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. L2

6–2 Renewable and Nonrenewable Resources

Guide for Reading

Key Concepts

- How are environmental resources classified?
- What effects do human activities have on natural resources?

Vocabulary

renewable resource
nonrenewable resource
sustainable development
soil erosion • desertification
deforestation • aquaculture
smog • pollutant • acid rain

Reading Strategy: Building Vocabulary

As you read, make notes about the meaning of each new term in the list above. Then, draw a concept map to show the relationships among the terms in this section.

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.

CHECKPOINT *What is the "tragedy of the commons"?*

▼ **Figure 6–7** **Natural resources can be classified as renewable or nonrenewable.** The grass growing in these pastures is a renewable resource—as long as the number of sheep grazing there is limited.

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.

▲ **Figure 6–8** This ladybug is eating an insect pest—a black aphid. New strategies for pest control that employ beneficial insects may help farmers reduce the use of pesticides. **Inferring** *How does biological pest control contribute to sustainable development?*

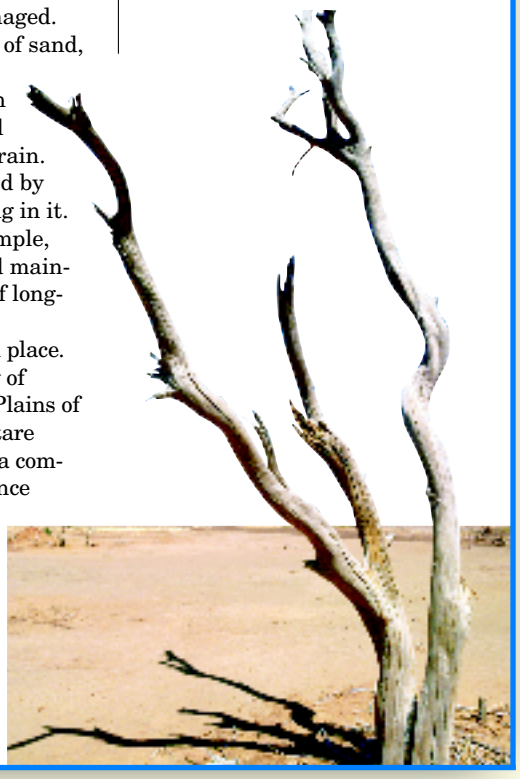
Land Resources

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.

▼ **Figure 6–9** **Human activities affect the supply and the quality of renewable resources.** In dry regions, human activities, such as farming practices that fail to protect the soil, can contribute to desertification.



Sustainable Development

Use Community Resources

Encourage students to visit local nurseries, greenhouses, and garden centers to see if they sell natural "pest controllers" such as ladybugs and praying mantises. Also suggest that students ask about plants (nasturtiums, for example) that are used to repel insect pests in gardens. L2

Land Resources

Make Connections

Environmental Science Explain that when land is overgrazed by livestock, the grasses die and are replaced by scrub, weeds, and toxic plants that do not provide good pasture. The death of grasses with wide-branching roots increases runoff of precipitation, causing soil erosion. Overgrazing also ruins wildlife habitats. For example, livestock trample the fertile areas that border streams, killing plants, causing erosion of the stream banks, and making the water too muddy to support aquatic life. Encourage students to interview local ranchers and farmers or do library research to find out how damage from grazing can be minimized. (Methods include moving herds at intervals, which allows grass in the grazed area to regrow. Controlled burning destroys scrub brush and toxic plants without harming grass, whose roots sprout anew.) L2

ESL SUPPORT FOR ENGLISH LANGUAGE LEARNERS

Comprehension: Prior Knowledge

Beginning Pronounce and define *sustainable* and *development* separately. Write each word on the board; then separate the suffixes *-able* and *-ment* from the roots *sustain* and *develop,* and define the roots and suffixes. Use concrete examples to clarify the concept of sustainable development. Then, ask students for examples from their own experience and cultures. For example: How do farmers keep soil fertile? What must be done to replace trees that are cut down? L1

Intermediate Expand on the Beginning activity by asking students to bring in photos that show specific examples that violate the principle of sustainable development. For each photo, ask students to write sentences describing things that people can do to remedy the situation. L2

Answers to . . .

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.*

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. L1 L2

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.)* L1 L2

Forest Resources

Earth's forests are an important resource for the products they provide and for the ecological functions they perform. People use the wood from forests to make products ranging from homes to paper. In many parts of the world, wood is still burned as fuel for cooking and heating. But living forests also provide a number of important ecological services. Forests have been called "lungs of the Earth" because they remove carbon dioxide and produce oxygen. Forests also store nutrients, provide habitats and food for organisms, moderate climate, limit soil erosion, and protect freshwater supplies.

Whether a forest can be considered a renewable resource depends partly on the type of forest. For example, the temperate forests of the northeastern United States can be considered renewable. Most of these forests have been logged at least once in the past and have grown back naturally. However, today's forests differ somewhat in species composition from the forests they replaced.

Other forests, such as those in Alaska and the Pacific Northwest, are called old-growth forests because they have never before been cut. Worldwide, about half of the area originally covered by forests and woodlands has been cleared. Because it takes many centuries to produce old-growth forests, they are in effect nonrenewable resources. Old-growth forests often contain a rich variety of species. When logging occurs in these forests, the species they contain may be lost.

▼ **Figure 6–10** Planting new trees is one way to counteract the effects of deforestation. **Applying Concepts** *What are two ways in which reforestation might affect the biosphere?*

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.

CHECK FOR UNDERSTANDING *What is deforestation?*

BIO INSIGHTS

FACTS AND FIGURES

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

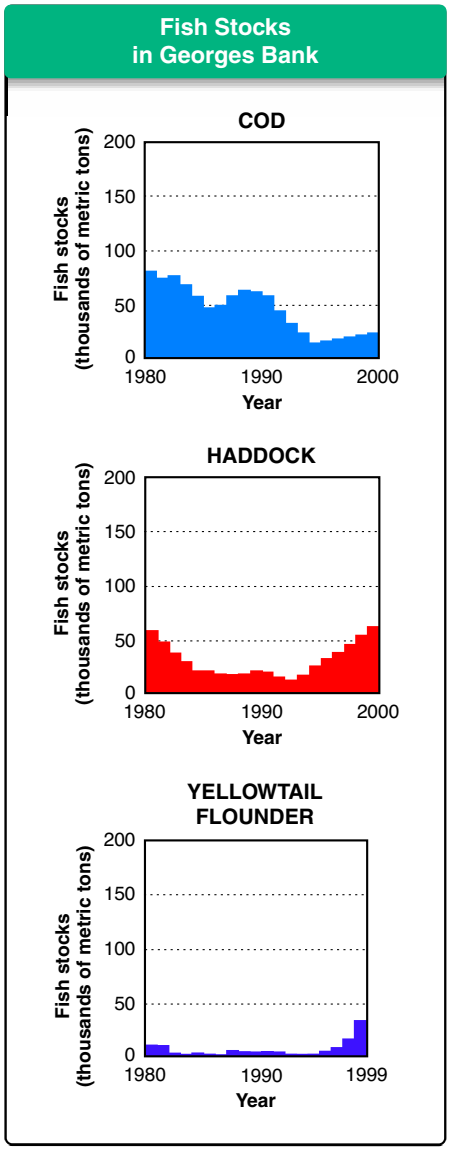
Fishes and other animals that live in water are a valuable source of food for humanity. For example, consider the food provided by the Chesapeake Bay and its watershed, which includes the saltwater bay itself and the freshwater rivers and streams that flow into it. This complex ecosystem supplies people with fishes such as striped bass and American shad, and shellfishes such as crabs and oysters. The recent history of fisheries, or fishing grounds, is an example of the tragedy of the commons. Fortunately, it also shows how ecological research can help people begin to correct an environmental problem.

Overfishing Overfishing, or harvesting fish faster than they can be replaced by reproduction, greatly reduced the amount of fish in parts of the world's oceans. Between 1950 and 1990, the world fish catch grew from 19 million tons to more than 90 million tons. The fish that were caught helped feed the world's people. But as the catch increased, the populations of some fish species began to shrink. By the early 1990s, populations of cod and haddock had dropped so low that researchers feared these fishes might disappear from the sea.

The declining fish populations are an example of the tragedy of the commons. People from several countries were taking advantage of a resource—fisheries—but no one took responsibility for maintaining that resource. Until fairly recently, fisheries seemed to be a renewable resource, one that could be harvested indefinitely. But overfishing threatened to destroy what was once a renewable resource.

Sustainable Development Is there a way to manage fisheries sustainably? That's where ecological research has entered the picture. Fishery ecologists gathered data on the size of fish populations and their growth rate. The U.S. National Marine Fisheries Service used these data to create guidelines for United States commercial fishing. The guidelines specified how many fish, and of what size, could be caught in various parts of the oceans. The regulations are helping fish populations recover, as shown in **Figure 6–11.** The regulations caused loss of jobs in the short term, but are designed to protect the fishing industry for the future.

Aquaculture The raising of aquatic animals for human consumption, which is called **aquaculture,** is also helping to sustain fish resources. If not properly managed, aquaculture can pollute water and damage aquatic ecosystems. However, environment-friendly aquaculture techniques are being developed.



▲ **Figure 6–11** The graphs show how three fish populations—cod, haddock, and yellowtail flounder—have changed in Georges Bank, a fishery off the New England coast. The fish populations began to rise after regulations restricted commercial fishing. **Interpreting Graphics** *Describe the history of the cod population in Georges Bank between 1980 and 2000.*

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. L2 L3

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. L2 L3

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.*

BIO INSIGHTS

FACTS AND FIGURES

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.

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. L1 L2

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. L2 L3

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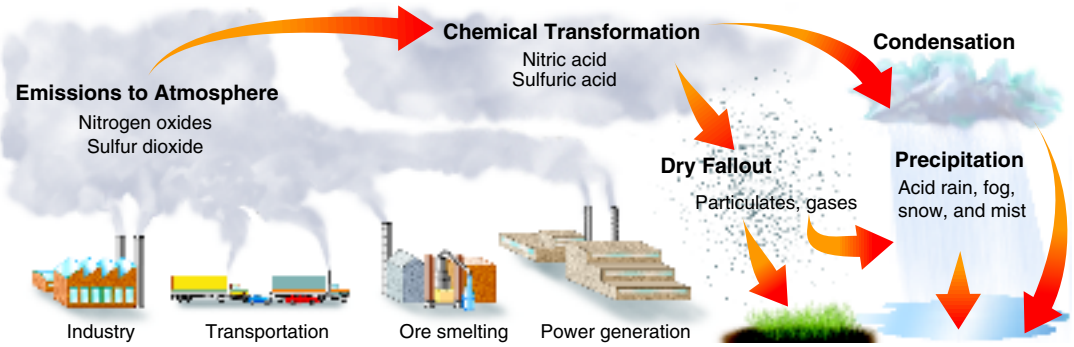

Figure 6–12 Acid rain results from the chemical transformation of nitrogen and sulfur products that come from human activities. The face of the statue (below) shows damage from acid rain. **Interpreting Graphics** *What pathways do the chemicals in atmospheric emissions take on their way to becoming acid rain?*

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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.

CHECK FOR UNDERSTANDING *What is a pollutant?*

BIO INSIGHTS

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.

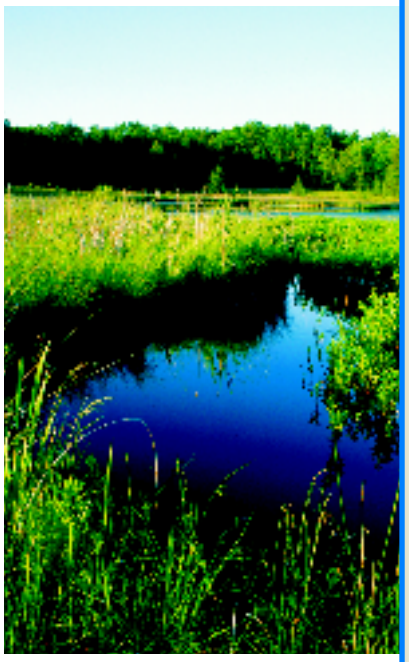
Freshwater Resources

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.



▲ **Figure 6–13** Wetlands provide a valuable ecosystem service by filtering certain pollutants from the water. **Applying Concepts** *How does this filtering process happen?*

6–2 Section Assessment

1. **Key Concept** What is the difference between a renewable and a nonrenewable resource?
2. **Key Concept** List two human activities that affect land resources, and explain the changes that can result. Do the same for air and water resources.
3. How does the decline in world fisheries represent a "tragedy of the commons"?
4. Identify two ways in which environmental resources are important to human health.
5. **Critical Thinking** **Applying Concepts** Describe sustainable development strategies to manage forests as a renewable resource.

Writing in Science

Cause-Effect Paragraph
Write a paragraph explaining the effect of fishing restrictions on fish populations. Your paragraph should explain why the regulations were needed as well as the effect of the regulations. *Hint*: For specific details to include, look at **Figure 6–11.**

Freshwater Resources

Use Community Resources

Ask a member of your local health board to visit the class and tell students about problems with water pollution that have been encountered in your immediate area, the state, or the region. Make sure the guest also discusses whether and how any pollution problems are being resolved. L1 L2

3 ASSESS

Evaluate Understanding

Call on students at random to name harmful human activities discussed in the section and identify each activity's effects on the biosphere.

Reteach

Name different natural resources, and ask students to identify each as renewable or nonrenewable. Then, have students describe ways they can help to conserve resources.

Interactive Textbook

If your class subscribes to the iText, use it to review the Key Concepts in Section 6–2.

Writing in Science

In explaining why regulations were needed, students should describe overfishing. A typical response will also explain that fishing restrictions may protect fish populations and cause their numbers to increase, using evidence from the graphs in Figure 6–11.

6–2 Section Assessment

1. A renewable resource can regenerate and is therefore replaceable. A nonrenewable resource cannot be replenished by natural processes.
2. Answers may vary. Students should draw from the examples discussed in the section as they explain changes that can result from six human activities that affect land, air, and water resources.
3. People from several countries were taking advantage of fisheries, but no one took responsibility for maintaining that resource.
4. Students may mention land, air, or water resources. A typical response might mention the air we breathe as well as the role that wetlands play in filtering pollutants from water.
5. Answers may vary. A typical response might mention selectively harvesting mature trees from forests and planting and harvesting trees from tree farms.

Answers to . . .

CHECKPOINT *A harmful material that can enter the biosphere through the land, air, or water*

Figure 6–12 *The gases combine with water vapor to form drops of nitric acid and sulfuric acid, which can drift long distances before they fall as acid rain.*

Figure 6–13 *As water flows slowly through a wetland, densely growing plants filter out certain pollutants.*