income source for their families and for rural communities. Individuals working within community networks have planted more than 30 million trees throughout the country. Degraded forested areas are experiencing regrowth, resulting in areas that can support plant and animal biodiversity.

Wendy Stone/CORBIS

Wangari Maathai

Soil erosion has slowed, and both soil fertility and water-holding capacity in planted areas has increased. By promoting the planting of fruit trees and other food plants, hunger has been reduced and nutrition has improved in rural households.

The impact of the Green Belt Movement, now more than 30 years old, has been phenomenal. Expanding beyond Kenya, Green Belt methods have been adopted in other African countries, including Tanzania, Uganda, Malawi, Lesotho, Ethiopia, and Zimbabwe.

### COMMUNITY SERVICE

**Action Plan** How can you get involved with tree planting in your community? Develop an action plan that includes contacting local groups for information, designing the project, obtaining resources, and implementing the activity. For more information about tree-planting programs across the country, visit biologygmh.com.

# BIOLAB

## FIELD INVESTIGATION: HOW CAN SURVEYING A PLOT OF LAND AROUND YOUR SCHOOL HELP YOU UNDERSTAND THE HEALTH OF YOUR ECOSYSTEM?

**Background** **One of the jobs of a conservation biologist is to survey land and provide an analysis of the health of the ecosystem. Then, if problems are discovered, he or she would propose possible solutions, decide on a course of action, and implement the plan.**

**Question:** *How can an ecosystem be restored to its natural state?*

### Materials

wire coat hangers or 1-m stakes (61)
field notebook
field guide of area species (plant, animal, and fungus)
colored plastic ribbon (50 m)
string (600 m)
pencil

### Safety Precautions

**WARNING:** ***Use care in observing wildlife; do not disturb the species.***

### Procedure

1. Read and complete the lab safety form.
2. Determine a site to be studied. Make sure the site owner has given permission to conduct a survey on that site.
3. With four stakes, mark off a 15 m × 15 m area within that site.
4. Further divide the area into 1 m × 1 m squares with 57 remaining stakes and string. These will be your sampling areas.
5. Using the method you used in **MiniLab 5.2,** survey your site and calculate the index of diversity.
6. Research the history of your area. How has it changed since it was first settled?
7. Research and recommend appropriate methods to care for the plot of land you surveyed in an environmentally responsible manner, perhaps by restoring it to its original state.
8. Make a plan to implement your methods. What limitations might you encounter?
9. If possible, implement part of your plan.

### Analyze and Conclude

1. **Predict** how your methods of care would impact your plot of land. Why is this important?
2. **Determine** Is there a key species you expect to be affected by your plan?
3. **Analyze** What are some possible negative consequences of your plan?
4. **Defend** Is there another possible conservation biology technique that could be used? Explain.
5. **Calculate** What might the index of diversity be if you made the changes you recommended?
6. **Interpret** Was an increase in biodiversity your goal? Why or why not?

### SHARE YOUR DATA

**Internet** Post your results at biologygmh.com. Graph the results of the current IOD and the proposed IOD of your plot and those of students analyzing other environments across the country. Describe any similarities and differences you observe in the data. To learn more about calculating biodiversity, visit BioLabs at biologygmh.com.

CHAPTER 5

# Study Guide

Download quizzes, key terms, and flash cards from **biologygmh.com.**

FOLDABLES **Evaluate** Select an endangered plant or animal and investigate what factors are contributing to its near extinction. Evaluate the organism's chances for survival, taking into consideration genetic diversity, species diversity, and ecosystem diversity.

## Section 5.1 Biodiversity

### Vocabulary

- biodiversity (p. 116)
- ecosystem diversity (p. 118)
- extinction (p. 116)
- genetic diversity (p. 116)
- species diversity (p. 117)

### Key Concepts

MAIN Idea Biodiversity maintains a healthy biosphere and provides direct and indirect value to humans.

- Biodiversity is important to the health of the biosphere.
- There are three types of biodiversity: genetic, species, and ecosystem.
- Biodiversity has aesthetic and scientific values and direct and indirect economic value.
- It is important to maintain biodiversity to preserve the reservoir of genes that might be needed in the future.
- Healthy ecosystems can provide some services at a lesser expense than the use of technology.

## Section 5.2 Threats to Biodiversity

### Vocabulary

- background extinction (p. 122)
- biological magnification (p. 126)
- edge effect (p. 126)
- eutrophication (p. 127)
- habitat fragmentation (p. 125)
- introduced species (p. 128)
- mass extinction (p. 122)
- natural resource (p. 123)
- overexploitation (p. 124)

### Key Concepts

MAIN Idea Some human activities reduce biodiversity in ecosystems, and current evidence suggests that reduced biodiversity might have serious long-term effects on the biosphere.

- The current rate of species extinction is abnormally high.
- Species on islands are particularly vulnerable to extinction.
- Historically, overexploitation of some species by humans has led to their extinction.
- Human activities, such as release of pollutants, destruction of habitat, and the introduction of nonnative species, can result in a decrease in biodiversity.

## Section 5.3 Conserving Biodiversity

### Vocabulary

- biological augmentation (p. 135)
- bioremediation (p. 134)
- endemic (p. 133)
- nonrenewable resource (p. 130)
- renewable resource (p. 130)
- sustainable use (p. 130)

### Key Concepts

MAIN Idea People are using many approaches to slow the rate of extinctions and to preserve biodiversity.

- There are two classes of natural resources—renewable and nonrenewable.
- One approach to using natural resources is sustainable use.
- There are many approaches used to conserve biodiversity in the world.
- Biodiversity hot spots contain a large number of endemic species that are threatened with extinction.
- Two techniques used to restore biodiversity in an ecosystem are bioremediation and biological augmentation.
- Since the 1970s, many forms of legislation have been passed to protect the environment.

## Section 5.1

### Vocabulary Review

*Each of these sentences is false. Make the sentence true by replacing the italicized word with a vocabulary term from the Study Guide page.*

1. *Biodiversity* of a species occurs when the last member of the species dies.
2. *Genetic diversity* refers to the variety of ecosystems that are present in the biosphere.
3. *Ecosystem diversity* is the number of different species and the relative abundance of each species in a biological community.

### Understand Key Concepts

4. In which location would you expect to find greater species diversity?
   **A.** Canada
   **B.** Costa Rica
   **C.** Mexico
   **D.** United States

*Use the photo below to answer questions 5 and 12.*

5. Which term best describes what the two rabbits in the photo demonstrate?
   **A.** ecosystem diversity
   **B.** genetic diversity
   **C.** species richness
   **D.** species diversity

6. Refer to **Figure 5.3.** What is the species diversity in southern Florida?
   **A.** 0–50 species
   **B.** 50–100 species
   **C.** 100–150 species
   **D.** 150–200 species

7. Which represents an indirect economic value of biodiversity?
   **A.** food
   **B.** clothing
   **C.** flood protection
   **D.** medicines

8. Which term best describes this collection of locations: a forest, a freshwater lake, an estuary, and a prairie?
   **A.** ecosystem diversity
   **B.** extinction
   **C.** genetic diversity
   **D.** species diversity

### Constructed Response

9. **Open Ended** Infer why there is more species diversity in southern Florida than there is in northern Alaska.
10. **Open Ended** Explain why increased ecosystem diversity contributes to increased biodiversity in the biosphere.
11. **Short Answer** Describe three indirect services the biosphere provides.
12. **Short Answer** Explain how a trait like the one demonstrated in the photos on the left helps the species survive.

### Think Critically

13. **Explain** why it is difficult to attach a value to the aesthetic qualities of biodiversity.
14. **Describe** a service that an ecosystem provides in your community that should be protected to ensure that the quality of the service continues.

## Section 5.2

### Vocabulary Review

*Explain the difference between each pair of terms below. Then explain how the terms are related.*

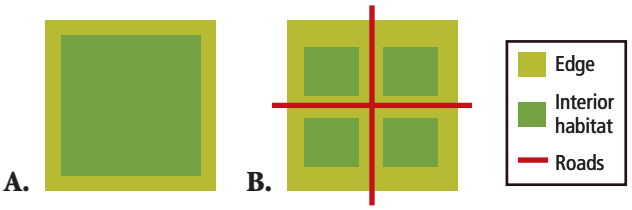
15. background extinction, mass extinction
16. habitat fragmentation, edge effect
17. overexploitation, introduced species

## Understand Key Concepts

**18.** Which group of organisms listed in **Table 5.2** has the greatest number of extinctions overall?
- **A.** birds
- **B.** flowering plants
- **C.** invertebrates
- **D.** mammals

**19.** Which group listed in **Table 5.2** has the greatest percentage of extinctions?
- **A.** birds
- **B.** fish
- **C.** mammals
- **D.** reptiles

*Use the figure below to answer questions 20 and 21.*




**20.** Which habitat has the greatest impact due to edge effects?
- **A.** A
- **B.** B
- **C.** A and B equally
- **D.** neither A nor B

**21.** Which habitat naturally supports the greater amount of biodiversity?
- **A.** A
- **B.** B
- **C.** A and B equally
- **D.** neither A nor B

**22.** Which is not a way in which species lose their habitat?
- **A.** background extinction
- **B.** destruction
- **C.** disruption
- **D.** pollution

**23.** Approximately how much greater is the current background extinction compared to the normal rate?
- **A.** 1 time
- **B.** 10 times
- **C.** 1000 times
- **D.** 10,000 times

**24.** Which condition triggered the chain of events off the coast of Alaska that caused the kelp forests to begin to disappear?
- **A.** a decrease in the amount of plankton
- **B.** an increase in the number of sea otters
- **C.** overharvesting of plankton-eating whales
- **D.** pollution caused by pesticides

## Constructed Response

**25. Short Answer** Explain why rhinos are in danger of becoming extinct.

## Think Critically

**26. Recommend** ways in which eutrophication can be reduced in waterways.

**27. Explain** why it is not a good idea to release exotic pets into a local ecosystem.

# Section 5.3

## Vocabulary Review

*Answer each question with a vocabulary term from the Study Guide page.*

**28.** What are resources called that are replaced by natural processes faster than they are consumed?

**29.** What are species called that are found only in one geographic location?

**30.** What is the process of using living organisms to detoxify a location?

**31.** What are resources called that are found in limited amounts or are replaced by natural processes over extremely long periods of time?

## Understand Key Concepts

**32.** Which term is a method that is used to restore biodiversity to a polluted or damaged area?
- **A.** biological augmentation
- **B.** biological corridor
- **C.** renewable resource
- **D.** sustainable use

*Use the figure below to answer question 33.*

Alan Sirulnikoff/SPL/Photo Researchers

**33.** Which is an advantage of the habitat corridor shown above?
- **A.** Corridors increase the edge effect in the area.
- **B.** Diseases are passed easily from one area to another.
- **C.** Parasites are passed easily from one area to another.
- **D.** Members of species can move safely from one area to another.



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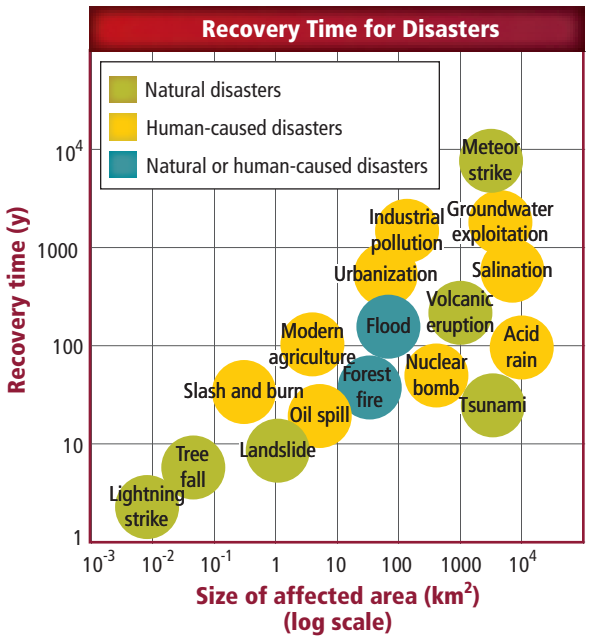
CONTENTS

*Use the graph below to answer questions 34 and 35.*




**34.** Which human-caused disaster requires the greatest recovery time?
- **A.** groundwater exploitation
- **B.** industrial pollution
- **C.** nuclear bomb
- **D.** oil spill

**35.** Which natural disaster requires the least amount of recovery time?
- **A.** lightning strike
- **B.** meteor strike
- **C.** tsunami
- **D.** volcanic eruption

## Constructed Response

**36. Short Answer** Explain why reserves protect biodiversity.

**37. CAREERS IN BIOLOGY** Explain how an environmental microbiologist might use bioremediation to detoxify polluted areas.

## Think Critically

**38. Evaluate** why it is important to develop a sustainable-use plan for the use of natural resources.

**39. Evaluate** how a sustainable-use plan for natural resources will change as the world population continues to grow, and people living in developing countries increase their standard of living.

# Additional Assessment

**40. WRITING in Biology** Write a short essay about the importance of preserving biodiversity.

**41. WRITING in Biology** Choose an organism that is in danger of becoming extinct, and write a song or poem detailing the organism's situation.

## Document-Based Questions

Data obtained from: Wilson, E.O. 1980. Resolutions for the 80s. *Harvard Magazine* (January–February): 20.

*The quote below was obtained from one of Pulitzer Prize winner Edward O. Wilson's journal articles.*

*"The worst that can happen–will happen–is not energy depletion, economic collapse, limited nuclear war, or conquest by a totalitarian government. As terrible as these catastrophes would be for us, they can be repaired within a few generations. The one process ongoing in the 1980s that will take millions of years to correct is the loss of genetic and species diversity by the destruction of natural habitats. This is the folly our descendants are least likely to forgive us."*

**42.** Describe how you think biodiversity has changed since the 1980s.

**43.** Why do you think Wilson compares the loss of biodiversity with energy depletion, economic collapse, nuclear war, and conquest?

**44.** What does Wilson mean when he says, "This is the folly our descendants are least likely to forgive us"?

## Cumulative Review

**45.** Discuss the stages of secondary succession after a forest fire. **(Chapter 3)**

**46.** Describe parasitism and give an example of a parasite that is found in an ecosystem near your community. **(Chapter 2)**

**47.** Explain the concept of carrying capacity. **(Chapter 4)**

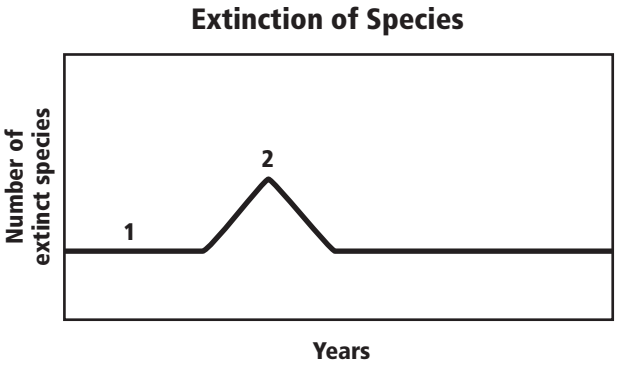
# Standardized Test Practice

**Cumulative**

## Multiple Choice

1. Which factor is most responsible for the lack of plants in polar regions?
   - **A.** heavy grazing by herbivores
   - **B.** little precipitation
   - **C.** no soil for plants to take root
   - **D.** not enough sunlight

*Use the graph below to answer questions 2 and 3.*



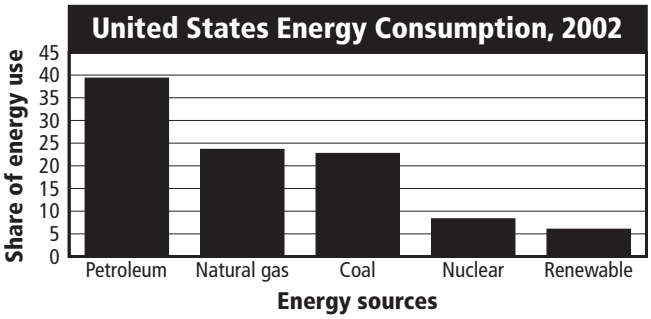

2. Which term describes the section of the graph labeled "1"?
   - **A.** background extinction
   - **B.** habitat destruction
   - **C.** mass extinction
   - **D.** species overexploitation

3. The peak labeled "2" on the graph could be related to extinctions caused by which event?
   - **A.** destruction of a native animal's habitat as humans populate an island
   - **B.** increasing industrialization and human influence over time
   - **C.** introduction of a nonnative animal into an island ecosystem
   - **D.** a fatal disease affecting a single population

4. Which factor is density-dependent?
   - **A.** climate
   - **B.** weather
   - **C.** barometric pressure
   - **D.** food competition

5. What would you expect to find in the profundal zone of a lake?
   - **A.** algae
   - **B.** plankton
   - **C.** debris from dead organisms
   - **D.** floating water plants

*Use the graph below to answer questions 6 and 7.*



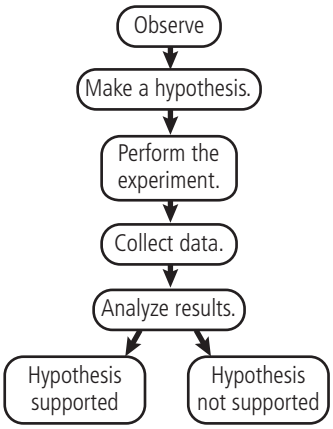

6. What percentage of the United States energy consumption in 2002 was fossil fuels?
   - **A.** 22.7
   - **B.** 23.6
   - **C.** 39.3
   - **D.** 85.6

7. What percentage of the United States energy consumption in 2002 were nonrenewable resources?
   - **A.** 8.3
   - **B.** 22.7
   - **C.** 39.3
   - **D.** 93.9

8. Based on what you know about the habitat of coral organisms, which one is an abiotic limiting factor for them?
   - **A.** annual rainfall
   - **B.** soil chemistry
   - **C.** temperature throughout the year
   - **D.** zooanthellae in the reef

## Short Answer

*Use the diagram below to answer questions 9 and 10.*




**9.** According to the diagram, state what a scientist does if the experimental data do not support his or her hypothesis.

**10.** Scientists do not always follow the same scientific method step-by-step. Name two steps in the scientific method shown above that often are omitted. Justify why each step is omitted.

**11.** If a population is experiencing a decrease in size, how do the birth and death rates compare?

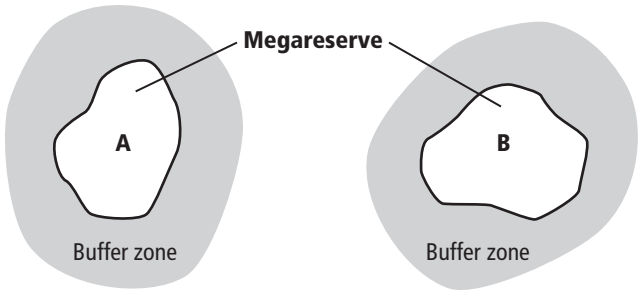
**12.** List an example of a renewable resource and a nonrenewable resource, and analyze why they are classified as such.

**13.** Explain the type of information that is displayed on an age structure graph.

**14.** The ginger plant is considered an invasive species in Hawaii. Justify why park officials in Hawaii have to kill ginger plants.

## Extended Response

*Use the illustration below to answer question 15.*




**15.** The map above shows two megareserves surrounded by buffer zones. Appraise a positive and negative point about these protected zones for a bird species living in Area A.

**16.** Explain why two species involved in a symbiotic relationship probably evolved at around the same time.

## Essay Question

The U.S. government takes a census of the population every ten years. The first census took place in 1790 and recorded 3.9 million people. In the last census, taken in 2000, the U.S. population was almost a quarter of a billion people. The census also shows population trends, such as people moving from rural areas to cities.

*Using the information in the paragraph above, answer the following question in essay format.*

**17.** The census provides a snapshot of the U.S. population every ten years. Many things can happen between census dates that affect the population. Compose a list of some of the factors that could contribute to a radical change in the U.S. population between each census.

| NEED EXTRA HELP? | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **If You Missed Question . . .** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| **Review Section . . .** | 3.2 | 5.2 | 5.2 | 4.1 | 3.3 | 5.3 | 5.3 | 3.2 | 1.3 | 1.3 | 4.2 | 5.3 | 4.2 | 5.2 | 5.3 | 2.1 | 4.2 |