

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.

WRITTEN FOR STUDENTS

HEADINGS AND SUBHEADINGS

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

CASE STUDIES

Case studies provide in-depth coverage of current topics.

POPULATION CHARACTERISTICS

A **population** can be defined as a group of individuals of the same species inhabiting an area. Just as individuals within a population are recognizable, different populations of the same species have specific characteristics that distinguish them from one another. Some important ways in which populations differ include natality (birthrate), mortality (death rate), sex ratio, age distribution, growth rates, density, and spatial distribution.

NATALITY—BIRTHRATE

Natality refers to the number of individuals added to the population through reproduction over a particular time period. There are two ways in which new individual organisms are produced: asexual reproduction and sexual reproduction.

Asexual Reproduction

Bacteria and other tiny organisms reproduce primarily asexually when they divide to form new individuals that are identical to the original parent organism. Even plants and many kinds of animals, such as sponges, jellyfish, and many kinds of worms, reproduce asexually by dividing into two parts or by budding off small portions of themselves that become independent individuals. Even some insects and lizards have a special kind of asexual reproduction in which the females lay unfertilized eggs that are genetically identical to the female.

Sexual Reproduction

However, most species have some stage in their life cycle in which they reproduce sexually. In plant populations, sexual reproduction

involves the production of numerous seeds, but the seeds must be in appropriate environments before they will germinate to produce a new individual. Animal species also typically produce large numbers of offspring as a result of sexual reproduction.

In human populations, natality is usually described in terms of the **birthrate**, the number of individuals born per 1000 individuals per year. For example, if a population of 2000 individuals produced 20 offspring during one year, the birthrate would be 10 per thousand per year. The natality for most species is typically quite high. Most species produce many more offspring than can be raised to replace the parents.

MORTALITY—DEATH RATE

It is important to recognize that the growth of a population is not determined by the birthrate (natality) alone. **Mortality**, the number of deaths in a population over a particular time period, is also important. For most species, mortality rates are very high, particularly among the younger individuals. For example, of all the seeds that plants produce, very few will result in a mature plant that itself will produce offspring. Many seeds are eaten by animals, some do not germinate because they never find proper soil conditions, and those that germinate must compete with other organisms for nutrients and sunlight.

In human population studies, mortality is usually discussed in terms of the **death rate**, the number of people who die per 1000 individuals per year. Compared to the high mortality of the young of most species, the infant death rate of long-lived animals such as humans is relatively low. In order for the size of a population to grow, the number of individuals added by reproduction must be greater than the number leaving it by dying. (See Figure 7.1.)

Water Connections

VARzea FORESTS—WHERE THE AMAZON RIVER AND LAND MEET

The Amazon River and 8 many tributaries constitute the largest drainage basin (about 40 percent of South America) and the highest volume of flow of any river system in the world—about 20 percent of all river flow in the world. The water is supplied by abundant rainfall—many areas receive over 300 cm (100 in.) of rain per year—in the basin and throughout the Andes. Because the snowmelt, and to a certain extent the rainfall, is seasonal, the Amazon and its tributaries are characterized by seasonal flooding. Much of the river basin is very flat. The city of Iquitos is about 3000 kilometers (2000 miles) from the ocean but the river at that point is only 100 meters (300 feet) above sea level. When the river floods, extensive areas along the river are flooded under several meters of water due to the flat terrain. The area flooded extends several kilometers from the river. This creates a seasonal wetland forest known as the varzea. The land farther from the river that does not flood is known as the terra firme. This seasonally flooded area accounts for about 4 percent of the total area of the Amazon rainforest. The vegetation of the varzea is different from that of the terra firme because the trees and other vegetation must be able to withstand extensive periods of flooding.

The animals of the river and the varzea are greatly affected by flooding. Animals of the river move into the forest with the flood and use forest resources as food. Varzea forest areas are critical to the freshwater

fisheries of the Amazon Basin, since many fish actually change their diet and become fruit eaters when they are able to enter the flooded forest. In the drier portions of the year when the river recedes, they return to the main river channel and eat carnivores. In addition to using the forest for food, the fish also distribute the seeds of fruits in their feces. Other river animals such as the caimans and the giant river otter also move into the forest with the flood.

The terrestrial animals of the forest face a different problem. As the river rises, they are forced to retreat to higher ground and often become trapped on islands. This results in intense competition for food. Monkeys and birds are less troubled by the flooding. Many of them rely on fruits of trees as their primary food source, which is available even during the flood. The monkeys can simply travel from tree to tree and the birds can fly over the water.

The periodic flooding of the area deposits silt, which provides a fertile soil. Therefore, the varzea is affected by human activity as farmers use the dry season to raise crops. Often the crops are a mixture of normal forest plants along with crops like bananas, rice, and root crops. Because of the flooding, people who live along the river build their houses on high ground and often on stilts. The rivers are also the primary highways of the region and small boats are the most common form of transportation.



Boats are primary form of transportation. Here bananas are being loaded to go to market.



The river nearly reaches to the top of this bank during floods that occur every year.



Varzea forest

purposes. In nations that are developing their industrial base, over half of the electricity is used by industry. For example, industries consume about 50 percent of the electricity used in South Korea.

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 has a major influence on the world economy and politics. The emphasis on low-priced fuels has encouraged high rates of consumption.

FUEL ECONOMY AND GOVERNMENT POLICY

Governments fashion policies that influence how people use en-

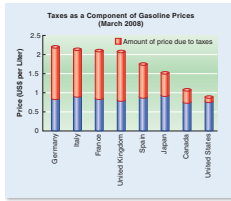


FIGURE B.12 Gasoline Taxes and Fuel Efficiency The price paid for fuel is greatly influenced by the amount of tax paid. High fuel prices cause consumers to choose automobiles with greater fuel efficiency. Source: International Energy Agency.

Another objective of governments is to have a mechanism for generating the money needed to build and repair roads. Many European countries raise more money from fuel taxes than they spend on building and repairing roads. The United States, on the other hand, raises approximately 60 percent of the monies needed for roads from fuel taxes. The relatively low cost of fuel in the United States encourages more travel, which in-



THE ARCTIC NATIONAL WILDLIFE REFUGE

The Arctic National Wildlife Refuge (ANWR) has been a source of controversy for many years. The major players are environmentalists who seek to preserve this region as wilderness; the state of Alaska, which funds a major portion of its activities with dividends from oil production; Alaska residents, who receive a dividend payment from oil revenues; oil companies that want to drill in the refuge; and members of Congress who see the oil reserves in the region as important economic and political issues.

In 1960, 3.6 million hectares (8.9 million acres) were set aside as the Arctic National Wildlife Refuge. Passage of the Alaskan National Interest Lands Conservation Act in 1980 expanded the refuge to 6 million hectares (15.8 million acres) and established 3.5 million hectares (8.6 million acres) as wilderness. The act also renamed the area the Arctic National Wildlife Refuge. There are international implications to this act. The refuge borders Canada's Northern Yukon National Park. Many animals, particularly members of the Porcupine caribou herd, travel across the border on a regular yearly migration. The United States is obligated by treaty to protect these migration routes.

Alaska relies on oil for about 60 percent of its revenue and has no sales or income tax. Furthermore, each Alaskan citizen receives a yearly dividend check from a state fund established with proceeds from oil companies. Even so, some Alaskan citizens support drilling; others oppose it. The Inupiat Eskimos who live along the north Alaskan coast mostly are in favor of drilling in ANWR. The Inupiat believe oil revenues and land rental fees from oil companies will raise their living standards. The other Native American tribe in the region, the Gwich'in, who live on

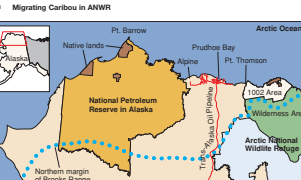
the southern fringe of the refuge, oppose drilling. They argue that the drilling will impact the caribou migration through the area every fall and thus affect their ability to provide food for their families.

In 2000, the Energy Information Administration (EIA) released a report on the potential oil production from the coastal plain of ANWR. The report stated that the coastal plain region of ANWR is the largest unexplored, potentially productive geologic onshore basin in the United States.

Oil companies have repeatedly stated that the oil can be recovered without endangering wildlife or the fragile Arctic ecosystem. Conservationists have argued that none of the reserve should be developed when improvements in energy conservation could reduce the demand for oil. They argue that drilling in the reserve will harm the habitat of millions of migratory birds, caribou, and polar bears.

In 2002, President George W. Bush reaffirmed his support for drilling. A decision on permitting the exploration and development is up to the U.S. Congress. The act that established ANWR requires specific authorization from Congress before oil drilling or other development activities can take place on the coastal plain in the refuge. The coastal plain has the greatest concentration of wildlife, is the calving ground for the Porcupine caribou, and has the greatest potential for oil production.

Members of Congress are split on this issue. Debate is heated. In 2007, an attempt was made by an Alaskan senator to allow drilling by attaching an appropriations bill. This attempt failed, but the issue will continue to come up as the United States continues to explore ways to meet its energy needs.



Migrating Caribou in ANWR

Source: Data from USGS Fact Sheet 0228-01, online report.

INTERRELATEDNESS IS A CENTRAL THEME

WATER CONNECTIONS

The new Water Connections feature shows how water is involved in most aspects of environmental issues.

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 new Going Green feature shows specific examples of actions that are environmentally friendly.

CAMPUS SUSTAINABILITY INITIATIVES

The new Campus Sustainability Initiative points out actions of students and the institutions they attend that are making a difference.

THINKING GREEN

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



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 2005, in the United States, over 6 million acres of land (an area about the size of Vermont) had been protected by conservation easements.



THINKING GREEN

1. Look for locally grown produce in the supermarket—less energy is used to transport locally grown products.
2. Join a local environmental organization.
3. Volunteer for your local Earth Day event in April.
4. Visit a natural area, nature center, or park typical of your region and learn to identify five plants.
5. Go to the website of the League of Conservation Voters, click on the Scorecard tab, and find out the "environmental score" of your senators and representative.

CAMPUS SUSTAINABILITY INITIATIVE




THE ASSOCIATION FOR THE ADVANCEMENT OF SUSTAINABILITY IN HIGHER EDUCATION

The Association for the Advancement of Sustainability in Higher Education (AASHE) was founded in 2006 as a membership organization of colleges and universities in the United States and Canada. There are currently about 500 member colleges and universities. AASHE's mission is to promote sustainability in all aspects of higher education. Its definition of sustainability includes human and ecological health, social justice, secure livelihoods, and a better world for all generations. A core concept of AASHE is that higher education must be a leader in preparing students and employees to understand the importance of sustainability and to work toward achieving it. Furthermore, campuses should showcase sustainability in their operations and curriculum.

To accomplish its goals, AASHE sponsors conferences and workshops to educate members. It also provides networking opportunities and an e-bulletin to facilitate the exchange of information about sustainable practices on campuses.

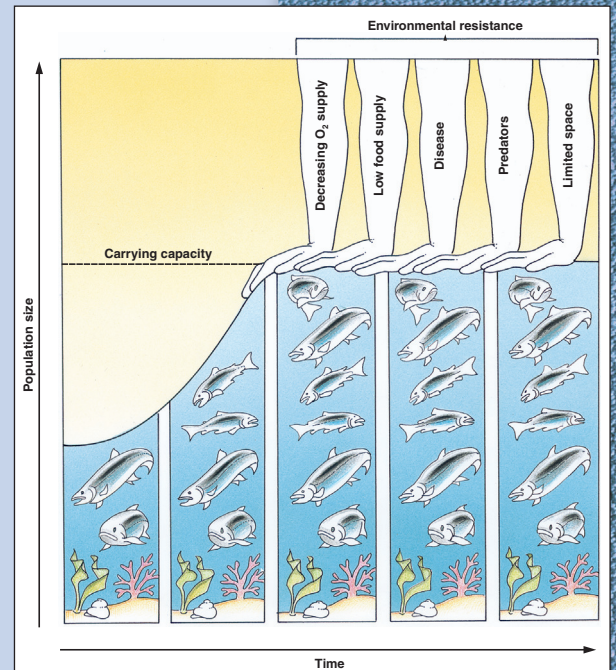
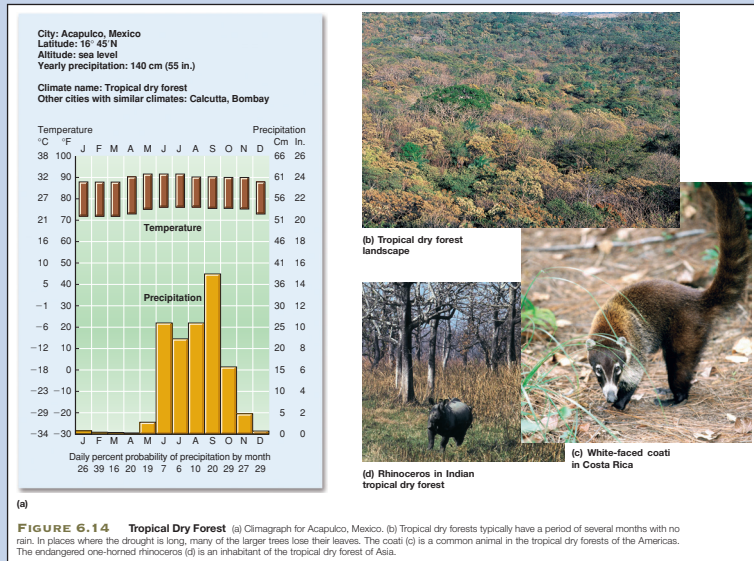
AASHE is currently developing a rating system that will allow educational institutions to assess their progress toward achieving sustainability. The Sustainability Tracking, Assessment, and Rating System (STARS) focuses on three major categories of activity: education and research, operations, and administration and finance.

In each chapter of this edition of *Environmental Science: A Study of Interrelationships*, we will highlight the efforts of one of the member colleges of AASHE to achieve sustainability. Is your college a member? Go to the AASHE website and check its membership list.



EXCELLENT ILLUSTRATIONS

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



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.

ISSUES & ANALYSIS

Ecosystem Loss in North America

North America contains a variety of species and ecosystems, including temperate rainforests, grasslands, wetlands, deserts, and more. Species in the United States include grizzly bears, spotted owls, ghost-faced bats, horned puffins, and reedwood trees, as only a few examples.

As in the tropics, North America's storehouse of biodiversity is being threatened. As of May 2002, the U.S. Fish and Wildlife Service and the National Marine Fisheries Service combined had listed 1231 species (496 animal species and 735 plant species) as endangered or threatened in the United States. Hundreds of other species are being considered as possible additions to the list. According to The Nature Conservancy, one-third of all U.S. plant and animal species are in need of protection. Many freshwater fishes and wetland species such as muskellunge, crayfish and amphibians are particularly vulnerable. Nearly 500 species in the United States may be nearly extinct.

Canada's endangered species list included 353 species as of May 2002. Among them are the wolverine, killer whale, eastern barn owl, western rattlesnake, tailed frog, white-throated swift, peregrine falcon, and whooping crane. Many of Canada's ecosystems are also in danger. According to the Canadian Nature Federation, 240 hectares (593 acres) of

wildlife habitat are converted or fragmented every hour in Canada, and habitat destruction threatens more than 80 percent of Canada's endangered species with extinction.

Mexico's rich biodiversity is also being lost. Home to nearly 10 percent of the world's terrestrial species, Mexico has a high number of endemic species, the richest diversity of reptiles and cacti, and the second richest diversity of mammals in the world. But almost half of Mexico's 25 million hectares (62 million acres) of tropical dry and humid forests have been cleared for agriculture and grazing, leaving only 10 percent in stable condition. More than 50 percent of Mexico is dry coastal sage scrub or desert, and overgrazing and human-caused fires have degraded much of this land.

Consider the following facts compiled by the World Wildlife Fund:

North American Ecosystem	Percent of Ecosystem Lost
Original North American tallgrass prairie	More than 99 percent transformed
Original primary forest in the 48 contiguous United States	More than 95 percent lost
Midwest oak savanna	More than 98 percent altered
Old-growth forest in the Pacific Northwest	About 90 percent cleared
Wild or scenic rivers in the United States	Between 90 percent and 98 percent degraded
Coastal sage scrub in the United States	Between 70 percent and 90 percent disturbed
Original wetlands in the United States	More than 50 percent drained and filled

- Can you give examples of ecosystem lost in your area?
- What were the circumstances that led to the loss in your area?
- Was there an alternative to the loss of the ecosystem?
- Were any endangered or threatened species affected?

Sources: President's Committee of Advisors on Science and Technology, *Biodiversity: Confronting with the Forces of Life*, Washington, D.C., 2002.



Most prairie has been converted to agriculture.

WHAT'S YOUR TAKE?

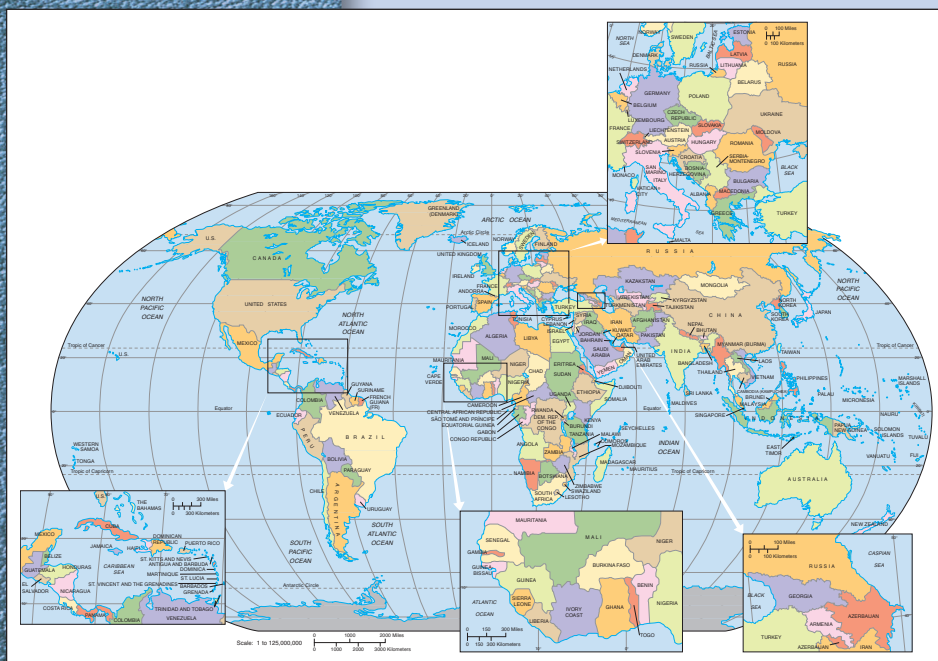
Like much of the developed world, the United States has an aging population and would cease to grow without immigration. Immigrants (both legal and illegal) have larger families than non-immigrants. Immigrants often take low-paying jobs that the rest of the population does not want. Illegal immigrants from Mexico constitute a major problem, and the United States spends over a billion dollars each year to try to control illegal immigration.

Consequently, many people support a guest-worker program in which immigrants could enter the country for specific time periods but must eventually return to their home countries. Choose support or oppose the concept of a guest-worker program, and develop arguments to support your point of view.

CRITICAL THINKING QUESTIONS

1. Why do you suppose some organisms display high natality and others display lower natality? For example, why do cottontail rabbits show high natality and wolves relatively low natality? Why wouldn't all organisms display high natality?
2. Consider the differences between K-strategists and r-strategists. What costs are incurred by adopting either strategy? What evolutionary benefits does each strategy enjoy?
3. Do you think it is appropriate for developed countries to persuade less-developed countries to limit their population growth? What would be appropriate and inappropriate interventions, according to your ethics? Now imagine you are a citizen of a less-developed country. What might be your reply to those who live in more-developed countries? Why?
4. Population growth causes many environmental problems. Identify some of these problems. What role do you think technology will play in solving these problems? Are you optimistic or pessimistic about these problems being solved through technology? Why?
5. Do you think that demographic transition will be a viable option for world development? What evidence leads you to your conclusions?

- What role should the developed countries play in the current demographic transition of developing countries? Why?
6. Imagine a debate between an American and a Sudanese person about human population and the scarcity of resources. What perspectives do you think the American might bring to the debate? What perspectives do you think the Sudanese would bring? What might be their points of common ground? On what might they differ?
 7. Many people in developing countries hope to achieve the standard of living of those in the developed world. What might be the effect of this pressure on the environment in developing countries? On the political relationship between developing countries and already developed countries? What ethical perspective do you think should guide this changing relationship?
 8. The demographic changes occurring in Mexico have an influence on the United States. What problems does Mexico face regarding its demographics? Should the United States be involved in Mexican population policy?



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.