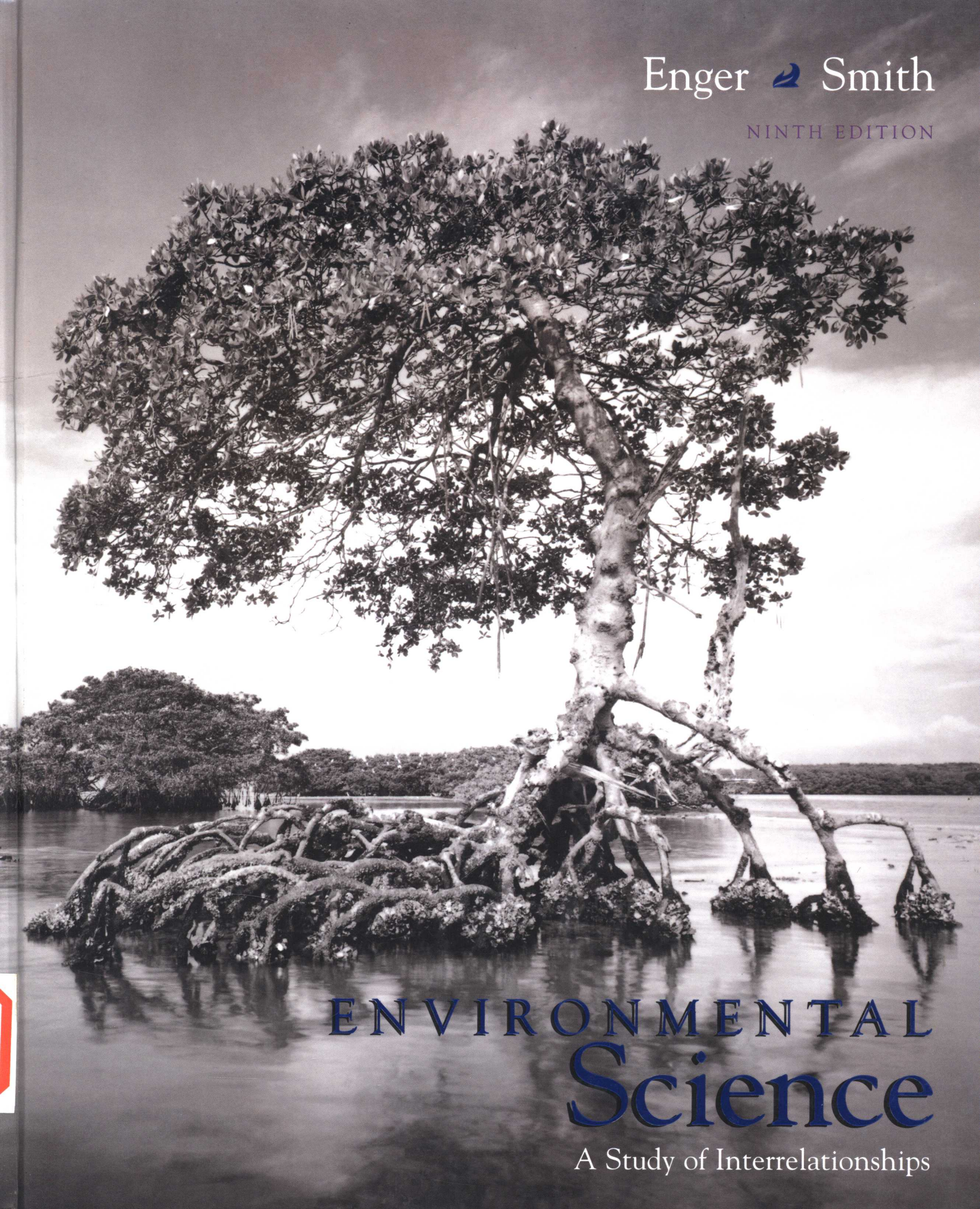


Enger  Smith

NINTH EDITION

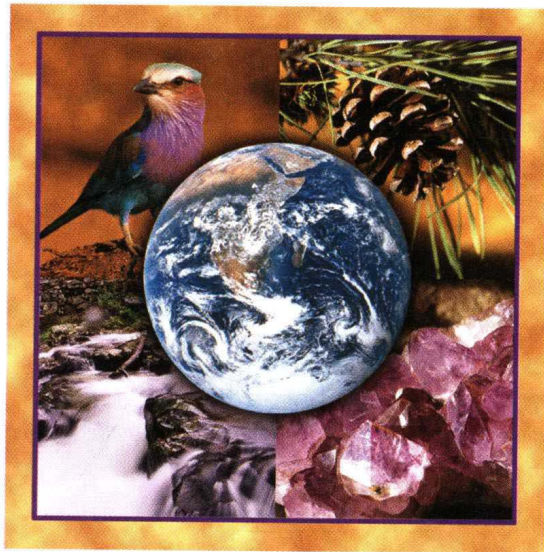


ENVIRONMENTAL
Science

A Study of Interrelationships

Eldon D. Enger
Delta College

Bradley F. Smith
Western Washington University



ENVIRONMENTAL
Science

A Study of Interrelationships



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ENVIRONMENTAL SCIENCE: A STUDY OF INTERRELATIONSHIPS
NINTH EDITION

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To Judy, my wife and friend, for
sharing life's adventures.
Eldon Enger

For Morgan and the summers on Beavertail,
where the roots of environmental
concern took hold.
Brad Smith

preface



Why “A Study of Interrelationships?”

Environmental science is an interdisciplinary field. Because environmental disharmonies occur as a result of the interaction between humans and the natural world, we must include both when seeking solutions to environmental problems. It is important to have a historical perspective, appreciate economic and political realities, recognize the role of different social experiences and ethical backgrounds, and integrate these with the science that describes the natural world and how we affect it. *Environmental Science: A Study of Interrelationships* incorporates all of these sources of information when discussing any environmental issue. Furthermore, the authors have endeavored to present a balanced view of issues, diligently avoiding personal biases and fashionable philosophies.

Environmental Science: A Study of Interrelationships is intended as a text for a one-semester, introductory course for students with a wide variety of career goals. They will find it interesting and informative. The central theme is interrelatedness. No text of this nature can cover all issues in depth. What we have done is to identify major issues and give appropriate examples that illustrate the complex interactions that are characteristic of all environmental problems. Many facts are presented in charts, graphs, and figures that help to illustrate the scope of environmental issues. This is not the core of the text, however, since the facts will change.

Organization and Content

This book is divided into five parts and 20 chapters. It is organized to provide an even, logical flow of concepts along with clear illustrations of the major environmental issues of today. In this ninth edition, each part opens with a guest author’s essay highlighting an environmental issue close to their home.

Part 1 establishes the theme of the book by looking at the kinds of **environmental issues** typical of different regions of North America. In each region, the specific issues selected involve scientific, social, political, and economic components typical of environmental problems. Chapter 2 focuses on the philosophical base needed to examine environmental issues by discussing various ethical and moral stands that shape how people approach environmental issues. Chapter 3 introduces economic issues and the concept of risk analysis. Both of these topics will be also brought up at several points later in the text.

Part 2 provides an understanding of the **ecological principles** that are basic to organism interactions and the flow of matter and energy in ecosystems. The nature of food chains and how they affect the flow of matter and energy are discussed. Other topics include the efficiency of energy flow through ecosystems, the intricacies of organism-to-organism interaction, and the creative role of natural selection in shaping ecological relationships. Principles of population structure and organization are also developed in this section, with particular attention to the implications of these principles to the growth and impact of human populations.

Part 3 focuses on **energy**. A major emphasis is on the historically important, nonrenewable fossil fuels that have stimulated economic success of the developed economies of the world. Renewable sources of energy are discussed, but with the recognition that they currently are a small part of the world energy picture. Weapons production and nuclear power plants use enormous amounts of energy that can be released from the nucleus of the atom. Both of these uses have caused fear among the public related to the dangers of radiation and the adequacy of waste disposal. These issues are discussed in this section.

Part 4 emphasizes the impact of **human activity on natural ecosystems**. As human populations grow and technology changes, the magnitude of human actions becomes more apparent. The natural ecosystems on land and water are modified to meet human needs. The heavy use of pesticides in agriculture is discussed in this section.

Part 5 deals with the major types of **pollution**. Pollution affects the health and welfare of humans and other organisms. Air pollution, solid waste, and hazardous and toxic substances are discussed in this section. The cost of pollution cannot always be measured in financial terms but may be reflected in the mental and physical health of the populace. Ultimately, governments must address environmental concerns and develop policy to address the concerns. Increasingly, the concerns are international in scope and require negotiations between governments with very different economic conditions and concerns.

What Makes This Text Unique?

This text is written with the student in mind. Both authors have many years of teaching experience and use their knowledge of what helps students learn to shape the text. All aspects of the text: writing style, illustrations, review materials, and boxed

readings are designed to be informative without being overly complex. Many of the factual details are included in illustrations and tables rather than in the narrative of the text. For the person who wants facts, they are present but do not obscure the general concepts and principles being described.

Often the clearest way to present information is with an illustration. Each drawing, chart, graph, or photograph is designed to help students visualize an idea or concept, or create a mental picture that enhances the written text. The review materials at the end of each chapter are designed as learning tools. Review questions, vocabulary lists, and concept maps are all useful aids to help students assess whether they have a firm grasp of the content of the chapter.

The authors work very hard to present a balanced, unbiased presentation of the material. It is not the purpose of a textbook to tell you what to think. The purpose of a text is to provide access to information and the conceptual framework needed to understand complex issues so that you can understand the nature of environmental problems and formulate your own views.

Special Features and Learning Aids

1. A **world map** with political boundaries can be found on the inside front cover. We believe that this will help the reader to more fully understand and appreciate global environmental issues. Each of the five parts of the text begins with a **guest essay** that places the upcoming chapters in context for the reader by describing a current environmental issue.
2. Each chapter begins with a set of **learning objectives**, an **outline**, and a **conceptual diagram**, all of which give the student a broad overview of the interrelated forces that are involved in the material to be discussed. The student is encouraged to refer to these resources while reading and reviewing the chapter.
3. Chapters conclude with an Issues—Analysis **case study**, a **summary**, a list of **key terms**, **review questions**, **critical thinking questions**, a list of topics that correspond to specific **Internet links** on the accompanying website, and a **new feature—concept mapping**. This new exercise helps to reinforce understanding of basic concepts and principles through creating concept maps from a list of key words. Combined with the introductory conceptual diagram at the beginning of the chapter, these mapping exercises help to illustrate the connections between environmental principles, issues, and possible solutions.
4. To dramatize and clarify text material, each chapter includes a number of **tables**, **charts**, **graphs**, **maps**, **drawings**, or **photographs**. Each illustration has been carefully chosen to provide a pictorial image or an organized format for showing detailed information, which helps the reader comprehend the chapter material by reinforcing the written word in the text.

5. Each chapter also includes **boxed readings**. Each is an in-depth consideration of a specific situation, an alternative viewpoint, or a wider worldview of the issues discussed in the chapter.
6. The text concludes with two **appendices** that deal with the following topics: critical thinking, and the periodic table of the elements. In addition, there is a complete **glossary** and an **index**. A table of **metric conversions** is located on the inside back cover.

New to This Edition!

Concept Mapping A new learning activity that involves the student in constructing a concept map has been added at the end of each chapter. This activity is designed to help students see how concepts and ideas are related to one another.

Guest Authors Each Part Opener in this edition features a guest author's essay that describes an environmental issue in the author's own backyard. These essays help point out the different types of concerns developing in various parts of the United States, and critical thinking questions help illustrate that these problems often have no easy solution.

Over 100 Reviewers As with previous editions, reviewers' suggestions are incorporated into the text, either through small changes in text or figures to improve clarity and accuracy, or by providing the most up-to-date information available.

Chapter Updates Several chapters have had *major changes* in content or emphasis:

- Chapter 1 has expanded coverage on **sustainable development** and **Agenda 21** to provide current information.
- Chapter 2 has a new section entitled “**Do We Consume Too Much?**” to highlight the economic and ecological impact of consumption.
- Chapter 4 has a completely rewritten section on the **scientific method** to better describe the process of science.
- Chapter 5 has a new section on **genes, populations, and species** to help the reader see the connections between these topics.
- Chapter 6 has new material on both **Mediterranean and dry tropical forests ecosystems**, as suggested by reviewers.
- Chapters 7 and 8 have been updated with recent information on **human population**.
- Chapter 12 has completely revised sections on **plantation forestry and aquaculture**.
- Chapter 13 has a new section on **smart growth** that highlights new trends in **urban land-use planning**.
- Chapter 15 has a rewritten section on **genetically modified organisms**, requested by reviewers.
- Chapter 16 has new information that emphasizes the need for careful **management of water resources**.

- Chapter 17 has been restructured to reflect **current ways of classifying** the different kinds of **air pollutants**.
- Chapter 18 has a new section that better describes the various **ways wastes are categorized**.
- Chapter 19 has new content on **hazardous wastes and brownfields**.
- Chapter 20 includes new material on **ecoterrorism**.

New Readings There are seven all new boxed readings, chosen to complement new text content.

New Art There are **over 20 new figures and tables**, and many other pieces have been revised.

Useful Supplements

- **Instructor's Manual.** Available to instructors via the accompanying website, this valuable resource contains chapter overviews, key concepts and terms, answers to review questions, suggested classroom activities, and a unique "Resource Locator" that pulls together appropriate material from numerous sources to use with each chapter.
- **Instructor's Testing and Resource CD-ROM.** This cross-platform CD-ROM provides a wealth of resources for the instructor. Supplements featured on this CD-ROM include the lab manual and a computerized test bank using Brownstone Diploma® testing software to quickly create customized exams. This user-friendly program allows instructors to search for questions by topic, format, or difficulty level; edit existing questions or add new ones; and scramble questions and answer keys for multiple versions of the same test. Other assets on the Instructor's Testing and Resource CD-ROM are grouped within easy-to-use folders.
- **Transparencies.** A set of 100 transparencies is available to users of the text. These acetates include key figures from the text, including new art from this edition.
- **Essential Study Partner CD-ROM.** A complete, interactive student study tool, this CD features animations, videos, and learning activities. From quizzes to interactive diagrams, you'll find that there has never been a better study partner to ensure the mastery of core concepts. Best of all, it's FREE with a new textbook purchase.
- **Digital Content Manager CD-ROM.** This multimedia collection of visual resources allows instructors to use art from the text in multiple formats to create customized classroom presentations, visually based tests or quizzes, dynamic course website content, or attractive printed support materials. The digital assets on this cross-platform CD-ROM are grouped within the following easy-to-use folders:
 - **Illustrations and Photos** All of the line drawings from the text and hundreds of photos are in ready-to-use digital files.

- **PowerPoint Lecture Outline** Ready-made presentations combine art from the text with customized lecture notes covering all 20 chapters.
- **Tables** Every table that appears in the text is provided in electronic form.
- **Active Art** These special art pieces consist of key images from the text that are converted to a format that allows instructors to break the art down into core elements and then group the various pieces and create customized images. This is especially helpful with difficult concepts, which can be presented step by step.
- **Animations** Numerous full-color animations illustrating many different concepts covered in the study of environmental science are provided. The visual impact of motion will enhance classroom presentations and increase comprehension.

- **Online Learning Center** (<http://www.mhhe.com/environmentalscience>). This comprehensive website offers numerous resources for both students and instructors:

Student Resources—Everything you need in one place:

- Study questions
- Labeling exercises
- Practice quizzing
- Hyperlinks on chapter topics
- Guide to electronic research
- Regional perspectives (case studies)
- Environmental issues world map
- Key-term flashcards
- How to write a paper
- Metric equivalents and conversion tables
- Career information
- PowerWeb's hundreds of current articles and daily news items integrated into each chapter on the OLC
- How to contact your government officials

Instructor Resources—In addition to all of the above, you'll receive:

- Instructor's manual with a supplements resource chart for each chapter
- Interactive lecture outlines on PowerPoint
- Answers to critical thinking questions
- PageOut (create your own course website)

Related Titles of Interest

1. *Field and Laboratory Activities Manual, 7ed.* (0-07-290913-7) by Enger and Smith
2. *Interactive World Issues: Of Place and Planet CD-ROM* (0-07-255648-X), Cambridge Studios
3. *Annual Editions: Environment 02/03* (0-07-250682-5), John L. Allen, editor
4. *Taking Sides: Clashing Views on Controversial Environmental Issues, 9ed.* (0-07-303184-4), Theodore D. Goldfarb, editor

5. *Sources: Notable Selections in Environmental Studies, 2ed.* (0-07-303186-0), Theodore D. Goldfarb, editor
6. *The Dushkin Student Atlas of Environmental Issues* (0-697-36520-4), John Allen, University of Connecticut, editor
7. *Life Science Living Lexicon* (CD = 0-697-37993-0; Print = 0-697-12133-X) by William Marchuk
8. *You Can Make a Difference: Be Environmentally Responsible* (0-07-292416-0) by Judy Getis
9. *Environmental Ethics: Divergence and Convergence* (0-07-006180-7) by Botzler and Armstrong
10. *Environmental Problem-Solving: A Case Study Approach* (0-07-027686-2) by Isobel W. Heathcote
11. *Eyewitness World Atlas CD-ROM* (0-07-233220-4), published by Dorling-Kindersley

Acknowledgements

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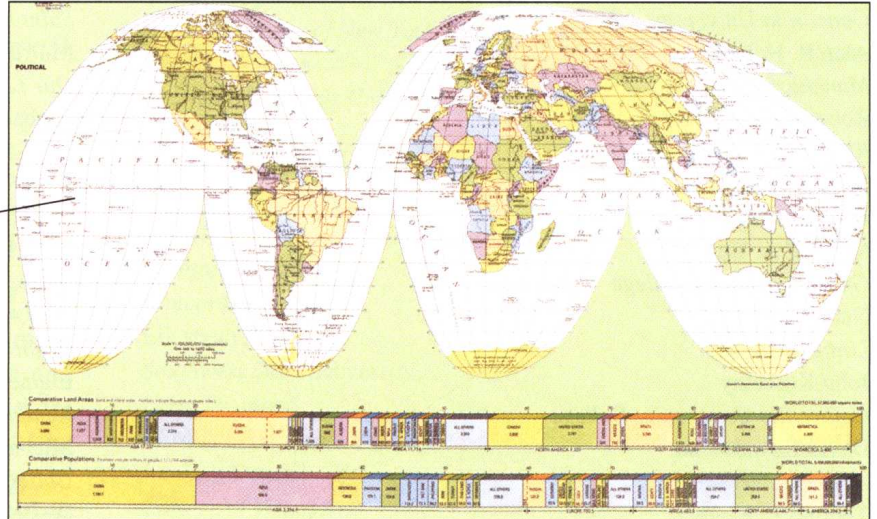
guided tour

The features of this book are *unique*:

The organization and principle features of this book were planned with the students' wholistic learning and comprehension in mind.

World Map

A **world map** with political boundaries can be found on the inside front cover. This will help the reader to more fully understand and appreciate global environmental issues.



Deer Hunting Within the City of Brotherly Love?

Anne Todd Bockarie

Philadelphia University/Pennsylvania

The industrial Northeast of the United States has had a long history of human intervention in nature. Our footprint on the land has resulted in radical changes in how plants and animals interact. As cities, suburbs, and industry grew, large expanses of forests were cut into small patches. These activities have affected our relationship to white-tailed deer, a keystone species of these forests. Deer were a critical source of food and clothing as Europeans settled the eastern seaboard. Logging, agriculture, and extensive hunting almost wiped out the population by 1930. People were concerned about the low numbers of deer, so the state of Pennsylvania embarked on a restocking program to bring the deer back for recreational hunting and to maintain their critical role in the forest ecosystem.

The program was successful, and today, we have the opposite problem—too many deer. Along the entire East Coast of the United States, deer numbers have surged due to the nutritious food resources found in millions of well-tended lawns, gardens, and farms; the loss of natural predators; and wildlife professionals managing the herd for hunting. The impact on humans of so many deer has been more than 100,000 cases of Lyme disease in the Northeast being reported to the Centers for Disease Control and Protection since 1982. Ticks on deer and mice transmit a bacterium, or spirochete, that causes Lyme disease into the bloodstream when they bite humans. Lyme disease can be treated with antibiotics, but it is difficult to diagnose, and symptoms may last months or years after the initial bite if the infection is not caught in its early stages. The auto accident rate also increased as more drivers struck deer as they crossed roads. Researchers estimate that in 1995, motor vehicle accidents involving deer resulted in 211 deaths, 29,000 injuries, and approximately \$1 billion in property damage.

Philadelphia's Fairmount Park Commission recently had to decide what to do about the overpopulation of deer in the 3642 hectares (9000 acres) of parks in the city. It was believed that the deer were eating all the native ground and understory plants, thereby inhibiting the forest from regenerating. Every time a tree would sprout, the deer would browse the seedling. As the plants disappeared, so did the habitat needed for songbirds that use the parks for food and cover on their migration north in the spring. However, part of what makes the park experience unique in Philadelphia is being able to walk through dense woods and see a herd of deer or other wildlife. Most park users want to see and watch deer. The commission hired a scientist to estimate the number of deer in the largest park. He found 60 deer per square mile. It is estimated that the park could feed eight deer per square mile without a negative impact on the forest.

What are the options? The park could be fenced, but it is over 607 hectares (1500 acres) in size and has many entrances, roads, railroad lines, bridges, and sewer and water pipes running through it. The deer in the park could be hunted or culled, but over 1 million people use the area throughout the day and evening, so safety would be a concern. Park officials could use birth control (immunocontraception) on the deer, but this method is very expensive; the park's budget has stayed the same over the past 15 years, and the number of employees has been reduced from 1000 to less than 250. The commission held a public hearing to discuss the options and the concerns of citizens around the park. Here are some of the comments:

"Deer have brothers, fathers, sisters, and mothers. I object on moral and ethical grounds."

"Why are only lethal methods approved by the Pennsylvania Game Commission? Seven percent of Pennsylvanians are hunters, yet they control this state agency and its policies."

"At Fire Island in New York, there has been a 17 percent reduction in herd size using birth control in the last seven years."

"The American Psychological Association has shown that exposure to violence leads to violent actions in children. We are the City of Brotherly Love. The message [of culling the deer] is it's okay to kill."

"Every relevant federal, state, and local agency has been consulted on this issue and supports the cull. One must look at the ecological big picture. The experts have given us the results."

"Our Park Friends Group has seen deer ravage the vegetation. Every tree we plant is eaten. Who is standing up for the vegetation in the park?"

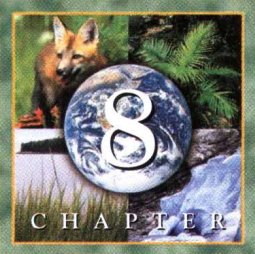
The Fairmount Park Commission decided that the best option would be to hire a professional sharpshooter to cull the herd and impose a curfew at night to keep park users out of harm's way. Protesters demonstrated against this option, and several were arrested when they went into the park and tried to stop the cull.

What Do You Think?

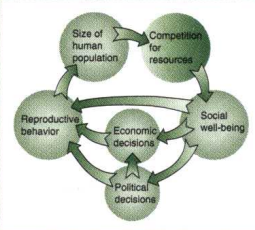
1. Should we leave nature to manage itself, even if it means starvation or the severe decline of a species?
2. In 1842, the U.S. Supreme Court declared that wildlife should be held in trust for all citizens, so how do we resolve the conflict between wildlife protectors and hunters?
3. Do plants and animals have the same inherent rights as humans?
4. Should we support hunting for recreational or management purposes?
5. How much would you be willing to pay to control white-tailed deer in a city with contraceptives?

New!

Guest authors contribute **essays** on environmental issues close to home. Appearing with each Part Opener, these essays are accompanied by critical thinking questions and present real problems with no easy solution.



Human Population Issues



Objectives

After reading this chapter, you should be able to:

- Apply some of the principles discussed in chapter 7 to the human population.
- Differentiate between birthrate and population growth rate.
- Describe the current population situation in the United States.
- Explain why the age distribution and the status and role of women affect population growth projections.
- Recognize that countries in the developed world are experiencing an increase in the average age of their populations.
- Recognize that most countries of the world have a rapidly growing population.
- Describe the implications of the demographic transition concept.
- Understand how an increasing world population will alter the worldwide ecosystem.
- Recognize that rapid population growth and poverty are linked.
- Explain why less-developed nations have high birthrates and why they will continue to have a low standard of living.
- Recognize that the developed nations of the world will be under greater pressure to share their abundance.

Chapter Outline

- Human Population Trends and Implications
- Global Perspective:** *Thomas Malthus and His Essay on Population*
- Factors That Influence Population Growth
 - Biological Factors
 - Social Factors
- Environmental Close-Up:** *Control of Births*
 - Political Factors
- Population Growth and Living Standards
- Population and the Demographic Cycle?
 - Hunger, Food Production, and the Environment
- The Demographic Transition
- Global Perspective of the World's Population:** *The U.S. Population and Anticipated Change*
- Global Perspective:** *Population Competition—Analysis of Populations*

Conceptual Study Aids

Each chapter begins with a set of **learning objectives**, an **outline**, and a **conceptual diagram**, all of which give the student a broad overview of the interrelated forces that are involved in the material to be discussed. Students are encouraged to refer to these resources while reading and reviewing the chapter.

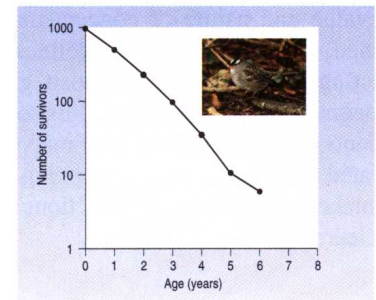
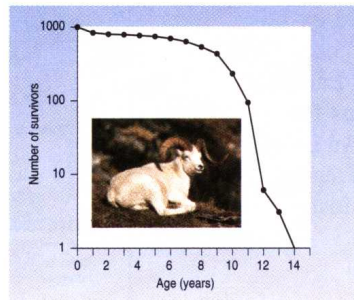
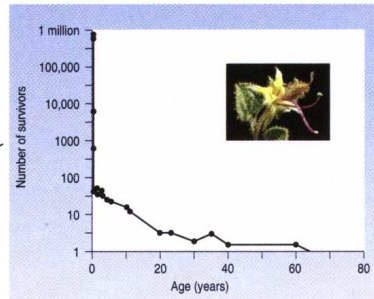


figure 7.2 Types of Survivorship Curves (a) The Dall sheep is a large mammal that produces relatively few young. Most of the young survive, and survival is high until individuals reach old age, when they are more susceptible to predation and disease. (b) The curve shown for the white-crowned sparrow is typical of that for many kinds of birds. After a period of high mortality among the young, the mortality rate is about equal for all ages of adult birds. (c) Many small animals and plants produce enormous numbers of offspring. Mortality is very high in the younger individuals, and few individuals reach old age.



Quality Art

To dramatize and clarify text material, each chapter includes a number of **tables**, **charts**, **graphs**, **maps**, **drawings**, or **photographs**. Every illustration has been carefully chosen to provide a pictorial image or an organized format for showing detailed information, helping the reader better comprehend the chapter material.

Population Density and Spatial Distribution

Because of such factors as soil type, quality of habitat, and availability of water, organisms normally are distributed unevenly. Some populations have many individuals clustered into a small space, while other populations of the same species may be widely dispersed. **Population density** is the number of organisms per unit area. For example, fruit-fly populations are very dense around a

source of rotting fruit, while they are rare in other places. Similarly, humans are often clustered into dense concentrations we call cities, with lower densities in rural areas. When the population density is too great, all individuals within the population are injured because they compete severely with each other for necessary resources. Plants may compete for water, soil nutrients, or sunlight. Animals may compete for food, shelter, or nesting sites. In animal populations, overcrowding might cause some individuals to ex-

plore and migrate into new areas. This movement from densely populated locations to new areas is called **dispersal**. It relieves the overcrowded conditions in the home area and, at the same time, increases the population in the places to which they migrate. Often, it is juvenile individuals that relieve overcrowding by leaving. The pressure to migrate from a population (**emigration**) may be a result of seasonal reproduction leading to a rapid increase in population size or environmental changes that intensify

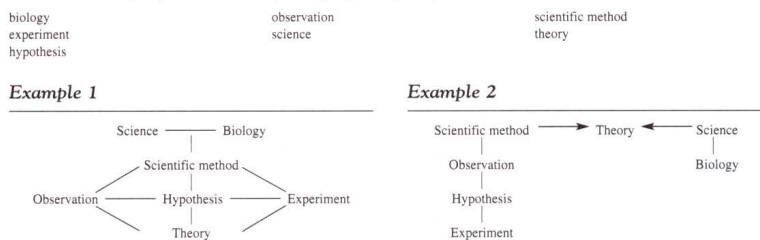
New! Concept Mapping

Chapters conclude with an “Issues—Analysis” case study, a **summary**, a list of **key terms**, **review questions**, **critical thinking questions**, and a new feature—**concept mapping**. In Chapter 1 the value and nature of concept maps are explained. Examples and guidelines for constructing concept maps are also given. Each subsequent chapter provides a list of terms for students to complete their own mapping. An integrated study tool, concept mapping helps readers make the important “connections” that foster real learning.

Concept Map

The construction of a concept map is a technique that helps students recognize how separate concepts are related to one another. Some concept maps may be simple, orderly lists. Others may form networks of connections that help to show how ideas are linked. It is important to understand that there is not just one way in which things can be put together. The examples show two different ways the same concepts can be organized. (Take another look at figure 1.2. It is a variety of concept map.)

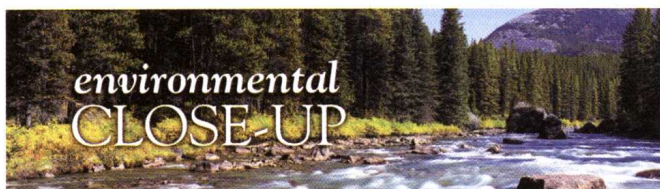
Construct a concept map to show relationships among the following concepts:



Interactive Exploration

Check out the website at <http://www.mhhe.com/environmentalscience> and click on the cover of this textbook for quizzing, career information, case studies, and hot links for the following topics:

- | | |
|---|--|
| General Environmental Sites | Introductory Sites |
| General Ecology Sites | Writing Papers and Study Tips |
| Environmental and Ecological Organization Sites | Glossaries and Dictionaries |
| History of Environmental Studies | Careers in Science |
| Miscellaneous Environmental Resources | Utility and Organizational Sites |
| Introductory Materials and Governmental Sites | Global Ecology |
| Science as a Process | |



Shaping U.S. Environmental Policy as the New Century Begins

During the presidential campaign of 2000, the economy, health care, and education were primary issues, and environmental issues were secondary. However, as the new administration began to formulate policy, national and global environmental issues became increasingly visible. Public debates about drilling in the Arctic National Wildlife Refuge, global warming, the Kyoto Protocol, and the envi-

ronmental concerns surrounding world trade made the environment front-page news.

Rather than attempting to pass judgment on the Bush administration's policies, it is perhaps more beneficial to look at the polarization that exists over the policies. The statements that follow present widely different perspectives on the significance of policy decisions of the Bush administration. One presents the views of the administration, the other the views of environmental organizations.

The Bush Administration's Environmental Record (Published by the Bush Administration)

Preamble

President Bush has articulated a vision for environmental protection that focuses on results: Cleaner air, water and land, and healthier people and ecosystems. To achieve these goals, we need a strong and growing economy. Our environmental policies thus recognize the importance of a robust economy, which provides the public and private resources needed to make new investments in environmental conservation. The President sees these goals as complementary, rather than competing—strong economic growth and strong environmental protection can and must go hand-in-hand. In his first year, President Bush made significant progress toward achieving each of these goals.

Brownfields Cleanup—Bringing New Life to Abandoned Sites in Our Cities and Towns: Fulfilling an important campaign commitment, President Bush signed historic legislation that will result in more cleanup and redevelopment of contaminated industrial sites, improving the environment, protecting public health, creating jobs, and revitalizing communities.

Clear Skies—A Clean Air Act for the 21st Century: President Bush's initiative would dramatically improve air quality by cutting power plant's emissions of three critical pollutants by 70 percent—more than any other presidential clean air initiative. This historic legislative proposal would bring clean air to American communities faster, more reliably, and more effectively than the current Clean Air Act.

Energy Bill—Promoting Clean, Affordable, Reliable Energy for America: President Bush has prepared the first national energy policy in years, and is working with Congress to pass legislation that will promote affordable, reliable, and clean energy that is essential to America's security, environmental quality, and economic growth.

Land Conservation—Working in Partnership with States: President Bush has pushed to fully fund the Land and Water Conservation Fund, and worked successfully with Congress to significantly increase its funding. President Bush has also used the Land and Water Conservation Fund to increase support for partnerships for cooperative conservation, and has requested \$100 million in FY '03 funding for a new Cooperative Conservation Initiative.

Global Environment—A Realistic, Growth-Oriented Approach to Climate Change: The President has committed America to a new strategy to meet the challenge of long-term global climate change by reducing the greenhouse gas intensity of our economy by 18 percent over the next 10 years. This goal is supported by a broad range of domestic and international climate change initiatives, including \$4.5 billion in FY '03 funding for climate change, as well as \$178 million for the Global Environment Facility and \$50 million to help conserve tropical forests through programs like debt-for-nature swaps.

Budget: President Bush's \$44.4 billion FY '03 environment and natural resources budget request is the highest ever—\$1.4 billion, or 3 percent, higher than FY '02 enacted. The President's budget proposal provides \$4.1 billion, the highest level ever for EPA's operating program, and provides the highest level ever for EPA state program grants, \$1.2 billion.

The Bush Budget: Bad News for Our Environment and Our Health (Published by the Sierra Club, with comments from the Natural Resources Defense Council)

Preamble

As this is written on the eve of Earth Day 2002, our nation's environmental landscape is changing for the worse. Agencies throughout the Bush administration are taking explicit directions from big corporate polluters, allowing these corporations to rewrite the agency rules that give life to America's environmental laws.

It is not news that the Bush administration has an anti-environmental tilt. In fact, the early months of this presidency were defined in part by overwhelming public disapproval of the administration's positions on arsenic in drinking water, drilling in the Arctic National Wildlife Refuge, and carbon dioxide pollution from power plants. Since September 11, however, the environmental assault has a quietly intensified, bolstered by a growing critical mass of presidential appointees at key federal agencies actively pursuing an anti-environment agenda, emboldened by the president's surge in popularity, and unchecked by news media distracted by the war on terrorism.

Energy Research Cuts: The Bush Administration has proposed cutting energy efficiency research and development by 27% overall, with over 50% cut in some specific programs in FY '03. These cuts would hamstring efforts to improve efficiency in homes, vehicles, businesses, and industry.

President Bush has proposed cutting renewable energy research and development programs by 36% in FY '03. This cut would slow the development of key renewable energy technologies.

Environmental Protection Agency Cuts: Overall President Bush is cutting \$500 million from the EPA's budget including a cut of \$158 million from the EPA's efforts to enforce laws that keep polluters from fouling the air we breathe and the water we drink. In addition to these cuts, his budgetary sleight of hand shifts money to states, crippling the federal government's ability to enforce fair and consistent environmental standards.

Interior Department Cuts: The President's budget includes numerous examples where he shifts money away from conserving landscapes and wildlife and instead uses the money for mining and oil drilling on our public lands. In addition, it tilts the balance from experienced federal oversight and lets individual states decide whether to protect wildlife and open space.

The President cuts the U.S. Fish and Wildlife Service budget by \$168 million, slashing money dedicated to protecting wildlife habitat, wetlands restoration, and endangered species.

Web Integration

In a section at the end of each chapter, **Interactive Exploration** lists important topics for which there are hyperlinks available on the accompanying website. Already researched and validated, these links are a helpful study tool for students.

Relevant Box Readings

Each chapter also includes **boxed readings**. These provide an in-depth consideration of a specific situation that is relevant to the content, an alternative viewpoint, or a wider worldview of the issues discussed in the chapter.



appendix 2

The Periodic Table of the Elements

Traditionally, elements are represented in a shorthand form by letters. For example, the formula for water, H₂O, shows that a molecule of water consists of two atoms of hydrogen and one atom of oxygen. These chemical symbols for each of the atoms can be found on any periodic table of the elements. Using the periodic table, we can determine the number and position of the various parts of atoms.

Notice that atoms number 3, 11, 19, and so on are in column one. The atoms in this column act in a similar way since they all have one electron in their outermost layer. In the next column, Be, Mg, Ca, and so on act alike because these metals all have two electrons in their outermost electron layer. Similarly, atoms number 9, 17, 35, and so on all have seven electrons in their outer layer.

Knowing how fluorine, chlorine, and bromine act, you can probably predict how iodine will act under similar conditions. At the far right in the last column, argon, neon, and so on all act alike. They all have eight electrons in their outer electron layer. Atoms with eight electrons in their outer electron layer seldom form bonds with other atoms.

Periodic Table of the Elements

Representative Elements (s Series)		Transition Metals (d Series of Transition Elements)										Representative Elements (p Series)						
IA	IIA	IIIB	IVB	VB	VIB	VII B	VIII B	IB	IIB	IIIA	IVA	VA	VIA	VIIA	VIIIA			
1 H 1.0079										3 Li 6.941	4 Be 9.0122					2 He 4.0026		
2 3 4										5 B 10.811	6 C 12.0112	7 N 14.0067	8 O 15.9994	9 F 18.9984	10 Ne 20.179			
3 11 12										13 Al 26.9815	14 Si 28.086	15 P 30.9738	16 S 32.064	17 Cl 35.453	18 Ar 39.948			
4 19 20		21 Sc 44.956	22 Ti 47.88	23 V 50.942	24 Cr 51.996	25 Mn 54.938	26 Fe 55.847	27 Co 58.933	28 Ni 58.71	29 Cu 63.546	30 Zn 65.38	31 Ga 69.723	32 Ge 72.63	33 As 74.922	34 Se 78.96	35 Br 79.904	36 Kr 83.80	
5 37 38		39 Y 88.906	40 Zr 91.224	41 Nb 92.906	42 Mo 95.94	43 Tc (99)	44 Ru 101.07	45 Rh 101.07	46 Pd 106.4	47 Ag 107.868	48 Cd 112.40	49 In 114.82	50 Sn 118.69	51 Sb 121.75	52 Te 127.60	53 I 126.905	54 Xe 131.30	
6 55 56		57 La 138.905	58 Ce 140.12	59 Pr 140.907	60 Nd 144.24	61 Pm (144.913)	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.925	66 Dy 162.50	67 Ho 164.930	68 Er 167.26	69 Tm 168.934	70 Yb 173.04	71 Lu 174.97		
7 87 88		89 Fr 223	90 Ra (226)	91 Ac (227)	92 Th (232)	93 Pa (231)	94 U 238.03	95 Np (237)	96 Pu (244)	97 Am (243)	98 Cm (247)	99 Bk (247)	100 Cf (251)	101 Es (252)	102 Fm (257)	103 Md (258)	104 No (259)	105 Lr (260)

Inner Transition Elements (f Series)

Lanthanides															
58	59	60	61	62	63	64	65	66	67	68	69	70	71		
Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu		
140.12	140.907	144.24	144.913	150.36	151.96	157.25	158.925	162.50	164.930	167.26	168.934	173.04	174.97		
Actinides															
88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr		
232.038	231	238.03	237	244.064	243	247	247	242.068	254	257.095	258.10	259.10	260.105		

A-2

Appendices

The text concludes with two **appendices** that offer some valuable information on critical thinking, and the periodic table of the elements. A chart on metric conversion can be found on the inside back cover. In addition, there is a complete **glossary** and **index**.

Populations

Principles

Populations

Living Resources

Physical Resources

Societal Issues

Unit Exam

Program Tools

Prepared By

Environmental Science

Essential Study Partner

Version 2.0

Content Director: Bill Ehmann, Drake University

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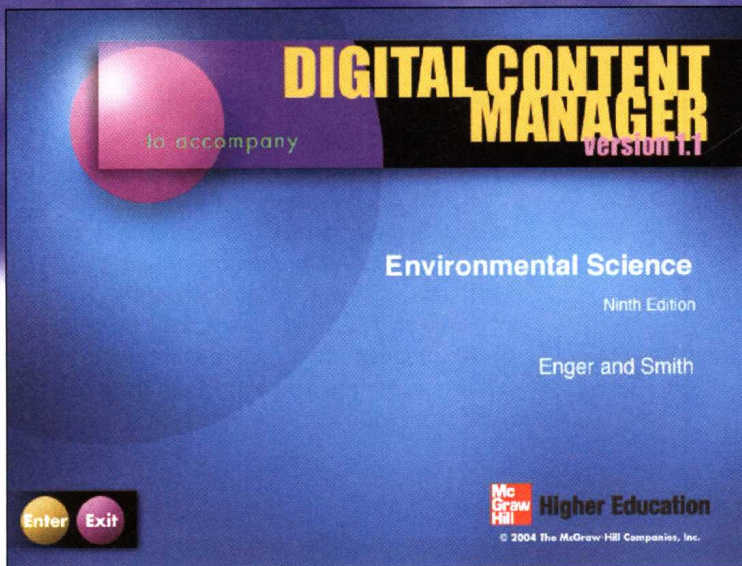
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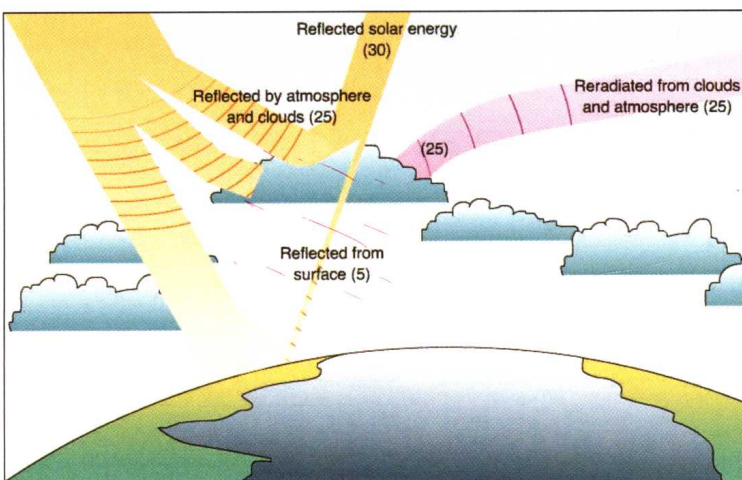
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The screenshot shows the 'Information Center' for the textbook 'Environmental Science: A Study of Interrelationships, 9/e' by Eldon Enger and Brad Smith. The page includes a navigation menu on the left with links like 'About The Book', 'Sample Chapter', and 'Table of Contents'. The main content area provides details about the book, including the authors' names, ISBN (0072440007), and copyright year (2003). It also features a paragraph explaining that McGraw-Hill wants to help learning expand beyond the textbook and offers premium content for registered users. At the bottom, there is a note about obtaining an instructor login and a copyright notice for 2003 McGraw-Hill Higher Education.

This screenshot displays the 'PowerWeb Articles' section of the website. It features a navigation menu on the left and a main content area with a 'POWERWEB with Annual Editions' logo. The page lists 'Topics in this chapter: Discussed in:' followed by three articles under the heading 'AGRICULTURE'. Each article entry includes the article number, title, author, and publication date, along with links to view the article in Acrobat or HTML format. The first article is '19. Continental Divide, Torsten Wohler, World Press Review, January 2000'. The second is '31. Gaining Perspective, Molly O'Meara Sheehan, World Watch, March/April 2000'. The third is '38. A Rare and Precious Resource, Houria Tazi Sedeq, The UNESCO Courier, February 1999'. A paragraph of text follows the third article, discussing water as a scarce resource and its regional availability.

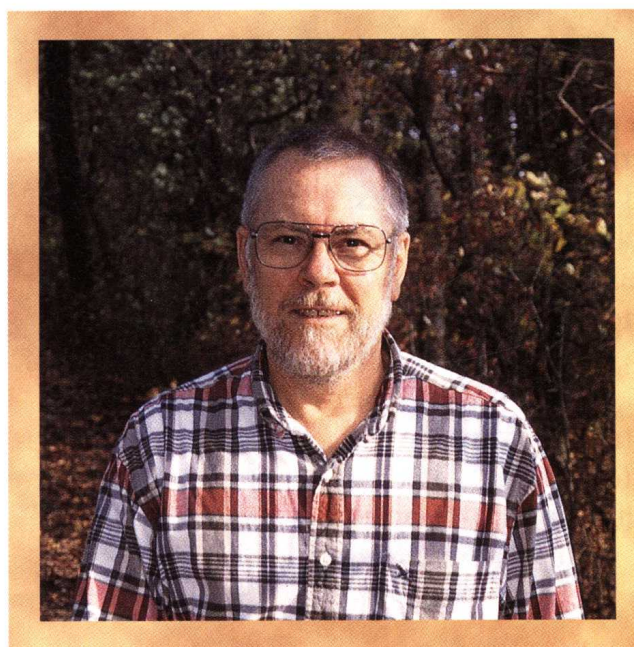
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about the authors

Eldon D. Enger

Eldon D. Enger is a professor emeritus of biology at Delta College, a community college near Saginaw, Michigan. He received his B.A. and M.S. degrees from the University of Michigan. Professor Enger has over 30 years of teaching experience, during which he has taught biology, zoology, environmental science, and several other courses. He has been very active in curriculum and course development. Recent activities include the development of a learning community course in stream ecology, and a plant identification course. He was also involved in the development of an environmental regulations course, and an environmental technician curriculum.

Professor Enger is an advocate for variety in teaching methodology. He feels that if students are provided with varied experiences, they are more likely to learn. In addition to the standard textbook assignments, lectures, and laboratory activities, his classes are likely to include writing assignments, student presentation of lecture material, debates by students on controversial issues, field experiences, individual student projects, and discussions of local examples and relevant current events. Textbooks are valuable for presenting content, especially if they contain accurate, informative drawings and visual examples. Lectures are best used to help students see

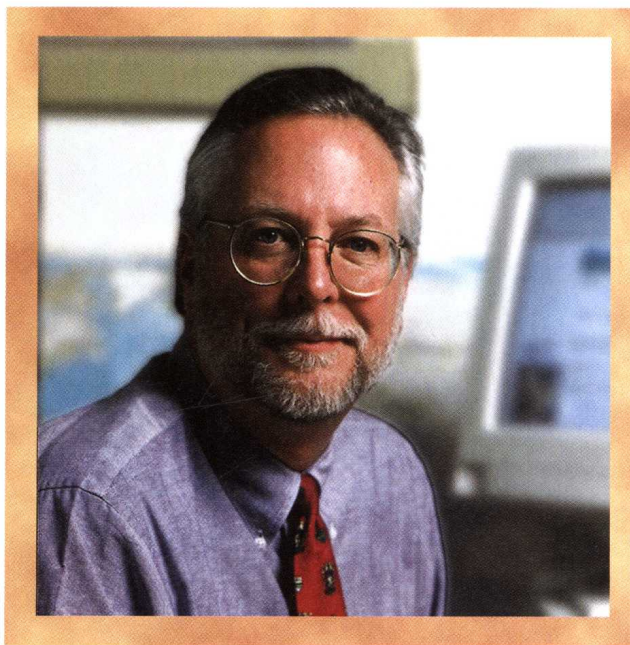


themes and make connections, and laboratory activities provide important hands-on activities.

Professor Enger has been a Fulbright Exchange Teacher to Australia and Scotland, received the Bergstein Award for Teaching Excellence and the Scholarly Achievement Award from Delta

College, and participated as a volunteer in an Earthwatch Research Program in Costa Rica, the Virgin Islands, and Western Australia. In 2002, he was a member of a People to People delegation to South Africa, which involved learning about issues and challenges concerning resource management in South Africa. He has also visited New Zealand, New Guinea, Fiji, Puerto Rico, Mexico, Canada, Morocco, many areas in Europe, and much of the United States. During these travels, he has spent considerable time visiting coral reefs, ocean coasts, mangrove swamps, alpine tundra, prairies, tropical rainforests, cloud forests, deserts, temperate rainforests, coniferous forests, deciduous forests, and many other special ecosystems. This extensive experience provides the background to look at environmental issues from a broad perspective.

Professor Enger is married, has two adult sons, and enjoys a variety of outdoor pursuits such as kayaking, cross-country skiing, hiking, hunting, fishing, beekeeping, camping, and gardening.



Bradley F. Smith

Bradley F. Smith is the dean of Huxley College of Environmental Studies at Western Washington University in Bellingham, Washington. Prior to assuming the position as dean in 1994, he served from 1991 to 1994 as the first director of the Office of Environmental Education for the U.S. Environmental Protection Agency in Washington, D.C. Dean Smith also served as the acting president of the National Environmental Education and Training Foundation in Washington, D.C., and as a special assistant to the EPA administrator.

Before moving to Washington, D.C., Dean Smith was a professor of political science and environmental studies for 15 years, and the executive director of an environmental education center and nature refuge for five years.

Dean Smith has considerable international experience. He was a Fulbright Exchange Teacher to England and worked as a research associate for Environment Canada in New Brunswick. He is a frequent speaker on environmental issues worldwide and serves on the International Scholars Program for the U.S. Information Agency. He also served as a U.S. representative on the Tri-Lateral Commission on Environmental Education with Canada and Mexico. In 1995, he was awarded a NATO fellowship to study the environmental problems

associated with the closure of former Soviet military bases in Eastern Europe. Dean Smith is an adjunct professor at Far Eastern State University in Vladivostok, Russia, and is a member of the Russian Academy of Transport. He also serves as a commissioner for the International Union for the

Conservation of Nature. He is a frequent speaker at universities in China.

Nationally, Dean Smith serves as a member/advisor for many environmental organizations' board of directors, advisory councils, and executive committees, including the President's Council for Sustainable Development (Education Task Force), the Science Advisory Boards for MOTE Marine Laboratory in Sarasota, Florida, and the Center for Sustainable Futures in Vermont. In 2002, he was appointed by the governor of the state of Washington to chair the States Sustainable Advisory Committee.

Dean Smith holds B.A. and M.A. degrees in political science and public administration and a Ph.D. from the School of Natural Resources and Environment at the University of Michigan.

Dean Smith lives with his wife, Daria, daughter, Morgan, son, Ian, and English setter, Skye, along Puget Sound south of Bellingham. He is an avid outdoor enthusiast.