# Land

CHAPTER 14


1 How We Use Land
2 Urban Land Use
3 Land Management and Conservation


## PRE-READING ACTIVITY

FOLDNOTES

**Layered Book**

Before you read this chapter, create the **FoldNote** entitled "Layered Book" described in the Reading and Study Skills section of the Appendix. Label the tabs of the layered book with "Rural Land Use," "Urban Land Use," "Land Management," and "Conservation." As you read the chapter, write information you learn about each category under the appropriate flap.

On the edge of Palm Springs, California, suburban housing has been built on what was once a desert ecosystem.

SECTION 1

# How We Use Land

Some years ago, officials in California decided to find out how land was being used in the state. Measurements were made using maps, aerial photographs, field surveys, and a computerized mapping system. The results were startling. Between 1984 and 1992, nearly 84,000 hectares (about 210,000 acres) of farmland, rangeland, and woodland had been converted into suburbs and cities. This change is happening all over the world.

## Objectives

- Distinguish between urban and rural land.
- Describe three major ways in which humans use land.
- Explain the concept of ecosystem services.

## Key Terms

**urban**
**rural**
**ecosystem services**

## Land Use and Land Cover

We use land for many purposes, including farming, mining, recreation, and building cities and highways. Land cover is what you find on a patch of land, and it often depends on how the land is used. For example, land cover might be a forest, a field of grain, or a parking lot. There are different types of land cover and different human uses for each cover type, as shown in **Table 1.**

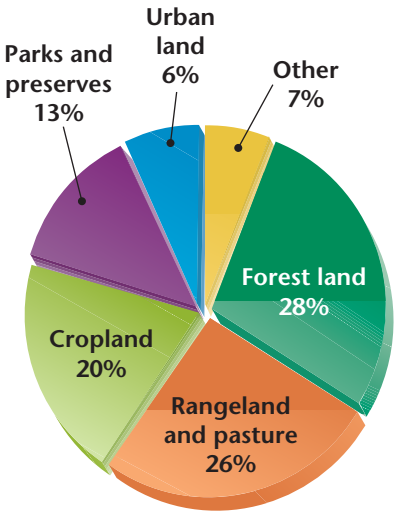
Land that is covered mainly with buildings and roads is called **urban** land. The U.S. Census Bureau defines an urban area as an area that contains 2,500 or more people and usually has a governing body, such as a city council. Any area not classified as urban is considered rural. Land that contains relatively few people and large areas of open space is a **rural** area. **Figure 1** shows the relative proportion of each of the types of land cover defined in **Table 1.** As the table shows, most land provides one or more resources that humans consume. These resources include wood in forests, crops in farmland, and mineral resources.

**Reading Check** **What are two different types of land cover? (See the Appendix for answers to Reading Checks.)**

**Table 1 ▼**

| Primary Land-Use Categories | |
|---|---|
| **Land cover type** | **Human use of land** |
| Rangeland | land used to graze livestock and wildlife |
| Forest land | land used for harvesting wood, wildlife, fish, nuts, and other resources |
| Cropland | land used to grow plants for food and fiber |
| Parks and preserves | land used for recreation and scenic enjoyment and for preserving native animal and plant communities and ecosystems |
| Wetlands, mountains, deserts, and other | land that is difficult to use for human purposes |
| Urban land | land used for houses, businesses, industry, and roads |

**Land Use in the United States**




Source: Natural Resources Conservation Service.

**Figure 1 ▶** The graph above shows the percentage of each land cover type in the United States.

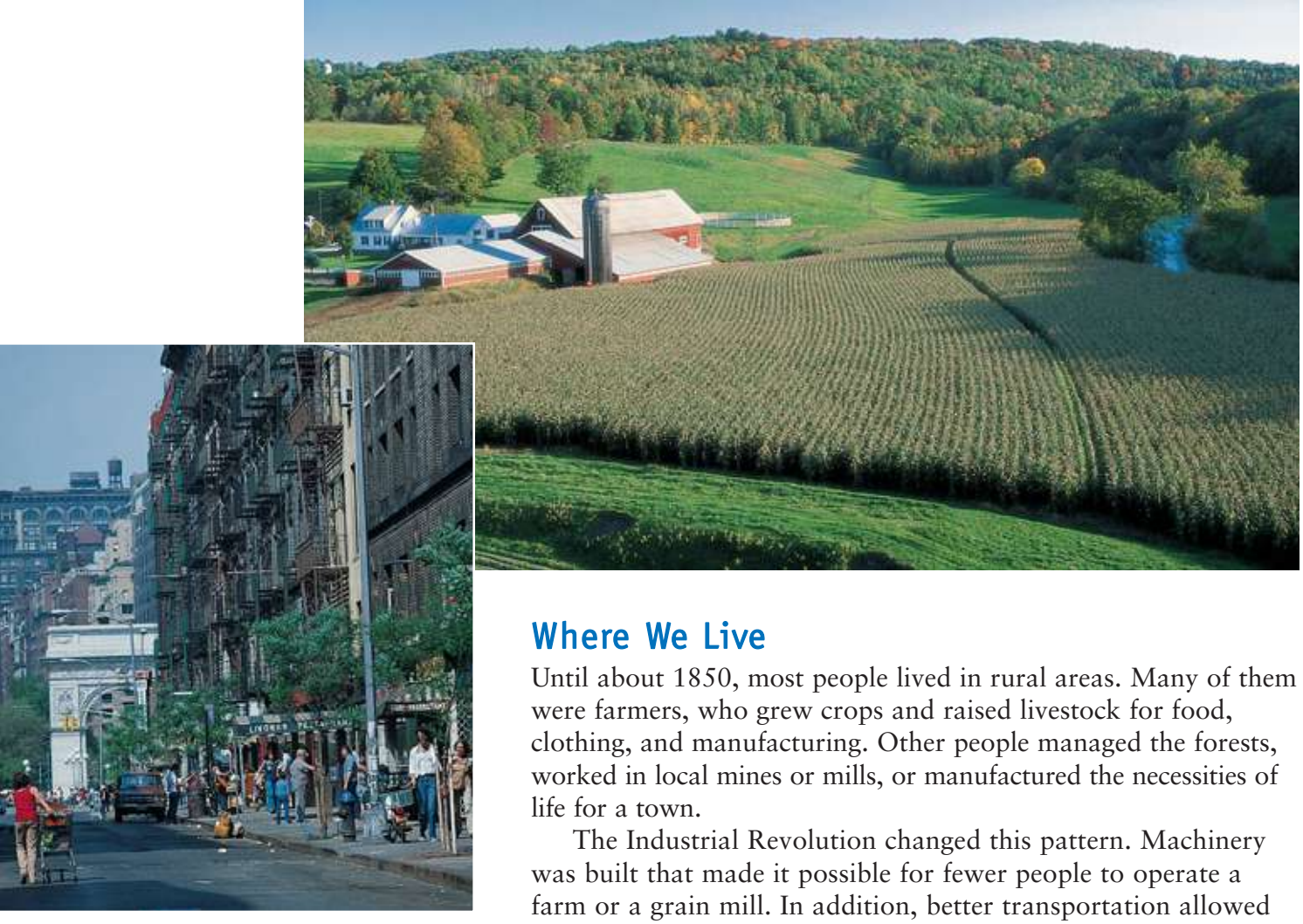


**Figure 2 ▶** The photo on the left, of New York City, shows a typical urban scene. The photo on the right, of the Connecticut River Valley, shows a typical rural scene.

## Where We Live

Until about 1850, most people lived in rural areas. Many of them were farmers, who grew crops and raised livestock for food, clothing, and manufacturing. Other people managed the forests, worked in local mines or mills, or manufactured the necessities of life for a town.

The Industrial Revolution changed this pattern. Machinery was built that made it possible for fewer people to operate a farm or a grain mill. In addition, better transportation allowed manufacturers to be located far from their customers. So thousands of jobs in rural areas were eliminated. Many people had to move to cities to find jobs. As a result, urban areas grew rapidly during the 20th century and spread over more land. **Figure 3** shows that today, most people throughout the world live in urban areas. The movement of people from rural areas to urban areas happened rapidly in developed countries between about 1880 and 1950. Now, this movement is occurring rapidly in developing countries.

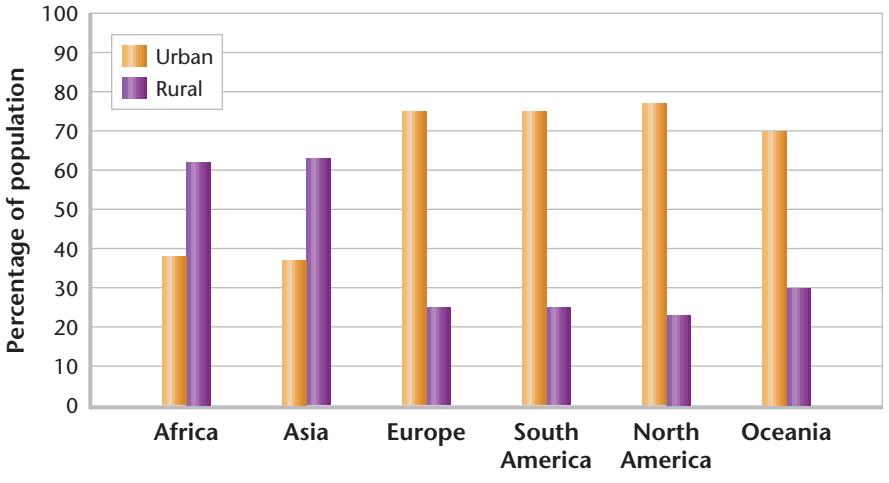



**Figure 3 ▶** This graph shows the proportion of people living in urban areas and rural areas in different parts of the world.

Source: Population Reference Bureau.

## The Urban-Rural Connection

Whether people live in cities or in the countryside, they are dependent on the resources produced in rural areas. These resources include clean drinking water, fertile soil and land for crops, trees for wood and paper, and much of the oxygen we breathe, which is produced by plants. The resources that are produced by natural and artificial ecosystems are called **ecosystem services.** Some examples of ecosystem services are listed in **Table 2.**

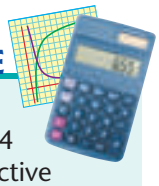
**Supporting Urban Areas** The area of rural land needed to support one person depends on many factors, such as the climate, the standard of living, and how efficiently resources are used. Each person in a developed country uses the ecosystem services provided by about 8 hectares of land and water. In the United States each person uses the ecosystem services from more than 12 hectares, whereas each person in Germany uses about 6 hectares' worth. Many people in developing nations do not have access to all the resources for a healthy life. They may use ecosystem services from less than a hectare of land per person.

**Reading Check** **How does each person's use of ecosystem services in the United States compare with each person's use in Germany?**

**Table 2 ▼**

| Examples of Ecosystem Services |
|---|
| purification of air and water |
| preservation of soil and renewal of soil fertility |
| prevention of flood and drought |
| regulation of climate |
| maintenance of biodiversity |
| movement and cycling of nutrients |
| detoxification and decomposition of wastes |
| aesthetic beauty |

**MATHPRACTICE**



**Ecosystem Services**
Earth contains about 12.4 billion hectares of productive land—cropland, grazing land, forest, fresh water, and fisheries. In 1996, the world population was about 5.7 billion people, for a mean of 2.18 hectares of productive land per person. The world population in 2010 is projected to be 6.8 billion. On average, how much productive land per person will there be in 2010?

SCILINKS
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Topic: Ecosystem Services
Code: HE80465

## SECTION 1 Review

1. **Explain** how ecosystem services link rural lands with urban lands.
2. **Describe** three main ways in which humans use land. Write a paragraph to explain your answer. WRITING SKILLS
3. **Distinguish** between rural lands and urban lands, and provide an example of each.

### CRITICAL THINKING

4. **Making Decisions** What could individuals do to reduce the loss of ecosystem services per person as the human population grows?
5. **Making Inferences** How does the movement of people from rural lands to urban lands affect people's relationship with natural resources?

SECTION 2

# Urban Land Use

## Objectives

- Describe the urban crisis, and explain what people are doing to deal with it.
- Explain how urban sprawl affects the environment.
- Explain how open spaces provide urban areas with environmental benefits.
- Explain the heat-island effect.
- Describe how people use the geographic information system as a tool for land-use planning.

## Key Terms

**urbanization**
**infrastructure**
**urban sprawl**
**heat island**
**land-use planning**
**geographic information system (GIS)**

People live where they can find the things that they need and want, such as jobs, schools, and recreational areas. For most people today, this means living in an urban area.

## Urbanization

The movement of people from rural areas to cities is known as **urbanization.** People usually leave rural areas for more plentiful and better paying jobs in towns and cities. In developed countries, urbanization slowed in the second half of the 20th century. In 1960, 70 percent of the U.S. population was classified as urban. By 1980, this percentage had increased only slightly to 75 percent. As urban populations have grown, many small towns have grown together and formed larger urban areas. The U.S. Census Bureau calls these complexes metropolitan areas. Some examples are Denver-Boulder in Colorado and Boston-Worcester-Lawrence in Massachusetts. **Figure 5** shows the expansion of the Washington, D.C.–Baltimore metropolitan area over the years. These maps were created using data from the U.S. Census Bureau.

Urban areas that have grown slowly are often relatively pleasant places to live. Roads and public transportation in these areas have been built to handle the growth, so that traffic flows freely. Buildings, roads, and parking lots are mixed in with green spaces and recreational areas. These green spaces may provide these urban areas with much needed ecosystem services such as moderation of temperature, infiltration of rainwater runoff, and aesthetic value.

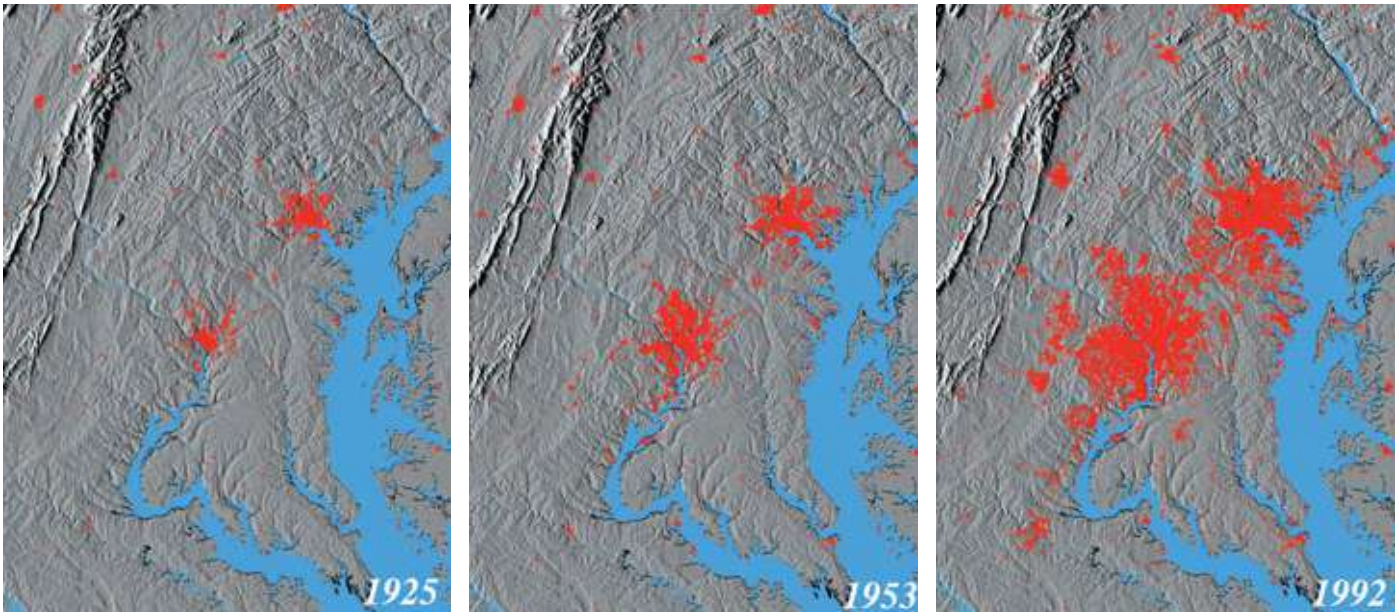



**Figure 5** ▶ The Washington, D.C.–Baltimore area has grown larger and more densely populated over the years. Red areas indicate urban development.

**The Urban Crisis** When urban areas grow rapidly, they often run into trouble. A rapidly growing population can overwhelm the infrastructure and lead to traffic jams, substandard housing, and polluted air and water. **Infrastructure** is all of the things that a society builds for public use. Infrastructure includes roads, sewers, railroads, bridges, canals, fire and police stations, schools, libraries, hospitals, water mains, and power lines. When more people live in a city than its infrastructure can support, the living conditions deteriorate. This growth problem has become so widespread throughout the world that the term *urban crisis* was coined to describe the problem. **Figure 6** shows an example of urban crisis in Hong Kong. The hillside is covered with substandard housing in an area that lacks the necessary infrastructure for people to live in healthy conditions.

**Urban Sprawl** Rapid expansion of a city into the countryside around the city is called **urban sprawl.** Much of this expansion results from building suburbs or housing and associated commercial buildings on the boundary of a larger town. People living in the suburbs generally commute to work in the city by car. Many of these suburbs are built on land that was previously used for food production, as shown in **Figure 7.** In 2000, more Americans lived in suburbs than in cities and the countryside combined. Each year suburbs spread over another 1 million hectares (2.5 million acres) of land in the United States.

**Figure 6** ▶ Rapid urban growth has led to substandard housing on the hillsides above Hong Kong.

**Figure 7** ▶ This photograph shows suburban development spreading out around Maui, Hawaii.

## FIELD ACTIVITY

**Local Urban Sprawl** On your way home from school, observe your surroundings. In your ***EcoLog,*** write down any signs of urban sprawl that you observed. What criteria did you use for making this assessment?

**Figure 8** ▶ The search for ocean views lead people to build these homes on the California coastline, which is giving way as a result of erosion.

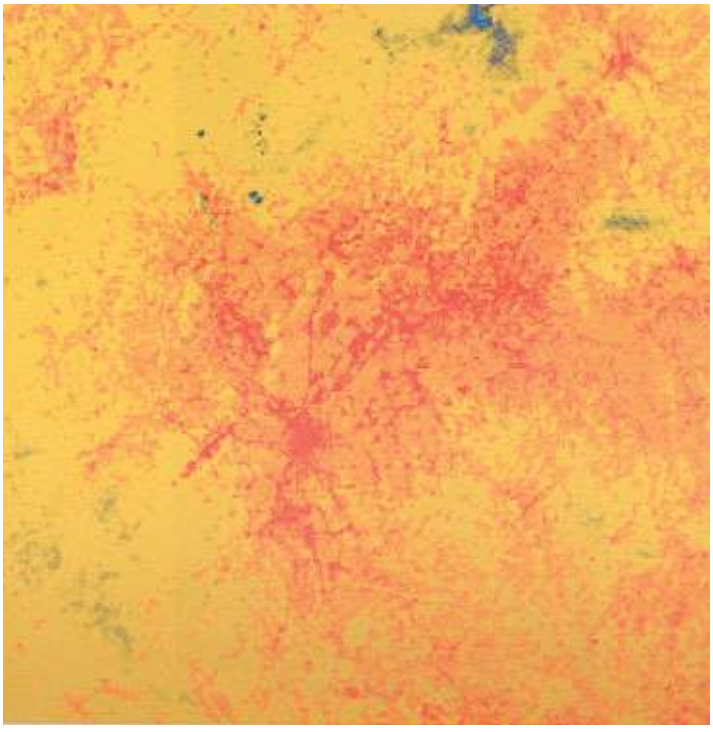
**Connection to Geology**

**Flood Plains** Rivers naturally flood their banks every so often. The potentially flooded area near a river is known as the flood plain. People increasingly build on flood plains, such as around the Mississippi River. Damage to buildings on flood plains often runs into the billions of dollars every year.

## Development on Marginal Lands

Many cities were first built where there was little room for expansion. As the cities grew, suburbs were often built on *marginal land*—land that is poorly suited for building. For example, Los Angeles and Mexico City are built in basins. These cities have expanded up into the surrounding mountains where the slopes are prone to landslides. The houses shown in **Figure 8** were built on land that is unsuitable for development because of the natural processes of erosion along the coastline. Structures built on marginal land can become difficult or impossible to repair and can be expensive to insure.

**Figure 9** ▶ The urban heat island over Atlanta is shown in this computer-enhanced satellite image. Areas with higher temperatures appear red.



## Other Impacts of Urbanization

Environmental conditions in a city are different from those of the surrounding countryside. Cities both generate and trap more heat. Roads and buildings absorb more heat than vegetation does. They also retain heat longer. The increased temperature in a city is called a **heat island.** Atlanta, Georgia, is an example of a city that has a significant heat island, as shown in **Figure 9.**

Heat islands can affect local weather patterns. Hot air rises over a city, cooling as it rises, and eventually produces rain clouds. In Atlanta and many other cities, increased rainfall is a side effect of the heat island. The heat-island effect may be moderated by planting trees for shade and by installing rooftops that reflect rather than retain heat.

**Reading Check** **How do heat islands affect the local rainfall?**

## Urban Planning

**Land-use planning** is determining in advance how land will be used—where houses, businesses, and factories will be built, where land will be protected for recreation, and so on. Land-use planners determine the best locations for shopping malls, sewers, electrical lines, and other infrastructure.

In practice, making land-use plans is complex and often controversial. The federal, state, and local governments require developers to prepare detailed reports assessing the environmental impact of many projects. And the public has a right to comment on these reports. Developers, city governments, local businesses, and citizens often disagree about land-use plans. Projects that affect large or environmentally sensitive areas are often studied carefully and even bitterly debated.

### Technological Tools

Land-use planners have sophisticated methods and tools available to them today. One important technological tool for land-use planning involves using the geographic information system.

A **geographic information system (GIS)** is a computerized system for storing, manipulating, and viewing geographic data. GIS software allows a user to enter different types of data about an area, such as the location of sewer lines, roads, and parks, and then create maps. **Figure 10** shows several images of Seattle, Washington, created from GIS data. Each image corresponds to a different combination of information. The power of GIS is that it allows a user to display layers of information about an area and to overlay these layers, like overhead transparencies, on top of one another.

### Connection to History

**Ancient Urban Planning**
People have practiced urban planning for thousands of years. The ancient Mexican city of Teotihuacan was a marvel of urban planning. The city had a grid plan oriented to 15 degrees, 25 minutes east of true north. It had two central avenues that divided the city into four quadrants. About 2,000 homes and apartment compounds lined the main avenue, which also had a channel running under it that gathered rainwater. Teotihuacan had all this—before 750 CE.

**Figure 10** ▶ The images below are of Seattle, Washington. Each image represents a different GIS layer, each with specific information.


**Figure 11** ▶ This mass transit system in California's San Francisco Bay Area moves thousands of people a day with much less environmental impact than if the people drove their own cars.

**Transportation** Most cities in the United States are difficult to travel in without a car. Many U.S. cities were constructed after the invention of the automobile. In addition, availability of land was not a limiting issue, so many American cities sprawl over large areas. By contrast, most cities in Europe were built before cars, have narrow roads, and are compact.

In many cities, *mass transit systems* have been constructed to get people where they want to go. Mass transit systems, such as the one shown in **Figure 11,** use buses and trains to move many people at one time. Mass transit systems save energy, reduce highway congestion, reduce air pollution, and limit the loss of land to roadways and parking lots. Where the construction of mass transit systems is not reasonable, carpooling is an important alternative.

**Open Space** *Open space* is land within urban areas that is set aside for scenic and recreational enjoyment. Open spaces include parks, public gardens, and bicycle and hiking trails. Open spaces left in their natural condition are often called *greenbelts*. These greenbelts provide important ecological services.

Open spaces have numerous environmental benefits and provide valuable functions. The plants in open spaces absorb carbon dioxide, produce oxygen, and filter out pollutants from air and water. The plants even help keep a city cooler in the summer. Open spaces, especially those with vegetation, also reduce drainage problems by absorbing more of the rainwater runoff from building roofs, asphalt, and concrete. This ecological service results in less flooding after a heavy rain. As well, open spaces provide urban dwellers with much-needed places for exercise and relaxation.

SCILINKS
www.scilinks.org
Topic: Land Use
Code: HE80847

**Reading Check** **What are three benefits that are provided by open spaces in urban areas?**

## SECTION 2 Review

1. **Describe** the urban crisis, and explain how people are addressing it.
2. **Explain** how urban areas create heat islands.
3. **Explain** how open spaces provide environmental benefits to urban areas.
4. **Describe** how a GIS system can be used as a land-use tool.

### CRITICAL THINKING

5. **Identifying Relationships** Write a short paragraph in which you describe the benefits of using a geographic information system for land-use planning. WRITING SKILLS
6. **Making Decisions** Describe the environmental implications of urban sprawl.

SECTION 3

# Land Management and Conservation

EARTH SCIENCE CONNECTION

As the human population grows, the resources of more rural land are needed to support the population. The main categories of rural land are farmland, rangeland, forest land, national and state parks, and wilderness. Throughout our history, we have sometimes managed these lands sustainably so that they will provide resources indefinitely. We have also sometimes reduced their productivity by overusing or polluting them. The condition of rural land is important because of the ecological services that it provides. These services are especially important for the urban areas that rely on the productivity of rural land.

## Objectives

- Explain the benefits of preserving farmland.
- Describe two ways that rangeland can be managed sustainably.
- Describe the environmental effects of deforestation.
- Explain the function of parks and of wilderness areas.

## Key Terms

**overgrazing**
**deforestation**
**reforestation**
**wilderness**

## Farmlands

Farmland, such as that shown in **Figure 12,** is land that is used to grow crops and fruit. The United States contains more than 100 million hectares of prime farmland. However, in some places, urban development threatens some of the most productive farmland. Examples of places where farmland is threatened are parts of North Carolina's Piedmont region and the Twin Cities area of Minnesota. In 1996, the U.S. government established a national Farmland Protection Program to help state, county, and local governments protect farmland in danger of being paved over or otherwise developed.

### Ecofact

**Hedgerows** Farmland forms an important habitat for wildlife in Great Britain, which has relatively few remaining natural areas. Fields are separated by rows of bushes called hedgerows, which provide shelter for a variety of birds, mammals, reptiles, and insects.

**Figure 12** ▶ This farmland next to the suburbs of Mililani, Hawaii, is used to grow a variety of crops.

## Rangelands

Land that supports different vegetation types like grasslands, shrublands, and deserts and that is not used for farming or timber production is called *rangeland*. Rangelands can be arid, like rangelands in the desert Southwest, or relatively wet, like the rangelands of Florida. The most common human use of rangeland is for the grazing of livestock, as shown in **Figure 13.** The most common livestock are cattle, sheep, and goats, which are valued for their meat, milk, wool, and hides. Native wildlife species also graze these lands. Like farmland, rangeland is essential for maintaining the world's food supply. World population growth may require a 40 percent increase in the food production of rangeland from 1977 to 2030.



**Problems on the Range** Some rangelands in the United States have become degraded by poor land management strategies. Most damage to rangeland comes from **overgrazing,** or allowing more animals to graze in an area than the range can support. When animals overgraze, too many of the plants are eaten, and the land can become degraded. Overgrazing often results in changes in the plant community. Less desirable plant species may invade the area and replace more-desirable plant species. In severe cases, all the vegetation is eaten. Once the plants are gone, there is nothing to keep the soil from eroding.

**Maintaining the Range** Much of the rangeland in the United States is public land managed by the federal government, which leases the rangeland to ranchers. Much of it is degraded. The Public Rangelands Improvement Act of 1978 was enacted to reverse this trend and improve land management practices.

Sustaining the productivity of rangeland generally means reducing overgrazing by limiting herds to sizes that do not degrade the land. Rangeland may also be left unused for periods of time so that the vegetation can recover. Improving rangeland that has been degraded by overgrazing often includes methods such as killing invasive plants, planting native vegetation, and fencing areas to let them recover to the state they were in before they were overgrazed. As well, ranchers control grazing by digging several small water holes so that livestock do not overgraze the vegetation around a single water hole.

**Reading Check** **How does rangeland become degraded?**

**Graphic Organizer**

**Venn Diagram** Create the **Graphic Organizer** entitled "Venn Diagram" described in the Appendix. Label the circles with "Rangelands Land Management" and "Forest Land Management." Then, fill in the diagram with characteristics that each type of land management shares with the other.

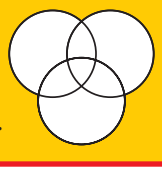
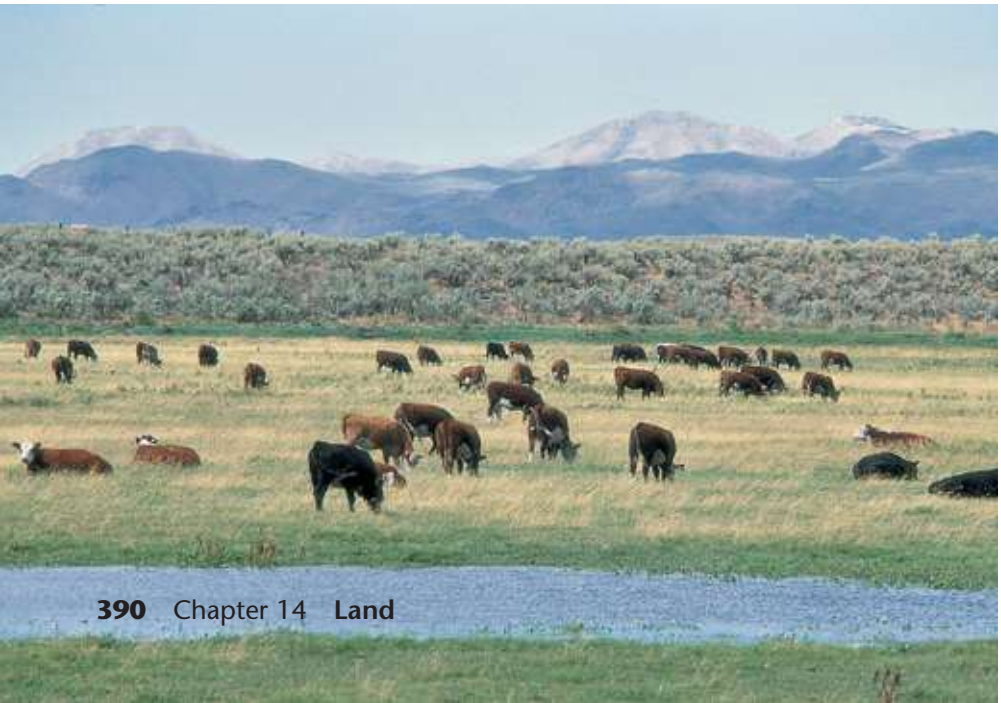


**Figure 13** ▶ The photo below shows productive rangeland in the western United States.



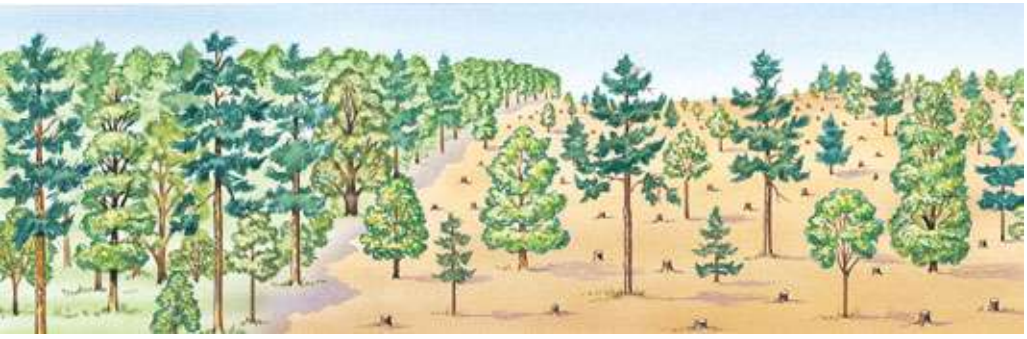


**Figure 14** ▶ Methods for harvesting trees include clear-cutting (top) and selective cutting (bottom).

## Forest Lands

Trees are harvested to provide products we use everyday, such as paper, furniture, and lumber and plywood for our homes. In addition to wood and paper, we value forest products such as maple syrup and turpentine. There are many ecosystem services provided by forests; however, one of the most important is the removal of $CO_2$ from the air.

**Harvesting Trees** People use enormous amounts of wood. The worldwide average is 1,800 $cm^3$ of wood used per person each day. However, on average, each person in the United States uses about 3.5 times this amount. This is the equivalent of each person in the United States cutting down a tree that is 30 m tall every year. About 1.5 billion people in developing countries depend on firewood as their main source of fuel.

The timber industry classifies forest lands into three categories—virgin forest, which is forest that has never been cut; native forest, which is forest that is planted and managed; and tree farms, which are areas where trees are planted in rows and harvested like other crops. The two most widely used methods of harvesting trees are clear-cutting and selective cutting. These methods are shown in **Figure 14.** *Clear-cutting* is the process of removing all of the trees from an area of land. Clear-cutting large areas destroys established wildlife habitat and may cause soil erosion. The main alternative is selective cutting, which is usually practiced on smaller areas owned by individuals. *Selective cutting* is the process of cutting and removing only middle-aged or mature trees. Selective cutting is more expensive than clear-cutting, but selective cutting is usually much less destructive.

### QuickLAB

#### Measuring Soil Depth and Compaction

**Procedure**

1. Find a plot of **undisturbed soil** in a forest, meadow, park, or other undisturbed area near your school.
2. Press a **meterstick** down into the undisturbed soil as far as it will go. Record how deep the meterstick went into the soil. Record how soft the soil was and how easy it was to press the meterstick into the soil. Repeat this five times in the same plot of undisturbed soil.
3. Pour 1 L of **water** onto the undisturbed soil. Use a **stopwatch** to record how long it takes for the soil to fully absorb the water.
4. Repeat this procedure at a plot of **disturbed soil** in a bike path, dirt road, or other area where the soil is bare and vegetation has been cleared or trampled.

**Analysis**

1. How did the soil depth and hardness in the plot of undisturbed soil differ from that in the plot of disturbed soil?
2. Which plot absorbed water faster?
3. How might grazing cattle affect the depth and compaction of an undisturbed plot of land?
4. How might clear-cutting affect an undisturbed plot of land?

## Ecofact

**Burning Trees and $CO_2$** When trees are cut and burned, they release carbon dioxide. From 1850 to 1990, deforestation released more than 100 billion metric tons of carbon dioxide into the atmosphere worldwide. Some scientists think this additional $CO_2$ is contributing to an increase in global temperatures.

**Deforestation** The clearing of trees from an area without replacing them is called **deforestation.** Most countries become severely deforested as populations expand and the demand for forest products increases. Forests are cleared to convert the land into farmland. People also clear forests to make space for roads, homes, factories, and office buildings.

Deforestation reduces wildlife habitat, but it has other impacts, too. For example, when forests are cleared from a hillside, soil erosion usually results if the area is not quickly planted with a cover crop. Without tree roots to hold the soil in place, soil is easily washed or blown into the valley below. In New York, forests on hillsides were cleared for farmland during the 19th century. Plowing also increased the rate of erosion, and as much as 90 percent of the soil eroded. Then, during the Great Depression, which was in the 1930s, hundreds of farmers in this area went bankrupt. The state bought many of the abandoned farms, and let the forests regenerate. Today, many of the hillsides are covered with state forest, which is used for recreation.

The rate of deforestation is especially high in tropical rain forests, where the soil is relatively thin. Farmers who clear forests in these areas must always move from one plot of land to another and clear more forest each time they move. Whether forests are cleared for farming or wood, if trees are not replanted, natural resources are steadily depleted.

CASE STUDY

## California's Wilderness Corridors

California has an extraordinary range of habitats, from coastal islands, where elephant seals breed, to mountains where salmon, cougars, bobcats, and badgers are found. Many of these animals live on wildlife preserves and other public lands or on private land.

Animals do not know that they are safest if they stay on preserves. Many animals naturally migrate at different times of the year. Young animals are often evicted from their territories by their parents and must search for territories of their own to survive. Many animals also leave their territories in search of mates from other populations. This process is important because if animals reproduce only with members of the species that live nearby, the population becomes inbred and genetic defects become more common.

As California becomes more urbanized, however, migration routes between one population of animals and another population are increasingly blocked by highways and housing developments.

A possible solution is the acquisition of conservation corridors—thin strips of protected land that connect one preserve with another preserve. Conservation biologists have argued for years over whether such corridors are


Source: Los Angeles Times

▶ This diagram shows suspected wildlife corridors around Los Angeles, California.

**Reforestation** Clear-cut forest can be replanted or allowed to regrow naturally, without human intervention. **Reforestation** is the process by which trees are planted to re-establish trees that have been cut down in a forest land. In some places, reforestation is happening faster than trees are being cut down. New England, for example, now contains more forest than it did a century ago. Much of the original forest had been cleared for farming, but the land was unable to sustain productive crops over a long period. As farming in this area became less economical, farms were abandoned and the forest regenerated. The same process has happened in places where steep hillsides were deforested for farming or development. The cost of deforestation, which caused soil erosion, landslides, and flooding, was too high. So forest has now been allowed to regenerate or has been replanted.

Some governments require reforestation after timber has been harvested from public land. A reforestation project is shown in **Figure 15.** Worldwide, more than 90 percent of all timber comes from forests that are not managed by an agency that monitors the health of forest ecosystems. Many governments are currently working to improve reforestation efforts and to promote less destructive logging methods. Private organizations have also established tree-planting programs on roadsides and in cities.

**Figure 15** ▶ Tree seedlings have been planted to reforest this hillside as part of a reforestation project in the Fiji Islands.

▶ Cougars may need wildlife corridors in order to survive in parts of California.

effective in linking habitats and protecting animals.

One such corridor in California is the Tenaja corridor, which connects the Santa Rosa Plateau Ecological Preserve and the larger Cleveland National Forest in the Santa Ana Mountains southeast of Los Angeles. Biologist Paul Beir studied the movements of a population of cougars in the Santa Ana Mountains by putting radio collars on more than 30 animals to track their movements. He found that the animals used the Tenaja corridor and avoided urban areas.

Now there is public pressure to preserve 232 of the corridors that link critical habitats. Voters have approved bond measures that will supply the money to buy some of the land, and the Nature Conservancy is also contributing land. The question of whether wildlife corridors preserve species may finally be answered by California's initiative.

## CRITICAL THINKING

**1. Applying Ideas** California's state emblem is a grizzly bear, which is a species no longer found in the state. Why do you think the bears disappeared?

**2. Expressing Viewpoints** Should California spend state money to preserve habitats? Explain your answer.


**Figure 16** ▶ National parks in the United States are concentrated in the West.

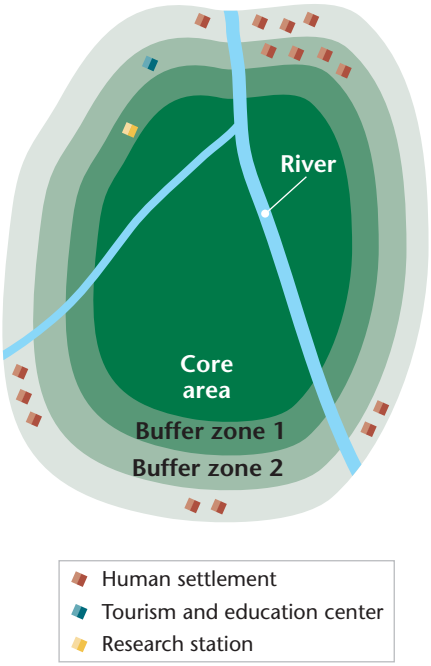
## Parks and Preserves

In the 1870s, a group of explorers brought news to Congress of a magnificent expanse of land in Wyoming and Montana. The explorers expressed their concern that the land would be damaged by the development that had changed the northeastern United States. Congress agreed to protect the land, and the first national park—Yellowstone—was created. Today, the United States has about 50 national parks, as shown in **Figure 16.**

Public lands in the United States have many purposes. Most public lands are not as protected as the national parks are. Some public lands are leased to private companies for logging, mining, and ranching. Other public lands are maintained for hunting and fishing, as wildlife refuges, or for protecting endangered species.

International efforts include the United Nations's Man and the Biosphere Program. This program has set up several hundred preserves throughout the world since 1976. These preserves are called *biosphere reserves* and are unusual in that they include people in the management plan of the reserves, as shown in **Figure 17.**

**Figure 17** ▶ Biosphere reserves are places where human populations and wildlife live side by side.




**Wilderness** The U.S. Wilderness Act, which was passed in 1964, designated certain lands as wilderness areas. **Wilderness** is an area in which the land and the ecosystems it supports are protected from all exploitation. So far, 474 regions covering almost 13 million hectares (32 million acres) have been designated as wilderness in the United States. **Figure 18** shows an example of a wilderness area. Wilderness areas are open to hiking, fishing, boating (without motors), and camping. Building roads or structures and using motorized equipment are not allowed in these areas.

**Reading Check** **What are three uses of public lands in the United States?**

**Benefits of Protected Areas** Without national and private parks and preserves around the world, many more species would now be extinct. In a crowded world, these protected areas often provide the only place where unspoiled forests, deserts, or prairies remain. Without these areas, the plants and animals that can survive only in these ecosystems would disappear. These protected areas also provide recreation for people. People can camp, hike, fish, and watch birds and other wildlife in these areas. Wilderness areas also serve as outdoor classrooms and research laboratories where people can learn more about the natural world.

**Threats to Protected Areas** There is a constant battle in our world between our conservation efforts and the growing and increasingly mobile population. Around the world, more people visit national parks and wilderness areas each year and leave their mark on the land. Litter and traffic jams that have plagued our cities now plague many of our national parks. Rangelands, mining and logging sites, oil and gas drilling operations, factories, power plants, and urban areas are often close enough to the parks to affect the parks. In addition, preserved areas are affected by climate change and by air and water pollution, as are most other parts of the world.

In attempts to protect wilderness from damage, limits have been set on the number of people permitted in some areas at any given time. Other areas are completely closed to visitors to allow wild animals to breed. In addition, volunteer programs are now active in many wilderness areas. Volunteers help pick up trash, build trails, control invading or exotic species, and educate the visiting public.

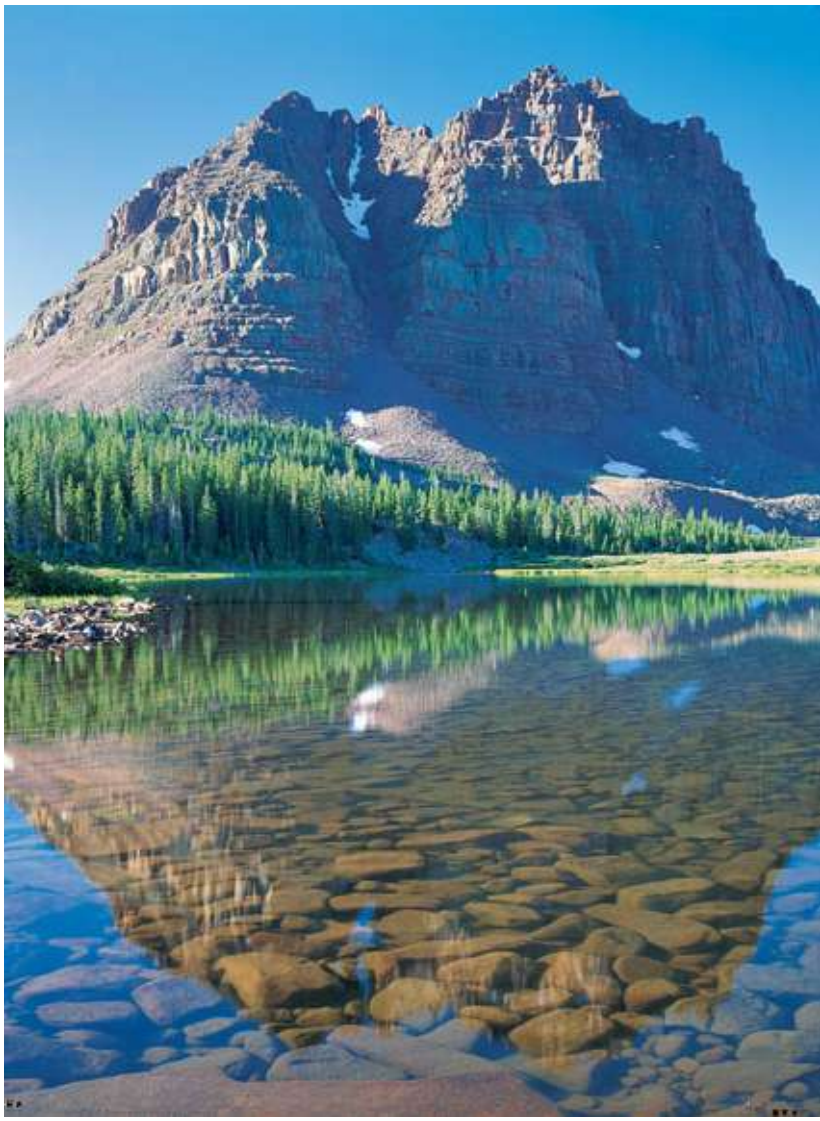


**Figure 18** ▶ In the United States, wilderness areas, such as the High Uintas Wilderness area shown here, are supposed to be preserved untouched for our own and future generations.

## SECTION 3 Review

1. **Explain** what reforestation is and why it is important.
2. **List** and explain two methods of managing rangelands sustainably.
3. **Describe** the function of parks and of wilderness.
4. **Describe** the environmental effects of deforestation.

### CRITICAL THINKING

5. **Recognizing Relationships** Read the first paragraph under the head "Threats to Protected Areas." Why do you suppose that some of our nation's national parks and wilderness areas are degraded?
READING SKILLS
6. **Recognizing Relationships** What are the benefits of preserving farmland?

CHAPTER 14

# Highlights

## 1 How We Use Land

### Key Terms

**urban,** 381
**rural,** 381
**ecosystem services,** 383

### Main Ideas

- Land is covered with forest, farm fields and pastures, roads, and towns.
- Urban areas are mostly covered with houses, roads, businesses, and industrial and municipal structures. Rural areas have less dense human populations and include forest land, cropland, rangeland, and other land cover types.
- Urban areas need very large areas of rural ecosystems to supply them with water, food, wood, and other ecosystem services.

## 2 Urban Land Use

**urbanization,** 384
**infrastructure,** 385
**urban sprawl,** 385
**heat island,** 386
**land-use planning,** 387
**geographic information system (GIS),** 387

- Urbanization is the migration of people from rural to urban areas.
- When cities grow more rapidly than infrastructure can be built, they tend to suffer from substandard housing and traffic problems.
- Unplanned growth of a city results in urban sprawl, as low-density development spreads into the surrounding countryside.
- Land-use planning is essential if urban areas are to be pleasant places to live.

## 3 Land Management and Conservation

**overgrazing,** 390
**deforestation,** 392
**reforestation,** 393
**wilderness,** 394

- Farmland is used to raise crops and livestock.
- Rangeland is land used primarily for grazing livestock. Rangeland is easily degraded by overgrazing.
- Trees are harvested for many purposes. Deforestation can cause soil erosion and may threaten forest plants and animals with extinction.
- National lands are used for many purposes, including lumber, mining, and recreation. Wilderness is national land that is protected from all exploitation for the benefit of future generations.

# CHAPTER 14 Review

## Using Key Terms

Use each of the following terms in a separate sentence.

1. *rangeland*
2. *infrastructure*
3. *urbanization*
4. *ecosystem services*
5. *geographic information system*

For each pair of terms, explain how the meanings of the terms differ.

6. *heat island* and *urban sprawl*
7. *overgrazing* and *deforestation*
8. *urban* and *rural*
9. *selective cutting* and *clear-cutting*

### STUDY TIP

**Flash Cards** With a partner, make flash cards for the key words and most important ideas in the chapter. Take turns quizzing each other about the content of the course. Do another round, and this time the person being asked questions should try to use each key word and idea in a complete sentence.

## Understanding Key Ideas

10. Building a mass transit system is likely to have which of the following effects?
    a. increasing air pollution
    b. traffic congestion
    c. increasing the temperature of the urban heat island
    d. none of the above
11. National parks and wilderness areas are designed to do which of the following?
    a. provide recreation
    b. protect wildlife
    c. preserve natural areas
    d. all of the above
12. Which of the following is *not* an example of urbanization?
    a. Immigrants settle in New York City.
    b. A farmer who can no longer afford to lease farmland moves to a city.
    c. A drop in timber prices in Oregon causes a lumberjack to lose his job and he moves to Portland.
    d. An Indian family moves to the city of Calcutta after a landslide destroys their village.
13. Which of the following is *not* an example of infrastructure?
    a. a railroad
    b. a school
    c. a telephone line
    d. a dairy farm
14. Which of the following is a likely result of deforestation?
    a. The amount of carbon dioxide removed from the atmosphere is reduced.
    b. Wind blows soil away because the plant cover has been removed.
    c. Water runs off the land more rapidly and causes floods.
    d. all of the above
15. Which of the following is *not* likely to cause the degradation of rangeland?
    a. adding more animals to a herd grazing on rangeland
    b. a drought in which rainfall is lower than usual for three years
    c. planting grass seed on the land
    d. driving a vehicle off-road
16. Which of the following is an example of reforestation?
    a. replanting forest land that has been clear-cut
    b. planting a cherry tree in your backyard
    c. planting oak trees in a city
    d. all of the above
17. Which of the following is *not* an ecosystem service provided by rural lands?
    a. oxygen in the air
    b. plastic for making bottles
    c. aesthetic beauty
    d. wood for making paper

# CHAPTER 14 Review

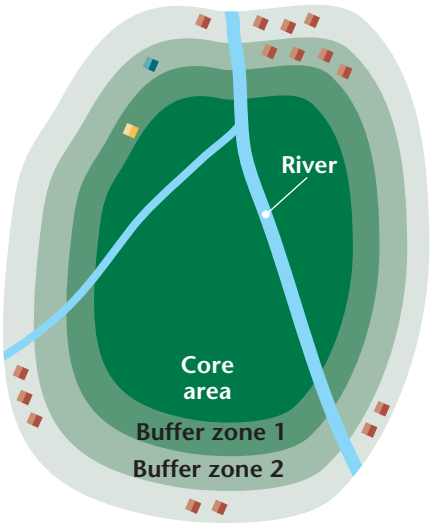
## Short Answer

18. Explain one way rangeland can be degraded.
19. Do national parks and forests in the United States protect ecosystems from human activities? Explain your answer.
20. What is the difference between a U.S. wilderness area and a national park?
21. Are national parks located only in the United States?
22. How can building a mass transit system improve living standards in an urban area?

## Interpreting Graphics

The map below shows a typical UN Biosphere Reserve. Use the map to answer questions 23–25.

23. Where is the reserve's research station located, and why has it been placed there rather than anywhere else in the reserve?
24. What indicators can you see that this reserve might be an ecotourism destination?
25. What does the map tell you about the function of buffer zone 2?




## Concept Mapping

26. Use the following terms to create a concept map: *geographic information system*, *land-use planning*, *infrastructure*, *population*, and *urban area*.

## Critical Thinking

27. **Recognizing Relationships** Read about clear-cutting under the head "Harvesting Trees." What effects does clear-cutting a hillside have on the environment? READING SKILLS
28. **Drawing Inferences** If we see many invasive plant species and large areas of bare soil on rangeland, what conclusions can we draw about the land management practices on this rangeland? Explain your answer.
29. **Evaluating Assumptions** We tend to think that the main use of livestock is for meat. However, the Masai herders of Africa do not slaughter their cattle. They use the milk. They also bleed the cattle and use the blood to make a protein-rich sausage. What other uses for livestock can you think of that do not involve killing the animals?

## Cross-Disciplinary Connection

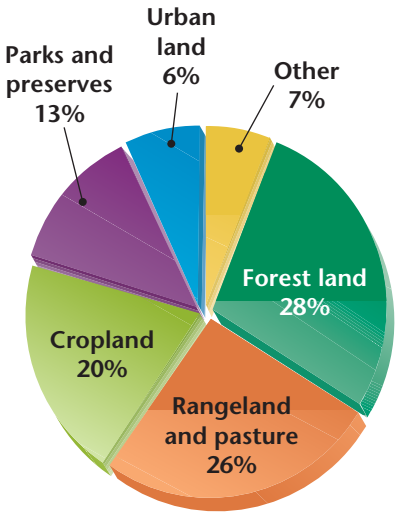
30. **History** Find out how deforestation has affected a community. If you live in a forest biome, you can document the effects of deforestation on local rivers and farmland. If not, you will probably have to find an example on the Internet or in a magazine. Write a paragraph for your answer, using at least three key terms from this chapter. WRITING SKILLS

## Portfolio Project

31. **Research** Diagram the growth of your community over the last 100 years. Express this as a graph that shows the growth of the population and a map that shows the area of ground the community covers. There are various possible sources for the data you will need. If there is a local historical society, this is probably the best source. Otherwise, city hall or the local newspaper will probably have the information.

## MATH SKILLS

The graph below shows land cover in the United States in 1997. Use the graph below to answer questions 32–33.




32. **Analyzing Data** If the percentage of cropland increased to 25 percent, and all other land cover categories except for rangeland and pasture remained the same, what percentage would rangeland and pasture be?

33. **Making Calculations** What percentage of the United States is planted in crops if 11 percent of cropland is idle (unplanted) at any one time?

## WRITING SKILLS

34. **Communicating Main Ideas** In what ways does urban sprawl reduce the quality of life for people in the suburbs as well as in the town or city?

## READING SKILLS

**Read the passage below, and then answer the questions that follow.**

When more people live in a city than its infrastructure can support, living conditions deteriorate. For example, many people do not have access to clean water for drinking and washing. In addition, overcrowding causes the prices of existing houses and apartments to rise above the reach of many workers. Increasing numbers of people become homeless. These problems have become so widespread throughout the developed and developing world, that the term *urban crisis* was coined to describe the problem. According to the United Nations, the crisis is so bad that almost one-fourth of the world's city dwellers could be homeless by the year 2020.

1. According to the passage, which of the following statements is true?
   a. Cities have grown so rapidly that the rural areas that supply the cities with food and fuel cannot do so fast enough.
   b. Overcrowded cities lead to unaffordable housing and homelessness.
   c. The urban crisis does not usually involve water pollution.
   d. Living conditions usually improve when the population of a city increases.

2. Which of the following is an example of the urban crisis, according to the passage?
   a. To make space for more cars, roads into and through a city are widened.
   b. Deforestation in the countryside surrounding a city causes the water level in a river that flows through the city to increase when it rains.
   c. Homelessness is increasing rapidly in cities in both developed and developing countries.
   d. Inadequate planning for a growing number of commuters results in traffic jams on roads leading into the city in rush hour.

CHAPTER 14

# Standardized Test Prep

## Understanding Concepts

***Directions (1–5):*** **For *each* question, write on a separate sheet of paper the letter of the correct answer.**

**1** What is the term for the movement of people from rural areas to cities?
- **A.** land-use planning
- **B.** infrastructure
- **C.** urban sprawl
- **D.** urbanization

**2** Unplanned, rapid urban growth can create what problem?
- **F.** degradation of the ecosystem
- **G.** elimination of invasive vegetation
- **H.** infrastructure that can not adequately support the population
- **I.** rangeland damaged from overgrazing

**3** Which of the following statements generalizes population distribution changes over the last 200 years?
- **A.** Urban areas have doubled in size in 200 years.
- **B.** More people lived in rural areas 200 years ago.
- **C.** Population distribution has not significantly changed in 200 years.
- **D.** Undeveloped countries have seen the most changes in 200 years.

**4** Which of the following is an important aspect of land management?
- **F.** increasing the overall size of the herds
- **G.** leasing public lands from the federal government
- **H.** reducing damage to land caused by overgrazing
- **I.** removing fences from rangeland to allow livestock more grazing area

**5** Which of the following is an environmental benefit of open space?
- **A.** Open space leads to a reduction in traffic flow.
- **B.** Open space helps filter pollutants from air and water.
- **C.** Open space means more land is available for planting.
- **D.** Open space results in lower temperatures in the wintertime.

***Directions (6–7):*** **For *each* question, write a short response.**

**6** As the human population grows, more land resources are needed to support the population. Describe two ways that human activities make rural lands less productive.

**7** Analyze the relationship between protecting rangeland and ensuring the world's food supply.

## Reading Skills

***Directions (8–10):*** **Read the passage below. Then answer the questions.**

People use enormous amounts of wood. The worldwide average is 1,800 $cm^3$ of wood per person each day. However, each person in the United States uses about 3.5 times this amount, the equivalent of cutting down a 30 m tall tree every year.

The timber industry classifies forest lands into three categories—virgin forests, which is forest that has never been cut; native forest, which is forest that is planted and managed; and tree farms, which are areas where trees are planted in rows and harvested like other crops. The two most widely used methods of harvesting trees are clear-cutting and selective cutting. Clear-cutting is the process of removing all trees from an area of land. Clear-cutting large areas destroys wildlife habitat and causes soil erosion. Selective cutting is the process of cutting and removing only middle-aged or mature trees. Selective cutting is more expensive than clear-cutting but selective cutting is usually much less destructive.

**8** The forest land classification that can be deduced as the most rare is
- **F.** deciduous forest
- **G.** evergreen forest
- **H.** native forest
- **I.** virgin forest

**9** Compare clear-cutting with selective logging.

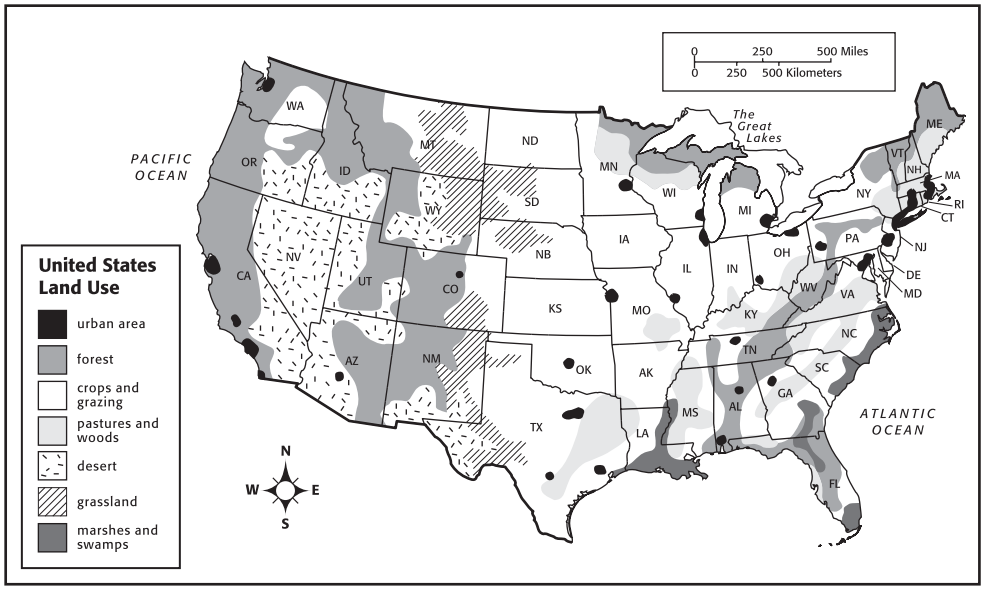
**10** What is the most effective way to help a forest recover from tree harvesting?

## Interpreting Graphics

***Directions (11–14):*** **For *each* question below, record the correct answer on a separate sheet of paper.**

The map below shows land use in the United States. Use this map to answer questions 11 through 14.

**Land Use in the United States**




**11** Which land-use designation has the **greatest** potential for growth?
- **A.** forest
- **B.** desert
- **C.** urban areas
- **D.** pasture lands

**12** What is the **most** prevalent land use in the continental United States?
- **F.** crops and grazing
- **G.** desert
- **H.** pastures and woods
- **I.** urban areas

**13** Which of the following conclusions is suggested by the map?
- **A.** Most farmers live west of the Rocky Mountains.
- **B.** There are more rural lands in the U.S. than there are urban lands.
- **C.** Manufacturing plants are concentrated along the Mississippi River.
- **D.** Industries dependent on wood and wood products are located mostly in the Midwest.

**14** What percentage of states in the continental United States have some land available for crops and grazing?
- **F.** 10%
- **G.** 50%
- **H.** 80%
- **I.** 100%

**Test TIP**

Try to picture in your mind the terrain and buildings that would be present in the various land-use designations.

CHAPTER 14

# Inquiry Lab: DESIGN YOUR OWN

## Objectives

- **Create** a simulated land-use model.
- **Recognize** conflicts of interest that arise during a negotiation.
- USING SCIENTIFIC METHODS **Analyze** and draw conclusions about the effect of compromise on the desired outcome for each interested party in a land-use plan.

## Materials

**colored pencils**
**graph paper**
**pens**

**Laws**

- At least 10 percent of each type of habitat must be preserved.
- Landfills must be at least two acres away from all housing, wetlands and freshwater sites.
- Roads and bridges may cross rivers and wetlands but they must go around large natural areas.
- Roads must be connected to all developed areas of the city.
- There must be no building over wetlands, slopes and fresh water. Only parks may partially cover these habitats. Roads and bridges may cross them.

## Creating a Land-Use Model

Land-use plans are drawn up by planners, but they are created with the combined input of various members of a community. Along with three other people, you are meeting to plan the development of 400 acres of land for your growing city. Your team is composed of the following four members:

**Team Members**

- The **Planner** is concerned with creating a plan that encourages the sort of growth that will attract businesses and new citizens to the area.
- The **Developer** bought the land from the city and is interested in the right to build housing and a shopping center.
- The **Conservationist** is interested in preserving open space and natural areas from further development.
- The **Law Enforcer** ensures that all of the laws and regulations are met for any new development project.

## Procedure

1. Have each team member select one of the four jobs above.
2. Use all or part of a large piece of graph paper as your map. Mark off an area that will represent 400 acres. Determine the approximate scale, and label the sides of your area accordingly.
3. The planner will color in the map as follows:
   a. 40 acres will be fresh water (rivers and/or lakes) and will be colored light blue.
   b. 80 acres will be wetlands that are right next to some of the fresh water and will be colored light purple or lavender.
   c. 40 acres will be land that is too sloped for building and will be colored tan.
   d. 240 acres is land that is good for development and will be colored light green.
4. Once the land is colored in, it cannot be altered. That will be the land you work with.
5. After the area is colored in, the group must discuss how and where to put the following items:
   a. 40 acres for a landfill
   b. 20 acres for utilities such as power plants and water treatment facilities.
   c. 40 acres for parks and wildlife
   d. 40 acres for housing. Try to put the houses near a beautiful area.

e. 40 acres for shopping

f. 20 acres for anything that the group agrees to add. For example, you could add a few acres for community gardens or for sports and playing fields. The law enforcer cannot suggest anything, but if the group can't agree on what to add, the law enforcer may cast the deciding vote.

g. 40 acres of roads and bridges (you can divide an acre up so that you can build long, thin roads rather than create short, fat roads that are an entire acre thick). Make sure at least one road goes into and out of town.

6. The law enforcer should make sure that the plans abide by the planning regulations by checking the map for violations.

7. Use the key under the map to mark which areas are which. For example, an R denotes a road or bridge. Use a pencil and write in the things softly at first in case changes are to be made. You may need a second copy of the map in case you make mistakes the first time.

## Analysis

1. **Describing Events** Did everyone on your team agree on the plan, or were there conflicts of interest? Explain.

2. **Describing Events** Were you able to get everything your team wanted into the plan or did you face any problems? Describe what happened.

3. **Identifying Patterns** How did the features of the land constrain the plan that you made? Did you encounter any problems?

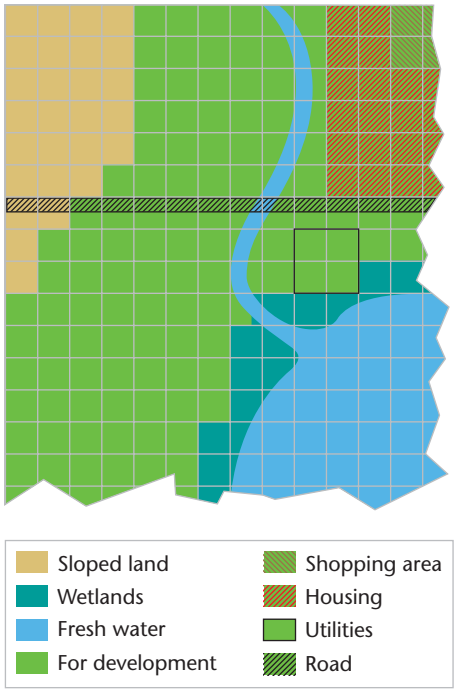
## Conclusions

4. **Evaluating Results** Does the plan your group created meet the needs of all of the group members? Does it allow for development while preserving the environment?

5. **Evaluating Models** How do you think this land planning "simulation" compares to the real-life process of land-use planning?

## Extension

1. **Research and Communications** Look in the newspaper or on the Internet for a story about a land-use controversy in your area. Identify the different members involved. Role-play with your team to see what forces will bear on this controversy.




▶ **Example Map** This is an example of what your land-use model might look like.

# Making a difference

## RESTORING THE RANGE

When Ohioan J. David Bamberger first moved to San Antonio, Texas as a vacuum cleaner sales representative, he was charmed by the dry, grass-covered rangeland of the Texas Hill Country. But much of the land was degraded. It had been overgrazed by cattle and was left with thin soil and dried-up creeks.

Bamberger became intrigued by the idea of restoring some of the range to its original beauty. He was inspired by a book his mother gave him called *Pleasant Valley,* by Louis Bromfield. Long before it was popular, Bromfield had theories about how degraded habitats could be restored and how they could then be managed in a sustainable manner. Bamberger was intrigued by the idea of putting Bromfield's theories into action.

### The Bamberger Ranch

In 1959, David Bamberger bought his first plot of land near Johnson City. Since then, David and Margaret Bamberger have expanded the ranch to nearly 2,300 hectares (5,500 acres). It is one of the largest habitat restoration projects in Texas, and shows the beauty of this area before it was damaged by human activities.

In its natural state, the ranch should have been grassland, with woody shrubs only near creeks. Instead, it had become overgrown with juniper shrubs and trees (often called cedar, *Juniperus ashei*), which can grow in poor soil and choke out other plants.

Bamberger read everything he could find on the degradation and restoration of rangeland. He found that two main things destroy the range: overgrazing and the suppression of wildfires. Overgrazing causes soil erosion. The lack of fires permits the growth of shrubs that shade out grasses and wildflowers.

The Bambergers set to work to restore the property. They cleared most of the junipers, which left more water in the soil. They planted native trees, wildflowers, and grasses, and they controlled the grazing.

Grazing is necessary for healthy grassland. The American prairies were home to huge herds of bison (buffalo), which cropped the grass and fertilized the soil with their droppings. The Bambergers combined the grazing they needed with the preservation of an endangered species. San Antonio Zoo asked the Bambergers if they could help preserve the endangered scimitar-horned oryx, an antelope with thin, curved horns that is native to North Africa. Only a few small herds of this species remained, and the zoo feared that the oryx were becoming inbred, with too little genetic diversity. The Bambergers agreed, and the ranch is now home to a large herd of oryx.

▶ David Bamberger, founder of the Bamberger Ranch Preserve.

### The Effects of Restoration

The change in the ranch since Bamberger first bought it is most obvious at the fence line bordering the ranch. Beyond the fence there is a small forest of junipers and little other vegetation. On Bamberger's side, the main plants are grasses and wildflowers, with shrubs and trees in canyons and gullies beside the creeks. When the Bambergers first arrived, they counted only 48 species of birds on the ranch. Now, there are more than 150 species because there are many more different plants on the ranch. In the early days, deer on the ranch weighed only about 20 kg. Now they weigh about 40 kg, thanks to the improved grazing.

In addition to deer and oryx, cattle and goats live on the ranch. Some of these are used for experiments on the effects of domestic animals on rangeland. Students and faculty from nearby universities are studying this question by using exclosures. These are fences that keep large animals out of an area. The vegetation inside an exclosure is invariably taller than that outside because grazing animals are excluded. But in addition, the plant mix inside the exclosure is different from that outside. This is because grazing mammals eat only a few nutritious species and leave the others.

## The Distribution of Water

One important change in the ranch under the Bambergers' management has been the change in water distribution. Water is very important in rangeland, which naturally gets little rainfall. Many of the creeks dry up between rainy periods, but water remains in the soil and underground. Grasses have spreading root systems that absorb water from a wide area. Poor management changes this balance by allowing junipers to take over the land. A juniper can take up 10 L of water a day from the soil, leaving too little for nearby grasses and wildflowers to survive. Then, when it rains heavily, the junipers cannot absorb all the water and it runs off the land. With no grass roots to hold the soil in place, the soil erodes into the creeks.

When the Bambergers arrived at the ranch, it was degraded rangeland. They drilled wells 150 m deep (500 ft) and did not reach the water table. Now, with the restoration of grassland, soil erosion has been reduced and much more water remains in the soil. Creeks and lakes contain water for most of the year, and a dry spell is not a disaster. The water in the creeks and lakes is clear and full of fish, instead of muddy because it is full of soil.

## Sustainability

The Bamberger Ranch is a working ranch, raising and selling livestock, but it is also home to dozens of other projects. Bamberger consultants advise others who are interested in managing rangeland in a sustainable fashion. Volunteers help by building and repairing nature trails and performing all kinds of maintenance work. The ranch hosts research on grasslands and range management, conferences on habitat restoration, educational workshops, as well as vacations for those interested in all aspects of nature.

▶ At nearly 2,300 hectares, the Bamberger Ranch is one of the largest habitat restoration projects in Texas. This is a photo of a portion of the Bamberger Ranch used for sustainable ranching.

### What Do You Think?

Habitat restoration shows us what the land was like before the settlers arrived. It also shows us how much the land has changed under human management. Can you think of any habitat in your area that could be restored? How would you go about trying to restore it? What do you think it would look like after restoration?