CHAPTER 16
Human Impact on Ecosystems

GETTING READY TO LEARN

Preview Key Concepts

16.1 Human Population Growth and Natural Resources
As the human population grows, the demand for Earth's resources increases.

16.2 Air Quality
Fossil fuel emissions affect the biosphere.

16.3 Water Quality
Pollution of Earth's freshwater supply threatens habitat and health.

16.4 Threats to Biodiversity
The impact of a growing human population threatens biodiversity.

16.5 Conservation
Conservation methods can help protect and restore ecosystems.

Review Academic Vocabulary

Write the correct word for each definition.

biodiversity  carrying capacity  keystone species  limiting factor

1. ____________ : number of individuals an environment can support
2. ____________ : variety of life in an area
3. ____________ : something that limits the size of a population
4. ____________ : organism with an unusually large effect on its ecosystem

Preview Biology Vocabulary

See how many key terms from this chapter you already know. Rewrite each phrase, using a different word or words for the words in bold.

<table>
<thead>
<tr>
<th>PHRASE</th>
<th>REWRITTEN WITH DIFFERENT WORDS</th>
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<tbody>
<tr>
<td>1. Some sources of energy, such as coal and oil, are nonrenewable resources.</td>
<td>Some sources of energy, such as coal and oil, ____________________________</td>
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<tr>
<td>2. Other sources of energy, such as wind and solar energy, are renewable resources.</td>
<td>Other sources of energy, such as wind and solar energy, ____________________________</td>
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<tr>
<td>3. Certain chemicals and waste products found in a lake are examples of pollution.</td>
<td>Certain chemicals and waste products found in a lake are examples of ____________________________</td>
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Earth’s human population continues to grow.

Humans depend on Earth’s nutrient and energy cycles. We use Earth’s energy to power our televisions, lights, cars, airplanes, and everything else in our homes and cities. Your cotton T-shirt and this paper page come from plants that need Earth’s nutrient cycles to grow. Humans, too, are part of Earth’s cycles. The way that we use resources and produce waste affects Earth’s energy and nutrient cycles.

Today there are more than 6 billion people on Earth, and the human population continues to grow. How many people can Earth support? Is there enough space to feed and shelter 10 billion people? 20 billion? We do not know of a limit to the amount of people Earth can hold. But some limit must exist. Earth cannot support an unlimited number of people.

Technologies developed by humans have allowed for continued human population growth. For example, developments in agriculture, medicine, and transportation have increased the number of people Earth can support.

- **Agriculture** The development of gas powered equipment and other technologies made it possible to produce great amounts of food.
- **Medicine** Advancements in medicine have lowered infant deaths and limited the spread of disease.
- **Transportation** Trains, trucks, boats, and airplanes help move food and materials around the world.

**Give one example of how technology has helped to support a growing population.**
The growing human population exerts pressure on Earth’s natural resources.

Over millions of years, natural processes change dead organisms into the substances that we use today as oil and coal. Oil and coal are the two main resources that we use for energy. These are nonrenewable resources because we use them much faster than they form.

Not all resources are nonrenewable. Renewable resources are ones that cannot be used up, or can be replaced as fast as they are used. Some resources, like wind and solar energy, cannot be used up. Other resources, such as wood, can be renewable if they are regrown as quickly as they are used.

Wood and other resources can become nonrenewable if they are not used carefully. Drinking water, for example, is threatened by pollution and overuse.

The number of people that Earth can support depends on the use of Earth’s resources. The United States uses more resources and produces more waste than any other country on Earth. This country’s population throws away around 1 ton of waste per person each year. What would happen if all of Earth’s 6 billion people made so much waste?

Name one example of a nonrenewable resource and one example of a renewable resource. ____________________________

Effective management of Earth’s resources will help meet the needs of the future.

Humans need natural resources to survive, but the way these resources are used threatens the well-being of the human population. The responsible use of resources can help to keep these resources for future generations.

The amount of land necessary to produce enough food, water, shelter, and energy, and to hold the waste of an individual or a population is called an ecological footprint. Individuals and populations vary in their use of resources and production of waste. Therefore, the size of ecological footprints also varies.
The average U.S. citizen’s ecological footprint is larger than 24 football fields and is one of the largest in the world. Nations such as China and India have smaller ecological footprints, but many more “feet.” These countries’ populations are more than three times the size of the U.S. population.

Which region has the second largest ecological footprint?

1. A(n) ____________________________ cannot be used up, or is remade as fast as it is used.
2. The size of a(n) ____________________________ depends on the amount of resources used and waste produced.

3. Can the supply of oil and gas ever run out? Explain your response.

4. What is one way individuals can decrease the size of their ecological footprints?

Different regions of the world have varying levels of impact on their environment. This graph shows the average ecological footprint of populations around the world.
Pollutants accumulate in the air.

Pollution is the addition of any undesirable material to the air, water, or soil. A pollutant is any material that causes pollution. Pollutants are harmful to ecosystems and human health.

Smog and Ozone

Smog is a type of air pollution that forms from the waste products of burned gas, coal, and oil. One component of smog is particulates, microscopic bits of dust, metal, and unburned fuel. Breathing air with particulates can cause many different types of health problems.

Another component of smog is ground-level ozone. The ozone that is formed from pollution stays near the ground and is harmful to human health and to ecosystems. Ozone is also found in the upper atmosphere. There, ozone plays an important role in protecting Earth from ultraviolet rays found in sunlight.

Acid Rain

Chemicals produced from the burning of coal and oil can become part of Earth’s cycles, including the water cycle. Acid rain is produced when pollutants in the water cycle cause the pH of rain to drop below normal.

Recall that pH 7 is neutral. All rain is slightly acidic and has a pH of around 5.6. When pollutants become part of the water cycle, they can react with water and oxygen and cause acid rain, which has a pH lower than 5.6. Acid rain falls in many areas of the United States. It threatens water supplies and harms ecosystems.

How are the effects of ground level ozone different from the effects of ozone in the upper atmosphere?

Air pollution is changing Earth’s biosphere.

Carbon dioxide is a natural part of Earth’s atmosphere. The levels of carbon dioxide rise and fall over time as a natural part of Earth’s climate cycles. Times of high carbon dioxide levels are also times of warmer global climates. Lower carbon dioxide levels are times of cooler global climates.
The Greenhouse Effect

It can be cold outside but warm inside a car that is parked in a sunny place. It can also be warm inside a greenhouse on a cold day. Like the greenhouse glass that helps to trap heat, Earth’s atmosphere contains gases that help to slow the loss of heat. These gases are called greenhouse gases, and the process by which they slow the loss of heat is called the greenhouse effect.

Carbon dioxide, water vapor, and methane are three of the most common greenhouse gases. You can think of these gases as forming a blanket that helps to keep Earth warm. The greenhouse effect keeps Earth warm enough to support life.

Global Warming

Over the last 100 years, the average global temperature has risen. Global temperature changes are a normal part of Earth’s climate cycle. But changes in temperature usually happen over tens of thousands of years—not over 100 years.

The trend of increasing global temperatures is called global warming. The warming is a result of increases in greenhouse gases. The increases in greenhouse gases come from automobiles, industry, and other human activities.

Global warming already threatens ecosystems around the world. Increased flooding, stronger tropical storms, and a loss of biodiversity are a few of the threats that may be caused by global warming. The polar ice cap is melting, and may affect global weather patterns. The future of global warming is uncertain, but continued global warming could greatly change our planet.

How has air pollution contributed to global warming?
Match each clue below with the correct term from the list above.

1. one component of smog ____________________________
2. a trend of increasing global temperatures ____________________________
3. keeps heat from escaping Earth ____________________________
4. rain with reduced pH due to pollution ____________________________
5. a kind of air pollution ____________________________

6. What is one main human activity that causes smog, acid rain, and contributes to global warming? ____________________________

7. Global weather patterns usually change over tens of thousands of years. What makes the current global warming trend different from normal climate cycles of the past? ____________________________
Water pollution affects ecosystems.

Pollution can have major effects on water ecosystems. Chemical contaminants, sewage, trash, and other wastes can end up in rivers, lakes, and other waters all over the world.

One way scientists determine the health of an ecosystem is by studying particular organisms, called **indicator species**. These species give a sign, or indication, of the health of an ecosystem. Frogs, for example, are sometimes used as indicator species for water quality. In polluted waters, frogs may have tumors or grow extra arms or legs.

**What is an indicator species?**

Biomagnification causes accumulation of toxins in the food chain.

Pollutants that dissolve in water will exit an organism through its wastes. Other types of pollutants do not dissolve in water, and will stay in the body fat of an organism. These pollutants will move from organism to organism up the food chain. **Biomagnification** is the process by which pollutants move up the food chain. The pollutants will accumulate, or collect, in organisms highest up the food chain.

For example, pollutants wash into a lake. Phytoplankton take in small amounts of these pollutants. Zooplankton feed on phytoplankton, and take in the pollutants from all of the phytoplankton they eat. Small fish eat many zooplankton, and therefore take in even larger amounts these pollutants. Larger fish eat the smaller fish, and the pollutants build up even more.
The top predator receives the largest dose of the pollutant. For example, the beluga whale is a top predator in certain ocean environments. A beluga whale population in eastern Canada has such extreme levels of toxic chemicals that dead whales are sometimes treated as hazardous waste. Humans are also top-level consumers and can be affected by biomagnification.

Look back at the biomagnification figure on page 275. Which of the organisms shown has the highest concentration of pollutants?

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16.3 Vocabulary Check

indicator species
biomagnification

1. To indicate means “to give a sign.” What does an indicator species indicate? __________________________

2. To magnify means “to increase, or make larger.” What gets magnified in biomagnification? __________________________

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16.3 The Big Picture

3. Why are the top level consumers in a food chain most affected by biomagnification? __________________________

4. Does biomagnification affect humans? Explain your response. __________

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Mark It Up

Go back and highlight each sentence that has a vocabulary word in bold.
Preserving biodiversity is important to the future of the biosphere.

Recall that biodiversity is the variety of organisms in an ecosystem. Biodiversity gives stability to an ecosystem. In other words, it helps an ecosystem adjust to changes. Biodiversity is also important for medicine and technology. Nearly half of all prescribed medicines are based on plant substances. Natural substances are also important models for many technologies. But biodiversity is not just measured in dollars. Biodiversity ensures the future health of Earth.

Many human actions threaten biodiversity. Loss of habitat and pollution are harming animal and plant populations around the world. Rain forests have the most biodiversity and are the most threatened ecosystems in the world. Preserving rain forests is an important part of preserving the biodiversity of our planet.

How does biodiversity affect the stability of ecosystems?

Loss of habitat eliminates species.

As the human population grows, humans are destroying more and more natural areas. Human activities also form barriers, such as roads and highways, which prevent organisms from moving between different parts of their habitats.

Barriers break a habitat into pieces, causing habitat fragmentation. As a result, organisms cannot move freely through their habitat. Some areas have built bridges and tunnels to connect habitats that are separated by roads.

How does habitat fragmentation affect organisms?
Introduced species can disrupt stable relationships in an ecosystem.

Native species are organisms with evolutionary histories in a particular habitat. In contrast, an introduced species is any organism that was brought to an ecosystem as the result of human actions. Introduced species can disrupt an ecosystem in many ways. For example,

- Introduced species can prey on native species. This predation decreases the populations of native species.
- Introduced species may not have predators in the habitat where they were introduced. As a result, they may have very large populations.
- Introduced species may be better competitors than native species in a particular niche, pushing the native species out of the niche.

Some species have been introduced because of irresponsible human activities. Other species have been introduced by accident, as humans travel the globe. Still other species have been introduced on purpose, but without any idea that the species could cause harm.

Effect on Native Species

The Florida Everglades is an ecosystem with plants and animals that have evolved together for tens of thousands of years. A snake called a Burmese python is an introduced species in this ecosystem. The python eats small animals, and may threaten endangered species in the Everglades. The snakes are native to Southeastern Asia, and are sold in the United States as pets. Irresponsible owners have released some of these snakes into the Everglades.

Introduced species of plants also disrupt ecosystems. A plant called kudzu was introduced to the U.S. in the late 1800s as a houseplant. It was also planted outdoors. This plant was meant to be helpful in controlling erosion. However, it is now a problem in many of the eastern states. It grows very fast and covers native plants, blocking them from sunlight.
Economic Damage

Introduced species also cause economic damage. The common house mouse, for example, was introduced to Australia in the late 1700s. These mice can cause big problems for farmers by eating through their crops. During 1993–1994, it was estimated that mice cost Australian farmers $65 million in lost crops.

What is one example of an introduced species?  

16.4 Vocabulary Check

habitat fragmentation
introduced species

1. How does habitat fragmentation affect an ecosystem?  

2. How is an introduced species different from a native species?  

16.4 The Big Picture

3. What is the importance of biodiversity to humans and to ecosystems?  

4. How does the loss of habitat affect biodiversity?  

5. How can an introduced species affect an ecosystem?  

Mice are an introduced species in Australia that have caused economic damage.
Sustainable development manages resources for present and future generations.

Currently, most use of natural resources is unsustainable. This unsustainable use of resources meets current needs, but is harmful to future generations. **Sustainable development** is a practice in which natural resources are used and managed in a way that meets current needs and does not harm future generations. Changes to current practices can lead to a more sustainable use of resources.

What are two components of sustainable development?

Conservation practices focus on a few species but benefit entire ecosystems.

Some laws, such as the Endangered Species Act, protect individual species. For the protected species to survive, its habitat must be protected. Because the habitat is protected, other species that live in the same habitat also benefit. The species that is legally protected is called an **umbrella species**, because its protection allows many other species to be protected.

The manatee, for example, is a protected mammal that lives in the Gulf of Mexico and the Atlantic Ocean along the southeastern coast of the United States. Efforts to protect the manatee involve protecting the waters in which they live and the seagrass that is their main food source. As a result, the entire ecosystem benefits from efforts to save a single species.

How does the protection of the manatee benefit coastal ecosystems?

Protecting Earth’s resources helps protect our future.

All living things, including humans, share Earth and its resources. Humans can have a very negative impact on our environment by polluting, destroying habitats, and introducing species.
But humans also have the ability and the technology to change the extent of the damage to our planet. Our economies and our lives depend on a healthy, sustainable Earth. We can

- control population growth by controlling birth rates
- develop technology to produce more food and less waste
- change our practices to limit the damage to ecosystems
- take action to protect ecosystems

Public actions also help to preserve and protect the future of our planet. Currently, for example, there are laws that protect air, water, and particular species. There are also national parks that protect natural areas from development.

What type of public action helped protect the bald eagle?

16.5 Vocabulary Check

sustainable development
umbrella species

1. Write a brief definition of sustainable development: __________________________

2. Write a brief definition of umbrella species: __________________________

16.5 The Big Picture

3. How is it possible that the protection of one species can benefit an entire ecosystem? __________________________

4. What is one way public action is helping to protect Earth’s resources? __________________________
Chapter 16 Review

1. Which energy source is more sustainable—renewable resources or nonrenewable resources? Explain your response. 

2. Wood can be a renewable resource. Under what conditions might wood become a nonrenewable resource? 

3. How does a growing human population threaten Earth's resources? 

4. Toxins accumulate in high-level consumers through 
   a. smog 
   b. particulates 
   c. indicator species 
   d. biomagnification 

5. How can the protection of just one species, such as the manatee, benefit other species in the same habitat? 

6. The opposite of a native species is 
   a. an introduced species 
   b. an indicator species 
   c. a predator 
   d. an umbrella species 

7. What is the main goal of sustainable development?