Chapter 6

Section 6–2

1 FOCUS

Objectives
6.2.1 Explain how environmental resources are classified.
6.2.2 Identify the characteristics of sustainable development.
6.2.3 Describe how human activities affect land, air, and water resources.

Guide for Reading

Vocabulary Preview
Help students understand the terms aquaculture, deforestation, and desertification by writing the words on the board, using lines or boxes to indicate the word parts (roots, prefixes, and suffixes). Then, have students use a dictionary to find the meaning of each word part.

Reading Strategy
Have students divide a sheet of paper into two columns. They can list the section’s Vocabulary terms in one column and the definitions in the other column. This chart should assist students when they draw the concept map for the terms.

2 INSTRUCT

Classifying Resources

Build Science Skills
Applying Concepts Role-playing the villagers described in the first paragraph of the section could benefit many students. Divide the class into groups of three to discuss the tragedy of the commons, with one student representing the viewpoint of a villager who wants to keep grazing cattle on the commons, another student representing a villager who wants to have all the cattle removed from the commons, and the third student representing a town official who is trying to find a compromise between the two people. After students have discussed the issue, ask for volunteers to role-play a meeting in which the villagers and the official find a solution.

A few hundred years ago, inhabitants of English villages could graze their cattle on shared pasture land called commons. Since grazing was free of charge, villagers often put as many cattle as possible on those commons. Occasionally there were more cattle on the commons than the land could support. Even as the land became overused, people kept putting more animals on it. After all, those who didn’t use that free land would sacrifice their own profit while others would continue to benefit. Overgrazing on village commons sometimes caused the pastures to deteriorate so badly that they could no longer support cattle.

Today, environmentalists often talk about the tragedy of the commons. This phrase expresses the idea that any resource, such as water in the ground or fish in the sea, that is free and accessible to everyone, may eventually be destroyed. Why? Because if no one is responsible for protecting a resource, and if no one benefits from preserving it, people will use it up. If humans do not preserve the goods and services of an ecosystem, these resources may suffer the same fate as the common grazing lands in English villages.

Classifying Resources

Environmental goods and services may be classified as either renewable or nonrenewable. A tree is an example of a renewable resource, because a new tree can grow in place of an old tree that dies or is cut down. Renewable resources can regenerate if they are alive or can be replenished by biochemical cycles if they are nonliving. However, a renewable resource is not necessarily unlimited. Fresh water, for example, is a renewable resource that can easily become limited by drought or overuse.

A nonrenewable resource is one that cannot be replenished by natural processes. The fossil fuels coal, oil, and natural gas are nonrenewable resources. Fossil fuels formed over hundreds of millions of years from deeply buried organic materials. When these fuels are depleted, they are gone forever.

The classification of a resource as renewable or nonrenewable depends on its context. Although a single tree is renewable, a population of trees in a forest ecosystem—on which a community of organisms depends—may not be renewable, because that ecosystem may change forever once those trees are gone.

What is the “tragedy of the commons”?

SECTION RESOURCES

Print:
- Laboratory Manual A, Chapter 6 Test
- Teaching Resources, Section Review 6–2, Enrichment
- Reading and Study Workbook A, Section 6–2
- Adapted Reading and Study Workbook B, Section 6–2

Issues and Decision Making, Issues and Decisions 21, 23, 27, 31
Lesson Plans, Section 6–2

Technology:
- iText, Section 6–2
- Transparencies Plus, Section 6–2
**Sustainable Development**

How can we provide for our needs while maintaining ecosystem goods and services that are renewable? The concept of sustainable development is one answer to this major question. Sustainable development is a way of using natural resources without depleting them and of providing for human needs without causing long-term environmental harm.

- **Human activities can affect the quality and supply of renewable resources such as land, forests, fisheries, air, and fresh water.** Ecological research can help us understand how human activities affect the functioning of ecosystems. To work well, sustainable development must take into account both the functioning of ecosystems and the ways that human economic systems operate. Sustainable strategies must enable people to live comfortably and improve their situation. The use of insects to control insect pests, as shown in Figure 6–8, is one such strategy. In finding sustainable-development strategies, ecological research can have a practical, positive impact on the environment we create for ourselves and future generations.

**Land Resources**

Land is a resource that provides space for human communities and raw materials for industry. Land also includes the soils in which crops are grown. If managed properly, soil is a renewable resource. Soil, however, can be permanently damaged if it is mismanaged.

- **Food crops grow best in fertile soil, which is a mixture of sand, clay, rock particles, and humus (material from decayed organisms). Most of the humus that makes soil fertile is in the uppermost layer of the soil, called topsoil. Good topsoil absorbs and retains moisture yet allows excess water to drain. It is rich in nutrients but low in salts. Such soil is produced by long-term interactions between the soil and plants growing in it.** Much agricultural land in the American Midwest, for example, was once covered by prairie ecosystems that produced and maintained a meter or more of very fertile topsoil. Deep roots of long-lived grasses held soil in place against rain and wind.

Plowing the land removes the roots that hold the soil in place. This increases the rate of soil erosion—the wearing away of surface soil by water and wind. A typical field on the High Plains of the Midwest loses roughly 47 metric tons of topsoil per hectare every year! In certain parts of the world with dry climates, a combination of farming, overgrazing, and drought has turned once productive areas into deserts, as shown in Figure 6–9. This process is called desertification. There are, however, a variety of sustainable-development practices that can guard against these problems. One practice is contour plowing, in which fields are plowed across the slope of the land to reduce erosion. Other strategies include leaving the stems and roots of the previous year’s crop in place to help hold the soil and planting a field with rye rather than leaving it unprotected from erosion.

**Checkpoint** The “tragedy of the commons” is the idea that any resource that is free and accessible to everyone may eventually be destroyed.

**Figure 6–8** Biological pest control does not cause pollution that can enter the food chain and harm other organisms.
Chapter 6

Forest Resources

Build Science Skills

Applying Concepts Have students review the diagram of the phosphorus cycle in Chapter 3. Explain that one consequence of the loss of forests is disruption of the phosphorus cycle. Normally, the rate of phosphorus loss from an undisturbed ecosystem is low. The removal of trees, however, causes a great deal of rainwater and snowmelt to wash over the soil as runoff. Large amounts of nutrients are washed away in this runoff.

Build Science Skills

Predicting Encourage students to share any experiences with national forests and parks. Explain that these areas are one of the ways in which the federal government has sought to preserve and protect our forests and the wildlife living there. Explain that trees in national forests are available for logging on a regulated basis, but that national parks are protected from all commercial exploitation of their resources. Ask: Do you think that these forests would remain as they are if the area were not set apart as a national forest or park? Why or why not? (Probably not, because the forests would probably be more extensively logged or destroyed to make room for industry, mining, housing, farming, or other uses.)

Deforestation

Loss of forests, or deforestation, has several effects. Deforestation can lead to severe erosion as soil is exposed to heavy rains. Erosion can wash away nutrients in the topsoil. Grazing or plowing after deforestation can cause permanent changes to local soils and microclimates that in turn prevent the regrowth of trees.

Forest Management

There are a variety of sustainable-development strategies for forest management. In some forests, mature trees can be harvested selectively to promote the growth of younger trees and preserve the forest ecosystem. In areas where forests have already been cut, foresters today often plant, manage, harvest, and replant tree farms, as shown in Figure 6–10. Tree farms can now be planted and harvested efficiently, making them fully renewable resources. Tree geneticists are also breeding new, faster-growing tree varieties that produce high-quality wood.

Trading forests for food

During the past 200 years, forest land in the United States has been reduced by approximately 20 percent. This amounts to an area of woodland about equal to the size of Texas. Forest land worldwide has been reduced by 20 percent in just the past 30 years. Many of these forests were cleared to grow crops for food—a need that no doubt continues to increase rapidly in developing nations.

A prime example of deforestation in a developing country is Madagascar, the island country off the southeast coast of Africa. Its forest is one of the most threatened in the world. Hundreds of hectares of forest disappear each year, mainly owing to slash-and-burn methods of clearing land to make way for the country’s largest cash crop, maize. One result of this extensive deforestation is a sharp decline in the island’s biodiversity.
Fishery Resources

Fisheries around the world

The meaning of the term fishery is confusing to many people. An area where fishes are caught, or harvested, is known as a fishery. Both the areas where commercial fishing occurs and the fishing industries themselves are known as fisheries. Here are some facts and figures about world fisheries.

- The world commercial catch for the year 2000 was almost 95 million metric tons, of which about 86 million metric tons came from the oceans.
- World aquaculture production for the year 2000 was almost 36 million metric tons.
- First on the list of commercial catches in 2000 was the grouping of herrings, sardines, and anchovies, with about 25 million metric tons.
- In 2000, the leading fishing countries were, in order of total production, China, Peru, Japan, India, the United States, Indonesia, Chile, and Russia.
- Pacific Ocean fisheries account for about half of the world’s fish catch.

Fishery Resources

Build Science Skills

Applying Concepts Have interested students work as a group to learn about the fishing industry in the United States. Encourage students to find out about the history of the fishing industry as well as the various types of fishes that are caught and sold in different parts of the United States today. Have students present their findings to the class in the form of an oral report. Also ask the group to prepare a map that shows where various types of fishes are found.

Use Community Resources

Designate several pairs of students to interview the owners or managers of fish stores and the managers of fish and seafood departments in local supermarkets. Encourage students to gather the following information: Which types of fish being sold in the store are caught in the wild, and which are raised on fish farms? Is there a price difference between wild and farmed fish? Which wild fish are abundant? Which are harder for the store to obtain? After the interviews, let the student pairs meet as a group to share their findings and prepare an oral report to share with the class.

Answers to . . .

Checkpoint The loss of forests

Figure 6–10 Sample answer: Reforestation would prevent further soil erosion and help reduce atmospheric carbon dioxide.

Figure 6–11 In 1980, there were about 80,000 metric tons of cod fish stocks in Georges Bank. That total dropped until the late 1980s, when stocks rebounded for a few years. Then, in the early 1990s stocks fell precipitously. In the mid-1990s, stocks began to rise again, though by 2000 the total was still much below what it was in 1980.
Air Resources Demonstration

Tie a 4-liter heavy-duty freezer-type bag over the end of the cold tailpipe of your car and start the engine. Turn the car off after 10 seconds or so, seal the bag tightly closed, and bring it to class. Let students use hand lenses to examine the emission particles in the bag. Point out that this bag of pollution is from only one car that ran for only 10 seconds. Ask students to imagine the amount of particles that would be released by hundreds or even thousands of vehicles during a morning commute.

Build Science Skills

Analyzing Data Have students collect samples of rainwater from various outdoor locations, test each sample’s pH level with litmus paper, and compare the pH level with that of a sample of tapwater. Explain that all rainwater is slightly acidic (pH 6–7) due to naturally occurring carbon dioxide in the air. However, a sample with a pH of less than 5.5 qualifies as acid rain.

Air Resources

Air is a common resource that we use every time we breathe. The condition of the air affects people’s health. The preservation of air quality remains a challenge for modern society. If you live in a large city, you have probably seen smog, a mixture of chemicals that occurs as a gray-brown haze in the atmosphere. Smog is primarily due to automobile exhausts and industrial emissions. Because it threatens the health of people with asthma and other respiratory conditions, smog is considered a pollutant. A pollutant is a harmful material that can enter the biosphere through the land, air, or water.

The burning of fossil fuels can release pollutants that cause smog and other problems in the atmosphere. Potentially toxic chemicals, like nitrates, sulfates, and particulates (pahr-TIK-yoo-lits), are especially troublesome in large concentrations. Particulates are microscopic particles of ash and dust that can enter the nose, mouth, and lungs, causing health problems over the long term. Today, most industries use technology to control emissions from factory smokestacks. Strict automobile emission standards and clean-air regulations have improved air quality in many American cities, but air pollution is an ongoing problem in other parts of the world.

Many combustion processes, such as the burning of fossil fuels, release nitrogen and sulfur compounds into the atmosphere. When these compounds combine with water vapor in the air, they form drops of nitric and sulfuric acids. These strong acids can drift for many kilometers before they fall as acid rain. Acid rain can kill plants by damaging their leaves and changing the chemistry of soils and standing-water ecosystems. Acid rain may also dissolve and release toxic elements, such as mercury, from the soil, freeing those elements to enter other portions of the biosphere. Figure 6–12 shows the processes that lead to the formation of acid rain.

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FACTS AND FIGURES

The Clean Water Act

Pressure by concerned voters resulted in the passage by Congress of the Water Pollution Control Act of 1972. This act and its amendments, now called the Clean Water Act, empower the federal government to set minimum water quality standards for rivers and streams. The act prohibits the discharge of any pollutant into a waterway unless a permit is first obtained from the state. The act gives the Environmental Protection Agency (EPA) the power to impose deadlines and levy fines on industries and municipalities that fail to comply with the law. For a long time, the EPA focused mainly on so-called point sources of pollution, including sewage plants and industrial facilities. In the 1980s, the agency began directing more of its attention to nonpoint sources of water pollution, including runoff from fertilized farmland and urban areas.
Freshwater Resources

Americans use billions of liters of fresh water daily for everything from drinking and washing to watering crops and making steel. Although water is a renewable resource, the total supply of fresh water is limited. For this reason, protecting water supplies from pollution and managing society’s ever-growing demand for water are major priorities.

Pollution threatens water supplies in several ways. Improperly discarded chemicals can enter streams and rivers. Wastes discarded on land can seep through soil and enter underground water supplies that we tap with wells. Domestic sewage, which is the wastewater from sinks and toilets, contains nitrogen and phosphorous compounds that can encourage the growth of algae and bacteria in aquatic habitats. Sewage can also contain microorganisms that can spread disease among humans and animals. In this country, most cities and towns now treat their sewage in order to make it safer.

One way of ensuring the sustainable use of water resources is to protect the natural systems involved in the water cycle. For example, wetlands such as the one shown in Figure 6–13 can help to purify the water passing through them. As water flows slowly through a swamp, densely growing plants filter certain pollutants out of the water. Similarly, forests and other vegetation help to purify the water that seeps into the ground or runs off into rivers and lakes.

As demand for water grows rapidly in many parts of the United States, water conservation is becoming an increasingly important aspect of sustainable development. There are many strategies for conserving water—in homes, industry, and agriculture. More than three quarters of all water consumed in this country is used in agriculture, so conservation in this area can save large amounts of water. For example, drip irrigation delivers water directly to plant roots. This reduces the amount of water lost through evaporation.