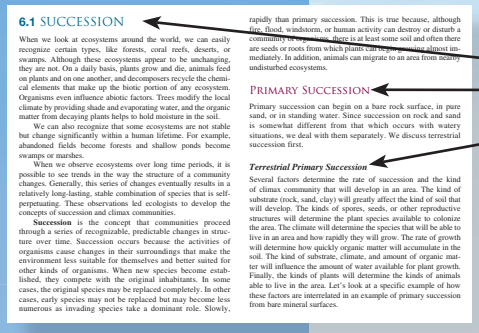
GUIDED TOUR

UP-TO-DATE COVERAGE OF CURRENT ISSUES

Environmental issues and the facts related to issues constantly change. Therefore, the authors strive to provide the most current information available.



6.1 SUCCESSION

When we look at ecosystems around the world, we can easily recognize certain types, like forests, coral reefs, deserts, or swamps. Although these ecosystems appear to be unchanging, they are not. On a daily basis, plants grow and die, animals feed on plants and on one another, and decomposers recycle the chemical elements that make up the biotic portion of any ecosystem. Organisms even influence abiotic factors. Trees modify the local climate by providing shade and evaporating water, and the organic matter from decaying plants helps to hold moisture in the soil.

We can also recognize that some ecosystems are not stable but change significantly within a human lifetime. For example, abandoned fields become forests and shallow ponds become swamps or marshes.

When we observe ecosystems over long time periods, it is possible to see trends in the way the structure of a community changes. Generally, this series of changes eventually results in a relatively long-lasting, stable combination of species that is self-perpetuating. These observations led ecologists to develop the concepts of succession and climax communities.

Succession is the concept that communities proceed through a series of recognizable, predictable changes in structure over time. Succession occurs because the activities of organisms cause changes in their surroundings that make the environment less suitable for themselves and better suited for other kinds of organisms. When new species become established, they compete with the original inhabitants. In some cases, the original species may be replaced completely. In other cases, early species may not be replaced but may become less numerous as invading species take a dominant role. Slowly, rapidly than primary succession. This is true because, although fire, flood, windstorm, or human activity can destroy or disturb a community of organisms, there is at least some soil and often there are seeds or roots from which plants can regrow, existing almost immediately. In addition, animals can migrate to an area from nearby undisturbed ecosystems.

PRIMARY SUCCESSION

Primary succession can begin on a bare rock surface, in pure sand, or in standing water. Since succession on rock and sand is somewhat different from that which occurs with watery situations, we deal with them separately. We discuss terrestrial succession first.

Terrestrial Primary Succession

Several factors determine the rate of succession and the kind of climax community that will develop in an area. The kind of substrate (rock, sand, clay) will greatly affect the kind of soil that will develop. The kinds of spores, seeds, or other reproductive structures will determine the plant species available to colonize the area. The climate will determine the species that will be able to live in an area and how rapidly they will grow. The rate of growth will determine how quickly organic matter will accumulate in the soil. The kind of substrate, climate, and amount of organic matter will influence the amount of water available for plant growth. Finally, the kinds of plants will determine the kinds of animals able to live in the area. Let's look at a specific example of how these factors are interrelated in an example of primary succession from bare mineral surfaces.

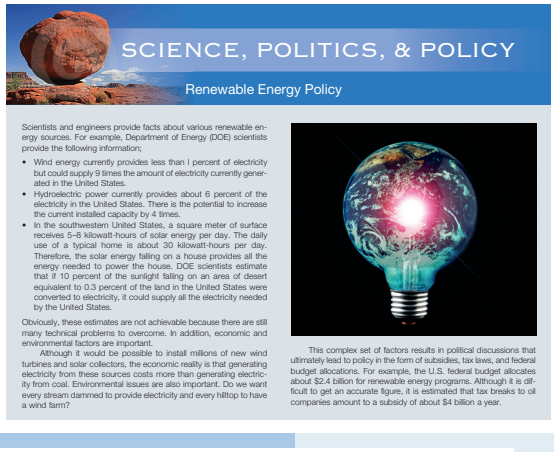
WRITTEN FOR STUDENTS

HEADINGS AND SUBHEADINGS

Numerous headings and subheadings help students follow the organization of the subject matter.

FOCUS ON

Focus On features provide in-depth coverage of current topics.



SCIENCE, POLITICS, & POLICY

Renewable Energy Policy

Scientists and engineers provide facts about various renewable energy sources. For example, Department of Energy (DOE) scientists provide the following information;

- Wind energy currently provides less than I percent of electricity but could supply 9 times the amount of electricity currently generated in the United States.
- Hydroelectric power currently provides about 6 percent of the electricity in the United States. There is the potential to increase the current installed capacity by 4 times.
- In the southwestern United States, a square meter of surface receives 5–8 kilowatt-hours of solar energy per day. The daily use of a typical home is about 30 kilowatt-hours per day. Therefore, the solar energy falling on a house provides all the energy needed to power the house. DOE scientists estimate that if 10 percent of the sunlight falling on an area of desert equivalent to 0.3 percent of the land in the United States were converted to electricity, it could supply all the electricity needed by the United States.

Obviously, these estimates are not achievable because there are still many technical problems to overcome. In addition, economic and environmental factors are important.

Although it would be possible to install millions of new wind turbines and solar collectors, the economic reality is that generating electricity from these sources costs more than generating electricity from coal. Environmental issues are also important. Do we want every stream dammed to provide electricity and every hilltop to have a wind farm?

This complex set of factors results in political discussions that ultimately lead to policy in the form of subsidies, tax laws, and federal budget allocations. For example, the U.S. federal budget allocates about $2.4 billion for renewable energy programs. Although it is difficult to get an accurate figure, it is estimated that tax breaks to oil companies amount to a subsidy of about $4 billion a year.

FOCUS ON

Whole Ecosystem Experiments

Many environmental issues are difficult to resolve because, although there are hypotheses about what is causing a problem, the validity of the hypotheses has not been tested by experiments. Therefore, when governments seek to set policy, there are always those who argue that there is little hard evidence that the problem is real or that the cause of the problem has not been identified. Several examples include: What causes eutrophication of lakes? What causes acidification of lakes and rivers? What are the causes of global climate change? What is the likelihood that emissions from coal-fired power plants are causing increased mercury in fish? The most powerful tests of hypotheses related to these problems are experiments that take place on a large scale in natural settings. Several such experiments have been crucial in identifying causes of environmental problems and led to policy changes that have alleviated environmental problems.

Beginning in 1966, the Canadian government established the Experimental Lakes Area in western Ontario. Many lakes were designated for experiments that would help answer questions about environmental issues. One experiment tested the hypothesis that phosphorus was responsible for eutrophication (excessive growth of algae and plants) of lakes. Laboratory studies had suggested that carbon, nitrogen, or phosphorus could be responsible. To help answer which of these three nutrients was the cause of eutrophication, a dumb-bell-shaped lake was divided in two at its narrow "waist" by placing a plastic curtain across the lake. One portion had carbon, nitrogen, and phosphorus added to it and the other portion had only carbon and nitrogen added. The results were clear. The portion of the lake with the added phosphorus had an abundant growth of algae and turned green. The other portion of the lake with carbon and nitrogen but no phosphorus did not (see photo). As a result of this experiment, governments were justified in requiring detergent manufacturers to remove phosphorous compounds from their products and requiring sewage treatment plants to eliminate phosphorus from their effluent.

Other experiments on whole lakes have investigated:

- The effects of acid deposition on food webs in lakes—predator fish starve as their prey disappear.
- The effects of flooding of land by dams—there is an increase i the mercury content of fish and carbon dioxide and methane an released into the atmosphere.
- The effects of removal of aquatic vegetation—northern pike popula tions declined.

After each experiment, the Canadian government requires that th lake be returned to its pristine condition.

INTERRELATEDNESS IS A CENTRAL THEME

SCIENCE, POLITICS, & POLICY

This new feature shows how the scientific understanding of environmental problems is filtered through the lens of social and political goals to determine policy.

resources of the country and government policy. Figure 8.11 shows several countries that were selected to show how individual countries use different combinations of technologies to produce electricity. Norway gets nearly all of its electricity from hydroelectric plants. Iceland gets its electricity from a combination of hydroelectricity and geothermal energy. France relies heavily on nuclear power. Most countries have a substantial amount of their energy produced from fossil fuels, primarily coal.

As with other forms of energy use, electrical consumption in different regions of the world varies widely. The industrialized countries of the world, with about 20 percent of the world's population, consume about 55 percent of the world's electricity. Less-developed nations of the world, which have about 80 percent of the world's population, use about 45 percent of the world's electricity. The per capita use of electricity in North America is about 9½ times greater than average per capita use in the less-developed countries. In Bangladesh, the annual per capita use of electricity is about 140 kilowatt hours, which is enough to light a 100-watt lightbulb for less than two months. The per capita consumption of electricity in North America is about 90 times greater than in Bangladesh.

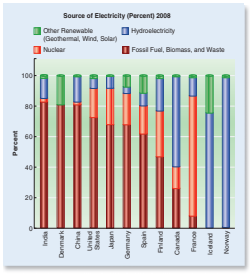


FIGURE 8.11 **Sources of Electricity** Electricity is generated from fossil fuels, nuclear power, hydropower, and other renewable forms of energy (wind, solar, geothermal, tidal). However, countries differ in the combination of technologies used to produce electricity. The differences are based on available natural resources and government policy. The countries shown here were selected to show these differences. Norway and Iceland have abundant hydroelectricity resources. In addition, Iceland has much geothermal energy. France has made the political decision to generate most of its electricity from nuclear power plants. Denmark, Spain, and Germany have made commitments to produce electricity from renewable technologies—particularly wind.
Sources: International Energy Agency online data 2011.

The production and distribution of electricity is a major step in the economic development of a country. In developed nations, about a quarter of the electricity is used by industry. The remainder is used primarily for residential and commercial purposes. In nations that are developing their industrial base, much of their electricity is used by industry. For example, industries consume about 50 percent of the electricity used in South Korea and 70 percent in China.

8.4 THE ECONOMICS AND POLITICS OF ENERGY USE

A direct link exists between economic growth and the availability of inexpensive energy. The replacement of human and animal energy with fossil fuels began with the Industrial Revolution and was greatly accelerated by the supply of cheap, easy-to-handle, and highly efficient fuels. Because the use of inexpensive fossil fuels allows each worker to produce more goods and services, productivity increased. The result was unprecedented economic growth in Europe, North America, and the rest of the industrialized world.

Because of this link between energy and productivity, most industrial societies want to ensure a continuous supply of affordable energy. The higher the price of energy, the more expensive goods and services become. To keep costs down, many countries have subsidized their energy industries and maintained energy prices at artificially low levels. International trade in fossil fuels (particularly oil and natural gas) has a major influence on the world economy and politics. The price of fuels has a huge impact on consumption: low prices encourage consumption and high prices discourage consumption.

FUEL ECONOMY AND GOVERNMENT POLICY

Governments fashion policies that influence how people use energy. Automobile fuel efficiency is one area in which government policy has had significant impact. For example, the price of a liter of gasoline is determined by two major factors: (1) the cost of purchasing and processing crude oil into gasoline and transporting it to the station and (2) various taxes. Most of the differences in gasoline prices among countries are a result of taxes and reflect differences in government policy toward motor vehicle transportation. The cost of taxes to the U.S. consumer is about 11 percent of the retail gasoline price, and in Canada, about 30 percent of the price of gasoline is taxes, while in Japan and many European countries, taxes account for 40 percent to 60 percent of the cost of gasoline. (See figure 8.12.) When we compare the kinds of automobiles driven, we find a direct relationship between the cost of fuel and fuel efficiency. In the United States and Canada, the average fleet fuel economy is about 8.6 liters per 100 kilometers (27 miles per gallon). This compares with a European average of about 5.2 liters per 100 kilometers (45 miles per gallon). The average European car driver pays about twice as much for fuel as U.S. and Canadian drivers and uses about 40 percent less fuel to drive the same distance as a U.S. driver. Since taxes make up the majority of the price of gasoline

TEXT INCLUDES MORE THAN SCIENCE

Social, political, and economic aspects of environmental issues are included throughout the text.

POSITIVE TRENDS ARE HIGHLIGHTED

Going Green

The Going Green feature provides specific examples that highlight positive change.


GOING GREEN

Conservation Easements

There are over 1600 private organizations in the United States that are involved in conservation of land. Some are small, single-purpose organizations that protect a small parcel of land with special conservation value. On the other hand, The Nature Conservancy is an international organization that has protected millions of acres.

People often develop an attachment to their land and wish to see it preserved even after they have died. People may have a long family history of using the land for farming or ranching and want to see that use continue. Others may recognize that their land has special conservation value because of its geology, scenic value, or biodiversity and wish to see it protected for the public good. Others may simply have a purely emotional reason for wanting to preserve their land. One of the tools used by land conservation organizations is a legal tool known as a *conservation easement*.

A conservation easement is a legally binding agreement placed on a piece of privately held land that limits the future use or development even when the land is passed to heirs or sold. For example, a conservation easement may prohibit the subdividing of a piece of land or restrict buildings to a specific portion of the property, or an easement may specify that the public must have access to view significant biological or geological features. Alternatively, the easement may restrict access to protect endangered species or archeological sites.

Regardless of their motivation, when people enter into a conservation easement they give up something. In some cases, people donate a conservation easement and receive no financial benefit. In other cases, they may sell a conservation easement to an organization that agrees to provide stewardship of the property into the future. In nearly all cases the placement of a conservation easement on property diminishes its economic value, since its future use is restricted. Yet, thousands of people have entered into such arrangements. As of "2011", in the United States over "18" million acres of land (an area about the size of "Maine") had been protected by conservation easements.

Thinking Green

The Thinking Green feature points out individual actions that can have an impact and encourage students to be involved.

THINKING GREEN

1. Calculate your ecological footprint.
2. Participate in sustainability activities in your community or university.
3. Give up the use of your car for part of each week. Walk, bicycle, or take public transportation.
4. Read *Silent Spring*, *A Sand County Almanac*, and *Walden*.
5. Work with a local business in helping it apply green business concepts.

EXCELLENT ILLUSTRATIONS

Photos, drawings, and tables are used to help students visualize complex ideas and organize their thinking.

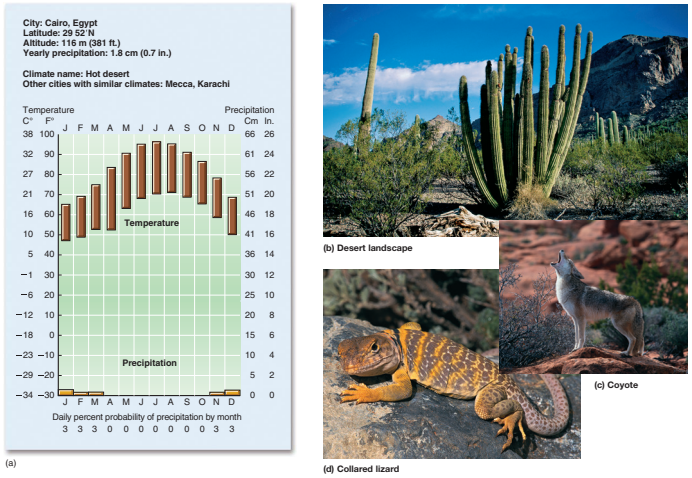


FIGURE 6.10 **Desert** (a) Climagraph for Cairo, Egypt. (b) The desert receives less than 25 centimeters (10 inches) of precipitation per year, yet it teems with life. Cactus, sagebrush, lichens, snakes, small mammals, birds, and insects inhabit the desert. (c) Coyotes are common in North American deserts. (d) Collared lizards are common reptiles in many deserts of the United States. Because daytime temperatures are often high, most animals are active only at night, when the air temperature drops significantly. Cool deserts also exist in many parts of the world, where rainfall is low but temperatures are not high.

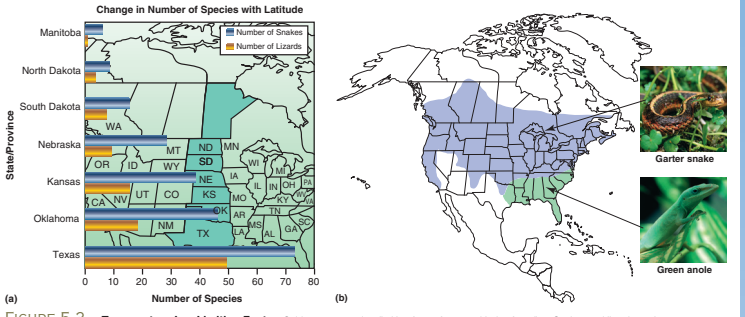
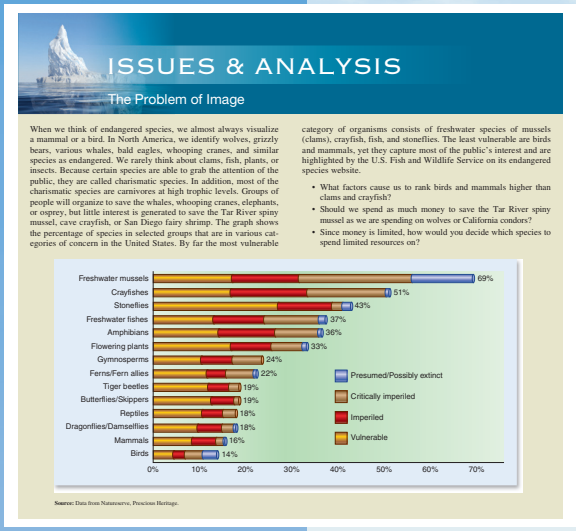


FIGURE 5.3 **Temperature Is a Limiting Factor** Cold temperature is a limiting factor for many kinds of reptiles. Snakes and lizards are less common in cold regions than in warm regions. (a) The graph shows the number of species of snakes and lizards in regions of central North America. Note that the number of species declines as one proceeds from south to north. (b) Some species, like the common garter snake (*Thamnophis sirtalis*), have a broad range of tolerance and are not limited by cold temperature. It is found throughout the United States and several Canadian provinces. However, the green anole (*Anolis carolinensis*) has a very narrow range of tolerance and is found only in the warm, humid southeastern states.

CRITICAL THINKING AND APPLICATIONS – VITAL FOR EVERY STUDENT!



Critical Thinking Essay

An essay on critical thinking is present in the front matter of the text.

Issues & Analysis Readings

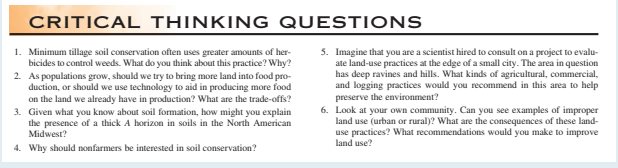
Issues & Analysis readings present real-world, current issues and provide questions that prompt students to think about the complex issues involved.

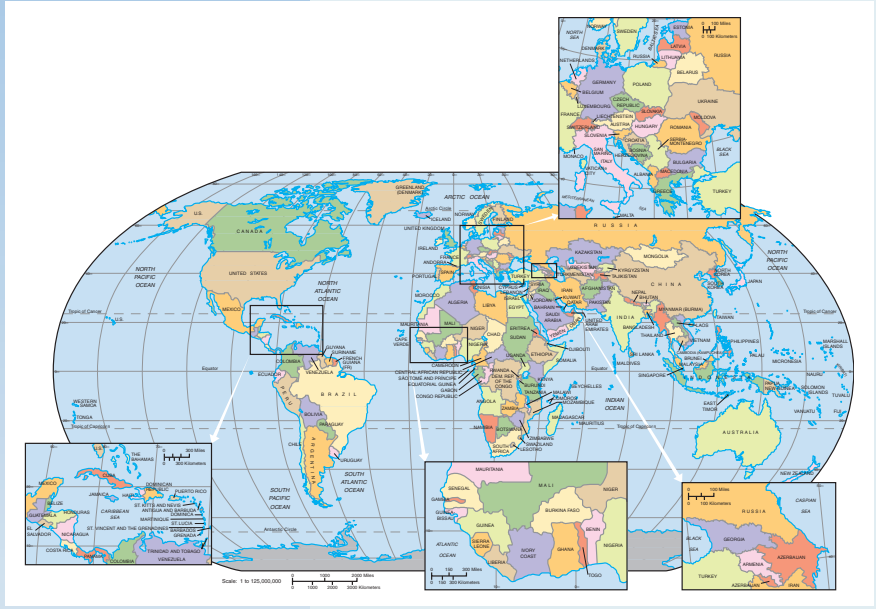
What's Your Take?

This feature presents an issue and asks students to choose one side of the issue and develop arguments that support their position. This activity helps students develop and enhance their critical thinking skills.

Critical Thinking Questions

Critical Thinking Questions appear at the end of each chapter. The questions require students to evaluate information, recognize bias, characterize the assumptions behind arguments, and organize information.





Foldout Maps

Included at the end of this book as foldouts are two maps: a political map showing the boundaries of the countries throughout the world and a global vegetation map.