Chapter 5

Biological Diversity and Conservation

What You'll Learn

- You will explain the importance of biological diversity.
- You will distinguish environmental changes that may result in the loss of species.
- You will describe the work of conservation biologists.

Why It's Important

When all the members of a species die, that species is gone forever. Knowledge of biological diversity leads to strategies to protect the permanent loss of species from Earth.

Understanding the Photo

In the tundra in the fall, carpets of brilliant red bearberry plants stretch for miles in all directions. These plants, along with dwarf blueberries, crowberry, and bog rosemary, are some of the producers on which tundra animals depend. The tundra ecosystem would change significantly if this selection of plants were to disappear. The other plantlike organisms shown are varieties of reindeer lichen.

Biology Online

Visit bdol.glencoe.com to

- study the entire chapter online
- access Web Links for more information and activities on biological diversity and conservation
- review content with the Interactive Tutor and self-check quizzes

Michio Hoshino/Minden Pictures

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Section 5.1

Vanishing Species

SECTION PREVIEW

Objectives

Explain biodiversity and its importance.

Relate various threats to the loss of biodiversity.

Review Vocabulary

habitat: the place where an organism lives out its life (p. 42)

New Vocabulary

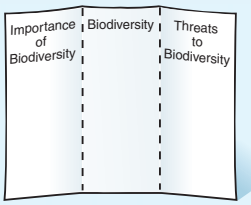
biodiversity
extinction
endangered species
threatened species
habitat fragmentation
edge effect
habitat degradation
acid precipitation
ozone layer
exotic species

FOLDABLES Study Organizer

Biodiversity Make the following Foldable to help you identify main ideas about biodiversity.

STEP 1 **Fold** the top of a vertical piece of paper down and the bottom up to divide the paper into thirds.

STEP 2 **Turn** the paper horizontally. **Unfold and label** the three columns as shown.



Read for Main Ideas Write a definition of biodiversity in the center column. Then, as you read Chapter 5, list factors that make biodiversity important in the left column, and list threats to biodiversity in the right column.

Biological Diversity

A rain forest has a greater amount of biological diversity, or biodiversity, than a cornfield. **Biodiversity** refers to the variety of species in a specific area. The simplest and most common measure of biodiversity is the number of different species that live in a certain area. For example, a hectare of farmland, like the one in ***Figure 5.1B***, is dominated by one species of plant—corn. In contrast, one hectare of a rain forest may contain 400 species of plants. The cornfield also may contain hundreds of species of insects and several species of birds, but the rain forest may have thousands of species of insects and hundreds of species of birds.

Figure 5.1
A temperate rain forest in Washington state **(A)** and a cornfield **(B)** have different biodiversities.

Where is biodiversity found?

Areas around the world differ in biodiversity. A hectare of tropical rain forest in Amazonian Peru may have 300 tree species, while one hectare of temperate deciduous forest in the United States is more likely to have only 30 tree species. Therefore, the tropical rain forest has more biodiversity. Biodiversity increases as you move toward the equator. Tropical regions contain two-thirds of all land species on Earth.

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MiniLab 5.1

Measure Species Diversity

Field Investigation
Index of diversity (I.D.) is a mathematical way of expressing the biodiversity and species distribution in a community. As you collect data, take care not to disturb the environment.

A tree-lined street

Procedure

1. Copy the data table below.
2. Survey a city block or an area designated by your teacher and in your data table, record the number of different species of trees present.
3. Survey the area again. This time, make a list of the trees by assigning each a number as you walk by it. Place an X under Tree 1 on your list. If Tree 2 is the same species as Tree 1, mark an X below it. Continue to mark an X under the trees as long as the species is the same as the previous one. When a different species is encountered, mark an O under that tree on your list. Continue to mark an O if the next tree is the same species as the previous. If the next tree is different, mark an X.
4. Record in your data table:
   a. the number of "runs." Runs are represented by a group of similar symbols in a row. Example: XXOOOXO would be 4 runs (XX = first run, OOO = second run, X = third run, O = fourth run).
   b. the total number of trees counted.
5. Calculate the I.D. using the formula in the data table.

Index of Diversity
Number of species =
Number of runs =
Number of trees =
Index of diversity = $\frac{\text{Number of species} \times \text{number of runs}}{\text{Number of trees}}$

Analysis

1. **Analyze Trends from Data** Compare how your tree I.D. might compare with that of a vacant lot and with that of a grass lawn. Explain.
2. **Make Inferences from Data** Would it be best to have a relatively low I.D. or high I.D. for an environment? Explain your answer.

The richest environments for biodiversity all seem to be warm places: tropical rain forests, coral reefs, and large tropical lakes. Learn one way to measure species diversity in the *MiniLab* on this page.

Studying biodiversity

How do ecologists perform experiments related to biodiversity? The study of islands has led to an understanding of factors that influence biodiversity. In the 1960s, an investigation was devised for testing the development of biodiversity on islands. The scientists thought that using a miniaturized situation such as very small islands would help them see clearly what changes take place when organisms move into or out of a defined area. To do this, the scientists selected some small islands of mangrove trees off the coast of Florida like those in ***Figure 5.2.*** They counted the number of insect and spider species that were on each island, and then removed all the existing species from the islands except for the trees. Then they observed the following as organisms moved back onto the islands.

1. Insects and spiders returned first.
2. The farther away the island was from the source of the new species (the mainland), the longer it took for the island to be recolonized.
3. Eventually, the islands had about the same number of species that they had originally, but the makeup of the community was now different from the original community.

The scientists also saw that the larger the island, the more habitats and species it seemed to have, implying that the number of species depends on the number of habitats.

Research like this is not simple to do. Today you can read about projects in rain forests that require

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Figure 5.2
Size may be an important factor in the level of biodiversity that an island can support. Research on red mangrove islets off the coast of Florida showed that the larger the island, the greater its biodiversity.

scientists to work 150 meters up in the canopy while they collect species that live only at that level. Other researchers catalogue the organisms that live in coral reefs, and others attach radio collars to deer. Still others work in laboratories comparing the DNA of members of isolated populations to see how or if these populations might be changing.

Importance of Biodiversity

Compare a parking lot covered with asphalt to your favorite place in nature, perhaps your backyard, a wooded area, or a local lake. You might go to an area like this to relax or to think. Artists get inspiration from these areas for songs, paintings, photographs, and literature. Looking at one of Art Wolfe's photographs in the *Connection to Art* on page 128 can help you appreciate the beauty biodiversity gives our world. Beyond beauty, why is biodiversity important?

Importance to nature

Living things are interdependent. Animals could not exist without green plants. Many flowering plants could not exist without animals to pollinate them. Plants are dependent on decomposers that break down dead or decaying material into nutrients they can absorb. In a rain forest, a tree grows from nutrients released by decomposers. A sloth eats the leaves of the tree. Moss grows on the back of the sloth. Thus, living things can be niches for other living things.

Populations are adapted to live together in communities. Although ecologists have studied many complex relationships among organisms, many relationships are yet to be discovered. Scientists do know that if a species is lost from an ecosystem, the loss may have consequences for other living things in the area. An organism suffers when a plant or animal it feeds upon is removed permanently from a food chain or food web. A population may soon exceed the area's carrying capacity if its predators are removed. If the symbiotic relationships among organisms are broken due to the loss of one species, then the remaining species will also be affected.

Figure 5.3
Biodiversity provides the basis for many important medical drugs.

A Taxol, a strong anti-cancer drug, was first discovered in the Pacific yew.

B Rosy periwinkle is the source of drugs for Hodgkin's disease and leukemia.

C Willow bark was the original source of aspirin.

Biodiversity brings stability

Biodiversity can bring stability to an ecosystem. A pest could easily destroy all the corn in a farmer's field, but it would be far more difficult for a single type of insect or disease to destroy all individuals of a plant species in a rain forest. There, instead of being clumped together, the plants exist scattered in many parts of the rain forest, making it more difficult for the disease organism to spread. In summary, ecosystems are stable if their biodiversity is maintained. A change in species can destabilize them.

Importance to people

Humans depend on other organisms for their needs. Oxygen, on which animals depend, is supplied, and carbon dioxide is removed from the air by diverse species of plants and algae living in a variety of ecosystems throughout the world. Beef, chicken, tuna, shrimp, and pork are a few of the meats and seafood humans eat. Think of all the plant products that people eat, from almonds to zucchini. Yet only a few species of plants and animals supply the major portion of the food eaten by the human population. Biodiversity could help breeders produce additional food crops. For example, through crossbreeding with a wild plant, a food crop might be made pest-resistant or drought-tolerant. People also rely on the living world for raw materials used in clothes, furniture, and buildings.

Another important reason for maintaining biodiversity is that it can be used to improve people's health. Living things supply the world pharmacy. Although drug companies manufacture synthetic drugs, active compounds in these drugs are usually first isolated from living things, such as those in ***Figure 5.3***. The antibiotic penicillin came from the mold *Penicillium*. The antimalarial drug quinine came from the bark of the cinchona tree. Even the importance of soil microorganisms should not be overlooked. The drug cyclosporine, which prevents rejection of transplanted organs, was discovered in a soil fungus in 1971. Preserving biodiversity ensures there will be a supply of living things, some of which may provide future drugs. Will a cure for cancer or HIV be found in the leaves of an obscure rain forest plant?

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Loss of Biodiversity

Have you ever seen a flock of passenger pigeons? How about a blue pike, or a dusky seaside sparrow? Unless you have seen a photograph or a specimen in a museum, your answer will be "No" to each of these questions. These animals are extinct. **Extinction** (ek STINGK shun) is the disappearance of a species when the last of its members dies. Extinction is a natural process and Earth has experienced several mass extinctions during its history. There is also a certain level of natural extinction, called background extinction, that goes on. Scientists estimate that background extinction accounts for the loss of one species per year per million species. However, the current rate of extinction exceeds that by many times. Scientists hypothesize that this rise is due in part to the needs of the expanding human population, habitat loss, and land exploitation. Is there evidence of a link between land use and species extinction? Look at one scientist's analysis in the *Problem-Solving Lab* on this page.

A species is considered to be an **endangered species** when its numbers become so low that extinction is possible. ***Figure 5.4*** shows species listed as endangered in the United States.

Problem-Solving Lab 5.1

Interpret Data

Does species extinction correlate to land area? Species are at risk of extinction when their habitats are destroyed. Is there a better chance for survival when land area is large?

Solve the Problem

A study of land mammals was conducted by a scientist to determine the effect of land area on species extinction. His research was confined to a group of South Pacific islands of Indonesia. The scientist's basis for determining the initial number of species present was based on research conducted by earlier scientists and from fossil evidence.

Relationship of Land Area to Extinctions

Island	Area in km^2	Initial Number of Species	Extinctions	Percent of Loss
Borneo	751 709	153	30	20
Java	126 806	113	39	35
Bali	5443	66	47	71

Thinking Critically

1. **Evaluate Trends from Data** From the data, what is the relationship between island size and the initial number of species?
2. **Analyze Trends from Data** From the data, how does land area seem to correlate with loss of species?
3. **Analyze Scientific Explanations** Hypothesize why the study was conducted on only land mammals. What might be some strengths and weaknesses of this research?

Figure 5.4
In the United States, scientists have developed programs designed to save some endangered species.

A In 1982, the California condor *(Gymnogyps californianus)* was nearly extinct in the wild. The 22 remaining condors were captured and placed in reserves. As of 2002, more than 70 birds were released to the wild. They remain endangered.

B The Endangered Species list includes several species of sea turtles.

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Figure 5.5
Through the Fish and Wildlife Service, information is available to the public on all species threatened or endangered. *T,* under *Listing Status*, refers to *threatened.* An *E* would indicate *endangered.*

Results of Species Search*

Scientific Name	Common Name	Group	Listing Status	Current Range
Loxodonta africana	African elephant	Mammals	T	Africa

***U.S. Fish & Wildlife Service Threatened and Endangered Species System (TESS)**

When the population of a species is likely to become endangered, it is said to be a **threatened species.** African elephants, for example, are listed as a threatened species. In 1979, the estimated wild elephant population was about 1.3 million. Twenty years later, the population was estimated to be 700 000. In 1998, a survey published by the African Elephant Database estimated a minimum number of elephants at about 300 000. The United States Fish and Wildlife Service maintains a listing of threatened and endangered species for the United States and the world. ***Figure 5.5*** shows the type of information available from the Fish and Wildlife Service on its Threatened and Endangered Species System database.

Reading Check **Explain** why biodiversity is important.

Figure 5.6
Coral reefs are rich in biodiversity. **Conclude** ***How does removal of coral result in a loss of habitat for reef organisms?***

Steve Wolper/DRK Photo

Threats to Biodiversity

Complex interactions among species make each ecosystem unique. The species there are usually well adapted to their habitats. Changes to habitats can therefore threaten organisms with extinction. What are some of the activities that can bring this about?

Habitat loss

One of the biggest reasons for decline in biodiversity is habitat loss. In the 1970s and 1980s, in the Amazonian rain forest, thousands of hectares of land were cleared in an effort to create farmland and to supply firewood. Much of this land lost its usefulness for agriculture after only a few years because rain forest soil by itself has little or no useful nutrient supply. Clearing the land erased habitats that will not be reestablished easily. Without these habitats, certain plants and animals become vulnerable to extinction.

Other areas affected by habitat loss are coral reefs. Coral reefs, like the one in ***Figure 5.6,*** are thought to be similar to tropical rain forests in biodiversity richness. The structure of coral provides habitats for varieties of fish, anemones, sponges, and other marine organisms. Disease and changes in water temperature can damage or kill coral. As a result, habitats are lost and the organisms that depend on the coral also are affected.

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Figure 5.7
Wildlife areas that are broken up or surrounded by development result in habitat fragmentation. The areas remaining may be too small to support reproducing populations. The pathway from one habitat to another may be cut off or greatly reduced in size.

Habitat fragmentation

Habitat fragmentation is the separation of wilderness areas from other wilderness areas. Habitat fragmentation has been found to contribute to:

- increased extinction of local species.
- disruption of ecological processes.
- new opportunities for invasions by introduced or exotic species.
- increased risk of fire.
- changes in local climate.

Fragmented areas are similar to islands. The smaller the fragment, the less biodiversity the area can support. This is because, as species migrate from an area that has become unsuitable for some reason, other species that depend on the migrating individuals lose their life support. As a result, overall species diversity declines.

Geographic isolation can lead to genetic isolation. When an individual organism's habitat becomes too small, its population becomes isolated from other populations of its species. The organism doesn't have the chance to breed with members of its species in other populations.

Habitat fragmentation, as shown in ***Figure 5.7***, presents problems for organisms that need large areas to gather food or find mates. Large predators may not be able to obtain enough food if restricted to too small an area. Habitat fragmentation also makes it difficult for species to reestablish themselves in an area. Imagine a small fragment of forest where a species of salamander lives. A fast-burning fire started by lightning destroys trees and the salamanders living there. In a nonfragmented forest, as the area recovers, new salamanders would eventually move into the area. However, if the burned forest was isolated from another forest where other salamanders live, no route would exist for these salamanders to reestablish populations in the burned area. In the next section of this chapter, read about corridors that connect one piece of fragmented land to another.

Edge Effect

The edge of a habitat or ecosystem is where one habitat or ecosystem meets another. This can be where a forest meets a field, where water meets land, or where a road cuts through a field or wooded area. The different conditions along the boundaries of an ecosystem are called **edge effects.** An edge may have two different sets of abiotic factors. Edges tend to have greater biodiversity because different habitats with different species are brought together. When an edge changes, animals from one area might migrate from the area or move to the new edge, thereby

Figure 5.8
Acid precipitation and acid fog may be major contributors of damage to these trees.

bringing species from different ecosystems in contact with one another. If a piece of land is cleared or divided by a road, new edges are created. This action may expose animals attracted to the edge to more predators than they were previously.

What happens at the edge of a habitat may affect what goes on in the interior of the area. In a developed area, there may be more housecats, and therefore, birds that nested undisturbed in the area before may be preyed upon.

Habitat degradation

Another threat to biodiversity is **habitat degradation,** the damage to a habitat by pollution. Three types of pollution are air, water, and land pollution. Air pollution can cause breathing problems and irritate membranes in the eyes and nose. Pollutants enter the atmosphere in many ways—including volcanic eruptions and forest fires. Burning fossil fuels is also a major source of air pollutants such as sulfur dioxide.

Acid precipitation—rain, snow, sleet, and fog with low pH values—has been linked to the deterioration of some forests and lakes. Sulfur dioxide from coal-burning factories and nitrogen oxides from automobile exhaust combine with water vapor in the air to form acidic droplets of water vapor. When these droplets fall from the sky, the moisture leaches calcium, potassium, and other nutrients from the soil. This loss of nutrients can lead to the death of trees. Acid precipitation also damages plant tissues and interferes with plant growth. Worldwide, many trees such as those shown in ***Figure 5.8*** are dying and acid rain and fog are thought to be the cause. Acid precipitation also is linked to degrading lake ecosystems. When acid rain falls into a lake, or enters as runoff from streams, the pH of the lake water falls.

Ultraviolet waves emitted by the Sun also can cause damage to living organisms. Ozone, a compound consisting of three oxygen atoms, is found mainly in a region of Earth's atmosphere between about 15 km and 35 km altitude. The ozone in this region—known as the **ozone layer**—absorbs some of the ultraviolet waves striking the atmosphere, reducing the ultraviolet radiation reaching Earth's surface. Over some parts of Antarctica, the amount of ozone overhead is reduced by as much as 60 percent during the Antarctic spring. Ozone amounts then increase during the summer. This seasonal ozone reduction is known as the Antarctic ozone hole, and is caused by the presence in the atmosphere of human-produced chemicals such as chlorofluorocarbons (CFCs). Smaller seasonal reductions also have been observed over the Arctic and there is a small downward trend in global ozone concentrations. However, the causes of this ozone loss and its biological consequences are still uncertain.

Physical Science Connection

Environmental impact of generating electricity More than 50% of the electrical energy produced in the United States comes from burning coal. Compared to other fossil fuels, coal contains more impurities, such as sulfur. As a result, more pollutants, such as sulfur dioxide, are produced when coal is burned than when oil or natural gas is burned.

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Water pollution

Water pollution degrades aquatic habitats in streams, rivers, lakes, and oceans. A variety of pollutants can affect aquatic life. Excess fertilizers and animal wastes, as shown in ***Figure 5.9***, are often carried by rain into streams and lakes. The sudden availability of nutrients causes algal blooms, the excessive growth of algae. As the algae die, they sink and decay, removing needed oxygen from the water. Silt from eroded soils can also enter water and clog the gills of fishes. Detergents, heavy metals, and industrial chemicals in runoff can cause death in aquatic organisms. Abandoned drift nets in oceans have been known to entangle and kill dolphins, whales, and other sea life.

Land pollution

How much garbage does your family produce every day? Trash, or solid waste, is made up of the cans, bottles, paper, plastic, metals, dirt, and spoiled food that people throw away every day. The average American produces about 1.8 kg of solid waste daily. That's a total of about 657 kg of waste per person per year. At what rate does it decompose? Although some of it might decompose quickly, most trash becomes part of the billions of tons of solid waste that are buried in landfills. Strict controls on the design, construction, and placement of landfills are meant to reduce contamination of groundwater supplies.

The use of pesticides and other chemicals can also lead to habitat degradation. For many years, DDT was used liberally to control insects and to kill mosquito larvae. Birds that fed on DDT-treated crops, or insects, fish, and other small animals exposed to DDT, were observed to have high levels of DDT in their bodies. The DDT was passed on in food chains to the predators that ate these animals.

Physical Science Connection

Wave energy The sun emits radiant energy that is carried by electromagnetic waves, such as infrared, visible light and ultraviolet waves. The energy carried by electromagnetic waves increases as their wavelength decreases. Ultraviolet waves have shorter wavelengths than visible light and carry more energy—enough energy to damage living cells.

Figure 5.9
Runoff from large feedlots and agricultural operations can contain large amounts of nitrogen and phosphorus.

A The cattle on this feedlot produce nitrogen-rich liquid and solid wastes. Because of the volume of these wastes, research is ongoing as to how to make good use of them.

B Large amounts of phosphorus in runoff from fertilized fields can stimulate the rapid growth of algae in waterways downstream. This lush growth consumes all or most of the oxygen in the water, making it impossible for insects, fishes, and other animals to live.

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A Kudzu was introduced intentionally into the U.S. as an ornamental and to reduce soil erosion. However, it grows rapidly, smothering areas of native plants.

B Zebra mussels were introduced unintentionally into the Great Lakes from the ballast of ships. These fast-growing mussels clear the water, but block many food chains.

Figure 5.10
Exotic species can cause many problems when introduced into new ecosystems either intentionally or unintentionally.

Because of the DDT in their bodies, some species of predators, such as the bald eagle and the peregrine falcon, were found to lay eggs with very thin shells that cracked easily, killing the chicks and leading to sharp population declines. These observations contributed to the ban on DDT in the United States in 1972.

Exotic species

People sometimes introduce a new species into an ecosystem, either intentionally or unintentionally. These species can cause problems for the native species. When people brought goats to Santa Catalina Island, located off the coast of California, 48 native species of plants soon disappeared from the local environment. Building the Erie canal in the nineteenth century made it possible for the sea lamprey to swim into the Great Lakes. The sea lamprey, which resembles an eel, clamps onto a fish's body and, using its sharp teeth and tongue, sucks fluids out of the fish. The lamprey has totally eliminated certain fish species from some of the Great Lakes. **Exotic species,** such as the goat and the lamprey, are not native to a particular area. Some other examples of exotic species are shown in ***Figure 5.10.*** When exotic species are introduced, these species can grow at an exponential rate due to the fact that they are not immediately as vulnerable to local competitors or predators as are the established native species.

Section Assessment

Understanding Main Ideas

1. What are two reasons for a species to become threatened or endangered?
2. Explain how land that gets broken up can contribute to loss of species diversity.
3. What is an edge effect? Explain how change in an ecosystem's edges can affect organisms.
4. How can exotic species affect populations of native species?

Thinking Critically

5. Explain the interactions in a tropical ecosystem that enable it to have great biodiversity.

Skill Review

6. **Recognize Cause and Effect** Explain why water is not subject to loss, but is subject to degradation. How does water degradation affect biodiversity? For more help, refer to *Recognize Cause and Effect* in the **Skill Handbook.**

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Section 5.2

Conservation of Biodiversity

SECTION PREVIEW

Objectives

Describe strategies used in conservation biology.

Relate success in protecting an endangered species to the methods used to protect it.

Review Vocabulary

biodiversity: the variety and abundance of life in an area (p. 111)

New Vocabulary

conservation biology
natural resources
habitat corridors
sustainable use
reintroduction programs
captivity

Back from the Brink

Using Prior Knowledge

Whoops! Have you ever stood at the sink and watched as a ring slid off your soapy finger and slipped down the drain before you could grab it? Could you retrieve it? The loss of a species is thought by many to be a significant occurrence. Once that species is gone, the unique role that it played and the unique genetic message that it contained are gone forever. Scientists, like the ones shown here reintroducing a gray wolf to the wild, are making efforts to keep species from becoming extinct.

A gray wolf

Research *Research some organisms that have been brought back from the brink of extinction. Describe the steps taken for one such organism. What are the strengths and weaknesses of such programs?*

Conservation Biology

Conservation biology is the study and implementation of methods to protect biodiversity. Effective conservation strategies are based on principles of ecology. These strategies include natural resource conservation and species conservation. Even soil has to be conserved. Learn about what can happen to soil in the *MiniLab* on the next page.

Natural resources are those parts of the environment that are useful or necessary for living organisms. Natural resources include sunlight, water, air, and plant and animal resources. Because species are dependent upon sufficient supplies of natural resources, they must be considered during the planning of any conservation activity.

Legal protections of species

In response to concern about species extinction, the U.S. Endangered Species Act became law in 1973. This law made it illegal to harm any species on the endangered or threatened species lists. Further, the law made it illegal for federal agencies to fund any project that would harm organisms on these lists. Harm includes changing an ecosystem where endangered or threatened species live.

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MiniLab 5.2

Investigate

Conservation of Soil Soil is as important a natural resource as plant and animal species and should be conserved. How does one conserve soil? What factors speed up the unnecessary loss or erosion of soil?

Procedure

1. Copy the data table below.

Soil Erosion

Source of Sample	Volume of Original Water	Volume of Collected Water	Volume of Eroded Soil
Bare soil			
Soil with grass			

2. Measure 200 mL of water in a beaker.
3. Fill a tray with soil as shown in the photograph.
4. Pour the water onto the soil, tilting the tray over a dish as indicated in the photograph.
5. Wait for all water and soil to drain into the dish.

6. Pour the soil and water from the dish into a graduated cylinder. Wait several minutes for the soil to settle. Measure the volume of soil and water that washed or eroded into the dish. Record these values in your data table.
7. Repeat steps 2–6. This time use a section of soil in which grass is growing. **CAUTION:** ***Always wash your hands with soap and water after working with soil.***
8. Make wise choices about disposal of the materials.

Analysis

1. **Analyze Trends from Data** What part of the experiment simulated soil erosion?
2. **Make Inferences from Data** Based on this experiment, explain why farmers usually plant unused fields with some type of crop cover.

Worldwide, the Convention on International Trade in Endangered Species (CITES) has established lists of species for which international trade is prohibited or controlled. This agreement has been endorsed by more than 120 countries.

Preserving habitats

The importance of preserving habitats has been recognized in the United States and many other countries. A habitat is the physical location where an organism lives and interacts with its environment. One way that habitats have been protected is through the creation of natural preserves and parks. The United States established its first national park—Yellowstone National Park—in 1872. Initially Yellowstone was created to protect the region's unique geology. However, its ecological importance is recognized as being equally significant. Species of bear, bison, moose, and elk roam the park in much the same way that they roamed the area hundreds of years ago. Other national parks in the United States include Big Cypress National Preserve, Crater Lake National Park, Big Bend National Park, and Sequoia National Park. Each park protects a unique natural environment and provides habitats for many organisms.

Establishing parks and other protected regions has been an effective way to preserve ecosystems and the communities of species that live in them. Although natural preserves make up a relatively small amount of land in some countries, these areas contain a large amount of biodiversity. For example, 3.9 percent of the land in the Democratic Republic of Congo in Africa has been protected. However, this small amount of land is home to almost 90 percent of the nation's bird species.

Matt Meadows

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Habitat corridors

Is it better to protect one large piece of land or several smaller, disconnected pieces of land? Recall the research describing the number of insect and spider species on islands of different sizes. In general, larger islands had more species than smaller islands had. Therefore, a general strategy for protecting the biodiversity of an area probably is to protect the largest area possible. However, research is showing that keeping wildlife populations completely separate from one another may be resulting in inbreeding within populations. Therefore, another strategy for preserving biodiversity is to connect protected areas with habitat corridors.

Corridors such as the one in ***Figure 5.11*** are being built in Florida to protect the Florida panther. **Habitat corridors** are protected strips of land that allow the migration of organisms from one wilderness area to another. Research has shown that corridors can help overcome some of the effects of habitat destruction and are beneficial for both plants and animals.

Figure 5.11
In Florida, the Florida panther can move from one habitat to another by crossing under a highway. Construction of these habitat corridors has resulted in a decrease of panthers being struck by cars.

Working with people

Saying an area is protected does not automatically make all the species there safe. Parks and protected areas usually hire people, such as rangers, to manage the parks and ensure the protection of organisms. In some areas, access by people is restricted. In other lands, people can harvest food or obtain materials but this sort of activity is managed. The philosophy of **sustainable use** strives to enable people to use natural resources in ways that will benefit them and maintain the ecosystem. For example, in ***Figure 5.12***, people harvest Brazil nuts to eat and to sell. This provides the opportunity to earn a living and the ecology of the area is maintained.

Figure 5.12
Sustainable use of wildlife areas enables people to protect these areas. The sale of Brazil nuts, sustainably harvested from rain forests in the Amazon, provides income for people living there.

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Problem-Solving Lab 5.2

Think Critically

A gray wolf

Why are conservation efforts sometimes controversial? There have been many attempts to breed wild animals or move them from one area to another. The goal is to preserve wildlife species. However, reintroduction programs of some species can have unintended consequences.

Solve the Problem

Case 1: In March 1998, the U.S. Fish and Wildlife Service reintroduced 11 captive-bred Mexican gray wolves *(Canis lupus baileyi)* into parts of Arizona. They had been extinct from the area for 20 years. By law, ranchers are not allowed to kill native wolves. However, reintroduced wolves received special legal status under the Endangered Species Act and can be killed by ranchers if the wolves threaten livestock.

Case 2: In 1995, a group of gray wolves *(Canis lupus)* was captured in Canada and introduced into Yellowstone National Park, where gray wolves once had been abundant. Because the wolves killed some cattle in the region, legal pressure was mounted to have the wolves removed from the park. In December 1997, a United States district court ruled that the wolves should be removed from the park. However, some groups have appealed the decision and the future home of the wolves is undecided.

Thinking Critically

1. **Evaluate the Impact of Research on Society** Imagine that you are a rancher described in Case 1. What complaints might you have about the 1998 reintroduction program?
2. **Evaluate the Impact of Research on Society** In Case 1, describe the arguments that might be offered in favor of the reintroduction program.
3. **Evaluate the Impact of Research on Society** In Case 2, describe the role that scientists might have in deciding whether the wolves should be removed.

Reintroduction and species preservation programs

The year is 1991. A wildlife manager carries a cage containing a captive-bred black-footed ferret, like the one in ***Figure 5.13***. She opens the cage door, and the ferret steps out onto the ground. In the 1970s, the black-footed ferret was almost lost from the wild and was listed as an endangered species. The ferret depends upon prairie dogs for food, and prairie dog habitat had been reduced by rural land use. In 1981, a small population of black-footed ferrets was found by a rancher. Biologists studied the ferrets and established a captive-breeding program at the National Black-footed Ferret Conservation Center in Wyoming. The captive-breeding program has become a success, and black-footed ferrets have been released into the wild in a number of western states. **Reintroduction programs,** such as this one, release organisms into an area where the species once lived. Today, about 350 black-footed ferrets live in the wild. To learn about the controversy surrounding the reintroduction of some species to the wild, read the *Problem-Solving Lab.*

Figure 5.13
A black-footed ferret is reintroduced into its native habitat in Wyoming. The caregiver wears a mask to reduce the chances she will transmit a human disease to the ferret.

CONTENTS

The most successful reintroductions occur when organisms are taken from an area in the wild and transported to a new suitable habitat. The brown pelican was once common along the shores of the Gulf of Mexico. DDT caused this bird's eggs to break, and the brown pelican completely disappeared from these areas. After DDT was banned in the United States in 1972, 50 brown pelicans were taken from Florida and put on Grand Terre Island in Louisiana. The population grew and spread, and today more than 7000 brown pelicans live in the area.

Captivity

Some species no longer exist in the wild, but a small number of individual organisms is maintained by humans. An organism that is held by people is said to be in **captivity.** The ginkgo tree, as shown in ***Figure 5.14,*** is an example of a species surviving extinction because it was kept by people. The ginkgo is an ancient tree; all similar species became extinct long ago. However, Chinese monks planted the ginkgo tree around their temples, thereby preventing the tree from becoming extinct.

Protecting plant species

The ideal way to protect a plant species is to allow it to exist in a natural ecosystem. But seeds can be cooled and stored for long periods of time. By establishing seed banks for threatened and endangered plants, the species can be reintroduced if they become extinct.

Reintroductions of captive animals are more difficult than for plants. Keeping animals in captivity, with enough space, adequate care, and proper food, is expensive. Animals kept in captivity may lose the necessary behaviors to survive and reproduce in the wild. Despite the difficulties involved, some species held in captivity, such as the Arabian oryx and the California condor, have been reintroduced to their native habitats after becoming nearly extinct in the wild.

Figure 5.14
The ginkgo tree would probably be extinct if not for the care given to specimens that had been planted on monastery grounds. *Ginkgo biloba* survives pollution well, making it useful for urban landscapes.

Section Assessment

Understanding Main Ideas

1. Contrast the fields of conservation biology and ecology.
2. Describe the U.S. Endangered Species Act. When did it become law, and how does it help protect or preserve endangered species?
3. Evaluate the difficulties with reintroduction programs using captive-born animals.
4. Choose one species that you have read about, either here or in your library, and explain how conservation strategies lead to its recovery.

Thinking Critically

5. How can habitat degradation cause changes in an area's biodiversity?

Skill Review

6. **Get the Big Picture** How might habitat corridors help overcome problems with habitat fragmentation? Research some actual situations concerning the Florida panther, including the costs involved. For more help, refer to *Get the Big Picture* in the **Skill Handbook.**

INTERNET BioLab

Researching Information on Exotic Pets

Before You Begin

What would it be like to own a pet like a snake or a black-footed ferret? Use bdol.glencoe.com/internet_lab as a research tool to locate information on exotic pets. Consider any animal as exotic if it is not commonly domesticated and is not native to your area.

Scarlet macaw

Preparation

Problem

How can you use the bdol.glencoe.com/internet_lab to gather information on keeping an exotic animal as a pet?

A rhesus monkey

Objectives

In this BioLab, you will:

- **Select** one animal that is considered an exotic pet.
- **Use the Internet** to collect and compare information from other students.
- **Conclude** whether the animal you have chosen would or would not make a good pet.

Materials

access to the Internet

Procedure

1. Copy the data table and use it as a guide for the information to be researched.
2. Pick an exotic pet from the following list of choices: hedgehog, large cat such as tiger or panther, monkey, ape, and iguana.
3. Go to bdol.glencoe.com/internet_lab to find links that will provide you with information for this BioLab.
4. Post your findings in the data table at bdol.glencoe.com/internet_lab.

A hedgehog

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Data Table

Category	Response
Exotic pet choice	
Scientific name	
Natural habitat (where found in nature)	
Adult size	
Dietary needs	
Special health problems	
Source of medical care, if needed	
Safety issues for humans	
Size of cage area needed	
Special environmental needs	
Social needs	
Cost of purchase	
Cost of maintaining (monthly estimate)	
Care issues (high/low maintenance)	
Additional information	
Additional sources	

A ferret

Iguanas

Analyze and Conclude

1. **Define Operationally** What is meant by the term *domesticated?*
2. **Interpret Data** Does your data make it clear as to why the organism you selected is considered exotic or not? Explain.
3. **Analyze Data** Look at the findings posted by other students. Which of the animals researched would make a pet? Which would not be a wise choice? Why?
4. **Think Critically** What positive contribution might be made to the cause of conservation when keeping an exotic pet? Explain.
5. **Think Critically** How can keeping exotic pets be a negative influence on conservation biology efforts?
6. **Analyze Data** What are some reasons why zoos rather than individuals are better able to handle exotic animals?

Share Your Data

Use the link below to post your findings in the data table provided for this activity. Use additional data from other students to answer the questions for this BioLab.

bdol.glencoe.com/internet_lab

connection to Art

Photographing Life

Art Wolfe received a degree in fine arts from the University of Washington where he was trained as a painter. He applied his knowledge of art and painting to become one of the world's best wildlife photographers. With more than 1 million images to his credit, Wolfe's photographs of Earth and its inhabitants capture the best nature has to offer.

Although he has captured many landscapes on film, photographer Art Wolfe is probably most well-known for his images of wildlife. These include just about every organism from A to Z in a variety of places around the world. Wolfe, for example, has traveled to Antarctica to photograph playful Adélie penguins as they waddle across the ice sheet. Journeys to the northern hemisphere brought Wolfe into contact with brown bears, mule deer, and wolves. Treks to Africa have allowed the photographer to capture the intricate patterns and symmetry of zebras, both alone and in herds.

Capturing the moment Wolfe generally has four goals in mind when out on a shoot. One of the goals is to get as close as possible to his subject. This, according to the artist, allows him to freeze the instant of contact between himself and his subject.

Another of Wolfe's goals is to try to capture an animal in its natural surroundings. Says Wolfe of one of his images of a black bear, ". . . habitat is as important as the animal." Wolfe's third goal is to capture patterns in nature, such as the patterns in a herd of zebras. His fourth goal while out on a shoot is to try to capture an animal's behavior. Among Wolfe's photographs illustrating this goal are brown bears sparring in a cold Alaskan river, a Northern gannet meticulously constructing its nest, a snowy owl chick practicing a fierce stare, and mule deer foraging in a grassy field somewhere in Montana.

Snowy owl chick

Preserving nature for posterity Wolfe's work has been seen by wide audiences. His photographs help people appreciate the natural world and want to protect it. In 1998, the North American Nature Photography Association awarded Wolfe its prestigious Outstanding Photographer of the Year Award. That year, Wolfe also received the first Rachel Carson Award presented by the National Audubon Society for his work in calling attention to animals and habitats that are in danger of disappearing forever.

Writing About Biology

Poetry and Prose Look in your neighborhood for a small area or an individual organism that interests you. Photograph or draw the area or organism. Then write a caption that connects to the photo or illustration.

To find out more about Art Wolfe or people who write about, take photographs of, or illustrate science creatively, visit bdol.glencoe.com/art

Art Wolfe

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Chapter 5 Assessment

Study Guide

Section 5.1

Vanishing Species

Key Concepts

- Biodiversity refers to the variety of life in an area.
- The most common measure of biodiversity is the number of species in an area.
- Maintaining biodiversity is important because if a species is lost from an ecosystem, the loss may have consequences for other species in the same area, including humans.
- Extinctions occur when the last members of species die.
- Habitat loss, fragmentation, and degradation have accelerated the rate of extinctions.
- Exotic species, introduced on purpose or by accident, upset the normal ecological balance in a given area because there are no natural competitors or predators in that area to keep their growth in check.

Vocabulary

acid precipitation (p. 118)
biodiversity (p. 111)
edge effect (p. 117)
endangered species (p. 115)
exotic species (p. 120)
extinction (p. 115)
habitat degradation (p. 118)
habitat fragmentation (p. 117)
ozone layer (p. 118)
threatened species (p. 116)

Section 5.2

Conservation of Biodiversity

Key Concepts

- Conservation biology is the study and implementation of methods to preserve Earth's biodiversity.
- In 1973, the Endangered Species Act was signed into law in response to concerns about species extinction. The law protects species on the endangered and threatened species lists in an effort to prevent their extinction.
- Larger protected areas generally have greater biodiversity than smaller protected areas.
- Animal reintroduction programs have been more successful when the reintroduced organisms come from the wild rather than from captivity.

Vocabulary

captivity (p. 125)
conservation biology (p. 121)
habitat corridors (p. 123)
natural resources (p. 121)
reintroduction programs (p. 124)
sustainable use (p. 123)

FOLDABLES Study Organizer

To help you review biological diversity and conservation, use the Organizational Study Foldables on page 111.

bdol.glencoe.com/vocabulary_puzzlemaker

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Chapter 5 Assessment

Vocabulary Review

Review the Chapter 5 vocabulary words listed in the Study Guide on page 129. Match the words with the definitions below.

1. when the last member of a species dies
2. number of species that live in an area
3. use of resources of wilderness areas in ways that do no damage
4. separation of wilderness into smaller parts
5. release of captive organisms into areas where they once lived

Understanding Key Concepts

6. In a study of major bodies of water in the world, aquatic ecologists sampled equal volumes of water and counted the number of species in each sample. Where would you expect to find the smallest number of species?
   - **A.** Lake Victoria, a very large tropical lake in East Africa
   - **B.** the Great Barrier Reef, a coral reef off the coast of Australia
   - **C.** Lake Champlain, a large lake between New York and Vermont
   - **D.** coral reefs in the Red Sea, between Israel and Egypt

7. A protected wildlife area allows local hunters to shoot deer when the deer population rises above a certain level. This is an effort to prevent _____.
   - **A.** habitat loss
   - **B.** habitat fragmentation
   - **C.** habitat degradation
   - **D.** habitat conservation

8. The variety of species in an ecosystem is referred to as its _____.
   - **A.** endangered species
   - **B.** edge effect
   - **C.** biodiversity
   - **D.** threatened species

9. The few remaining California condors, nearly extinct in the wild, were taken and bred in captivity. Offspring were successfully released. The success might be due to the fact that _____.
   - **A.** the birds were released in an area away from the factors that caused them to die out
   - **B.** corridors were built to allow the birds to fly unrestricted in the wild
   - **C.** the bird is an exotic species and when released survived because there were no predators
   - **D.** the birds were reintroduced to an area similar to their original territory but in another state.

Constructed Response

10. **Open Ended** Each year, more than a million people die from malaria, which is carried by mosquitoes. These mosquitoes could be controlled by the application of DDT. Research and analyze the strengths and weaknesses of explanations about DDT use.

11. **Open Ended** Research how island size may help in planning national parks and preserves. Use scientific evidence to discuss the strengths and weaknesses of this hypothesis.

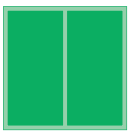
12. **Open Ended** Why is habitat loss a threat to biodiversity? Describe a situation in which a specific animal or plant might be at risk.

Thinking Critically

13. **Analyze** A national park has four choices for how roads will cross through the park. Which method would produce the least habitat fragmentation? Give reasons for your choice.

A.

B.



C.

D.

bdol.glencoe.com/chapter_test

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Chapter 5 Assessment

14. Refer to the illustration below. An adult male Florida panther requires an average of 10.52 km^2 of territory to survive and reproduce. Development has changed a particular panther's territory from 21 km^2 in diagram A to the territory configuration in diagram B which is broken up by roadways. What can be done to improve the panther's habitat in situation B?

Habitat fragmentation

A.  B.

15. Using the idea of carrying capacity, design a plan for sustainable use of trout in a midwestern lake.

16. **REAL WORLD BIOCHALLENGE** In recent years there have been some important successes with reintroduction programs. Visit **bdol.glencoe.com** to investigate some of the success stories. What are the similarities between each of the successful reintroductions? Make a map to show the range of at least two species before and after their reintroduction and relate your findings to the class.

Standardized Test Practice

All questions aligned and verified by The Princeton Review

Part 1 Multiple Choice

Use the graph below to answer questions 17 and 18 about wetland-dependent species in a northeastern state.

State Wetland Data	
Total number of endangered species	Percent wetland dependent
157 plants	65
510 vertebrates	58

17. Calculate the number of endangered plants that are wetland dependent.

A. 157 **C.** 102
B. 296 **D.** 123

18. What is the total number of endangered species that are wetland dependent?

A. 102 **C.** 296
B. 157 **D.** 398

19. A federally funded project was halted when an endangered species was found on the land. This probably occurred because _____.

A. the U.S. Endangered Species Act forbids the development
B. a reintroduction program was under way
C. the endangered species was an animal and not a plant
D. the Endangered Species list needed to be updated

20. Which of the following is an abiotic factor associated with loss of biodiversity?

A. An exotic species is introduced to the area.
B. A predator disappears.
C. A population doubles.
D. Habitat corridors open new territories.

Part 2 Constructed Response/Grid In

Record your answers on your answer document.

21. **Open Ended** Large carnivores have a greater chance of becoming extinct than smaller organisms. What factors make this statement true? Provide examples.

22. **Open Ended** Why is it important for people to know something about the social and economic as well as the scientific aspects of an area when planning a national park?

BioDigest

UNIT 2 REVIEW

Ecology

This coral reef's survival strategies include methods of obtaining needs and avoiding dangers.

An organism's environment is the source of all its needs and all its threats. Living things depend on their environments for food, water, and shelter. Yet, environments may contain things that can injure or kill organisms, such as storms, diseases, or predators. Ecology is the study of the interactions between organisms and their environments.

Ecosystems

The relationships among living things and how the nonliving environment affects life are the key aspects of ecology. An ecosystem is made up of all the interactions among organisms and their environment that occur within a defined space.

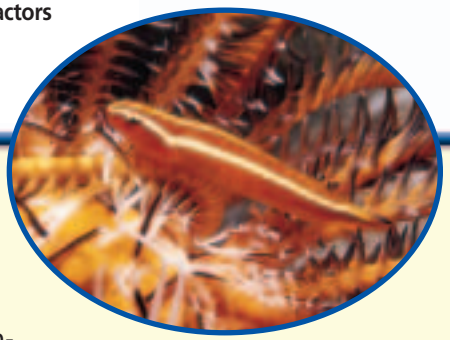
Abiotic Factors

Around the world there are many types of biomes, such as rain forests and grasslands. The nonliving parts of the environment, called abiotic factors, influence life. For example, latitude, temperature, and precipitation influence the type of life in a terrestrial biome.

Hot temperatures and little precipitation are abiotic factors in this desert biome.

Focus on Adaptations

Symbiosis



Clingfish hide in the spines of a sea urchin.

Bees pollinate flowers, and in return, bees obtain nectar.

Relationships formed between organisms are important biotic factors in an environment. Adaptations, which can be physiological, structural, or behavioral, enable organisms to profit from relationships. In symbiosis, the close relationship between two species, at least one species profits. There are three categories of symbiosis that depend on whether the other species profits, suffers, or is unaffected by the relationship.

Mutualism In mutualism, both species benefit from their relationship. For example, bees have a mutualistic relationship with flowers. As the bee eats nectar from the flower, pollen becomes attached to the bee. The bee moves to another flower, and some of the pollen from the first flower may pollinate the second flower. The bee gets food, and the plant is able to reproduce.

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In photosynthesis, plants use nonliving (abiotic) materials, including water, carbon dioxide, and light energy, to produce energy-rich nutrients. For this reason, photosynthetic organisms are called producers.

The water cycle, featuring evaporation from lakes and oceans, condensation to produce clouds, and precipitation, provides an understanding of how water cycles through an ecosystem. Nitrogen and carbon also cycle through ecosystems. In the carbon cycle, plants produce nutrients from carbon dioxide in the atmosphere. When these nutrients are broken down, energy is released. Carbon dioxide is also released and returns to the atmosphere.

Biotic Factors

Living organisms and the effects they have on each other are biotic factors. A population consists of one species. Within a community, different populations compete for needs, predators kill prey, and diseases spread.

Autotrophs and Heterotrophs

Organisms that make their own food, such as plants and algae, are called autotrophs. Organisms that cannot make their food must consume other organisms. These organisms are called heterotrophs or consumers. Heterotrophs that consume only plants are called herbivores. Heterotrophs that consume only animals are called carnivores. Omnivores are heterotrophs that consume plants and animals.

Nutrient and Energy Flow

Life on Earth depends on energy from the sun. Plants use this light energy to make food. Animals eat plants or other animals for food.

The path the nutrients and energy take can be shown in a food chain such as:

rose ➔ aphid ➔ ladybug

This shows that the aphid eats the rose and obtains its nutrients and energy. The ladybug eats the aphid and obtains its nutrients and energy. This food chain is simple. More complex feeding relationships are represented by a food web.

In summary, nutrients cycle through ecosystems. Today, there is as much nitrogen and carbon or phosphorus and water as there was millions of years ago. Energy is transferred from one organism to another, but at each transfer, some energy is given off to the environment as heat.

Commensalism In commensalism, one species benefits, while another species is neither helped nor hurt. A clingfish hiding in the stinging spines of a sea urchin is an example of commensalism. The clingfish hides from predators because the sea urchin's sting deters many predatory organisms. The clingfish benefits from the relationship, but the sea urchin is not harmed.

Parasitism Another form of symbiosis is parasitism, which exists when a smaller parasite obtains its nutrition from a larger host. The relationship benefits the parasite, and is harmful to the host. An example of parasitism includes a tapeworm in the intestines of a human.

A tree parasitized by mistletoe

Trophic Levels

Nutrients and energy move from autotroph to herbivore to carnivore. Each of these steps is called a trophic level. If a forest area were roped off and three piles created—autotrophs, herbivores, and carnivores, the autotroph pile would be larger than the herbivore pile, which would be larger than the carnivore pile. The mass of the piles indicates the biological mass, or biomass, of the three trophic levels. The mass of autotrophs is usually about ten times the mass of the herbivores, and the mass of the herbivores is about ten times the mass of the carnivores.

VITAL STATISTICS

Vital Statistics

Energy in a 100 m × 100 m section of forest:
Producers—24 055 000 kilocalories
Herbivores—2 515 000 kilocalories
Carnivores—235 000 kilocalories

Population Size

A population is defined as all the members of one species living in an area. The size of a population is influenced by the environment. For example, a lack of food could limit the number of organisms. Other limiting factors in population growth are water, shelter, and space. As population size increases, competition for some needed items intensifies.

Populations may be kept below their carrying capacity due to predation.

Carrying Capacity

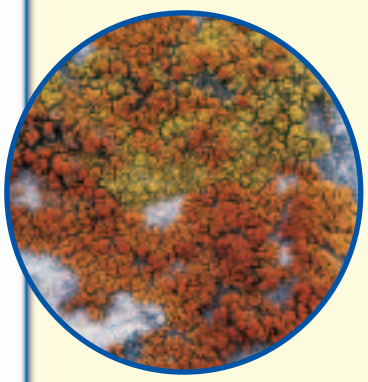
The maximum population size an environment can support is called its carrying capacity. When population size rises above the carrying capacity, some organisms die because they cannot meet all their needs. The population falls back to below the carrying capacity until it reaches equilibrium with the environment.

Exponential Growth

If a population has no predators, and the organisms are in a resource-rich environment, population size would grow quickly. This fast growth is called exponential growth. Exponential growth cannot continue forever; at some point, some need will become a limiting factor in the population's growth.

FOCUS ON ADAPTATIONS

Pioneer Species



As lichens grow, they break down rocks and produce soil.

The first organisms to colonize new areas are pioneer species. Rocky areas, such as land recently covered by a lava flow, have pioneer species different from areas that already have soil. Rocky areas are usually first colonized by lichens.

On rock Lichens are made up of two organisms, a species of fungus and a species of photosynthetic algae or bacteria. The fungus holds its photosynthetic partner between thick fiber layers, allowing just enough light to penetrate to allow photosynthesis (food production) without drying out the lichen. The fungus provides a tough case and the photosynthetic partner supplies nutrition. Through this mutualistic relationship, lichens are able to survive in the harshest of climates such as high on mountains, in cold arctic regions, and in hot deserts.

Succession

What happens when a building is torn down and not replaced? Usually the land begins to change almost immediately. New plants sprout. No doubt, one of the first things to grow are weeds. Blown in or carried by animals into an area that already has soil, plants act as pioneer species, the first organisms to thrive in a new environment.

After the plants take hold in an area, others appear, including annual flowers, grasses and then bushes. These provide shade. Now tree seeds germinate. Once the tree saplings are large enough, they shade the ground, blocking the sun from plants underneath. New conditions are forming to make the environment suitable for other organisms. If left to themselves long enough, abandoned areas become new forests. Succession is the process by which these and other types of areas change.

Biodiversity

During succession, the species living in an ecosystem change, usually by moving in or dying out of an area, over time. Consequently, the ecosystem changes too. Earth's biosphere, the part of the planet that supports life, changes over time as well. The measure of change that takes place in a small habitat or a large ecosystem is the number of species of organisms—plants, animals, bacteria, fungi, and other microorganisms that are found in the area. This number of species in an area is the area's biodiversity.

The variety of species in coral reefs is important in maintaining Earth's biodversity.

Populations

There are many pressures that act as controls on the growth of all populations. Predators and disease help control populations. In addition, Earth's organisms compete with each other for food, shelter, and space. Some of these pressures bring about the extinction or threat of extinction of species. How to use and find enough of the resources needed by all living organisms, especially land, food, air, and water, is of immediate concern for maintaining Earth's biodiversity. As land is converted for other uses, organisms lose their habitats. When organisms die out of a habitat that has been destroyed, organisms that depend on those habitats are also affected.

In soil After existing land is disturbed, such as after a forest fire, secondary succession begins as pioneer species appear. Most pioneer plants produce many small seeds that are dispersed easily over wide areas, so that when land is disturbed, the seeds are there, ready to grow. Another characteristic of pioneer species is they tend to grow and reproduce quickly. When a fresh patch of soil is disturbed, pioneer species sprout quickly and produce many new seeds to colonize other areas.

Dandelions are an effective pioneer species for secondary succession because they grow fast and disperse many seeds.

(t)Bruce Watkins/Animals Animals, (b)Envision/B.W. Hoffman

Standardized Test Practice

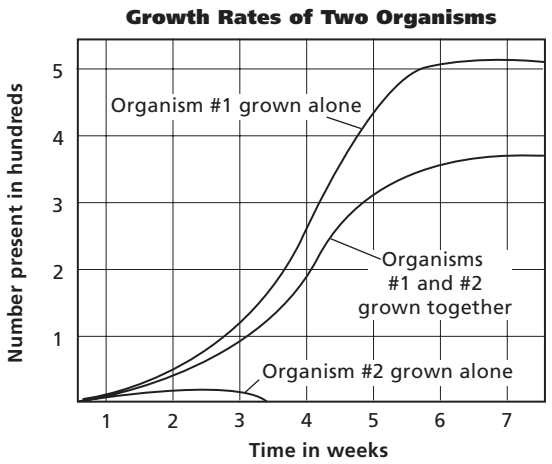
The Princeton Review TEST-TAKING TIP

Stumbling Is Not Falling

From time to time you find a question that completely throws you. You read the question over and over, and it still doesn't make sense. If it is a multiple choice question, focus on something in the question that you do know something about. Eliminate as many of the choices as you can. Take a best guess, and move on.

Part 1 Multiple Choice

Use the graph below to answer questions 1–3. The graph compares the growth rates of two organisms when grown together and when grown separately.



1. When grown separately, how would you best describe what happened to organism 2 during week 3?

A. It reached carrying capacity.
B. The population died out.
C. It became threatened.
D. It began to grow exponentially.

2. When the organisms were grown together, what was the approximate rate of growth between weeks 2 and 6?

A. 75 per week
B. 100 per month
C. 50 per week
D. 25 per day

3. From the data, the association between the organisms is _____.

A. commensalism
B. parasitism
C. mutualism
D. socialism

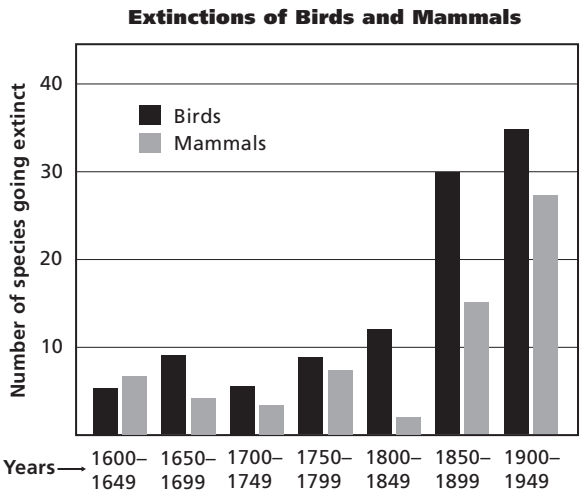
4. The number of species in an area is known as _____.

A. population
B. competition
C. biodiversity
D. carrying capacity

5. Which of the following is a biotic factor in an ecosystem?

A. number of predators
B. amount of light received
C. average precipitation
D. average temperature

Study the graph and answer questions 6–9.



6. In which interval were there more extinctions for mammals than for birds?

A. 1600–1649
B. 1650–1699
C. 1750–1799
D. 1850–1859

7. In which interval were there the most mammal extinctions?

A. 1600–1649
B. 1650–1699
C. 1850–1859
D. 1900–1949

8. Approximately how many bird species became extinct in the interval 1650–1699?

A. 5
B. 10
C. 15
D. 20

9. Approximately how many bird species became extinct in the interval 1600–1949?

A. 37
B. 70
C. 110
D. 300

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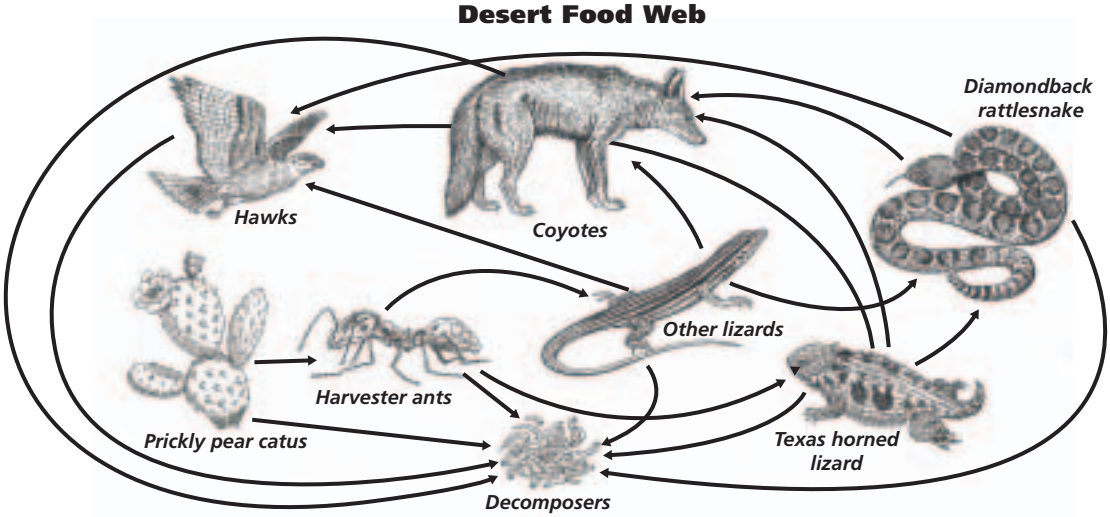
Use the information below and your knowledge of science to answer questions 10–13.

The Texas Horned Lizard

The Texas "horny toad," *Phrynosoma cornutum,* is known by many names, but it is a lizard—a true reptile—and not a toad. Despite its spiny appearance, this lizard was collected extensively as a pet for many years. However, horned lizards do not do well as pets, and once in captivity, most starve to death even if food is available.

In the wild, horned lizards will eat some grasshoppers and beetles, but harvester ants make up about 66 percent of their diet. Where harvester ant habitats have been damaged, horned lizard populations have also declined. When fire ants established themselves in Texas, harvester ant populations decreased. The horned lizard will not feed on fire ants.

Desert Food Web



10. According to the food web shown, all organisms except the cactus are _____.
- **A.** decomposers
- **B.** consumers
- **C.** producers
- **D.** scavengers

11. Texas horned lizards may have declined in number because they are _____.
- **A.** preyed upon by harvester ants
- **B.** protected by law
- **C.** a threatened species
- **D.** losing their supply of food

12. The Texas horned lizard primarily competes with _____ for its food.
- **A.** snakes
- **B.** cactus plants
- **C.** other lizards
- **D.** fire ants

13. Horned lizards are ectotherms. Energy they absorb by lying on hot rocks is transferred by _____.
- **A.** convection
- **B.** radiation
- **C.** conduction
- **D.** evaporation

Part 2 Constructed Response

Record your answers on your answer document.

14. Open Ended What eventually happens to a population that is currently experiencing exponential growth? Explain.

15. Open Ended Describe how a specific abiotic factor and a specific biotic factor could affect the life of a deer.