CHAPTER 10
Land, Public and Private

[Notes/Highlighting]

Who Owns a Tree? Julia Butterfly Hill versus Maxxam
For most of its history, northern California's Pacific Lumber Company was a leader in environmental stewardship. It pioneered the practice of selectively cutting some trees on its land while leaving nearby trees intact. Unlike the usual practice of clear-cutting—clearing all the trees from an area of land—selective cutting allows the roots of the remaining trees to retain water and hold soil in place. In addition, the surviving trees allow forest regrowth that more closely mimics natural succession after a disturbance. Pacific Lumber developed a 100-year sustainable logging plan that ensured relatively healthy forests as well as job security for the loggers and their families.

Julia Butterfly Hill proved indomitable. In her most famous tree sit, she occupied Luna, a 55-meter (180-foot) redwood tree that was nearly a thousand years old.

In 1986, however, Pacific Lumber was purchased by new owners and renamed Maxxam. To increase revenue from the company’s land holdings, the new management clear-cut hundreds of thousands of acres of redwood forests. Because the new harvesting method removed vegetation and tree roots, Maxxam’s practices left the forests susceptible to soil erosion and landslides. On December 31, 1996, an immense landslide began on a steeply sloped Maxxam site above the town of Stafford, California. The landslide destroyed a number of homes and drastically altered the natural environment.

The adjacent uncut land, owned by Maxxam, was home to the largest remaining intact forest of ancient redwood trees and to a number of endangered species. Environmental activist Julia Butterfly Hill was appalled by Maxxam’s forest management practices. In response, she joined a “tree sit” on Maxxam’s land organized by the direct action group Earth First!

The ultimate goal of a tree sit is to remain in a tree long enough to save it from logging. However, many such actions merely delay the inevitable. Still, activists support tree sits because they gain time for further legal proceedings and increase media awareness. But Julia Butterfly Hill proved indomitable. In her most famous tree sit, she occupied Luna, a 55-meter (180-foot) redwood tree that was nearly a thousand years old, and resolved to remain there until Maxxam agreed to spare the tree. She spent 2 years in the tree without coming down once. She stayed through gale-force winds, two winters, intimidation tactics, the death of another activist, and the cutting of most of the trees in the stand that she occupied. Julia’s efforts were rewarded when Maxxam
agreed to protect Luna, and a 61-meter (200-foot) buffer around it, in perpetuity. In a separate, complex deal that included many stipulations about logging practices, Maxxam and another company also agreed to sell the U.S. government 3,035 hectares (7,500 acres) of ancient forest for $480 million. That property has now become the Headwaters Forest Reserve.

Julia Butterfly Hill sitting in Luna.

Hill’s actions cost Maxxam millions of dollars in delays and lost revenue and brought unsustainable logging practices to the attention of many people. Because of its large debt load, Maxxam filed for bankruptcy protection in January 2007, and its depleted assets were reorganized and transferred to a new company in 2008. Although Maxxam’s logging practices appeared to have placed profit before sustainability, the new company has stated that it will return to more sustainable practices with the trees that remain on its holdings.

The conflict over logging practices raises many questions. Do citizens of the United States have the right to influence what activities occur on private lands? What if the land is public? Was Julia Butterfly Hill a hero or a villain? Some see her as having made a personal sacrifice to save an ancient tree and to bring the issue of unsustainable
logging practices to the public’s attention. Others see her as a lawbreaker who trespassed on private property in an effort to prevent a legal activity.


**Key Ideas**

The issues involved in land use are not simple, and there are no easy solutions to many of the conflicts that arise. In this chapter we will begin to explore how our use of land affects the environment and what we can do to minimize its negative impacts. We will look at land use and management in both the public and private sectors, and we will explore the topic of sustainable land use practices. We will also look at how land use has changed with shifting and growing populations.

After reading this chapter you should be able to

- describe the concepts of the tragedy of the commons and maximum sustainable yield, and explain how they pertain to land use.
- describe the function, operation, and efficacy of the four major public land management agencies in the United States.
- understand the causes and consequences of urban sprawl.
- describe approaches and policies that promote sustainable land use.

### 10.1 Human land use affects the environment in many ways

Agriculture, housing, recreation, industry, mining, and waste disposal are all uses of land that have benefits to humans. But, as we have seen in previous chapters, some of these activities also have negative consequences. Extensive logging may lead to mudslides. Deforestation of large areas contributes to climate change and many other environmental problems. Changes to the landscape are the single largest cause of species extinctions today. Paving over land surfaces reroutes water runoff. The paved surfaces also absorb heat from the sun and reradiate it, creating urban “heat islands.” Overuse of farmland can lead to soil degradation and water pollution *(FIGURE 10.1).*
Humans value land for what it can provide: food, shelter, and natural resources. In addition, many people recognize that land has intrinsic value apart from its instrumental, or monetary, value. Every human use of land alters it in some way. Furthermore, individual activities on any parcel of land can have wide-ranging effects on other lands. For this reason, communities around the world use laws, regulations, and other methods to influence or regulate private and public land use.

As we saw in this chapter’s opening story, people do not always agree on land use and management priorities. Do we save a beautiful, ancient stand of trees, or do we harvest the trees in order to gain benefits in the form of jobs, profit, structures made of wood, and economic development? Such conflicts can arise from both public and private land uses.
Let’s begin with three concepts that are essential for understanding land use: the tragedy of the commons, externalities, and maximum sustainable yield.

**10.1.1 The Tragedy of the Commons**

In certain societies, land was viewed as a common resource: anyone could use land for foraging, growing crops, felling trees, hunting, or mining. As populations increased, such common lands tended to become degraded—overgrazed, overharvested, and deforested. In 1968, ecologist Garrett Hardin brought the issue of overuse of common resources to the attention of the broader scientific community when he described the tragedy of the commons: the tendency of a shared, limited resource to become depleted because people act from self-interest for short-term gain. Hardin observed that when many individuals share a common resource without agreement on or regulation of its use, it is likely to become overused very quickly.

For example, imagine a communal pasture on which many farmers graze their sheep. At first, no single farmer appears to have too many sheep. But because an individual farmer gains from raising as many sheep as possible, each farmer may be tempted to continue adding sheep to the pasture. However, if the total number of sheep owned by all the farmers continues to grow, it will soon exceed the carrying capacity of the land. The sheep will overgraze the common pasture to the point at which plants will not have a chance to recover. The common land will be degraded, and the sheep will no longer have an adequate source of nourishment, as Figure 10.2 shows. Over a longer period, the entire community will suffer. When the farmers make decisions that benefit only their own short-term gain and do not consider the common good, everybody loses.
The tragedy of the commons. If the use of common land is not regulated in some way—by the users or by a government agency—that land can easily be degraded to the point at which it can no longer support that use.

The tragedy of the commons applies not only to agriculture, but to any publicly available resource that is not regulated, including land, air, and water. For example, the use of many global fisheries as commons has led to the overexploitation and rapid decline of many commercially harvested fish species, and has upset the balance of entire marine ecosystems.

10.1. Externalities

The tragedy of the commons is the result of an economic phenomenon called a negative externality. More generally, an externality is a cost or benefit of a good or service that is not included in the purchase price of that good or service. For example, if a bakery moves into the building next to you and you wake up every morning to the delicious smell of freshly baked bread, you are benefiting from a positive externality. On the other hand, if the bakers arrive at three in the morning and make so much noise that they interrupt your sleep, and you are not as productive at your job the next day, you are suffering from a negative externality.

In environmental science, we are especially concerned with negative externalities because they so often lead to serious environmental damage for which no one is held legally or financially responsible. For example, if one farmer grazes too many sheep in a common pasture, his action will ultimately result in more total harm than total...
benefit. But, as long as the land continues to support grazing, the individual farmer will not have to pay for the harm he is causing—ultimately, this cost is externalized to the other farmers. If the farmer responsible for the extra sheep had to bear the cost of his overuse of the land, he would not graze the extra sheep on the commons; the cost of doing so would exceed the benefit. From this example, we can see that in order to calculate the true cost of using a resource, we must always include the externalized cost. In other words, we must account for any potential harm that comes from the use of that resource.

Some economists maintain that private ownership can prevent the tragedy of the commons. After all, a landowner is much less likely to overgraze his own land than common land. Regulation is another approach. For example, a local government could prevent overuse of a common pasture by passing an ordinance that permits only a certain number of sheep to graze there.

Challenging the idea that government regulation is necessary, Professor Elinor Ostrom of Indiana University showed that many commonly held resources can be managed effectively at the community level or by user institutions. Ostrom’s work, for which she was awarded the 2009 Nobel Prize in Economics, has shown that self-regulation by resource users can prevent the tragedy of the commons.

10.1. Maximum Sustainable Yield

When we want to obtain the maximum amount of a resource, we need to know how much of a given plant or animal population can be harvested without harming the resource as a whole.

Imagine a situation in which deer hunting in a public forest is unregulated. Each hunter is free to harvest as many deer as possible. As a result of unlimited hunting, the deer population could be depleted to the point of endangerment. This, in turn, would disrupt the functioning of the forest ecosystem. On the other hand, if hunting were prohibited entirely, the deer herd might grow so large that there would not be enough food in the forests and fields to support it. In extreme cases, such as that of the reindeer of St. Paul Island (summarized graphically in FIGURE 6.8), the population could grow unchecked until it crashed due to starvation.

Some intermediate amount of hunting will leave enough adult deer to reproduce at a rate that will maintain the population, but not so many that there is too much competition for food. This intermediate harvest is called the maximum sustainable yield. Specifically, the maximum sustainable yield (MSY) of a renewable resource is the maximum amount that can be harvested without compromising the future
availability of that resource. In other words, it is the maximum harvest that will be adequately replaced by population growth.

**Figure 10.3** Maximum sustainable yield. Every population has a point at which a maximum number of individuals can be harvested sustainably. That point is often reached when the population size is about one-half the carrying capacity.

MSY varies case by case, but a reasonable starting point is to assume that population growth is the fastest at about one-half the carrying capacity of the environment, as shown on the S-shaped curve in **FIGURE 10.3**. (You may wish to review the logistic growth model described in Chapter 6.) Looking at the graph, we can see that at a small population size, the growth curve is shallow and growth is relatively slow. As the population increases in size, the slope of the curve is steeper, indicating a faster growth rate. As the population size approaches the carrying capacity, the growth rate slows. The MSY is the amount of harvest that keeps the resource population at about one-half the carrying capacity of the environment.

Forest trees, like animal populations, have a maximum sustainable yield. Loggers may remove a particular fraction of the trees at a site in order to allow a certain amount of light to penetrate to the forest floor and reach younger trees. If they cut too many trees, an excess of sunlight will penetrate and dry the forest soil. This drying may create conditions inhospitable to tree germination and growth, thus inhibiting adequate regeneration of the forest.

In theory, harvesting the maximum sustainable yield will permit an indefinite use without depletion of the resource. In reality, it is very difficult to calculate MSY with certainty because in a natural ecosystem, it is difficult to obtain necessary information such as birth rates, death rates, and the carrying capacity of the system. Once an MSY calculation is made, we still cannot know if a yield is truly sustainable until months or years later, when we can evaluate the effect of the harvest on reproduction. By that
time, if the harvest rate has been too great, it is too late to prevent harm to the population.

**CHECKPOINT**
- Why do humans value land?
- What is the tragedy of the commons? What is an externality?
- What is maximum sustainable yield?

10.2 Public lands are classified according to their use

All countries have public lands, which they manage for a variety of purposes, including environmental protection. The 2003 United Nations List of Protected Areas—the most recent global study of protected areas—includes almost 1.7 billion hectares (4.2 billion acres) of land in a variety of categories. Given that Earth’s total land area is about 15 billion hectares (37 billion acres), this means that approximately 11 percent, or one-ninth, of Earth’s land area is protected in one way or another. These areas, as well as protected marine areas, are shown on the map in **FIGURE 10.4**. Let’s look at both international and national categories of land protection.
10.2. International Categories of Public Lands

The 2003 United Nations List of Protected Areas classifies protected public lands into six categories according to how they are used:

- **National Parks.** There are roughly 3,400 national parks in the world, covering more than 400 million hectares (1 billion acres). This means that national parks make up about 2.7 percent of Earth’s land area. National parks are managed for scientific, educational, and recreational use, and sometimes for their beauty or unique landforms. In most cases, they are not used for the extraction of resources such as timber or ore. Some of the most famous national parks in the world are found in Africa. These parks include Amboseli National Park in Kenya and Kruger National Park in South Africa. Parks like these generally exist to protect animal species such as elephants, rhinoceroses, and lions, as well as areas of great natural beauty. They also generate tourism, which can be a large source of income. On the
negative side, in order to create and maintain national parks, governments have sometimes evicted and excluded indigenous human populations from the land. For example, in the winter of 2009, a new round of evictions from the Mau Forest in the Rift Valley of Kenya led to the displacement of 20,000 families. Such programs continue to generate controversy in Kenya and other countries.

- **Managed Resource Protected Areas.** This classification allows for the sustained use of biological, mineral, and recreational resources. In most countries, these areas are managed for multiple uses. There are approximately 4,100 such sites in the world, encompassing more than 440 million hectares (1.1 billion acres). In the United States, national forests are one example of this kind of area.

- **Habitat/Species Management Areas.** These areas are actively managed to maintain biological communities, for example with fire prevention or predator control. There are approximately 27,600 of these sites, covering more than 300 million hectares (740 million acres). Karelia, a part of Russia bordering Finland, has one of the highest proportions of protected areas in Europe: 5 percent of its total area. Of this total, more than one-half consists of habitat or species management areas that are actively managed for hunting and conservation.

- **Strict Nature Reserves and Wilderness Areas.** These areas are established to protect species and ecosystems. There are approximately 6,000 such sites worldwide, covering more than 200 million hectares (490 million acres). The Chang Tang Reserve, on the Tibetan Plateau in China, was set aside to protect a number of species—including the declining population of wild yak—from hunting, habitat destruction, and hybridization with domesticated animals.

- **Protected Landscapes and Seascapes.** These areas combine the nondestructive use of natural resources with opportunities for tourism and recreation. Orchards, villages, beaches, and other such areas make up the 6,500 such sites worldwide, which cover more than 100 million hectares (250 million acres). Among these protected areas is the Batanes Protected Landscape and Seascape in the northernmost islands of the Philippines, home to several endemic plant and animal species as well as important marine habitats.

- **National Monuments.** These areas are set aside to protect unique sites of special natural or cultural interest. There are almost 20,000 national monuments and landmarks in the world, covering nearly 28 million hectares (69 million acres). Most of these are established to protect historical landmarks, such as the Arc de Triomphe in Paris, France.
In the United States, publicly held land may be owned by federal, state, or local governments. Of the nation’s land area, 42 percent is publicly held—a larger percentage than in any other nation. The federal government is by far the largest single landowner in the United States: it owns 240 million hectares (600 million acres), or roughly 25 percent of the country (FIGURE 10.5). Most of this land—55 percent—is in the 11 western continental states, and an additional 37 percent is in Alaska. Less than 10 percent of federal land is located in the Midwest and on the East Coast.

**Figure 10.5** Federal lands in the United States. Approximately 42 percent of the land in the United States is publicly owned, and 25 percent of the nation’s land is owned by the federal government. [After http://nationalatlas.gov.]

**PUBLIC LAND CLASSIFICATIONS** Public lands in the United States include rangelands, national forests, national parks, national wildlife refuges, and wilderness areas. Since the founding of the nation, many different individuals and groups have expressed interest in using these public lands. However, most environmental
policies, laws, and management plans have been based, at least partially, on the resource conservation ethic, which calls for policy makers to consider the instrumental value of nature (recall our discussion of ecosystem services and instrumental value in Chapter 3). The resource conservation ethic states that people should maximize resource use based on the greatest good for everyone. In conservation and land use terms, it has meant that areas are preserved and managed for economic, scientific, recreational, and aesthetic purposes.

Of course, many of these purposes conflict. In order to manage competing interests, the U.S. government has, for decades, adopted the principle of multiple use in managing its public resources. Some public lands are in fact classified as multiple-use lands, and may be used for recreation, grazing, timber harvesting, and mineral extraction. Others are designated as protected lands in order to maintain a watershed, preserve wildlife and fish populations, or maintain sites of scenic, scientific, and historical value.

![Figure 10.6 Land use in the United States](image)

**Figure 10.6 Land use in the United States.** Public and private land in the United States is used for many purposes. [After R. N. Lubowski et al., Major land uses in the United States, Economic Research Service, USDA, 2002.]

**LAND USE AND FEDERAL AGENCIES** As shown in **FIGURE 10.6**, land in the United States, both public and private, is used for many purposes. These uses can be divided into a number of categories. The probable use of public land determines how it is classified and which federal agency will manage it. More than 95 percent of all federal lands are managed by four federal agencies (see **FIGURE 10.5**): the Bureau of Land Management (BLM), the United States Forest Service (USFS), the National Park Service (NPS), and the Fish and Wildlife Service (FWS). BLM, USFS, and NPS lands are typically classified as multiple-use lands because most, and sometimes all, public uses are allowed on them.
Although individual tracts may differ, the following are typical divisions of public land uses:

- BLM lands: grazing, mining, timber harvesting, and recreation
- USFS lands: timber harvesting, grazing, and recreation
- NPS lands: recreation and conservation
- FWS lands: wildlife conservation, hunting, and recreation

**CHECKPOINT**
- What are the main uses of public lands in the United States?
- How do human land use decisions influence categories of public land classification?

10.3 Land management practices vary according to land use

Now that we have a basic picture of how public land is classified and of the relationship between public land use and management agencies in the United States, let’s turn to some of the specific issues involved in managing different types of public lands. Note that many of the management issues we discuss here apply to private lands as well.

**10.3. Rangelands**

Rangelands are dry, open grasslands. They are used primarily for cattle grazing, which is the most common use of land in the United States. Rangelands are semi-arid ecosystems and are therefore particularly susceptible to fires and other environmental disturbances. If humans overuse rangelands, they can easily lose biodiversity.
Like most human activities, livestock grazing has mixed environmental effects. One environmental benefit of grazing is that ungulates—hoofed animals such as cattle and sheep—can be raised on lands that are too dry to farm. In addition, grazing these animals uses less fossil fuel energy than raising them in feedlots. However, improperly managed live-stock can damage stream banks and pollute surface waters. Grazing too many animals can quickly denude a region of vegetation (FIGURE 10.7). Loss of vegetation leaves the land exposed to wind erosion and makes it difficult for soils to absorb and retain water when it rains.

Many environmental scientists argue that rangeland ecosystems are too fragile for multiple uses. Certain environmental organizations have suggested that as much as 55 percent of U.S. rangeland soils are in poor or very poor condition, due in large part to overgrazing. However, the BLM, which manages most public rangelands in the United States, has maintained that the percentage is not nearly that high. Reconciling this difference is a challenge because of the many factors that influence how soil condition is determined.

The Taylor Grazing Act of 1934 was passed to halt overgrazing. It converted federal rangelands from a commons to a permit-based grazing system. The goal of a permit-based system is to limit the number of animals grazing in a particular area and thereby avoid a tragedy of the commons situation. However, critics maintain that the low cost of the permits continues to encourage overgrazing. In 2006, the federal government spent seven times more money managing its rangelands than it received in permit fees. Thus, in effect, grazing is subsidized with federal funds.

The BLM focuses on mitigating the damage caused by grazing. The agency considers “rangeland health” when it sets guidelines for grazing. For example, state and regional rangeland managers are required to ensure healthy watersheds, maintain ecological processes such as nutrient cycles and energy flow, preserve water quality, maintain or restore habitats, and protect endangered species. However, these managers are not given detailed guidance, and the BLM regulations do not require the involvement of environmental scientists. This omission gives the managers wide latitude to set their own guidelines and standards. As a result, BLM regulations are not consistently successful in preserving vulnerable rangeland ecosystems.

10.3. Forests

Forests are dominated by trees and other woody vegetation. Approximately 73 percent of the forests used for commercial timber operations in the United States are privately
owned. Commercial logging companies are allowed to use U.S. national forests, usually in exchange for a *royalty*—a percentage of their revenues. Many national forests were originally established to ensure a steady and reliable source of timber. As with grazing, the federal government typically spends more money managing the timber program and building and maintaining logging roads than it receives from these royalties.
Figure 10.8  Timber harvest practices. (a) Clear-cutting removes most, if not all, trees from an area and is often coupled with replanting. The resulting trees are all the same age. (b) In selective cutting, single trees or small numbers of trees are harvested. The resulting forest consists of trees of varying ages.
TIMBER HARVEST PRACTICES The two most common ways in which trees are harvested for timber production, both of which are illustrated in FIGURE 10.8, are clear-cutting and selective cutting. Clear-cutting involves removing all, or almost all, the trees within an area (FIGURE 10.8a). It is the easiest harvesting method and, in most cases, the most economical. When a stand, or cluster, of trees has been clear-cut, foresters often replant or reseed the area. Often the entire area will be replanted at the same time, so all the resulting trees will be the same age. Because they are exposed to full sunlight, clear-cut tracts of land are ideal for fast-growing tree species that achieve their maximum growth rates with large amounts of direct sunlight. Other species may not be so successful, which can lead to a reduction in overall biodiversity. However, if a commercially valuable tree species constitutes only a small fraction of a stand of trees, it may not be economically efficient to clear-cut the entire stand. This is particularly true in many tropical forests, where valuable species constitute only a small percentage of the trees and are mixed in with many other species.

Clear-cutting, especially on slopes, increases wind and water erosion, which causes the loss of soil and nutrients (FIGURE 10.9). Erosion also adds silt and sediment to nearby streams, harming aquatic populations. In addition, the denuded slopes are prone to dangerous mudslides like the Stafford, California, mudslide described in this chapter’s opening story. Clear-cutting also increases the amount of sunlight that reaches rivers and streams. The increased sunlight raises water temperatures, which can adversely affect certain aquatic species. Even the replanting process can have negative environmental consequences. Timber companies often use fire or herbicides to remove bushy vegetation before a clear-cut is replanted. These practices reduce soil quality, and herbicides may contaminate water that runs off into streams and rivers. Many environmental scientists identify clear-cutting as a cause of habitat alteration and destruction and forest fragmentation. These effects, in turn, lead to decreased biodiversity and sometimes to a lower aesthetic value for the affected forest.
A clear-cut on a steep slope increases the likelihood of erosion and delayed regeneration of vegetation.

Selective cutting (FIGURE 10.8b) removes single trees or relatively small numbers of trees from among many in a forest. This method creates many small openings in a stand where trees can reseed or young trees can be planted, so the regenerated stand contains trees of different ages. Because seedlings and young trees must grow next to larger, older trees, selective cutting produces optimum growth only among shade-tolerant tree species.

The environmental impact of selective cutting is less extensive than that of clear-cutting. However, many of the negative environmental impacts associated with logging remain the same. For example, whether a company uses clear-cutting or selective cutting, it will need to construct logging roads to carry equipment and workers into the area to be harvested. These roads fragment the forest habitat, leading to species diversity changes, and compact the soil, leading to nutrient loss and reductions in water infiltration.
A third approach to logging removes trees from the forest in ways that do not unduly affect the viability of other, noncommercial tree species. Known as ecologically sustainable forestry, this approach has a goal of maintaining all species—both plants and animals—in as close to a natural state as possible (FIGURE 10.10). Some loggers have even returned to using animals such as horses to pull logs in order to reduce soil compaction, although the costs of such methods make it difficult to compete economically with mechanized logging practices.

LOGGING, DEFORESTATION, AND REFORESTATION

Approximately 30 percent of all commercial timber in the world is produced in the United States and Canada. Compared with South America and Africa, forest losses in these two major timber-producing countries have been relatively small over the last several decades. Still, timber production presents important ecological challenges in these countries.

Throughout this chapter we have seen examples of the conflicts over land use created by competing interests and values. Perhaps nowhere is this conflict so clear as in the case of logging. For example, timber production has always been a part of the mission of the USFS. Yet maintaining biodiversity is an equally important goal. It would seem that we can’t have both.

All logging disrupts habitat and usually has an effect, either negative or positive, on plant and animal species. One such species is the marbled murrelet (Brachyramphus marmoratus). This bird spends most of its life along the coastal waters of the Pacific Northwest, but it nests in coastal redwood forests. With the intensive logging of these forests, the marbled murrelet has become endangered. The tree sit described in this chapter’s opening story brought this species, among others, to the public’s attention.
Logging often replaces complex forest ecosystems with tree plantations: large areas typically planted with a single rapidly growing tree species. These same-aged stands can be easily clear-cut for commercial purposes, such as pulp and wood, and then replanted. Because of this cycle of planting and harvesting, tree plantations never develop into mature, ecologically diverse forests. If too many planting and harvesting cycles occur, the soil may become depleted of important nutrients such as calcium. Since 1982, federal regulations have required the USFS to provide appropriate habitat for plant and animal communities while also meeting multiple-use goals. However, these regulations fail to specify how biodiversity protection should be achieved or how the results should be quantified, leaving the USFS to choose its own approach to biodiversity management. Critics charge that the USFS is not adequately protecting biodiversity and forest ecosystems. The USFS maintains that it is doing the best it can at meeting many different objectives.

**FIRE MANAGEMENT** In many ecosystems, fire is a natural process that is important for nutrient cycling and regeneration. As discussed briefly in Chapter 3, when fires periodically move through an ecosystem, they liberate nutrients tied up in dead biomass. In addition, areas where vegetation is killed by the fire provide openings for early-successional species.

Humans have followed a variety of management policies with respect to fire. For many years, managers of forest ecosystems, including the USFS, did everything they could to suppress fires. This strategy led to the accumulation of large quantities of dead biomass on the forest floor. Eventually, this fuel built up until a large fire became inevitable. One method for reducing the accumulation of dead biomass is a prescribed burn, in which a fire is deliberately set under controlled conditions. Prescribed burns help reduce the risk of uncontrolled natural fires and provide some of the other benefits of fire as well. More recently, forest managers have allowed certain natural fires to burn. This policy appears to have been accepted in many parts of the United States, as long as human life and property are not threatened.

Probably the best-known forest fires in the United States are those that occurred in Yellowstone National Park in the summer of 1988, the driest year on record at the park. A combination of human activity and lightning set off multiple fires (FIGURE 10.11). Over 25,000 people participated in fighting the fires. While this effort saved human lives and property, the firefighters had little impact on the fires. When the fires were over, more than one-third of Yellowstone National Park had burned. Initially, many people were outraged that the NPS and others had “allowed” the park to burn. However, within a few years, it became clear that the fires had created new, nutrient-rich habitat for early-successional plant species, which attracted elk and other herbivores. Ultimately, researchers and forest managers concluded that the
Yellowstone fires of 1988 provided many benefits to the Yellowstone ecosystem. Today, a typical visitor viewing a portion of the park that burned in 1988 probably wouldn’t even know that there had been a major fire so recently.

![Figure 10.11 Yellowstone fires of 1988. As can be seen from the map, extensive areas of the park were burned in this exceptionally hot and dry year.]

As we have already noted, many national parks were established to preserve scenic views and unusual landforms. Today, national parks are managed for scientific, educational, aesthetic, and recreational use. Since Yellowstone National Park was founded in 1872, 58 national parks have been established in the United States. The NPS manages a total of 391 national parks and other areas, such as historical parks and national monuments, and the list continues to grow.

**THE GOALS OF NATIONAL PARK MANAGEMENT** Management of national parks, like that of national forests, is based on the multiple-use principle. Unlike the national forests, the U.S. national parks were set aside specifically to protect ecosystems. In establishing Yellowstone National Park, Congress mandated the Interior Department to regulate the park in a manner consistent with the preservation of timber resources, mineral resources, and “natural curiosities.” However, it did not require a management process based on ecological principles.
It was not until the 1960s that ecology became a focus of national park management. In 1963, an advisory board on wild-life management presented the Leopold Report to Secretary of the Interior Stewart Udall. This report established the guiding principles of national park management today. It proposed that the primary purpose of NPS should be to maintain the parks in the same biotic condition in which they were first found by European settlers. To this end, the authors believed that NPS should focus its efforts on conservation and on protection of wildlife species and their habitats. The report claimed that human activity had severely affected normal ecological processes in the parks and that active intervention was required to achieve the goal of a return to a more “natural” state.

Today, NPS applies environmental science to maintain biodiversity and ecosystem function in all national parks. As we saw in the example of the Yellowstone fires, its policies continue to be controversial. Each national park adapts U.S. policy to its specific needs. In parks with high levels of endemic biodiversity, for example, management focuses on conserving endemic species. For instance, the Channel Islands National Park off the coast of southern California is an important breeding ground for many seabirds, including a pelican species that is rare elsewhere in the western United States. Because of this special feature, the park is managed primarily to conserve its biodiversity. Other national parks balance biodiversity protection with recreational use.

![Figure 10.12 ATV-caused damage near Olympic National Park in Washington State. Although today many national parks limit ATV use, the conflict between those who want to use the parks for this form of recreation and those who wish to protect biodiversity remains.](image)

**NATIONAL PARKS AND HUMAN ACTIVITIES** Reducing the impact of human activities both outside and inside the park borders is the primary challenge of most national parks throughout the world. Air and water pollution from distant sources can reduce biodiversity as well as recreational value and economic opportunities. Ongoing development adjacent to park boundaries can be particularly problematic. In many
locations, national parks have become islands of biodiversity amid increasing human development, but even their protected status cannot defend them completely from invasive species and other problems, such as pollution. These external threats require large-scale evaluation, planning, and management that extend beyond park borders. National parks are also victims of their popularity. Although the park system was established in part to make areas of great beauty accessible to people, human overuse can harm the very environment that people visit to enjoy. For example, all-terrain vehicles (ATVs) are a major cause of air and noise pollution in national parks, as well as a direct cause of habitat destruction (FIGURE 10.12). Today, many parks strictly limit or even ban the use of ATVs. Still, park managers grapple with how to determine appropriate limits on human activity. In many cases, the trade-off between short-term recreational uses and long-term protection of biodiversity does not permit an easy answer.

10.3. Wildlife Refuges and Wilderness Areas

National wildlife refuges are the only federal public lands managed for the primary purpose of protecting wildlife. The Fish and Wildlife Service manages more than 450 national wildlife refuges and 28 waterfowl production areas on 34.4 million hectares (85 million acres) of publicly owned land. National wilderness areas are set aside with the intent of preserving large tracts of intact ecosystems or landscapes. Sometimes only a portion of an ecosystem is included. Wilderness areas are created from other public lands, usually national forests or rangelands, and are managed by the same federal agency that managed them prior to their designation as wilderness. National wilderness areas allow only limited human use and are designated as roadless. Although logging, road building, and mining are banned in national wilderness areas, roads that existed before the designation sometimes remain in use, and activities, such as mining, that were previously permitted on the land are allowed to continue. More than 38.5 million hectares (95 million acres) of federal land, 60 percent of which is in Alaska, are classified as wilderness.

10.3. Federal Regulation of Land Use

Government regulation can influence the use of private as well as public lands. The 1969 National Environmental Policy Act (NEPA) mandates an environmental assessment of all projects involving federal money or federal permits. Along with other major laws of the 1960s and 1970s, such as the Clean Air Act, the Clean Water Act, and
the *Endangered Species Act*, NEPA creates an environmental regulatory process designed to ensure protection of the nation’s resources. Before a project can begin, NEPA rules require the project’s developers to file an **environmental impact statement (EIS)**. An EIS typically outlines the scope and purpose of the project, describes the environmental context, suggests alternative approaches to the project, and analyzes the environmental impact of each alternative. NEPA does not require that developers proceed in the way that will have the least environmental impact. However, in some situations, NEPA rules may stipulate that building permits or government funds be withheld until the developer submits an **environmental mitigation plan** stating how it will address the project’s environmental impact. In addition, preparation of the EIS sometimes uncovers the presence of endangered species in the area under consideration. When this occurs, the protection measures of the *Endangered Species Act*, a 1973 law designed to protect species from extinction, are applied.

Members of the public are entitled to give input into the environmental assessment, and decision makers are required to respond. And, although developers are not obligated to act in accordance with public wishes, in practice, public concern often improves the project’s outcome. For this reason, attending information sessions and providing input is a good way for concerned citizens to learn more about local land use decisions and to help reduce the environmental impact of land development.

**CHECKPOINT**

- What are the ways in which timber is harvested in U.S. forests, and how do they compare in terms of their environmental impact?
- What is the significance of the National Wilderness Area designation for parts of federally owned lands?
- What is NEPA, and what is an environmental impact statement (EIS)?
- 10.4 Residential land use is expanding
While many public lands are located in relatively rural areas, there is a very different kind of land use pressure in locations close to cities. In the last 50 years, the greatest percentage of population growth in the United States has occurred in two classes of communities: suburban and exurban. Suburban areas surround metropolitan centers and have low population densities compared with those urban areas. Exurban areas are similar to suburban areas, but are unconnected to any central city or densely populated area. Since 1950, more than 90 percent of the population growth in metropolitan areas has occurred in suburbs, and two out of three people now live in suburban or exurban communities.

**FIGURE 10.13** shows U.S. population trends since 1950. The population of cities has grown somewhat in absolute terms, but has declined as a percentage of the U.S. population. The rural population has been declining since 1900, and a century later it made up less than a fifth of the total U.S. population. These population shifts have brought with them a new set of environmental problems, including urban sprawl and urban blight. Attempts to find creative solutions to these problems have been increasingly successful.

### 10.4. Urban Sprawl

If you have ever been to a strip mall, you are familiar with the phenomenon known as urban sprawl, which occurs when populations shift away from rural and urban areas and
into suburban and exurban areas. **Urban sprawl** is the creation of urbanized areas that spread into rural areas and remove clear boundaries between the two. The landscape in these areas is characterized by clusters of housing, retail shops, and office parks, which are separated by miles of road. Large feeder roads and parking lots that separate “big box” retail stores from the road discourage pedestrian traffic.

Urban sprawl has had a dramatic environmental impact. Dependence on the automobile has led to suburban residents driving more than twice as much as people who live in cities. Between 1950 and 2000, the number of vehicle miles traveled per person in U.S. suburban areas tripled. Because suburban house lots tend to be significantly larger than urban parcels, suburban communities also use more than twice as much land per person as urban communities. Urban sprawl tends to occur at the edge of a city, often replacing farmland and increasing the distance between farms and consumers. In its most recent survey, the U.S. Department of Agriculture estimated that between 1992 and 1997, U.S. farmland was being converted to residential uses at a rate of 500,000 hectares (1.2 million acres) per year.

### 10.4. Causes and Effects of Sprawl

There are four main causes of urban sprawl in the United States: automobiles and highway construction, living costs, urban blight, and government policies.

**AUTOMOBILES AND HIGHWAY CONSTRUCTION** Before automobiles and highway systems existed, transportation into and out of cities was difficult: horses were slow, roads were bad, and trolley services rarely went far beyond the city limits. In those days, if you wanted to take advantage of the many amenities of city life, such as job opportunities, cultural institutions, shopping, and social activities, you had to live within a few miles of the city center.

The advent of the automobile, and the subsequent development of the interstate highway system in the 1950s and 1960s, changed everything. Today we think nothing of working in the city during the day and commuting home to the suburbs at night. And if you live in the suburbs but want to get into the city on a Saturday night for dinner, a concert, or a movie, that’s no problem either. With rapid, comfortable transportation between urban and suburban areas, it became possible to work or play in the city and return to a large home in a quiet neighborhood. For the first time in history, people could enjoy the best of both worlds.

**LIVING COSTS** Many people find suburban living more desirable than city living because they can obtain more land and a larger house for the same amount of money. Because land is readily available in the suburbs, it is relatively inexpensive compared with land in the city. For the cost of a tiny one-bedroom condominium in a
desirable section of a city, you may be able to purchase a five-bedroom house with a big yard in the suburbs. In addition, because suburban governments usually provide fewer public services than cities do, tax rates in the suburbs are likely to be lower. For these reasons, moving to the suburbs allows some people to enjoy a higher standard of living than they could afford with the same income in the city.

On the other hand, those with lower incomes may not be able to afford these benefits. Although single-family homes in the suburbs are likely to be less expensive than desirable housing in the city, they are still out of reach for many people. Most suburban communities have little, if any, low-income or “affordable” housing. Because single-family homes are usually the only housing option available in the suburbs, those with lower incomes are excluded. Furthermore, in many suburban locations, it is difficult to commute to the city without a car, which compounds the difficulties for lower-income individuals. Even when public transportation is available, commuting costs can be high.

**URBAN BLIGHT** As population shifts to the suburbs, the city’s revenue from sources such as property, sales, and service taxes begins to shrink. At the same time, the cost of maintaining urban services, including public transportation, police and fire protection, and social services, remains stable. Faced with declining tax receipts, cities are forced to reduce services, raise tax rates, or both. As services decline, crime rates may increase, either because police resources are stretched thin or because conditions for lower-income residents decline even further. Infrastructure also deteriorates, leading to a decline in the quality of the built environment. These problems, combined with higher taxes, make cities less attractive places to live, and those who can afford to move away are more likely to do so.
Urban blight. As people move away from a city to suburbs and exurbs, the city often deteriorates, causing yet more people to leave. This cycle is an example of a positive feedback system. The green arrow indicates the starting point of the cycle.

In addition, as the population shifts to the suburbs, jobs and services follow. Suburbanization has spawned suburban office parks, which have led to an increase in suburb-to-suburb commuting. Commuting patterns develop around cities rather than into and out of them. These new traffic patterns make it more difficult to provide public transportation to the spreading region. As wealthy and middle-income people leave cities, urban retail stores lose customers. As stores close, people have fewer reasons to go to the city to shop, further decreasing the customer base for the remaining stores. This cascade of effects leads to the positive feedback loop shown in Figure 10.14. This loop creates urban blight: the degradation of the built and social environments of the city that often accompanies and accelerates migration to the suburbs.

Historically, urban blight has contributed to racial segregation. In the 1950s and 1960s, when migration to the suburbs began in earnest, those leaving the cities for the suburbs were predominantly middle- or upper-income Caucasians. This so-called “white flight” resulted in highly concentrated minority populations in city centers and almost entirely white populations in the suburbs. Over time, the disparity of opportunity increased because higher property tax revenues in suburban communities often allowed for better schools. Very recently, some of this segregation has begun to decline as Caucasians return to the cities and more minorities, after having accumulated wealth, move out to the suburbs. Nevertheless, large racial disparities remain.

GOVERNMENT POLICIES Urban sprawl has also been influenced by federal and local laws and policies, including the Highway Trust Fund, zoning laws, and subsidized mortgages.

Induced demand as a cause of traffic congestion and urban sprawl. The use of gasoline tax money to build highways leads to development of suburbs and traffic congestion, at which...
point yet more money is spent on highways to alleviate the congestion. The green arrow indicates the starting point of the cycle.

The **Highway Trust Fund**, begun by the Highway Revenue Act of 1956 and funded by a federal gasoline tax, pays for the construction and maintenance of roads and highways. We have already seen that highways allow people to live farther from where they work. **FIGURE 10.15** shows the resulting positive feedback loop. More highways mean more driving and more gasoline purchases, which lead to more gasoline tax receipts, and so on. As people move farther away from their jobs, traffic congestion increases, and roads are expanded. But the new, even larger roads encourage even more people to live farther away from work. This cycle exemplifies a phenomenon known as **induced demand**, in which an increase in the supply of a good causes demand to grow.

Governments may use **zoning** to address issues of traffic congestion, urban sprawl, and urban blight. **Zoning** is a planning tool developed in the 1920s to separate industry and business from residential neighborhoods and create quieter, safer communities. Governments that use zoning can classify land areas into “zones” in which certain land uses are restricted. For instance, zoning ordinances might prohibit developers from building a factory or a strip mall in a residential area or a multi-dwelling apartment building in a single-home neighborhood. Nearly all metropolitan governments across the United States have adopted zoning. Zoning often regulates much more than land use. The number of parking spaces a building must have, how far from the street a building must be placed, or even the size and location of a home’s driveway are among the development features that zoning may stipulate. Zoning laws have been helpful in addressing issues of safety and sometimes in minimizing environmental damage caused by new construction. One negative aspect of zoning, however, is that it generally prohibits suburban neighborhoods from developing a traditional “Main Street” with shops, apartments, houses, and businesses clustered together. Many communities are now attempting to incorporate **multi-use zoning** into their municipal plans. **Multi-use zoning** allows retail and high-density residential development to coexist in the same area. However, most zoning in the United States continues to promote automobile-dependent development.

The federal government has also played a large part in encouraging the growth of suburbs through the Federal Housing Administration (FHA). Congress established the FHA during the Great Depression of the 1930s, in part to jump-start the economy by creating more demand for new housing. Through the FHA, people could apply for federally subsidized mortgages that offered low interest rates. This program allowed many people who otherwise could not afford a house to purchase one. However, the
FHA financed mortgages only for homes in financially “low risk” areas. Inevitably, these areas were almost always the newly built, low-density suburbs. When, at the end of World War II, the GI Bill extended generous credit terms to war veterans, the suburban housing boom continued. The greater availability of cars as well as mass-produced housing, which allowed developers to sell newly convenient suburban homes at a steep discount, made the suburbs even more attractive.

10.4. Smart Growth

People are beginning to recognize and address the problems of urban sprawl. One way they are doing so is through the principles of smart growth. Smart growth focuses on strategies that encourage the development of sustainable, healthy communities. The Environmental Protection Agency lists 10 basic principles of smart growth:

1. **Mixed land uses.** Smart growth mixes residential, retail, education, recreation, and business land uses. Mixed-use development allows people to walk or bicycle to various destinations and encourages pedestrians to be in a neighborhood at all times of the day, increasing safety and interpersonal interactions.

2. **Create a range of housing opportunities and choices.** By providing housing for people of all income levels, smart growth counters the concentration of poverty in failing urban neighborhoods. Mixed housing also allows more people to find jobs near where they live, improves schools, and generates strong support for neighborhood transit stops, commercial centers, and other services.

3. **Create walkable neighborhoods.** Walkable neighborhoods are created by mixing land uses, reducing the speed of traffic, encouraging businesses to build stores directly up to the sidewalk, and placing parking lots behind buildings. In neighborhoods that encourage walking, people use their cars less, which both reduces fossil fuel use and traffic congestion and provides health benefits. Communities with more pedestrians tend to see more interaction among neighbors because people stop to talk with each other. This, in turn, creates opportunities for civic engagement. When people interact, the environment usually benefits.

4. **Encourage community and stakeholder collaboration in development decisions.** There is no single “right” way to build a neighborhood; residents and stakeholders—people with an interest in a particular place or issue—need to work together to determine how their neighborhoods will appear and be structured.

5. **Take advantage of compact building design.** Smart growth incorporates multistory buildings and parking garages—as opposed to sprawling lots—to reduce a neighborhood’s environmental footprint and protect more open space. Ideally, shops, cafés, and small businesses should be easily accessible to
pedestrian traffic on the ground floor near sidewalks, with two or three stories of apartments and offices above.

Figure 10.16 The French Quarter of New Orleans. One principle of smart growth is to foster communities with a strong sense of place. The French Quarter of New Orleans, Louisiana, is known for its architecture, food, and, especially, music.

6. Foster distinctive, attractive communities with a strong sense of place. A sense of place is the feeling that an area has a distinct and meaningful character. Many cities have such unique neighborhoods. For example, the French Quarter of New Orleans (FIGURE 10.16) has a sense of place that adds to the quality of life for people living there. Smart growth attempts to foster this sense of place through development that fits into the neighborhood.

7. Preserve open space, farmland, natural beauty, and critical environmental areas. Working farmland is a source of fresh local produce and other goods. Open space provides opportunities for recreation and enjoyment. Land protected from development through restricted growth also provides habitats for a variety of species.

8. Provide a variety of transportation choices. Transit-oriented development (TOD) attempts to focus dense residential and retail development around stops for public transportation, giving people convenient alternatives to driving. Bicycle racks and safe roads, pleasant sidewalks for walking, frequent bus service, and light rail can all aid in this goal (FIGURE 10.17). Car-sharing networks such as Zipcar can provide easy access to a fleet of rental automobiles. This increasingly popular service reduces the need for private car ownership where public transportation is not available.
9. **Strengthen and direct development toward existing communities.** Development that fills in vacant lots within existing communities, rather than expanding into new land outside the city, is known as **infill.** This type of development can help to reinvigorate urban neighborhoods that are caught in a vicious cycle of depopulation and blight and can protect rural lands from sprawl. Some cities, such as Portland, Oregon, have had success with **urban growth boundaries,** which place restrictions on development outside a designated area.

10. **Make development decisions predictable, fair, and cost-effective.** One reason why suburban developments in all regions of the country often look the same is that standardized designs allow developers to move rapidly through the permitting process. A streamlined approval process that encourages smart growth could increase the number of individualized plans rather than promoting cookie-cutter development.
Of course, no individual new development or neighborhood plan is likely to incorporate all of these ideals, but as a guide to thinking about how to build communities, the smart growth concept has been quite successful. Smart growth can have important environmental benefits. Compact development reduces the amount of impervious surface, reducing runoff and flooding downstream. A 2000 study found that smart growth in New Jersey would reduce water pollution by 40 percent compared with the more common, dispersed growth pattern. By mixing uses and providing transportation options, smart growth also reduces fossil fuel consumption. A 1999 EPA study found that infill development can reduce miles driven by as much as 58 percent. A 2005 study in Seattle found that residents of neighborhoods incorporating just a few of the techniques to make nonauto travel more convenient traveled 26 percent fewer vehicle miles than residents of more dispersed, less-connected neighborhoods.

CHECKPOINT

- What are urban sprawl and smart growth?
- How can zoning help reduce urban sprawl?

WORKING TOWARD SUSTAINABILITY

The Dudley Street Neighborhood

The Dudley Street area of Roxbury and North Dorchester, in Boston, was once a prime example of urban blight. In the 1980s, years of urban decay and the loss of large numbers of primarily Caucasian families to the suburbs had left 21 percent of the Dudley Street neighborhood vacant—amounting to 1,300 abandoned parcels. Almost 30 percent of the neighborhood’s residents had an income below the federal poverty level, making the neighborhood one of the poorest in Boston. Fires were a particular problem; in some cases, arsonists attempted to gain insurance money on homes that could not be sold. The residents felt that they were being ignored by City Hall. Some suggested that this was because 96 percent of the neighborhood’s residents were members of ethnic minority groups.

In 1984, residents banded together to turn their neighborhood around. They formed the Dudley Street Neighborhood Initiative (DSNI), designed to allow the residents to move toward a common vision for a sustainable neighborhood. Participants chose a large Board of Directors—34 members—so that they would hear a diversity of perspectives and, in coming to consensus, ensure that decisions had broad support. The DSNI also
obtained something no other neighborhood organization has: the power of *eminent domain*. **Eminent domain** allows a government to acquire property at fair market value even if the owner does not wish to sell it. It is frequently used to acquire land for highway projects, but also has been used recently, and controversially, in urban redevelopment.

By 1987, DSNI had worked with community members to develop a comprehensive revitalization plan, which has been periodically updated since then. The main goals of the DSNI plan are

- to rehabilitate existing housing
- to construct homes that are affordable according to criteria set by residents
- to assemble parcels of vacant land for redevelopment, using the power of eminent domain if necessary
- to plan environmentally sound, affordable development that is physically attractive
- to convert some vacant properties into safe play areas, gardens, and facilities that the entire community can enjoy
- to run a full summer camp program for area children
- to develop strong public and private partnerships to ensure the economic vitality of the neighborhood
- to increase both the economic and political power of residents

DSNI has had many successes. Its first major action was to force the city to remove trash, appliances, and abandoned cars that littered the streets and vacant lots. The city also cleaned up two illegal dumps in the area. Residents planted community gardens to grow produce and flowers. DSNI successfully reduced drug dealing in the neighborhood park, although that remains a constant struggle. And, perhaps most significantly, its work led to the construction of 300 new homes on formerly vacant lots. New residents help to add vitality to the neighborhood, reversing the cycle of depopulation and business closure.

It is evident that the individuals involved in DSNI have taken many of the principles of smart growth to heart. The community mixes residential with retail development, and residents live within walking distance of a grocery store, ethnic markets, and other amenities (FIGURE 10.18). Moreover, since the founding of DSNI, two small manufacturing businesses—a furniture maker and an electronics company—have moved into the neighborhood, providing additional jobs within walking distance for residents.
The Dudley Street neighborhood still has a relatively low per capita income, and its development choices have not been without controversy. However, it serves as an example of one of hundreds of neighborhoods that have begun to turn the positive feedback loop of urban decay into one of urban renewal and hope.

**References**


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**KEY IDEAS REVISITED**

- **Describe the concepts of the tragedy of the commons and maximum sustainable yield and explain how they pertain to land use issues.**

  Individuals have no incentive to conserve common resources when they do not bear the cost of using those resources. A cost or benefit not included in the price of a good is an externality. The lack of incentive to conserve common resources leads to overuse of these resources, which may be degraded if their use is not regulated. The maximum sustainable yield is the largest amount of a renewable resource that can be harvested indefinitely. Harvesting at the MSY keeps the resource population at about one-half the carrying capacity of the environment. However, uncertainty about population dynamics can lead to a miscalculation of the MSY and overharvesting.

- **Describe the function, operation, and efficacy of the four major public land management agencies in the United States.**
In the United States, public land is managed for multiple uses, including grazing, timber harvesting, recreation, and wildlife conservation. The Bureau of Land Management manages rangeland, which is used for grazing. Grazing is subsidized with federal funds, and some lands are overgrazed. The United States Forest Service manages national forests, which are used for timber harvesting, recreation, and other uses. Timber can be harvested by clear-cutting or selective cutting, both of which have environmental impacts, or by ecologically sustainable forestry methods. National parks, managed by the National Park Service, were created primarily for preservation of their scenery and unique landforms, although scientific, educational, and recreational uses have become more important over time. The Fish and Wildlife Service manages national wildlife refuges, which are designed to protect wildlife.

- **Understand the causes and consequences of urban sprawl.**
  
  Causes of urban sprawl include the development of the automobile, construction of highways, less expensive land at the urban fringe, and urban blight. Government institutions and policies, such as the federal Highway Trust Fund, zoning, and subsidized mortgages also contribute to the problem. The result of urban sprawl is automobile dependence, traffic congestion, and social isolation including less involvement in community affairs.

- **Describe approaches and policies that promote sustainable use of land.**
  
  Smart growth is one possible response to urban sprawl. It advocates more compact, mixed-use development that encourages people to walk, bicycle, or use public transportation. Smart growth not only consumes less land than more typical, dispersed development, but has numerous other environmental benefits.

**PREPARING FOR THE AP EXAM**

**MULTIPLE-CHOICE QUESTIONS**

**[Notes/Highlighting]**

1. Which of the following is *not* an example of the tragedy of the commons?
   
   - (a) Overgrazing by sheep on community-owned pastures
   - (b) Depletion of fish stocks in international waters
   - (c) Automobile congestion in Yellowstone National Park
   - (d) Depletion of soil minerals by farmers on private land
   - (e) Tropical deforestation due to clearing land for agriculture and then moving on to another location
2. In the accompanying graph of the population growth of the common pheasant, one of the world’s most hunted birds, $X$ represents
   - (a) carrying capacity.
   - (b) maximum sustainable yield.
   - (c) resource depletion.
   - (d) endangered species designation.
   - (e) population overshoot.

3. Under the provisions of the National Environmental Policy Act (NEPA), which of the following would require the preparation of an environmental impact statement (EIS)?
   - (a) The construction of a house on privately owned land
   - (b) The paving of a parking lot for a local business
   - (c) The expansion of an interstate highway
   - (d) The planting of trees in front of City Hall
   - (e) The revision of local zoning ordinances

4. Federally owned land in the United States can best be described as
   - (a) 25 percent of all land, with the majority of it in the west.
   - (b) 42 percent of all land, with the majority of it in the east.
   - (c) 28 percent of all land, with most of it in Texas.
   - (d) 20 percent of all land, with 10 percent of it in the west.
   - (e) 35 percent of all land, with the majority of it in the east.
5. The four major public land management agencies in the United States operate under the principle of multiple use. Which of the following uses is common to all four agencies’ lands?
   - (a) Hunting
   - (b) Mining
   - (c) Grazing
   - (d) Timber harvesting
   - (e) Recreation

6. For many years, forest fires were suppressed to protect lives and property. This policy has led to
   - (a) a buildup of dead biomass that can fuel larger fires.
   - (b) many forest species being able to live without having their habitats destroyed.
   - (c) increased solar radiation in most ecosystems.
   - (d) soil erosion on steep slopes.
   - (e) economic instability.

7. When we purchase an item, we are charged for the labor and supply costs of producing that item. However, we are not charged for the costs of any environmental damage that occurred in manufacturing that item. Those costs are known as
   - (a) externalities.
   - (b) the tragedy of the commons.
   - (c) the maximum sustainable yield.
   - (d) marginal costs.
   - (e) economic cost-benefit analysis.

8. Which of the following is not an environmental consequence of clear-cutting?
   - (a) Increased soil erosion and sedimentation in nearby streams
   - (b) Decreased biodiversity due to habitat fragmentation
   - (c) Increased fish populations due to the influx of nutrients into streams
   - (d) Decreased tree species diversity due to the loss of shade-tolerant species
   - (e) Stands of same-aged trees

9. Which of the following are environmental impacts of urban sprawl?
   I  Greater reliance on the automobile and increased fossil fuel consumption
   II Increased consumption of land for housing and highway construction
   III Loss of valuable farmlands
   - (a) I only
   - (b) II only
10. Which of the following was a significant cause of urban sprawl over the past 50 years?
- (a) Migration of people from rural areas to large central cities
- (b) Increased availability of public transportation
- (c) Lower property taxes in urban areas
- (d) Use of the federal gasoline tax to construct and maintain highways
- (e) Improved infrastructure and reduced crime rates in urban areas

[Answer Field]

11. Which of the following is not an environmental benefit of smart growth?
- (a) Reduced flooding
- (b) Increased impervious surfaces
- (c) Reduced fossil fuel consumption
- (d) Increased open space
- (e) Decreased water pollution

[Answer Field]

FREE-RESPONSE QUESTIONS

1. The property pictured below is the Farm Barn at Shelburne Farms, a National Historic Landmark, nonprofit environmental education center, and 1,400-acre working farm on the shores of Lake Champlain. However, for the sake of this exercise, let’s assume that the property pictured below belongs to the federal government.
• (a) Identify and explain which of the four public land management agencies would be involved in managing this public land. (2 points)

• (b) Applying any three of the basic principles of smart growth, explain how the private land surrounding this federally owned property might be developed to minimize environmental impacts. (4 points)

• (c) Define *environmental impact statement* and describe one condition under which an EIS might be required for the use of either the privately owned or federally owned lands associated with this tract. (4 points)

**[Answer Field]**

2. The town of Fremont met recently to discuss the pros and cons of protecting prairie dogs. Prairie dogs are burrowing rodents the size of rabbits that live in colonies underground in grasslands and prairies. Their numbers have been greatly reduced over the last few decades. Dr. Masser, a local biologist, pointed out that prairie dogs are an important part of the prairie food web, as they are prey for many birds and mammals. Without federal protection from both the Bureau of Land Management and the U.S. Fish and Wildlife Service, they could become extinct in a few years. Dr. Masser also explained that 2 of the 5 species of prairie dogs are already listed as either threatened or endangered. Local ranchers disagreed. Mr. Smith stated that he will continue to poison or shoot the prairie dogs on his land because they destroy the grasses that are needed by his livestock, and he encouraged the BLM to do the same on public lands.

• (a) Explain the tragedy of the commons in general terms. Then, using the information you just read about the prairie dog and any other relevant information, incorporate the town of Fremont’s discussion into your explanation. (4 points)
• (b) Identify and discuss one argument in favor of preserving western grasslands as habitat for prairie dogs and one argument in favor of maintaining those grasslands for the grazing of livestock. (3 points)

• (c) Identify one action that the Bureau of Land Management and one action that the U.S. Fish and Wildlife Service could take to resolve this land use conflict. (3 points)

MEASURING YOUR IMPACT

1. The Costs of Commuting Imagine that you are one of 1,000 people who used to live in a downtown area and walked or took public transportation to work. Now you and the others have moved to the suburbs and drive 20 km per day each way.

• (a) How many additional kilometers are being driven each day by those 1,000 people?

• (b) How many additional kilometers are being driven each week by those 1,000 people? (Assume that each person works 5 days a week.)

• (c) How many additional kilometers are being driven each year by those 1,000 people?

• (d) If the average car gets 10 km per liter, how many liters of gasoline will be used by those 1,000 people each year?

• (e) Assuming that you are not going to move back to an urban area or change your job, what measures could you take to lessen your impact on the environment?