CHAPTER 24

# Our Environmental Future

The *Deepwater Horizon* oil drilling platform on fire April 22, 2010. Eleven workers were killed.

## LEARNING OBJECTIVES

The learning objectives of this final chapter are to put it all together and then ask yourself the following questions:

- How can we take what we have learned and apply it to improving the environment?
- How can we think about a future in which we use our environment wisely—an "ecotopia"?
- Can we do this in a way that is good for people, human societies, and for nature?
- Will our environmental future "self-organize," or will it require more laws and formal planning?
- How have environmental laws affected people and environment, and what guidance does that experience provide for us in planning the future?

CASE STUDY

# The Oil Spill in the Gulf of Mexico in 2010

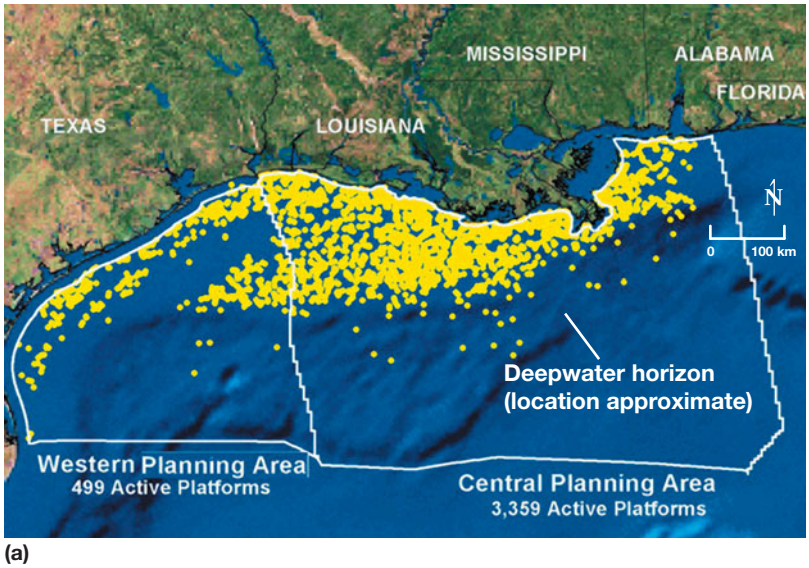
America's biggest oil spill began on April 20, 2010, about 66 km (41 miles) south of the Louisiana Coast in the Gulf of Mexico. Everything about the spill was big, very big (Figure 24.1a). It happened on the *Deepwater Horizon,* a floating, semisubmerged drilling platform whose surface was larger than a football field—121m (396 ft) long and 78 m (256 feet) wide. Built in 2001 at a cost of $600 million and owned by Transocean, the platform had previously dug the deepest offshore gas and oil well ever, down 10,685 m (35,055 feet). In February 2010, Transocean began a new job under lease by British Petroleum (BP), drilling in waters 1,500 m (5,000 ft) deep. BP's plan was to use this platform to drill an exploratory well into the bedrock below to a depth of 5,600 m (18,360 feet)—almost 3½ miles into the rock! Pipes descended from the platform through the seawater to the bedrock below, and then drilling began. The wellhead, which sits atop the seafloor, contains devices to control the drilling, to insert drilling fluids (called "muds") into the hole drilled below, and to control the upward flow of oil and gas once those deposits are reached.

On April 20, things went wrong. Methane (natural gas) from the oil and gas deposits that were being drilled into from the platform broke through the wellhead at the surface far below. It rose rapidly, reaching the platform in a short time, starting a fire there at 9:56 P.M. local time, and then causing a major explosion. Eleven of the 126 crew members were killed, and many others were injured; some saved themselves by diving off the collapsing rig into the ocean. The fire was big—so big and bright that people in boats that came to help said it was hard to look at and melted the paint off the boats.

The *Deepwater Horizon* burned for 36 hours and then, on April 22, it sank, and the oil spill began in earnest. At first, the U.S. Coast Guard reported that 8,000 barrels a day were leaking, but it was difficult to determine just how much oil was pouring out thousands of feet below. By July the best estimate was about 60,000 barrels per day. The oil spread widely; by mid-June 2010, medium to heavy amounts of oil had reached more than 160 km (100 miles) east of the platform's position (Figure 24.1*b*).[1]

The total amount of oil spilled by mid-July when the leak was stopped was about 5 million barrels (210 million gallons). At this rate of release, the BP spill equaled the *Exxon Valdez* oil spill (until then the largest spill in U.S. history) every 4½ days.

To put these large numbers in perspective, the average school gymnasium would hold about 1.3 million gallons of oil. Thus, the oil spilled in just the first two months of the BP spill would fill over 100 school gymnasiums.

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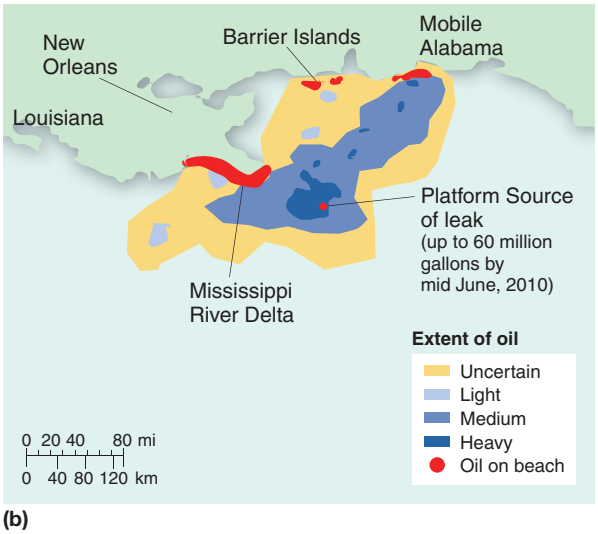



(b)

**FIGURE 24.1** **(a)** Active oil platforms (about 4,000) on the northern slope of the Gulf of Mexico. The location of the *Deepwater Horizon* is shown; **(b)** the extent of the Gulf spill as of mid-June 2010. (*Source*: Modified after NOAA.)

How does this compare to other blowouts and oil spills? The largest known blowout on land, which happened in Iran in 1956, involved about 120,000 barrels per day and lasted 3 months before being capped, releasing a total of almost 11 million barrels. A number of other "gushers" in the history of oil drilling released about 100,000 barrels per day. (We discuss other spills on land and offshore in Chapter 15.)

Any way you look at it, the BP spill is a lot of oil released into the Gulf's fragile marine and coastal environments. Spilled oil that remains near the water surface moves with currents and winds, some of it ending up on shorelines, partly covering plants and animals, infiltrating the sediment, and doing other kinds of ecological damage (Figure 24.2). Although most effects of oil spills are relatively short-lived (days to a few years), previous marine spills have killed thousands of seabirds, temporarily spoiled beaches, and caused loss of tourist and fishing revenues. Complicating matters, four species of sea turtles (loggerheads, Kemp's ridley, leatherback, and green) lay their eggs along Gulf State coasts that either have already been reached by the oil or are likely to in the near future. By June 25, 2010, 555 turtles had been found within the spill, 417 of them were dead.[2]

**FIGURE 24.2** Oil on land: **(a)** Chandeleur Beach, Louisiana, 2010; **(b)** oil invades a Louisiana coastal wetland marsh in 2010; **(c)** dolphins swimming through some of the BP oil spill; **(d)** Kemp's ridley sea turtle at a rehabilitation center; **(e)** oil-covered seabird in Louisiana.

A large volume of natural gas (methane) has been released with the oil, some dissolved in the oil and some from gas pockets. Eventually, much of the methane in the water is degraded by bacteria, whose increased respiration decreases oxygen levels in the water. Scientists studying the oxygen content of the deep water near the oil rig have found oxygen depletion of 2% to 30% at depths of about 1,000 feet.

The spill is an economic disaster for BP and for the U.S. states along the Gulf coast. If the oil that was spilled in the first 60 days had been obtained and sold, it would have provided BP with about $288 million. But by that time BP had already admitted that the spill had cost the company $1 billion, and BP had agreed to provide the U.S. government with $20 billion to repay those who suffered damage from the spill. Fishermen, for example, have been put out of work because a large area of the Gulf's waters—from Morgan City west of New Orleans, Louisiana, to well east of Panama City, Florida, and south parallel to the Florida Keys, approximately 300 miles east–west and 300 miles north–south—were closed to fishing (Figure 24.3). Some closed areas were opened by August 2010. People in tourist areas lost money, too, because vacationers are choosing other locations where they won't have to contend with oil on beaches. All the supporting businesses for fishing and tourism also suffered.

Will the Gulf recover from the 2010 oil spill? Certainly it will. Scientific studies of previous oil spills show that there is always an immediate (scientists call it an "acute") effect, killing fish, birds, and marine mammals and damaging vegetation and nearshore algae. Over the long run, the oil decomposes and much of it becomes food for bacteria, or nutrients for algae and plants. However, studies of previous oil spills also show that some oil remains even decades after spills, and therefore the effects on people, economics, and the environment that people value and enjoy are, from a human perspective, damaged for a long time.

**FIGURE 24.3** A large part of the commercial fisheries in the Gulf of Mexico were closed to fishing by late June 2010 because of the BP oil spill.

By late August 2010 it was hard to find much floating oil in the Gulf and some saltmarsh plants were showing signs of recovery. Recovery may be quicker in the Gulf than in Alaska because the warm water favors biologic decomposition of the oil, the oil is light and the Gulf is a very large, deep, body of water subject to active surface processes from storm generated wind and waves.

How did the BP spill happen? As with many major environmental disasters, a series of poor decisions were involved, including a failure to take advantage of the safest and best technology. Before the blowout, problems with the well caused workers and others to express concern about being able to prevent an incident in which oil or natural gas would escape. The *Deepwater Horizon* had problems prior to the blowout and received 18 government citations for pollution. The BP wellhead had been fitted with a blowout preventer, but not with remote control or acoustically activated triggers for use in an emergency. The blowout preventer malfunctioned shortly after the heavy drilling mud had been withdrawn from the wellhead (the function of the drilling mud is to help keep oil from moving up the well to the surface). This is considered one of the major mistakes because without the mud and with the blowout-preventer malfunction, there was only water pressure to keep the oil and gas from escaping, and that was a recipe for disaster.

In addition, the response to the oil spill was inadequate. Rather than proactive, it was reactive: Each time something went wrong, there was spur-of-the- moment action. Also lacking was a clear line of authority and responsibility. The drilling was being done offshore by a private corporation, but it had large-scale effects, many of which were on government lands and waters and thus came under government control. Some available technologies that could have been applied were not; others were applied in too limited and tentative a way (Figure 24.4). News reports were rife with speculation by poorly informed people about all sorts of things that might be done, from gathering the oil with hay to blowing up the well with an atomic bomb.

About 6,000 boats were deployed with about 25,000 workers to try to minimize the spread of the spill by collecting it in the sea and on land. Some oil was burned, and chemical dispersants were applied from aircraft as well as at the bottom of the sea where the leak was occurring. These dispersants are chemicals and have environmental impacts themselves. It is known that these chemicals can damage marine ecosystems, but in this situation some scientists considered dispersants the lesser of two evils. Dispersants are being used, but their long-term impact, particularly on the deep-sea bed and in the seawater, is largely un-

(a)

(b)

**FIGURE 24.4** Cleaning up an oil spill. **(a)** Boats use booms and skimmers to collect oil during 2010 spill; **(b)** cleaning a Louisiana beach, 2010.

known. This brings up an important point: The science of the deep-ocean basin has not progressed enough to be able to adequately predict the processes there and how they will interact with the oil and dispersants. [3]

The *Deepwater Horizon* was just one of nearly 4,000 other platforms in the Gulf off the coast of the United States. From the perspective of environmental science, what lessons can we take home from the BP oil spill?

First of all, it did not have to happen. Best practices—those that take advantage of the best and safest modern technology, developed from modern science—were not followed.

Second, modern industrialized nations use huge amounts of petroleum, and even with widespread movements away from petroleum, the need will not cease quickly. Therefore, it is essential that oil exploration and development make use of the best available technology and science, including the sciences that inform us about the environmental and ecological effects of an oil spill.

And third, after decades of concern about offshore oil spills, the technologies to deal with their cleanup remain insufficient. What is needed is an oversight program that includes advance planning, early warning, and rapid and sufficient response. Given the huge amount of money spent on energy within the United States and the importance of energy to our nation's standard of living, creativity, and productivity, we can no longer deal with such things as oil spills in a haphazard way.

## 24.1 Imagine an Ecotopia

Imagine a future in which we use our environment wisely—an "ecotopia." A learning objective of this chapter is to work out, to the best that present information allows, what you think is possible and desirable for this future world, focusing primarily on the United States, and also describe how this might be accomplished. Having read this book, you may well imagine a future in which, for example, we move away from fossil fuels and shift to renewable energy, no longer needing to damage the environment by mining and burning fossil fuels, nor forced to import them from uncertain and unfriendly sources. But which alternative energy sources would you favor?

This may seem an empty academic exercise, but unless we have an idea of what we want, we won't know in which direction to seek our future. Ideas are powerful, as history has proved. Wars have been fought over ideas. Ideas led Europeans to the New World and forged the American democracy. So what seems simply an academic exercise could be a powerful force for the future. It is not difficult today to imagine an "ecotopia"—a world in which the environment, human societies, and individuals are treated well in the present and helped to persist long into the future. But it would be extremely difficult to help it come about. What would that ecotopia be like? Here are a dozen qualities you would probably want to include:

- Since human population growth is the underlying environmental problem, an ecotopia would have to include a human population that had stabilized or even perhaps declined.
- All living resources would be sustainable, as would harvests of those resources.
- There would be enough wilderness and other kinds of natural or naturalistic areas for everyone to have opportunities for recreation and the enjoyment of nature.
- Pollution would be minimized.
- The risk of extinction of many species would be minimized.
- There would be enough functioning ecosystems to handle the public-service functions of ecosystems.

- Representatives of all natural ecosystems would be sustained in their dynamic ecological states.
- Poverty would be alleviated, benefiting both people and environment, because when you are poor it is hard to devote your resources to anything beyond immediate necessities.
- Energy would be abundant but, as much as possible, not cause pollution or otherwise damage land, water, and ecosystems.
- Water would be available to meet the needs of people and natural ecosystems,
- Natural resources, both finite and renewable, would also be available, and recycled where possible.
- Societies would have ample resources to be creative and innovative.

Admittedly, achieving all of this—and/or whatever else you've thought of—will be far from easy.

## 24.2 The Process of Planning a Future

Both human societies and natural ecosystems are complex systems. One of the questions asked by modern science is the degree to which such systems are *self-organizing.* A seed of a plant, for example, is a self-organizing system: It can develop into a mature plant without any outside planning or rational effort. But plants grown in agriculture are not simply left to their self-organizing abilities. Farmers plan for them and carry out those plans, and in these ways a plant is no longer completely self-organizing.

In our discussion of ecosystems in Chapter 5, we said that an ecosystem is the basic unit that can sustain life, and, in that sense, is necessary for life to persist. To some extent ecosystems show self-organizing characteristics, as in ecological succession, but that process of succession isn't as fixed, neat, and perfect a pattern as the growth of a seed into a mature plant.

One of the major themes of this book is the connection between people and nature. We understand today that human societies are linked to natural ecosystems. To what degree can these linked, complex systems self-organize? In various chapters, we have reviewed some examples that appear as self-organization. For example, as we saw in Chapter 22 (urban environments), cities developed at important transportation centers and where local resources could support a high density of people. In medieval Europe, bridges and other transportation aids developed in response to local needs. People arriving at a river would pay the farmer whose land lay along the river to row them across. Sometimes this would become more profitable than farming, or at least an important addition to the farmer's income. Eventually, he might build a toll bridge. People would congregate naturally at such a crossing and begin to trade. A town would develop.[4] The combination of environment and society led in a self-organizing way to cities.[4]

In contrast, the oil-drilling platform *Deepwater Horizon* was not self-organizing at all. It was imagined, designed, and built by a large manufacturing corporation with a planned purpose: to serve as a floating platform for drilling into difficult oil and gas reserves. It functioned within the laws of the United States and international treaties that affected activities in the Gulf of Mexico. These are external plans and agreements to regulate and control how the complex structure of the *Deepwater Horizon* could be and would be used. The failure of this platform was also not the result of self-organization, but of external (human) decisions.

In a democracy, planning with the environment in mind leads to a tug-of-war between individual freedom and the welfare of society as a whole. On one hand, citizens of a democracy want freedom to do what they want, wherever they want, especially on land that, in Western civilizations, is "owned" by the citizens or where citizens have legal rights to water or other resources. On the other hand, land and resource development and use affect society at large, and in either direct or indirect ways everyone benefits or suffers from a specific development. Society's concerns lead to laws, regulations, bureaucracies, forms to fill out, and limitations on land use.

Our society has formal planning processes for land use. These processes have two qualities: a set of rules (laws, regulations, etc.) requiring forms to be filled out and certain procedures to be followed; and an imaginative attempt to use land and resources in ways that are beautiful, economically beneficial, and sustainable. All human civilizations plan the development and use of land and resources in one way or another—through custom or by fiat of a king or emperor, if not by democratic processes. For thousands of years, experts have created formal plans for cities (see Chapter 22) and for important buildings and other architectural structures, such as bridges.

How can we balance freedom of individual action with effects on society? How can we achieve a sustainable use of Earth's natural resources, making sure that they will still be available for future generations to use and enjoy? In short, the questions are: Who speaks for nature? Who legally represents the environment? The landowner? Society at large? At this time, we have no definitive answers. Planning is a social experiment in which we all participate. Planning occurs at every level of activity, from a garden to a house, a neighborhood, a city park and its surroundings, a village, town, or city, a county, state, or

nation. However, the history of our laws provides insight into our modern dilemma.

Issues of environmental planning and review are closely related to how land is used. Land use in the United States is dominated by agriculture and forestry; only a small portion of land (about 3%) is urban. However, rural lands are being converted to nonagricultural uses at about 9,000 $km^2$ (about 3,500 $mi^2$) per year. About half the conversion is for wilderness areas, parks, recreational areas, and wildlife refuges; the other half is for urban development, transportation networks, and other facilities. On a national scale, there is relatively little conversion of rural lands to urban uses. But in rapidly growing urban areas, increasing urbanization may be viewed as destroying agricultural land and exacerbating urban environmental problems, and urbanization in remote areas with high scenic and recreational value may be viewed as potentially damaging to important ecosystems.

## 24.3 Environment and Law: A Horse, a Gun, and a Plan

The legal system of the United States has historical origins in the British common law system—that is, laws derived from custom, judgment, and decrees of the courts rather than from legislation. The U.S. legal system preserved and strengthened British law to protect the individual from society—expressed best perhaps in the frontier spirit of "Just give me a little land, a horse, and a gun and leave me alone." Individual freedom—nearly unlimited discretion to use one's own property as one pleases—was given high priority, and the powers of the federal government were strictly limited.

But there is a caveat: When individual behavior infringed on the property or well-being of others, the common law provided protection through doctrines prohibiting trespass and nuisance. For example, if your land is damaged by erosion or flooding caused by your neighbor's improper management of his land, then you have recourse under common law. If the harm is more widespread through the community, creating a public nuisance, then only the government has the authority to take action—for instance, to limit certain air and water pollution.

The common law provides another doctrine, that of public trust, which both grants and limits the authority of government over certain natural areas of special character. Beginning with Roman law, navigable and tidal waters were entrusted to the government to hold for public use. More generally, "The public trust doctrine makes the government the public guardian of those valuable natural resources which are not capable of self-regeneration and for which substitutes cannot be made by man."[5] For such resources, the government has the strict responsibility of a trustee to provide protection and is not permitted to transfer such properties into private ownership. This doctrine was considerably weakened by the exaltation of private-property rights and by strong development pressures in the United States, but in more recent times it has shown increased vitality, especially concerning the preservation of coastal areas. Here is the basis for much modern environmental law, policy, regulation, and planning: common law with respect to you and your neighbors and the public trust doctrine.

### The Three Stages in the History of U.S. Environmental Law

The history of federal legislation affecting land and natural resources occurred in three stages. In the first stage, the goal for public lands was to convert them to private uses. During this phase, Congress passed laws that were not intended to address environmental issues but did affect land, water, minerals, and living resources—and thereby had large effects on the environment. In 1812, Congress established the General Land Office, whose original purpose was to dispose of federal lands. The government disposed of federal lands through the Homestead Act of 1862 and other laws. As an example of Stage 1, in the 19th century the U.S. government granted rights-of-way to railroad companies to promote the development of rapid transportation. In addition to rights-of-way, the federal government granted the railroads every other square mile along each side of the railway line, creating a checkerboard pattern. The square miles in between were kept as federal land and are administered today by the Bureau of Land Management. These lands are difficult to manage for wildlife or vegetation because their artificial boundaries rarely fit the habitat needs of species, especially those of large mammals.

The second stage began in the second half of the 19th century, when Congress began to pass laws that conserved public lands for recreation, scenic beauty, and historic preservation. Late in the 19th century, Americans came to believe that the nation's grand scenery should be protected and that public lands provided benefits, some directly economic, such as rangelands for private ranching.

Federal laws created the National Park Service in the second half of the 19th century in response to Americans' growing interest in their scenic resources. Congress made Yosemite Valley a California state park in 1864 and created Yellowstone National Park in 1872 "as a public park or pleasuring-ground for the benefit and enjoyment of the people."[6] Interest in Indian ruins led soon after to the establishment in 1906 of Mesa Verde National Park, putting into public lands the prehistoric

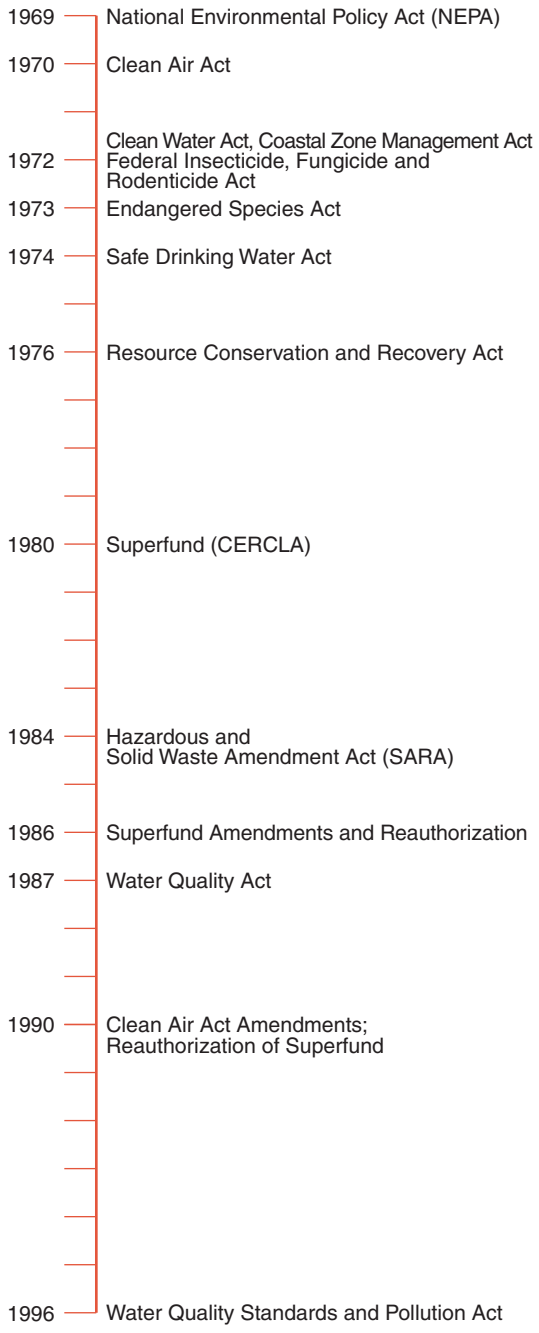



**FIGURE 24.5** Major federal environmental legislation and the year enacted. Most of the important environmental legislation was adopted from 1969 to 1996. Some laws were enacted earlier in a much less comprehensive form (e.g., the Clean Air Act in 1963), and most were amended subsequently.

cliff dwellings of early North Americans and at the same time creating national monuments. The National Park System was created by Congress in 1916. Today it consists of 379 areas.

Also in the second stage, the United States Forest Service began in 1898, and President Grover Cleveland appointed Gifford Pinchot to be head of the Division of Forestry, soon renamed the U.S. Forest Service. Pinchot believed that the purpose of national forests was "the art of producing from the forest whatever it can yield for the service of man." The focus was on production of useful products.

Although the term *sustainability* had not yet become popular, in 1937 the federal government passed the Oregon and California Act, which required that timberland in western Oregon be managed to give sustained yields.[7]

In the third stage, Congress enacted laws whose primary purpose was environmental. This stage has antecedents in the 1930s but didn't get going in force until the 1960s and it continues today. The acknowledged need to regulate the use of land and resources has been filled by legislation enacted at all levels of government. In the late 1960s, public awareness and concern in the United States that our environment was deteriorating reached a high level. Congress responded by passing the National Environmental Protection Act (NEPA) in 1969 and a series of other laws in the 1970s (Figure 24.5). Federal laws relating to land management proliferated to the point where they became confusing. By the end of World War II, there were 2,000 laws about managing public lands, often contradicting one another. In 1946 Congress set up the Bureau of Land Management (BLM) to help correct this confusion.

Government regulation of land and resources has also given rise to controversy: How far should the government be allowed to go to protect what appears to be the public good against what have traditionally been private rights and interests? Today, the BLM attempts to balance the traditional uses of public lands—grazing and mining—with the environmental era's interest in outdoor recreation, scenic beauty, and biological conservation. Part of achieving a sustainable future in the United States will be finding a balance among these uses, as well as a balance between the amount of land that should be public and the amount of land that need not be.

## 24.4 Planning to Provide Environmental Goods and Services

One important experiment of the 20th century was regional planning. In the United States, this means planning across state boundaries. One of the best-known regional plans in the United States began in 1933, when President Franklin D. Roosevelt proposed the establishment of the Tennessee Valley Authority (TVA), a semi-independent agency responsible for promoting economic growth and social well-being for the people throughout parts of seven states, which were economically depressed at the time the authority was established. There had been rampant exploitation of timber and fossil-fuel

resources in the region, and the people living there were among the poorest in the country.[8]

Today, the TVA is considered one of the world's best examples of regional planning (Figure 24.6). It is characterized by multidimensional and multilevel planning to manage land and water resources and is involved in the production and regulation of electrical power, as well as flood control, navigation, and outdoor recreation. In the midst of the Great Depression, Roosevelt sought new ways to invigorate the economy, especially in depressed rural areas. He envisioned the TVA as a corporation clothed with the power of government but with the flexibility and initiative of a private enterprise. The TVA granted legal control over land use to a multistate authority of a new kind and posed novel issues of governmental authority. The act creating the TVA contained the following stipulations:

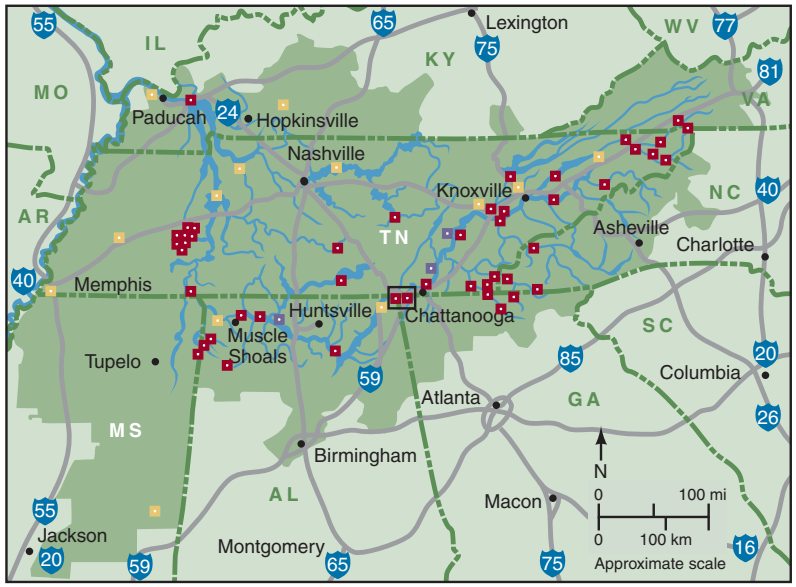
> The unified development and regulation of the Tennessee River system require that no dam, appurtenant works, or other obstruction, affecting navigation, flood control, or public lands or reservations shall be constructed, and thereafter operated or maintained across, along, or in the said river or any of its tributaries until plans for such construction, operation, and maintenance shall have been submitted to and approved by the Board; and the construction, commencement of construction, operation, or maintenance of such structures without such approval is hereby prohibited.[9]

## 24.5 Planning for Recreation on Public Lands

Today, management of public lands for recreational activities requires planning at a variety of levels, with considerable public input. For example, when a national forest is developing management plans, public meetings are often held to inform people about the planning process and to ask for ideas and suggestions. Maximizing public input promotes better communication between those responsible for managing resources and those using them for recreational purposes.

Government officials and scientists involved in developing plans for public lands are often faced with land-use problems so complex that no easy answers can be found. Nonetheless, because action or inaction today can have serious consequences tomorrow, it is best to have at least some plans to protect and preserve a quality environment for future generations. Plans for many of the national forests and national parks in the United States have been or are being developed, generally taking into account a spectrum of recreational activities and attempting to balance the desires of several user groups.

Severe 1996–1997 winter floods in Yosemite National Park damaged roads, campgrounds, bridges, and other structures. The flood led to a rethinking of the goals and objectives of park management, and one result was that some land claimed by the floods was returned to natural




(a)

(b)

**FIGURE 24.6** **(a)** A map showing the region encompassed by the TVA (darker area) and one of the major impoundments, the Raccoon Mountain Dam; **(b)** a large reservoir created by one of the TVA dams.

ecosystems. Another result was the elimination of private vehicles in parts of the park. Many other important policies have also been implemented in U.S. forests and parks. For example:

- In wilderness areas, only a limited number of people are admitted.
- In coastal areas, regulations may limit such activities as jet skiing and surfing in swimming areas.
- Regions that are home to endangered species, or to species that may pose a danger to people, may have more stringent regulations governing the activities of visitors. In Yellowstone National Park in Wyoming and Montana, for example, special consideration is given to grizzly bear habitats through controls on where people may venture.

Other recreational activities that are, or may become, subject to increased regulation include hiking, camping, fishing, boating, skiing, snowmobiling, and such recently popularized activities as treasure hunting, which includes panning for gold. At the extremes, certain areas have been set aside for intensive off-road-vehicle use, while other areas have been closed entirely. Activities on government lands can be more easily regulated than those occurring elsewhere. However, park management may be difficult if goals are not clear and natural processes not understood.

## Who Stands for Nature? Skiing at Mineral King

Planning for recreational activities on U.S. government lands (including national forests and national parks) is controversial. At the heart of the controversy are two different moral positions, both with wide support in the United States. On one side, some argue that public land must be open to public use, and therefore the resources within those lands should be available to citizens and corporations for economic benefit. On the other side are those who argue that public lands should serve the needs of society first and individuals second, and that public lands can and must provide for land uses not possible on private lands.

**FIGURE 24.7** Mineral King Valley, now part of Sequoia National Park after nearly 20 years of controversy about the development of a ski resort in the valley.

A classic example of this controversy concerned a plan by the Disney Corporation in the 1960s and 1970s to develop a ski resort with a multimillion-dollar complex of recreational facilities on federal land in a part of California's Sierra Nevada called Mineral King Valley (Figure 24.7 ), which had been considered a wilderness area. The Sierra Club, arguing that such a development would adversely affect the aesthetics of this wilderness, as well as its ecological balance, brought a suit against the government.

The case raised a curious question: If a wrong was being done, who was wronged? Christopher D. Stone, a lawyer, discussed this idea in an article entitled "Should Trees Have Standing? Toward Legal Rights for Natural Objects." The California courts decided that the Sierra Club itself could not claim direct harm from the development, and because the government owned the land but also represented the people, it was difficult to argue that the people in general were wronged. Stone said that the Sierra Club's case might be based, by common-law analogy, on the idea that in some cases inanimate objects have been treated as having legal standing—as, for example, in lawsuits involving ships, where ships have legal standing. Stone suggested that trees should have that legal standing, that although the Sierra Club was not able to claim direct damage to itself, it could argue on behalf of the nonhuman wilderness.

The case was taken to the U.S. Supreme Court, which concluded that the Sierra Club itself did not have a sufficient "personal stake in the outcome of the controversy" to bring the case to court. But in a famous dissenting statement, Justice William O. Douglas addressed the question of legal standing (*standing* is a legal term relating here to the right to bring suit). He proposed establishing a new federal rule that would allow "environmental issues to be litigated before federal agencies or federal courts in the name of the inanimate object about to be despoiled, defaced, or invaded by roads and bulldozers and where injury is the subject of public outrage." In other words, trees would have legal standing.

While trees did not achieve legal standing in that case, it was a landmark in that legal rights and ethical values were explicitly discussed for wilderness and natural systems. This subject in ethics still evokes lively controversy. Should our ethical values be extended to nonhuman, biological communities and even to Earth's life-support system? What position you take will depend in part on your understanding of the characteristics of wilderness, natural systems, and other environmental factors and features, and in part on your values.


**FIGURE 24.8** Powell's map of water in the West.

Mineral King Valley and surrounding peaks of Mineral King, about 6,000 ha (12,600 acres), were transferred from the national forest to Sequoia National Park in September 1978. The transfer ended nearly 20 years of controversy over proposed development of a ski resort.

## How Big Should Wildlands Be? Planning a Nation's Landscapes

Recent thinking about the environment has focused on the big picture: What is necessary at a national scale, or at some landscape scale, to achieve our goals? We are not the first to ask this question. John Wesley Powell, the famous one-armed American explorer who was the first to lead men down the Colorado River through the Grand Canyon, observed the dry American West and suggested that the land should be organized around major watersheds rather than laid out for political and social reasons, as the states ultimately were (Figure 24.8). His utopian vision was of a landscape where farmers spent their own money on dams and canals, doing so because the land was organized politically around watersheds. They could use, but not sell, their water. This plan seemed to impose too much control from the top and never happened.[10] Instead, in 1902 Congress passed an act that began the 20th-century construction of large dams and canals funded with federal dollars. Water rights could be sold, and cities like Los Angeles could assert the right to water hundreds of miles away.

While we cannot go back to Powell's vision completely, our society is gradually thinking more and more in terms of planning around large watersheds. This regional approach may help us move closer to the dream of our ecotopia. Modern scientific studies of ecosystems and landscapes also lead to speculation about the best way to conserve biological resources. Some argue that nature can be saved only in the large. A group called the Wildlands Project argues that big predators, referred to as "umbrella species," are keys to ecosystems, and that these predators require large home ranges. The assumption is that big, wide-ranging carnivores offer a wide umbrella of land protection under which many species that are more abundant but smaller and less charismatic find safety and resources.[11] Leaders of the Wildlands Project feel that even the biggest national parks, such as Yellowstone, are not big enough, and that America needs "rewilding." They propose that large areas of the United States be managed around the needs of big predators and that we replan our landscapes to provide a combination of core areas, corridors, and inner and outer buffers (Figure 24.9). No human activities would take place in the core areas, and even in the corridors and buffers human activity would be restricted.

The Wildlands Project has created a major controversy, with some groups seeing the project as a fundamental threat to American democracy. Another criticism of the Wildlands Project is directed at its scientific foundation. These critics say that although some ecological research suggests that large predators may be important, what controls populations in all ecosystems is far from understood. Similarly, the idea of keystone species, central to the rationale of the Wildlands Project, lacks an adequate scientific base.

A related idea that developed in the last two decades was *rewilding*—that is, returning the land that was once American prairie to land without towns and cities, where bison are once again allowed to roam free. As Reed Noss, one of the founders of the Wildlands Project, has written:

> A cynic might describe rewilding as an atavistic obsession with the resurrection of Eden. A more sympathetic critic might label it romantic. We contend, however, that rewilding is simply scientific realism, assuming that our goal is to insure the long-term integrity of the land community. Rewilding with extirpated carnivores and other keystone species is a means as well as an end. The "end" is the moral obligation to protect wilderness and to sustain the remnants of the Pleistocene—animals and plants—not only for our human enjoyment, but because of their intrinsic value.[11]

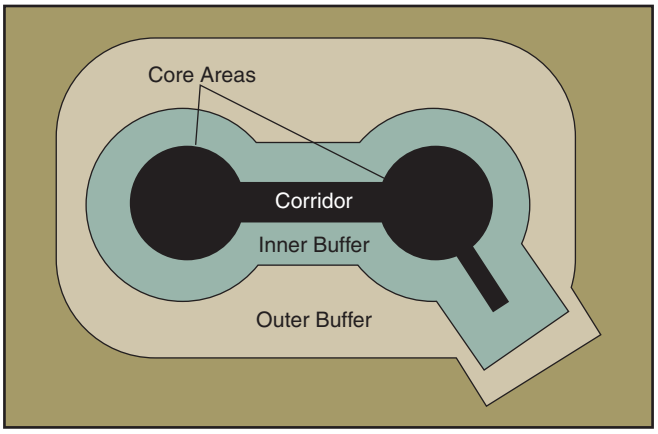



**FIGURE 24.9** Wildlands Project diagram of land divisions.

Proposals for the environment of the future thus involve science and values, and people and nature. So what do you want? A vast area of the United States returned to what might be self-functioning ecosystems? Or some open system of conservation that integrates people and allows for more freedom of action? The choices lie with your generation and the next, and tests of those choices' validity are also yours. The implications for the environment and for people are huge.[11, 12]

# 24.6 How You Can Be an Actor in the Environmental Law Processes

The case of Mineral King raises the question: What is the role of our legal system—laws, courts, judges, lawyers—in achieving environmental goals? The current answer is that environmental groups working through the courts have been a powerful force in shaping the direction of environmental quality control since the early 1970s. Their influence arose in part because the courts, appearing to respond to the national sense of environmental crisis of that time, took a more activist stance and were less willing to defer to the judgment of government agencies. At the same time, citizens were granted unprecedented access to the courts and, through them, to environmental policy.

## Citizen Actions

Even without specific legislative authorization for citizens' suits, courts have allowed citizen actions in environmental cases as part of a trend to liberalize standing requirements.[13]

In the 1980s, a new type of environmentalism (which some people would label radical) arose, based in part on the premise that when it comes to the defense of wilderness, there can be no compromise. Methods used by these new environmentalists have included sit-ins to block roads into forest areas where mining or timber harvesting is scheduled; sitting in trees to block timber harvesting; implanting large steel spikes in trees to discourage timber harvesting; and sabotaging equipment, such as bulldozers (a practice known as "ecotage").

Ecotage and other forms of civil disobedience have undoubtedly been responsible for millions of dollars' worth of damage to a variety of industrial activities related to the use of natural resources in wilderness areas. One result of civil disobedience by some environmental groups is that other environmental groups, such as the Sierra Club, are now considered moderate in their approach to protecting the environment. There is no doubt, however, that civil disobedience has been successful in defending the environment in some instances. For example, members of the group Earth First succeeded in halting construction of a road being built to allow timber harvesting in an area of southwestern Oregon. Earth First's tactics included blockading the road by sitting or standing in front of the bulldozers, which slowed the pace of road work considerably. In conjunction with this action, the group filed a lawsuit against the U.S. Forest Service.

Environmentalists are now relying more on the law when arguing for ecosystem protection. The Endangered Species Act has been used as a tool in attempts to halt activities such as timber harvesting and development. Although the presence of an endangered species is rarely responsible for stopping a proposed development, those species are increasingly being used as weapons in attempts to save remaining portions of relatively undisturbed ecosystems.

## Mediation

The expense and delay of litigation have led people to seek other ways to resolve disputes. In environmental conflicts, an alternative that has recently received considerable attention is mediation, a negotiation process between the adversaries guided by a neutral facilitator. The task of the mediator is to clarify the issues, help each party understand the position and the needs of the other parties, and attempt to arrive at a compromise whereby each party gains enough to prefer a settlement to the risks and costs of litigation. Often, a citizens' suit, or the possibility that a suit might be filed, gives an environmental group a place at the table in mediation. Litigation, which may delay a project for years, becomes something that can be bargained away in return for concessions from a developer. Some states require mediation as an alternative or prior to litigation in the highly contentious siting of waste-treatment facilities. In Rhode Island, for example, a developer who wishes to construct a

hazardous-waste treatment facility must negotiate with representatives of the host community and submit to arbitration of any issues not resolved by negotiation. The costs of the negotiation process are borne by the developer.

A classic example of a situation in which mediation could have saved millions of dollars in legal costs and years of litigation is the Storm King Mountain case, a conflict between a utility company and conservationists. In 1962, the Consolidated Edison Company of New York announced plans for a new hydroelectric project in the Hudson River Highlands, an area with thriving fisheries and also considered to have unique aesthetic value (Figure 24.10). The utility company argued that it needed the new facility, and the environmentalists fought to preserve the landscape and the fisheries. Litigation began with a suit filed in 1965 and ended in 1981 after 16 years of intense courtroom battles that left a paper trail exceeding 20,000 pages. After spending millions of dollars and untold hours, the various parties finally managed to forge an agreement with the assistance of an outside mediator. If they had been able to sit down and talk at an early stage, mediation might have settled the issue much sooner and at much less cost to the parties and to society.[14] The Storm King Mountain case is often cited as a major victory for environmentalists, but the cost was great to both sides.

**FIGURE 24.10** Storm King Mountain and the Hudson River Highlands in New York State were the focus of environmental conflict between a utility company and conservationists for nearly 20 years before a dispute about building a power plant was finally resolved by mediation.

## 24.7 International Environmental Law and Diplomacy

Legal issues involving the environment are difficult enough within a nation; they become extremely complex in international situations. International law is different from domestic law in basic concept because there is no world government with enforcement authority over nations. As a result, international law must depend on the agreement of the parties to bind themselves to behavior that many residents of a particular nation may oppose. Certain issues of multinational concern are addressed by a collection of policies, agreements, and treaties that are loosely called international environmental law. There have been encouraging developments in this area, such as agreements to reduce air pollutants that destroy stratospheric ozone (the Montreal Protocol of 1987 and subsequent discussion and agreements; see Chapter 21).

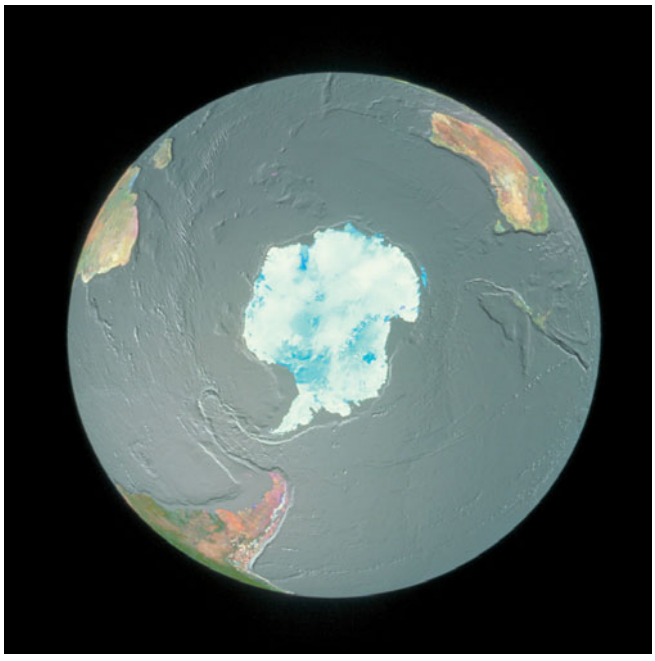
Antarctica provides a positive example of using international law to protect the environment. Antarctica, a continent of 14 million km$^2$, was first visited by a Russian ship in 1820, and people soon recognized that the continent contained unique landscapes and life-forms (Figure 24.11). By 1960, a number of countries had claimed parts of Antarctica to exploit mineral and fossil-fuel resources. Then, in 1961, an international treaty was established designating Antarctica a "scientific sanctuary." Thirty years later, in 1991, a major environmental agreement, the Protocol of Madrid, was reached, protecting Antarctica, including islands and seas south of 60° latitude. The continent was designated "nuclear-free," and access to its resources was restricted. This was the first step in conserving Antarctica from territorial claims and establishing the "White Continent" as a heritage for all people on Earth.

Other environmental problems addressed at the international level include persistent organic pollutants (POPs), such as dioxins, DDT, and other pesticides. After several years of negotiations in South Africa and Sweden, 127 nations adopted a treaty in May 2001 to greatly reduce or eliminate the use of toxic chemicals known to contribute to cancer and harm the environment.

## 24.8 Global Security and Environment

The terrorist attacks on New York City and Washington, DC, on September 11, 2001, brought the realization that the United States—in fact the world—is not as safe as we had assumed. The attacks led to a war on terrorists and their financial and political networks around the world. However, for every terrorist removed, another will fill the void unless the root causes are recognized and eliminated.

Achieving sustainability in the world today has strong political and economic components, but it also has an environmental component. Terrorism comes in part from poverty, overcrowding, disease, and conflicts



(a)

(b)

**FIGURE 24.11** International agreements determine environmental practices in Antarctica. **(a)** Satellite image of Antarctica and surrounding southern oceans; **(b)** emperor penguins and chicks in Antarctica.

that have environmental significance. Over 1 billion people on Earth today live in poverty with little hope for the future. In some large urban regions, tens of millions of people exist in crowded, unsanitary conditions, with unsafe drinking water and inadequate sewage disposal. In the countryside, rural people in many developing countries are being terrorized and displaced by armed conflicts over the control of valuable resources, such as oil, diamonds, and timber. Examples include oil in Nigeria, Sudan, and Colombia; diamonds in Sierra Leone, Angola, and the Democratic Republic of the Congo; and timber in Cambodia, Indonesia, and Borneo.[15]

The goal of the 1992 Rio Earth Summit on Sustainable Development was to address global environmental problems of both developed and developing countries, with an emphasis on solving conflicts between economic interests and environmental concerns. In many countries today, the gap between the rich and the poor is even wider than it was in the early 1990s. As a result, political, social, and economic security remains threatened, and serious environmental damage from overpopulation and resource exploitation continues. Environmental protection continues to be inadequately funded. Worldwatch Institute reported in 2002 that the United Nations' annual budget for the environment is about $100 million, while the governments of the world are spending $2 billion per day for military purposes.[15]

## 24.9 Challenges to Students of the Environment

To end this book on an optimistic note—and there *are* reasons to be optimistic—we note that the Earth Summit on Sustainable Development, held in the summer of 2002 in Johannesburg, South Africa, had the following objectives:

- To continue to work toward environmental and social justice for all the people in the world.
- To enhance the development of sustainability.
- To minimize local, regional, and global environmental degradation resulting from overpopulation, deforestation, mining, agriculture, and pollution of the land, water, and air.
- To develop and support international agreements to control global warming and pollutants, and to foster environmental and social justice.

Solving our environmental problems will help build a more secure and sustainable future. This is becoming your charge and responsibility, as you, students of the environment and our future leaders, graduate from colleges and universities. This transfer of knowledge and leadership is a major reason why we wrote this book.

# CRITICAL THINKING ISSUE

## Is It Possible to Derive Some Quantitative Statements about Thresholds beyond Which Unacceptable Environmental Change Will Occur?

A *threshold* is a condition or level that, if exceeded, will cause a system to change, often from one mode of operation to another, in terms of actual processes or rates of processes. In the environmental literature, thresholds are sometimes spoken of as tipping points, beyond which adverse consequences are likely to occur. Other definitions of a tipping point are: a point when a system (say the global climate) changes from one stable state to another stable state (this is a threshold); and a point where slow small changes over time results in a sudden large change (also a threshold). However, thresholds are not tipping points where change becomes catastrophic and may be irreversible. For example, some believe that if global warming continues past a particular point, say a two degree Celsius rise of temperature, then changes will become more rapid and the consequences of those changes more severe. The purpose of this critical thinking issue is to examine some of these hypotheses in more detail.[16]

In previous chapters, we discussed the major environmental problems related to human population, water, energy, and climate. In discussing human population, we introduced the concept of what Earth's carrying capacity might be. In answering that question, we posed another: "What would we *like* it to be?" It is acknowledged that human population growth is the environmental problem, but at what population level would the degree of environmental degradation become unacceptable to us? Similar limits or thresholds might be introduced for biological productivity; loss of biological diversity; use of nutrients, such as nitrogen and phosphorus; transformation of the land; and our use of freshwater resources. For this list, some scientists have tried to pinpoint thresholds beyond which environmental degradation is unacceptable (a value judgment).

Table 24.1 is based on a paper published in 2009 in the major scientific journal *Nature* and entitled "A Safe Operating Space for Humanity." You should treat these ideas as proposals for discussion, not as truths or facts. The table lists these systems in terms of parameters that may be measured, along with suggested thresholds, which are compared to the present status and also to pre-industrial levels. For example, for human population, a suggested threshold might be 5 billion people—fewer than are on Earth today and 4 billion more than the pre-industrial level of about 1 billion. This 5 billion threshold might be based on the fact that biological productivity, when it was more in balance with human needs, peaked around 1985, when the population was 5 billion people. The arbitrary choice of 5 billion is obviously linked to other factors shown in the table, as they are interrelated. Any specific number for the optimum carrying capacity of the planet will be controversial, but your evaluation will depend on the knowledge you bring to bear and your values.

With respect to climate change, Table 24.1 lists a hypothetical threshold of 350 parts per million for carbon dioxide concentration in the atmosphere, versus the present level of 390 parts per million and the pre-industrial level 280 parts per million. Setting the threshold at 350 parts per million was based on examination of the geologic record, the possible effects of previous climate change, and the likely levels of carbon dioxide in the atmosphere. This table is intended just for the sake of our discussion here. Similarly, the amount of land transformation or water use is also related to our present scientific knowledge.

Looking at Table 24.1 in more detail, we can see that some of the suggested thresholds have already been exceeded, and others have not. However, whether they actually have been exceeded will depend on how much we know about the particular system, whether the consequences are unacceptable, and whether this can be shown with some degree of certainty.

### Critical Thinking Questions

1. Do you think it is a valid argument that some sorts of thresholds, or tipping points, exist beyond which unacceptable environmental degradation will occur?
2. Has science satisfactorily answered whether or not these thresholds, or tipping points, can in fact be established?
3. From your reading of *Environmental Science*, can you make other suggestions as to where thresholds or tipping points might be placed?
4. If you are not able to set thresholds, what sorts of studies might be necessary to establish them in the future? Of course, this assumes that the whole concept of thresholds, or tipping points, is a valid approach in environmental science.

**Table 24.1 GLOBAL THRESHOLDS THAT, TRANSGRESSED, COULD CAUSE UNACCEPTABLE ENVIRONMENTAL CHANGE [FOR DISCUSSION PURPOSES ONLY; NOT TO BE TAKEN AS FACTS]**

| SYSTEM | PARAMETER | SUGGESTED THRESHOLD | PRESENT STATUS | PRE-INDUSTRIAL LEVEL |
|---|---|---|---|---|
| Human population | Billions of people | 5.0 | 6.8 | 1.0 |
| Climate | Carbon dioxide concentration (parts per million) | 350 | 390 | 280 |
| Biological productivity | Portion used by humans | 0.6 | 1.2 | <0.2 |
| Biodiversity loss (extinction) | Extinction rate (number of species per million species per year) | 10 | >100 | 0.1–1.0 |
| Nitrogen use | Amount removed from the air for human use (millions of tons per year) | 35 | 120 | 0 |
| Phosphorus use | Quantity flowing into the ocean (millions of tons per year) | 11 | 9 | -1.0 |
| Land transformation | % of land converted to agriculture | 15 | 12 | Low |
| Global freshwater use | $km^3/yr$ | 4,000 | 2,600 | 415 |
| Air pollution | Metric tons per year | To be determined | To be determined | To be determined |
| Water pollution | Metric tons per year | To be determined | To be determined | To be determined |

*Source*: Modified from J. Rockström et al., 2009. "A Safe Operating Space for Humanity," *Nature* 461: 472–475. doi:10.1038/461472a.

## SUMMARY

- A fundamental question, continuously debated in a democracy, is the extent to which human societies and their environment can function as self-organizing systems, and how much formal planning—laws and so on—is necessary.
- Both natural ecosystems and human societies are complex systems. The big question is how the interaction among these can lead to the long-term persistence of both, and perhaps even improvements.
- Mistakes are always likely; advance planning, including rapid response, is essential to maintaining the best environment.
- Our environmental laws have grown out of a combination of the English common law—derived from custom and judgment, rather than legislation—and American perspectives on freedom and planning.
- In the 19th and 20th centuries, America experimented with a variety of approaches to conserving nature, some involving laws, some new kinds of plans and organizations. The best combination is yet to be determined.
- International environmental law is proving useful in addressing several important environmental problems, including preservation of resources and pollution abatement.
- Global security, sustainability, and environment are linked in complex ways. Solving environmental problems will improve both sustainability and security.

## STUDY QUESTIONS

1. Based on what you have learned in this book and in your studies about environment, what would an "ecotopia" include, in addition to what is mentioned in this chapter? Which of these items, if any, do you think could be achieved during your lifetime?
2. Just how big should a wilderness be?
3. The famous ecologist Garrett Hardin argued that designated wilderness areas should not have provisions for people with handicaps, even though he himself was confined to a wheelchair. He believed that wilderness should be truly natural in the ultimate sense—that is, without any trace of civilization. Argue for or against Garrett Hardin's position. In your argument, consider the "people and nature" theme of this book.
4. How can we balance freedom of individual action with the need to sustain our environment?
5. Visit a local natural or naturalistic place, even a city park, and write down what is necessary for that area to be sustainable in its present uses.
6. Should trees—and other nonhuman organisms—have legal standing? Explain your position on this topic.
7. Since there are no international laws that are binding in the same way that laws govern people within a nation, what can be done to achieve a sustainable environment for world fisheries or other international resources?
8. Do you think the Gulf oil spill could have been prevented? If so, how?
9. Do you think Garrett Hardin is right—that there are some technologies (such as drilling in deep water) that humans are not prepared to adequately address and that there will thus be continued accidents due to human error?