Ninth Edition

ENVIRONMENTAL SCIENCE

A GLOBAL CONCERN

William P. Cunningham
Mary Ann Cunningham
Barbara Woodworth Saigo

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ENVIRONMENTAL SCIENCE: A GLOBAL CONCERN, NINTH EDITION

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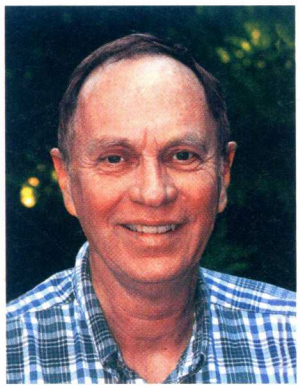


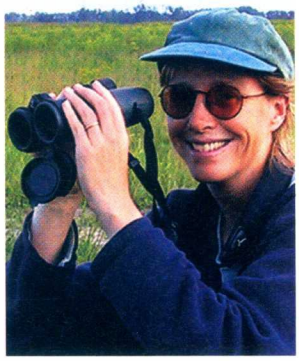
William P. Cunningham is an emeritus professor at the University of Minnesota. In his 38-year career at the university, he taught a variety of biology courses, including Environmental Science, Conservation Biology, Environmental Health, Environmental Ethics, Plant Physiology, and Cell Biology. He is a member of the Academy of Distinguished Teachers, the highest teaching award granted at the University of Minnesota. He was a member of a number of interdisciplinary programs for international students, teachers, and nontraditional students. He also carried out research or taught in Sweden, Norway, Brazil, New Zealand, China, and Indonesia.

Professor Cunningham has participated in a number of governmental and nongovernmental organizations over the past 40 years. He was chair of the Minnesota chapter of the Sierra Club, a member of the Sierra Club national committee on energy policy, vice president of the Friends of the Boundary Waters Canoe Area, chair of the Minnesota governor's task force on energy policy, and a citizen member of the Minnesota Legislative Commission on Energy.

In addition to environmental science textbooks, Cunningham was managing editor for three editions of an *Environmental Encyclopedia* published by Thompson-Gale Press. He has also authored or co-authored about 50 scientific articles, mostly in the fields of cell biology and conservation biology as well as several invited chapters or reports in the areas of energy policy and environmental health. His Ph.D. from the University of Texas was in botany.

Professor Cunningham's hobbies include backpacking, canoe and kayak building (and paddling,) birding, hiking, gardening, and traveling. He lives in St. Paul, Minnesota with his wife, Mary. He has three children (one of whom is co-author of this book) and six grandchildren.

Mary Ann Cunningham



Mary Ann Cunningham is an Assistant Professor of Geography at Vassar College, in New York's Hudson Valley. A biogeographer with interests in landscape ecology, geographic information systems (GIS), and remote sensing, she teaches environmental science, natural resource conservation, and land-use planning, as well as GIS and remote sensing. Field research methods, statistical methods, and scientific methods in data analysis are regular components of her teaching. As a scientist and educator, Mary Ann enjoys teaching and conducting research with both science students and non-science liberal arts students. As a geographer, she likes to engage students with the ways their physical surroundings and social context shape their world experience. In addition to teaching at a liberal arts college, she has taught at community colleges and research universities.

Mary Ann has been writing in environmental science for over a decade, and she has been co-author of this book since its seventh edition. She is also co-author of *Principles of Environmental Science* (now in its fourth edition), and an editor of the *Environmental Encyclopedia* (third edition, Thompson-Gale Press). She has published work on pedagogy in cartography, as well as instructional and testing materials in environmental science. With colleagues at Vassar, she has published a GIS lab manual, *Exploring Environmental Science with GIS,* designed to provide students with an easy, inexpensive introduction to spatial and environmental analysis with GIS.

In addition to environmental science, Mary Ann's primary research activities focus on land-cover change, habitat fragmentation, and distributions of bird populations. This work allows her to conduct field studies in the grasslands of the Great Plains as well as in the woodlands of the Hudson Valley. In her spare time she loves to travel, hike, and watch birds.

Mary Ann holds a bachelor's degree from Carleton College, a master's degree from the University of Oregon, and a Ph.D. from the University of Minnesota.

Preface

ENVIRONMENTAL SCIENCE IN A CHANGING WORLD

Our world is changing rapidly. Our physical environment is being degraded by global climate change, species extinctions, habitat loss, pollution, and other human-caused disruptions. Our social or cultural environment is stressed by unsustainable population growth, increasing gaps between the rich and poor, and sudden social, political, and economic shifts. Pollution drifts between continents. Diseases spread rapidly between countries. The coal burned in China, the nuclear waste dumped in the ocean by the former USSR, or the pesticides used on farms in Central America affect us all. Increasingly, we compete with people in far-away places for the same scarce energy, food, and water resources.

At the same time, we are seeing unparalleled innovations in environmental management and ecological design. Many cities and industries are developing ingenious strategies for ecological efficiency and sustainability. Rapid information exchange allows unprecedented opportunities for creating sustainable economies. To understand these changes, we all need to learn about our global environment—both natural and cultural—in order to find ways to live sustainably in this transformed world.

Our purpose in writing this book is to introduce a global concern into the field of environmental science, as well as to link the science of our environmental change to the human dimensions of problem solving and decision making. Globalizing economies require attention to the environmental problems and opportunities we all share. Ecology, evolution, biogeography, and other natural sciences form a core in the study of our environment, but we need to understand the human dimensions of environmental problems as well, if we hope to find lasting solutions to the dilemmas we face. To accomplish this goal, we have expanded the field of environmental science to include a discussion of ethics and philosophy, health, economics, policy and planning, urban studies, law, and political science. We hope this interdisciplinary approach will give students a broad base for examining an array of important issues.

WHAT SETS THIS BOOK APART?

Although several environmental science books already exist in the market, a variety of features make this text different from the rest.

Global perspective

We provide a global perspective. We live in an interconnected world and, increasingly, colleges and universities promote international studies. To remain competitive in a global economy, it is critical that we understand foreign countries and cultures. We hope that this international perspective will contribute to that educational initiative. Our case studies and examples show the integration between environmental, social, and economic conditions in the United States and abroad. At the same time, we provide familiar examples that demonstrate here at home the urgency of the issues we discuss.

Emphasis on science

Science helps us understand environmental change. The underlying principles and methods of science help us understand the processes of environmental change. The examples and explanations found in the text will help students appreciate why scientific inquiry is such an important and exciting approach for modern society. Our "Exploring Science" essays give examples of how scientists work, how we observe and understand the practical details of science.

Critical thinking

Critical thinking is a central theme. Environmental science is a complex field, one in which special interests, contradictory data, and conflicting interpretations battle for our attention. How can we decide what to believe when different experts hold contradictory opinions on controversial topics? Perhaps the most valuable skill any student can gain from the study of environmental science is the ability to think purposively, analytically, and clearly about evidence. In brief "Think About It" boxes and in longer "What Do You Think?" essays, we encourage students to reflect on readings and to practice open-mindedness, skepticism, independence, and an ability to empathize with others. We discuss all these skills in the unique introductory chapter of this book titled, "Learning to Learn," and then model their application throughout the text and questions at the end of each chapter.

Balanced presentation

A balanced, optimistic view keeps students engaged. We encourage students to form their own opinions. Environmental science has many dilemmas, and we present multiple views on complex debates. While acknowledging dilemmas, we also are careful to describe good news, progress toward solutions, and the many ways individuals can make positive contributions toward environmental protection. We also recognize that there are multiple ways to interpret data, and we attempt to find a balance between competing views.

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CHANGES TO THE NINTH EDITION

The ninth edition of *Environmental Science: A Global Concern* is the result of extensive analysis of the text and evaluation of input from instructors who constructively reviewed chapters during various stages of this revision. Listed first are general changes that have been made to the entire text, followed by more specific changes to various chapters. Visit http://www.mhhe.com/cunningham9e to access a detailed list of changes for each chapter.

Global changes

- A new lively and colorful design presents information that will capture and hold student attention.
- Current, global case studies with accompanying graphs, maps, and photos now introduce each chapter. The concepts presented are then expanded throughout the chapter to help students appreciate and understand how environmental issues impact our lives on a daily basis. Forty-five additional case studies can also be found on the textbook's website (http://www.mhhe.com/cunningham9e).
- Two hundred twenty-five figures and photos are new or revised, providing students with more realistic images that reflect current data and illustrate changing topics.
- New "Think About It" boxes provide several opportunities in each chapter for students to review material, practice critical thinking, or apply principles they have just read.
- Twelve new or updated "Exploring Science" boxed readings throughout the text allow students to focus on the underlying principles and methods of science.
- Each chapter has an updated "Further Readings" list.
- A NEW Subject and Internet Index allows the reader to quickly scan the subject Index to identify correlating content located on the website (http://www.mhhe.com/cunningham9e). Supporting Web content for *Environmental Science: A Global Concern* features a NEW Index for quick and efficient search capabilities.

Specific changes

- Chapter 1—new opening case study on climate change in the Arctic (and effect on Inuit people) that correlates to the image on the cover; new "What Do You Think?" box on ecological footprints; new graphs of ecological footprints by world region.
- Chapter 2—revised to emphasize science and systems approaches.
- Chapter 4—includes greatly enhanced coverage of evolution and speciation.
- Chapter 5—maintains and builds coverage of marine ecosystems as well as adding climate graphs to biome discussions.
- Chapter 7—updated data on global population trends and family planning policies.
- Chapter 9—new opening case study on rapid expansion of farming in Brazil; added discussions on CAFOs, desertification, and China's efforts to stop spread of deserts.
- Chapter 10—rewritten section on pesticide history.
- Chapter 11—new section on molecular taxonomy.
- Chapter 12—new material on the Monteverde cloud forest, Brazil's Atlantic rainforest, and the Malpai borderlands; added extensive section on new methods of fire management.
- Chapter 14—new opening case study on the 2004 Indian Ocean tsunami; new section and table on worst natural disasters; new discussion on earthquakes and tsunamis.
- Chapter 15—new material of ice core research and volcanoes; major revision of evidence for climate change; major revision of section on Kyoto and carbon trading.
- Chapter 16—new opening case study on mercury pollution; new section on new source review and the 2005 Clean Air Interstate Rule.
- Chapter 18—new opening case study on the Gulf of Mexico dead zone.
- Chapter 19—revised discussions of the history of energy use and modern energy use; added material on oil exploration and directional drilling; revised section on natural gas supplies and use.
- Chapter 21—expanded coverage of commercial-scale recycling programs.
- Chapter 22—new opening case study on the BedZED sustainable living project in London; expanded discussion of sustainable cities.
- Chapter 23—new opening case study on market mechanisms (cap-and-trade system) for controlling carbon emissions.
- Chapter 25—new section on stewardship and environmental science; increased emphasis on shared interests of minority groups, businesses, and others in environmental quality.

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The professional team involved in producing this text has vested many hours in making it the best environmental science text possible. The authors wish to express special thanks to McGraw-Hill for editorial support through Marge Kemp and Joan Weber; the marketing expertise of Tami Petsche; the production team led by April Southwood, Michelle Whitaker, Lori Hancock, Melissa Leick, and Sandy Ludovissy; and the media team of Dan Wallace and Jodi Banowetz.

We thank Dr. Kim Chapman, who wrote four case studies for this edition and offered other helpful advice. His depth of experience in the field of ecological restoration and ecosystem management is a welcome addition to the book. We're indebted to all the students and teachers who have sent helpful suggestions, corrections, and recommendations for improving this book. We hope that those who read this edition will offer their advice and insights as well. Little of the vast range of material in this book represents our own personal research. All of us owe a great debt to the many scholars

whose work forms the basis of our understanding of environmental science. We stand on the shoulders of giants. If errors persist in spite of our best efforts to root them out, we accept responsibility and ask for your indulgence.

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ART AND PHOTOS

View the realistic illustrations and high-quality photos and be assured that your students are getting the highest quality visuals to support their learning experience.

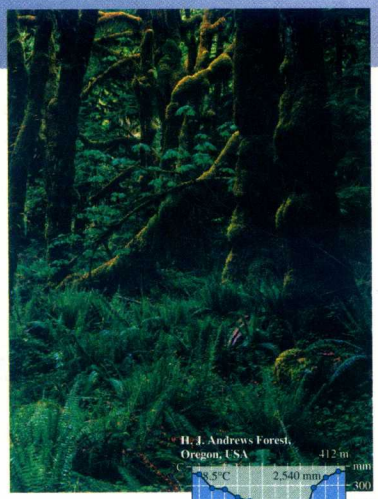


Figure 5.1 Coral polyps are animals containing photosynthetic algae within their tissues. Corals filter food from the water but are also nourished by their symbiotic algae.

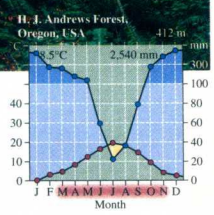
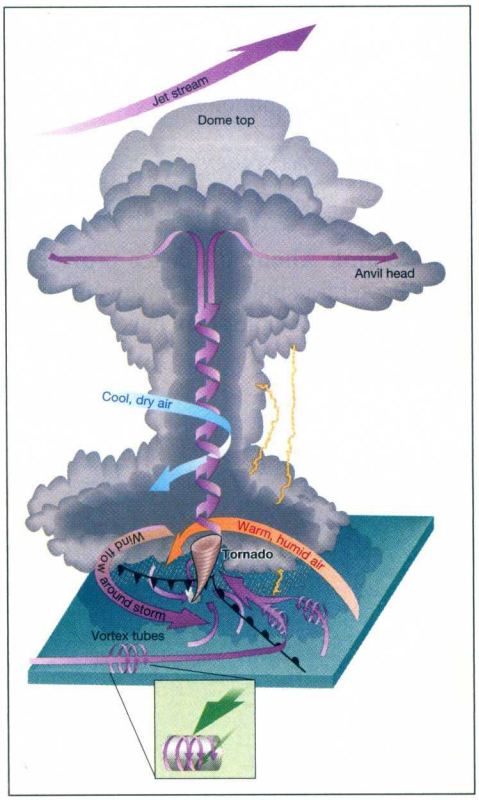


Figure 5.10 Temperate rainforests, have abundant but often seasonal precipitation that supports magnificent trees and luxuriant understory vegetation. Often these forests experience dry summers.

Figure 10.17 A Nigerian woman examines a neem tree, the leaves, seeds, and bark of which provide a natural insecticide. Food and Agriculture Organization (FAO) photo/W. Ciesla.



(a) Survive to old age

(c) High infant mortality

(b) Die randomly

(d) Long adult life span

Figure 6.7 Different survivorship patterns. (*a*) Most elephants survive to old age. (*b*) Seagulls die randomly at all ages from accidents. (*c*) Antelope have high infant mortality, but adults survive well. (*d*) Redwood trees have very high seedling losses, but mature trees live thousands of years.

Figure 4.21 Tropical rainforests are complex structurally and ecologically. Trees form layers, each with a different amount of light and a unique combination of flora and fauna. Many insects, arthropods, birds, and mammals spend their entire life in the canopy. In Brazil's Atlantic Rainforest, a single hectare had 450 tree species and many times that many insects. With so many species, the ecological relationships are complex and highly interconnected.

Figure 12.7 Workers move logs into a paper mill in Oregon, part of a $100 billion per year global trade in forest products.

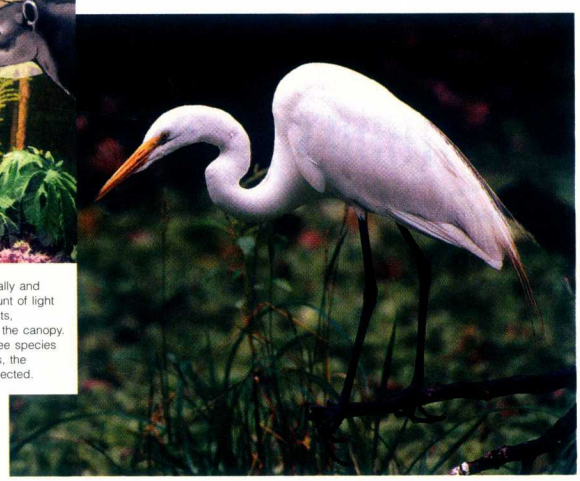


Figure 5.22 Wetlands support astonishing and important biodiversity, though they are often small. Like most herons and egrets, this great egret subsists mainly on frogs and salamanders it finds in wetlands.

INQUIRY AND CRITICAL THINKING

How to convey the excitement and challenge of scientific investigation? These innovative tools provide a framework for "thinking and acting" like a scientist.

"Exploring Science", **"What Do You Think?"**, **"What Can You Do?"**, and **"Think About It"** boxes build upon chapter content and encourage students to practice critical thinking skills and formulate reasoned opinions.

> ***Think About It***
>
> Why might you and your mother rank some risks differently? List some activities on which the two of you might disagree.

New **"Think About It"** boxes provide several opportunities in each chapter for students to review material, practice critical thinking, or apply principles they have just read.

A white-tailed deer (*Odocoileus virginianus*)

what do you THINK?

Too Many Deer?

A century ago, few Americans had ever seen a wild deer. Uncontrolled hunting and habitat destruction had reduced the deer population to about 500,000 animals nationwide. Some states had no deer at all. To protect the remaining deer, laws were passed in the 1920s and 1930s to restrict hunting, and the main deer predators—wolves and mountain lions—were exterminated throughout most of their former range.

As Americans have moved from rural areas to urban centers, forests have regrown, and deer populations have undergone explosive growth. Maturing at age two, a female deer can give birth to twin fauns every year for a decade or more. Increasing more than 20 percent annually, a deer population can double in just three years, an excellent example of irruptive, exponential growth.

Wildlife biologists estimate that the contiguous 48 states now have a population of more than 30 million white-tailed deer (*Odocoileus virginianus*), probably triple the number present in pre-Columbian times. Some areas have as many as 200 deer per square mile (77/km^2). At this density, woodland plant diversity is generally reduced to a few species that deer won't eat. Most deer, in such conditions, suffer from malnourishment, and many die every year of disease and starvation. Other species are diminished as well. Many small mammals and ground-dwelling birds begin to disappear when deer populations reach 25 animals per square mile. At 50 deer per square mile, most ecosystems are seriously impoverished.

The social costs of large deer populations are high. In Pennsylvania alone, where deer numbers are now about 500 times greater than a century ago, deer destroy about $70 million worth of crops and $75 million worth of trees annually. Every year some 40,000 collisions with motor vehicles cause $80 million in property damage. Deer help spread Lyme disease, and, in many states, chronic wasting disease is found in wild deer herds. Some of the most heated criticisms of current deer management policies are in the suburbs. Deer love to browse on the flowers, young trees, and ornamental bushes in suburban yards. Heated disputes often arise between those who love to watch deer and their neighbors who want to exterminate them all.

In remote forest areas, many states have extended hunting seasons, increased the bag limit to four or more animals, and encouraged hunters to shoot does (females) as well as bucks (males). Some hunters criticize these changes because they believe that fewer deer will make it harder to hunt successfully and less likely that they'll find a trophy buck. Others, however, argue that a healthier herd and a more diverse ecosystem is better for all concerned.

In urban areas, increased sport hunting usually isn't acceptable. Wildlife biologists argue that the only practical way to reduce deer herds is culling by professional sharpshooters. Animal rights activists protest lethal control methods as cruel and inhumane. They call instead for fertility controls or trap and transfer programs. Birth control works in captive populations but is expensive and impractical with wild animals. Trapping, also, is expensive, and there's rarely anyplace willing to take surplus animals.

This case study shows that carrying capacity can be more complex than the maximum number of organisms an ecosystem can support. While it may be possible for 200 deer to survive in a square mile, there's an ecological carrying capacity lower than that if we consider the other species dependent on that same habitat. There's also an ethical carrying capacity if we don't want to see animals suffer from malnutrition and starve to death every winter. And there's a cultural carrying capacity if we consider the tolerable rate of depredation on crops and lawns or an acceptable number of motor vehicle collisions.

If you were a wildlife biologist charged with managing the deer herd in your state, how would you reconcile the different interests in this issue? How would you define the optimum deer population, and what methods would you suggest to reach this level? What social or ecological indicators would you look for to gauge whether deer populations are excessive or have reached an appropriate level?

Twelve new or updated **"Exploring Science"** boxed readings throughout the text allow students to focus on the underlying principles and methods of science.

EXPLORING SCIENCE

The Cichlids of Lake Victoria

If you visit your local pet store, chances are you'll see some cichlids (*Haplochromis* sp.). These small colorful, prolific fish come in a wide variety of colors and shapes from many parts of the world. The greatest cichlid diversity on earth—and probably the greatest vertebrate diversity anywhere—is found in the three great African rift lakes: Victoria, Malawi, and Tanganyika. Together, these lakes once had about 1,000 types of cichlids—more than all the fish species in Europe and North America combined. All these cichlids apparently evolved from a few ancestral varieties in the 15,000 years or so since the lakes were formed by splitting of the continental crust. This is one of the fastest and most extensive examples of vertebrate speciation known.

We believe that one of the factors that allowed cichlids to evolve so quickly is that they found few competitors or predators and a multitude of ecological roles to play in these new lakes. There are mud biters, algae scrapers, leaf chewers, snail crushers, zooplankton eaters, prawn predators, and fish feeders. Because they live in different habitats in the lakes, are active at different times of the day, and have developed different body sizes and shapes to feed on specialized prey, the cichlids have been ecologically isolated for long enough to evolve into an amazing variety of species. Cichlids are a good example of radiative evolution.

Unfortunately, a well-meaning but disastrous fish-stocking experiment has wiped out at least half the cichlid species in these lakes in just a few decades and set off a series of changes that are upsetting important ecological relationships. Lake Victoria, which lies between Kenya, Tanzania, and Uganda, has been particularly hard hit. Cichlids once made up 80 percent of the animal biomass in the lake and were the base for a thriving local fishery, supplying much-needed protein for local people. Management agencies regarded the bony little cichlids as "trash fish," and decided in the 1960s to introduce Nile perch (*Lates niloticus*), a voracious, exotic predator that can weigh up to 100 kg (220 lbs) and grow up to 2 m long. The perch, they believed, would support a lucrative commercial export trade.

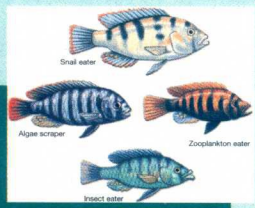
The perch gobbled up the cichlids so quickly that, by 1980, two-thirds of the haplochromine species in the lake were extinct. Although there are still lots of fish in the lake, 80 percent of the biomass is now made up of perch, which are too large and powerful for the small boats, papyrus nets, and woven baskets traditionally used to harvest cichlids. International fishing companies now use large power boats and nylon nets to harvest great schools of perch, which are filleted, frozen, and shipped to markets in Europe and the Middle East. Because the perch are oily, local fishers can't sun dry them as they once did the cichlids. Instead, they are cooked or smoked over wood fires for local consumption. Forests are being denuded for firewood, and protein malnutrition is common in a region that exports 200,000 tons of fish each year.

Perhaps worst of all, Lake Victoria, which covers an area the size of Switzerland, is dying. Algae blooms clot the surface, oxygen levels have fallen alarmingly, and thick layers of soft silt are filling-in shallow bays. Untreated sewage, chemical pollution, and farm runoff are the immediate causes of these deleterious changes, but destabilization of the natural community plays a role as well. The swarms of cichlids that once ate algae and rotting detritus were the lake's self-cleaning system. Eliminating them threatens the long-term ability of the lake to support any useful aquatic life.

As this example shows, species and ecological diversity are important. Misguided management and development schemes that destroyed native species in Lake Victoria have resulted in an ecosystem that no longer supports the natural community or the local people dependent on it. It's difficult to see how we could replace the variety of species and the ecological roles they played, which evolution provided for free.

For more information, see

Stiassny, M. L. J., and A. Meyer. 1999. Cichlids of the rift lakes. *Scientific American* 280(2):64–69.



Cichlid fishes of Lake Victoria. More than 300 species have evolved from an original common ancestor to take advantage of different food sources and habitats.

What Can You DO?

Working Locally for Ecological Diversity

You might think that diversity and complexity of ecological systems are too large or too abstract for you to have any influence. But you can contribute to a complex, resilient, and interesting ecosystem, whether you live in the inner city, a suburb, or a rural area.

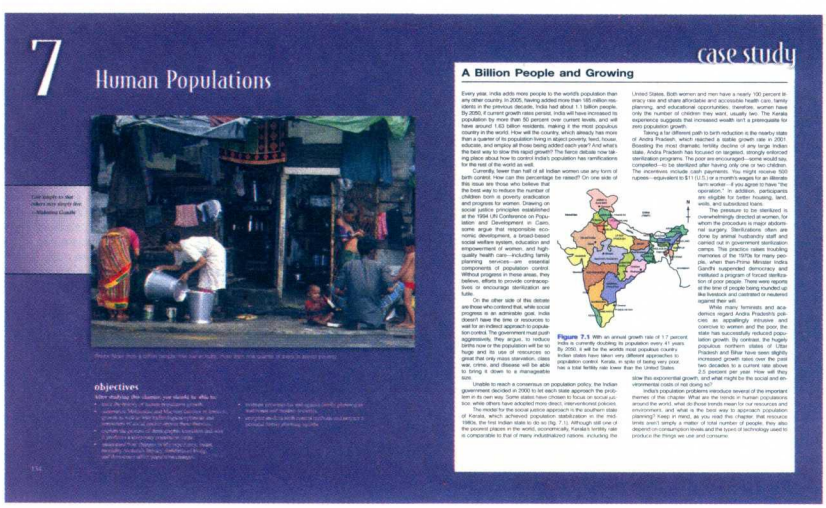
- Keep your cat indoors. Our lovable domestic cats are also very successful predators. Migratory birds, especially those nesting on the ground, have not evolved defenses against these predators (What Do You Think? p. 92).
- Plant a butterfly garden. Use native plants that support a diverse insect population. Native trees with berries or fruit also support birds. Be sure to avoid non-native invasive species: see chapter 11.) Allow structural diversity (open areas, shrubs, and trees) to support a range of species.
- Join a local environmental organization. Often, the best way to be effective is to concentrate your efforts close to home. City parks and neighborhoods support ecological communities, as do farming and rural areas. Join an organization working to maintain ecosystem health; start by looking for environmental clubs at your school, park organizations, a local Audubon chapter, or a local Nature Conservancy branch.
- Take walks. The best way to learn about ecological systems in your area is to take walks and practice observing your environment. Go with friends and try to identify some of the species and trophic relationships in your area.
- Live in town. Suburban sprawl consumes wildlife habitat and reduces ecosystem complexity by removing many specialized plants and animals. Replacing forests and grasslands with lawns and streets is the surest way to simplify, or eliminate, ecosystems.

"What Can You Do?" boxes help students learn that small, individual steps can make a real difference in affecting our environment.

"What Do You Think?" boxes provide challenging case studies that offer an opportunity for students to practice critical thinking skills as well as to learn about an important current issue.

CASE STUDIES

Case studies are an integral instructional aid that utilizes stories to portray real-life issues that affect our resources, our food, our quality of life, and our future. Forty-five additional case studies can be found on the website (http://www.mhhe.com/cunningham9e).



CURRENT/GLOBAL COVERAGE

Current and Contemporary! This edition features current topics covered in today's headlines.

Global Emphasis! View numerous examples from many regions of the world. Students are exposed to the fact that environmental issues are not isolated and easily cross borders and oceans.

Exclusive with McGraw-Hill, students can reference geographical locations quickly and easily by viewing beautiful foldout maps.

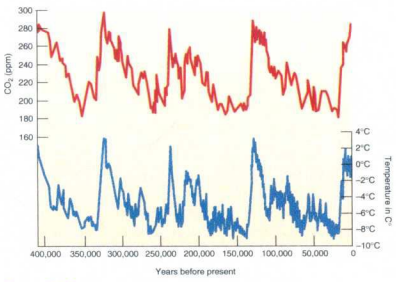


Figure 15.16 Atmospheric CO_2 concentrations and global mean temperatures estimated from the antarctic Vostok ice core. Note the relatively rapid changes and close correlation in both climate and atmospheric chemistry. *Source: Data from United Nations Environment Programme.*

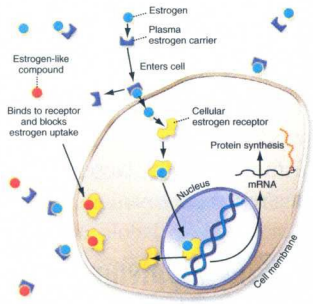


Figure 8.11 Steroid hormone action. Plasma hormone carriers deliver regulatory molecules to the cell surface, where they cross the cell membrane. Intracellular carriers deliver hormones to the nucleus, where they bind to and regulate expression of DNA. Estrogen-like compounds bind to receptors and either block uptake of endogenous hormone, or act as a substitute hormone to disrupt gene expression.

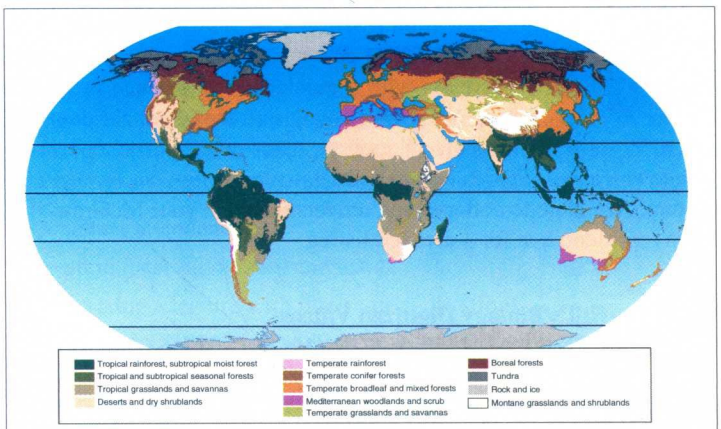


Figure 5.3 Major world biomes. Compare this map to figure 5.2 for generalized temperature and moisture conditions that control biome distribution. Also compare it to the satellite image of biological productivity (fig. 5.13). *Source: WWF Ecoregions.*

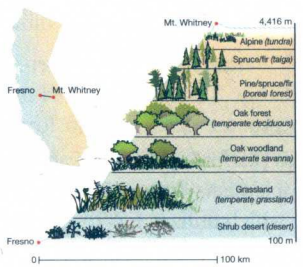


Figure 5.4 Vegetation changes with elevation because temperatures are lower and precipitation is greater high on a mountain side. A 100-km transect from Fresno, California, to Mt. Whitney (California's highest point) crosses vegetation zones similar to about seven different biome types.

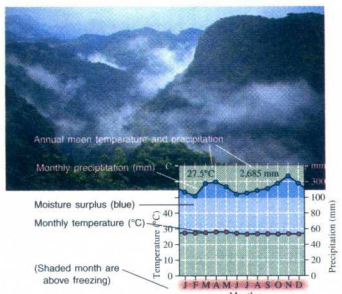


Figure 5.5 Tropical rainforests have luxuriant and diverse plant growth. Heavy rainfall in most months, shown in the climate graph, supports this growth.

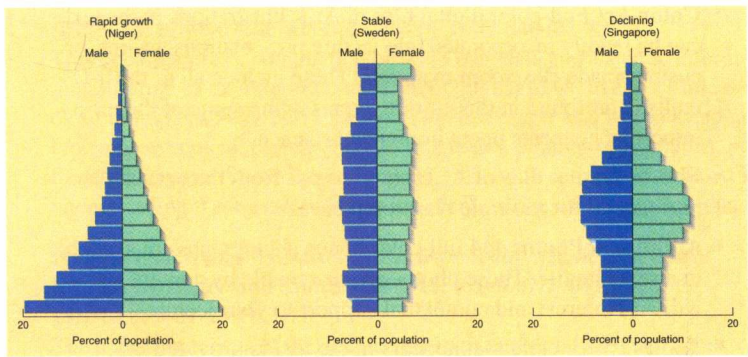


Figure 7.10 Age structure graphs for rapidly growing, stable, and declining populations. *Source: U.S. Census Bureau, 2003.*

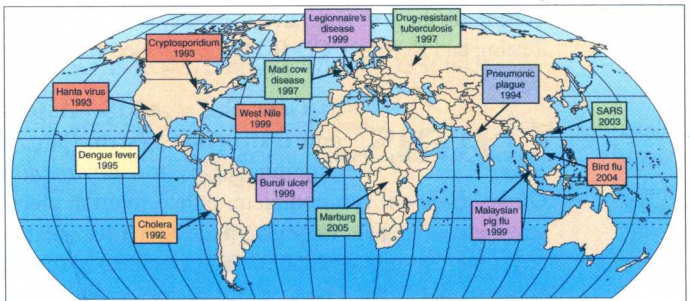


Figure 8.5 Some recent outbreaks of highly lethal infectious diseases. Why are supercontagious organisms emerging in so many different places? *Source: Data from U.S. Centers for Disease Control and Prevention.*

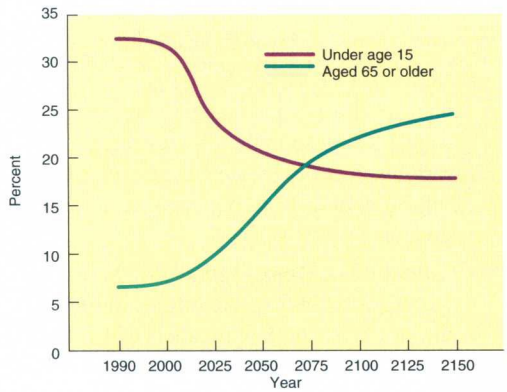


Figure 7.11 Changing age structure of world population. In the twenty-first century, children under 15 years of age will make up a smaller percentage of world population, while people over 65 years old will make up a rapidly rising share of the population.

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Teaching supplements for instructors

Digital Content Manager (CD ISBN-13: 978-0-07-312796-5; CD ISBN-10: 0-07-312796-5; DVD ISBN-13: 978-0-07-326211-6; DVD ISBN-10: 0-07-326211-0)
This easy-to-use multimedia resource allows instructors to utilize artwork from the text in multiple formats to create customized classroom presentation, visually based tests and quizzes, dynamic course website content, or attractive printed support materials. The following digital assets are grouped by chapter on this cross-platform tool.

- **Color Art** Full-color digital files of ALL illustrations in the text can be readily incorporated into lecture presentations, exams, or custom-made classroom materials. These include all of the 3-D realistic art found in this edition, representing some of the most important concepts in environmental science.
- **Photos** Digital files of ALL photographs from the text can be reproduced for multiple classroom uses.
- **Additional Photos** 444 full-color bonus photographs are available in a separate file. These photos are searchable by content and will add interest and contextual support to your lectures.
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- **Animations** 100 full-color animations that illustrate many different concepts covered in the study of environmental science are available for use in creating classroom lectures, testing materials, or online course communication. The visual impact of motion will enhance classroom presentations and increase comprehension.
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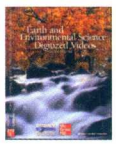

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This CD-ROM contains a wealth of cross-platform (Windows and Macintosh) resources for the instructor. Supplements featured on this CD-ROM include a computerized test bank, which utilizes EZ Test software to quickly create customized exams. This flexible and user-friendly program allows instructors to search for questions by topic, format, or difficulty level, and edit existing questions or add new ones. Multiple versions of the test can be created, and any test can be exported for use with course management systems such as WebCT, Blackboard, or PageOut. Word files of the test bank are included for those instructors who prefer to work outside of the test-generator software. Other assets on the Instructor's Testing and Resource CD-ROM are grouped within easy-to-use folders.

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