

大 学 环 境 教 育 丛 书

影 印 版

Eldon D. Enger  
Bradley F. Smith

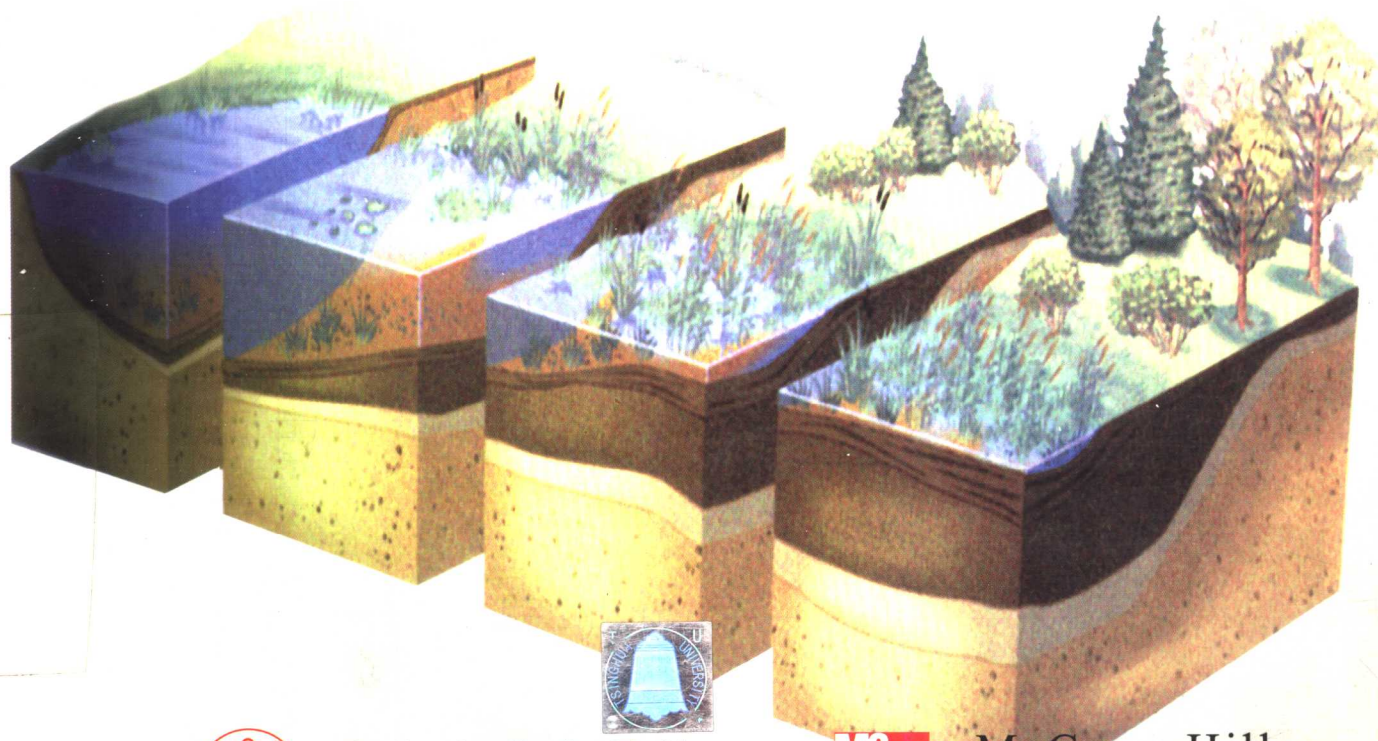
# Environmental Science

A Study of Interrelationships

(seventh edition)

环 境 科 学

—— 交叉关系学科 (第 7 版)



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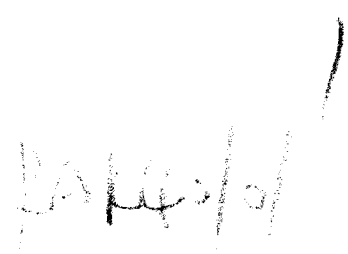
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# 出版前言

在跨入 21 世纪之际,面临不断恶化的生存环境,人类清醒地认识到要走可持续发展之路。而发展环境教育是解决环境问题和实施可持续发展战略的根本。高等学校的环境教育,是提高新世纪建设者的环境意识,并向社会输送环境保护专门人才的重要途径。为了反映国外环境类教材的最新内容和编写风格,同时也为了提高学生阅读专业文献和获取信息的能力,我们精选了一些国外优秀的环境类教材,组成大学环境教育丛书(影印版),本书即为其中的一册。所选教材均在国外被广泛采用,多数已再版,书中不仅介绍了有关概念、原理及技术方法,给出了丰富的数据,还反映了作者不同的学术观点。

我们希望这套丛书能对高等院校师生和广大科技人员有所帮助,同时对我国环境教育的发展作出贡献。

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2000 年 1 月



# PREFACE

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. There are many facts presented in charts, graphs, and figures that help to illustrate the scope of environmental issues. However, this is not the core of the text, since the facts will change.

## ORGANIZATION AND CONTENT

This book is divided into five parts and twenty chapters. It is organized to provide an even, logical flow of concepts and to provide clear illustrations of the major environmental issues of today.

**Part 1** establishes the theme of the book in chapter 1 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.

**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 included are: 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 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. Government often uses risk assessment and analysis to help set policy regarding pollution and other environmental issues. Separate chapters deal with the ways in which government sets policy and evaluates risk.

## NEW TO THIS EDITION

1. The text has been edited throughout and rewritten where needed to include the most recent data and ways of thinking about environmental issues.
2. Many new illustrations were developed and many others were modified to improve their ability to convey information.
3. Several chapters have been substantially reorganized. Chapter 11, "Human Impact on Resources and Ecosystems," has been modified to add separate sections on agricultural ecosystems and the discussion on managing aquatic ecosystems was divided into freshwater and marine sections. Chapter 12, "Land-Use Planning," was completely reorganized and updated. Chapter 15, "Water Management," was significantly reorganized and many new and revised illustrations were included. Chapter 20 was completely rewritten with emphasis on environmental policy, personal responsibility for the environment, regulations, and the impact of multinational organizations.
4. Many new topics or boxed readings have been introduced into chapters that did not require major changes in chapter organization.

- Chapter 1 has new material on salmon concerns in the Northwest.
- Chapter 2 has additional material on environmental ethics and three new boxed readings on environmental philosophy, the Kyoto Protocol, and a code of environmental ethics and conduct.
- Chapter 4 has several new boxed readings on habitat conservation plans, ecological roles of humans, human impact on nutrient cycles, and the reintroduction of wolves into Yellowstone.
- Chapter 5 has two new readings on destruction of rainforests and rainforest products.
- Chapter 7 has new boxed readings on the impact of AIDS on populations, and Malthus' essay on population.
- Chapter 8 was updated throughout and has three new boxed readings on daily gasoline price fluctuations, and China's energy policy.
- Chapter 9 has a new boxed reading on the Three Gorges Dam in China and added material on hydroelectric power.
- Chapter 12 features a new boxed reading on the urbanization of the world population, including a chart of cities with the most rapidly growing populations.
- Chapter 13 has a new section on geologic processes—plate tectonics and a new boxed reading on world soil degradation. A new illustration denotes the various components in soil.
- Chapter 14 has increased coverage of sustainable and organic farming practices, world use of fertilizer and pesticides, and new subtitles in sections to make it easier for students to follow the text. A section on protecting soil and water was also added.
- Chapter 16 has expanded coverage of market-based incentives and extended product responsibility. Three new readings on corporate recycling of wood in urban environments, sustainable development, and valuing ecosystem services have been added.
- Chapter 17 has expanded coverage of secondhand smoke and two new boxed readings on global warming and indoor air pollution.
- Chapter 18 has 14 new or significantly modified illustrations.
- Chapter 19 has a new boxed reading on hazardous waste management in China.
- Chapter 20 features new readings on the Wise Use Movement, environment policy in the European Union, and the International Whaling Commission.

## SPECIAL FEATURES AND LEARNING AIDS

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1. Each of the five parts of the text begins with an **introduction** that places the upcoming chapters in context for the reader

by recalling previously discussed material and by describing the organization of the chapters to come. We believe that this will help the reader to more fully understand and appreciate environmental issues.

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 and Analysis** case study, **summary**, a list of **key terms**, **review questions**, **critical thinking questions**, and a list of topics that correspond to specific Internet links on the accompanying web site. The case studies have been specifically selected to allow the reader to apply the chapter concepts to actual situations. Review questions are related to the chapter objectives, and thus serve to reinforce understanding of basic concepts and principles.
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.
5. 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 world view of the issues discussed in the chapter.
6. The text concludes with several appendixes that deal with the following topics: critical thinking, the metric system, the periodic table of the elements, some thoughts on what you can do to make the world a better place in which to live. In addition there is a complete glossary and index.

## USEFUL ANCILLARIES

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1. An **Instructor's Manual** accompanies the text. It includes chapter outlines, objectives, and key terms; a range of test and discussion questions; suggestions for demonstrations; and suggestions for audiovisual materials and other teaching aids. The Instructor's Manual also provides **additional case studies** for instructors who wish to use additional concrete examples of how the concepts in the chapter can be applied to the real world. It is available on disk only, in either Mac or IBM format.
2. A set of **one hundred transparencies** is also available to users of the text. The transparencies duplicate text figures that clarify essential ecological, political, economic, social, and historical concepts.
3. **Computerized Testing Software** rounds out the supplementary materials. Available for either Windows® or Mac-

Intosh®, this software allows for easy test generation using the questions found in the printed testbank.

4. *Environmental Science Visual Resource Library* (VRL) (0-07-290683-9) © 1999. This dual platform CD-ROM allows the user to search with key words or terms and access hundreds of images to illustrate classroom lectures, with just the click of a mouse. Contains images from three McGraw-Hill textbooks and over 400 additional photographs.
5. *Comprehensive Web Site*. Visit our web site at <http://www.mhhe.com/environmentalscience/> and discover a variety of valuable resources for both instructor and student. Examples include: chapter-by-chapter Internet links (updated regularly) that correspond to the end-of-chapter topics listed in the text, sample syllabi, laboratory exercises, classroom activities, current global environmental events in the news, practice quizzes, career information, and more.

## RELATED TITLES OF INTEREST/ PACKAGING OPPORTUNITIES

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*Annual Editions: Environment 99/00* (0-07-228498-6) © 1999. Editor: John L. Allen, University of Connecticut, Storrs—31 articles that address the current state of Earth and the changes it faces; world population and hunger; present and future energy needs and problems; endangered species; natural resources; and pollution.

*Taking Sides: Clashing Views on Controversial Environmental Issues*, 8th edition (0-07-303184-4) © 1999. Editor: Theodore D. Goldfarb, State University of New York, Stony Brook—18 issues debating general philosophical and political issues; the environment and technology; disposing of wastes; and the environment and the future.

## STUDENT ANCILLARIES

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1. *Environmental Science Essential Study Partner* (ESP) (0-07-303867-9) © 2000. This tutorial CD-ROM contains high-quality 3-D animations, interactive study activities, illustrated overviews of key topics in environmental science, and supplementary quizzes and exams that students will find extremely valuable.
2. *Life Science Living Lexicon* (CD-ROM or paperback print version). (CD = 0-697-37993-0; Print = 0-697-12133-X) © 1996. Author: William Marchuk. A powerful, interactive CD-ROM that contains a complete lexicon of life science terminology. Conveniently assembled on an easy-to-use CD-ROM are components such as a glossary of common biological roots, prefixes, and suffixes; a categorized glossary of common biological terms; and a section describing the classification system.
3. *Field and Laboratory Activities Manual* (0-07-290913-7) © 2000. Authors: Enger and Smith. Newly revised with additional contributors, this laboratory manual features a variety

of exercises on environmental topics. Supporting resources, directions, and interesting activities to accompany the manual may be found on the textbook's web site.

4. *Comprehensive Web Site*. Visit our web site at <http://www.mhhe.com/environmentalscience/> and discover a variety of valuable resources for both instructor and student. Examples include: chapter-by-chapter Internet links (updated regularly) that correspond to the end-of-chapter topics listed in the text, sample syllabi, laboratory exercises, classroom activities, current global environmental events in the news, practice quizzes, career information, and more.

*Sources: Notable Selections in Environmental Studies*, 2nd edition (0-07-303186-0) © 2000. Editor: Theodore D. Goldfarb, State University of New York, Stony Brook. Overviews of environmental issues focus specifically on energy, environmental degradation, population issues and the environment, human health and the environment, and environment and society.

*The Dushkin Student Atlas of Environmental Issues*, 1st edition (0-697-36520-4) © 1997. Editor: John Allen, University of Connecticut, Storrs—covers recent agricultural, industrial, and demographic changes in every world region; 48 full-color maps illustrate global patterns in the physical and human environments; and presents human impact on the air, fresh water and the oceans, the biosphere, and land.

*You Can Make a Difference: Be Environmentally Responsible*, 2nd edition (0-07-292416-0) © 1999. Author: Judy Getis. This book is organized around the three parts of the biosphere: land, water, and air. Each section contains descriptions of the environmental problems associated with that part of the biosphere. In the section on the atmosphere, for example, such problems as acid rain and the greenhouse effect are discussed. Immediately following each discussion or "challenge" are suggested ways that individuals can help solve or alleviate them—i.e., the "response."

*Environmental Ethics: Divergence and Convergence*, 2nd edition (0-07-006180-7) © 1998. Authors: Botzler and Armstrong. This anthology surveys diverse approaches to environmental ethics by leading writers from a variety of disciplines, and provides a historical survey of thought on our responsibility to the environment. The perspectives are represented by articulate spokespersons and are accompanied by appraisals of their respective strengths and weaknesses. New topics include biodiversity, ecological restoration, environmental justice, and genetic engineering. A new section in the appendix on conflict resolution was requested by students.

*The Age of Environmentalism* (0-07-060841-5) © 1997. Author: J. E. de Steiguer. A scholarly treatment of environmental thought, this work provides information on the changing social and economic factors which gave rise to the modern environmental era, and examines a broad array of academic disciplines—biology, history, theology, philosophy, computer science and economics—which have contributed to modern environmentalism.



*Environmental Problem Solving: A Case Study Approach* (0-07-027686-2) © 1997. Author: Isobel W. Heathcote. This book focuses on real environmental case studies that illustrate an interaction of several disciplines and require analytical techniques to help students gain the "hands-on" experience needed to handle today's environmental issues.

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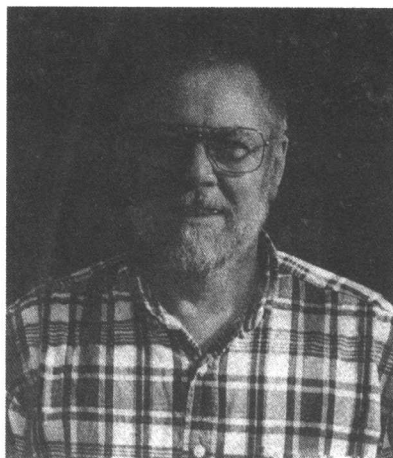
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**Eldon D. Enger**

### ELDON D. ENGER

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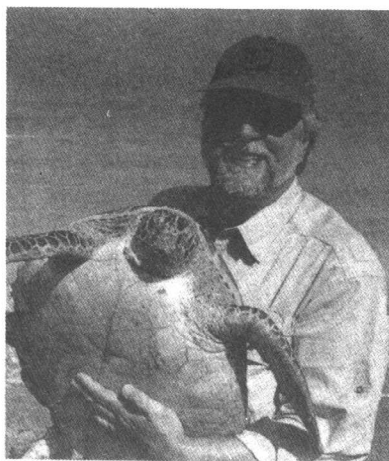
Eldon D. Enger is a professor of biology at Delta College, a community college near Saginaw, Michigan. He received his B.A. and M.S. degrees from the University of Michigan. Professor Enger has over 30 years of teaching experience, during which he has taught biology, zoology, environmental science, and 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, which involves students in two weekend activities including canoeing and camping, and a plant identification course that incorporates weekend field activities with backpacking and camping. In addition, he was 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 very 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, studying the behavior of a bird known as the long-tailed manakin. He has also visited Australia, 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 college-aged sons, and enjoys a variety of outdoor pursuits such as cross-country skiing, hiking, hunting, fishing, camping and gardening. Other interests include reading a wide variety of periodicals, beekeeping, singing in a church choir, and preserving garden produce.



**Bradley F. Smith**

## **BRADLEY F. SMITH**

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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 as the first Director of the Office of Environmental Education for the U.S. Environmental Protection Agency in Washington, D.C. from 1991 to 1994. 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 fifteen 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, Canada. 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 (IUCN).

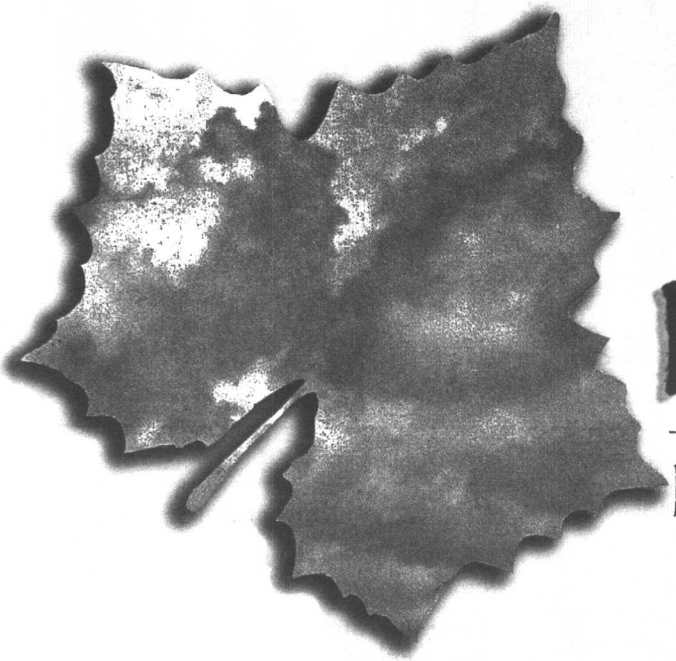
Nationally, Dean Smith serves as a member/advisor for many environmental organizations' boards of directors, advisory councils, and executive committees, including President Clinton's Council for Sustainable Development (Education Task Force).

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.







# PART ONE

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## Interrelatedness

**E**nvironmental science is an interdisciplinary study that describes problems caused by human use of the natural world. It also seeks remedies for these problems. To learn about this complex field of study, it helps to understand three things: First, it is important to understand the natural processes (both physical and biological) that operate in the world. Second, it is important to appreciate the role that technology plays in our society and its capacity to alter natural processes as well as solve problems caused by human impact. Third, it helps to understand the complex social processes that characterize human populations. When we integrate that understanding with a knowledge of technology and natural processes, we can fully appreciate our role in the natural world.

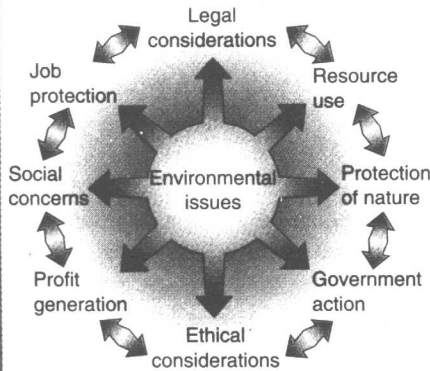
**Chapter 1** introduces the central theme of interrelatedness by analyzing some environmental issues in North America region by region.

**Chapter 2** discusses the differences that can exist among individuals in a society and the different behaviors people exhibit, depending on whether they are acting as individuals, as part of a corporation, or as part of government.

# 1

## chapter

# Environmental Interrelationships



## OBJECTIVES

After reading this chapter, you should be able to:

- Understand why environmental problems are complex and interrelated.
- Realize that environmental problems involve social, political, and economic issues, not just scientific issues.
- Understand that acceptable solutions to environmental problems are not often easy to achieve.
- Understand that all organisms have an impact on their surroundings.
- Understand what is meant by an ecosystem approach to environmental problem solving.
- Recognize that different geographic regions have somewhat different environmental problems, but the process for resolving them is the same and involves compromise.

## CHAPTER OUTLINE

The Field of Environmental Science

The Interrelated Nature of Environmental Problems

**Environmental Close-Up:** *Science Versus Policy*

**Global Perspective:** *Fish, Seals, and Jobs*

An Ecosystem Approach

Regional Environmental Concerns

**Environmental Close-Up:** *The Greater Yellowstone Ecosystem*

**Environmental Close-Up:** *Ecosystem Size*

The Wilderness North

The Agricultural Middle

The Dry West

The Forested West

The Great Lakes and Industrial Northeast

The Diverse South



# THE FIELD OF ENVIRONMENTAL SCIENCE

**Environmental science** is an interdisciplinary area of study that includes both applied and theoretical aspects of human impact on the world. Since humans are generally organized into groups, environmental science must deal with politics, social organization, economics, ethics, and philosophy. Thus, environmental science is a mixture of traditional science, societal values, and political awareness. (See figure 1.1.)

Environmental science as a field of study is evolving, but it is rooted in the early history of civilization. Many ancient cultures expressed a reverence for the plants, animals, and geographic features that provided them with food, water, and transportation. These features are still appreciated by modern people. The following quote from Henry David Thoreau (1817–1862) is over a century old but is consistent with current environmental philosophy:

I wish to speak a word for Nature, for absolute freedom and wildness, as contrasted with a freedom and culture merely civil . . . to regard man as an inhabitant, or a part and parcel of Nature, rather than a member of society.

The current interest in the state of the environment began with philosophers like Thoreau and received an additional push by the organization of the first Earth Day on April 22, 1970. Subsequent Earth Days reaffirmed this commitment, as have similar Earth Days since then. As a result of this continuing interest in the state of the world and how people affect it, environmental science is now a standard course on many college campuses and is also a part of most high school course offerings. Most of the concepts covered by environmental science courses had previously been taught in ecology, conservation, or geography courses. Environmental science incorporates the scientific aspects of these courses with input from the social sciences, such as economics, sociology,

and political science, creating a new interdisciplinary field.

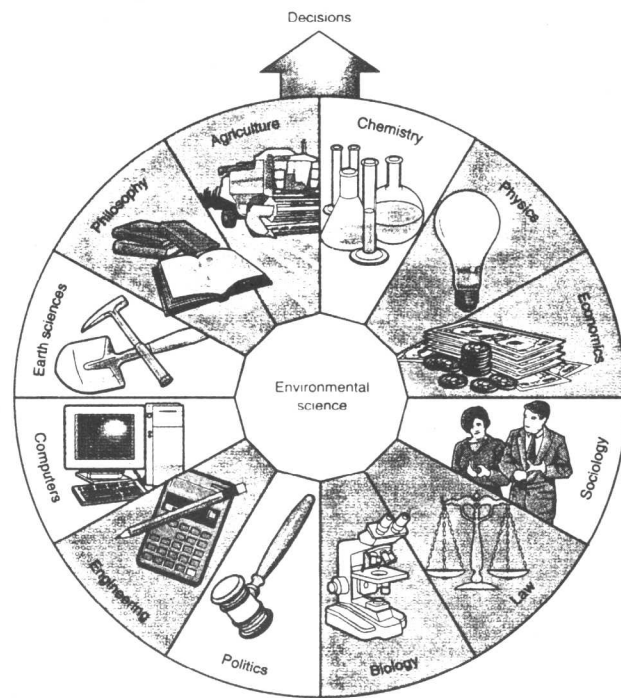
## THE INTERRELATED NATURE OF ENVIRONMENTAL PROBLEMS

Environmental science is by nature an interdisciplinary field. The word *environmental* is usually understood to mean the surrounding conditions that affect people and other organisms. In a broader definition, **environment** is everything that affects an organism during its lifetime. From a human perspective, environmental issues involve concerns about science, nature, health, employment, profits, politics, ethics, and economics.

Most social and political decisions are made with respect to political jurisdictions, but environmental problems do not necessarily coincide with these artificial, political boundaries. For example, air pollution

may involve several local units of government, several states or provinces, and even different nations. The forest fires that raged in Mexico in 1998 had a severe impact on air quality in Texas. On a more local level, the air pollution problems in Juarez, Mexico, are also problems in El Paso, Texas. But the issue is more than air quality and human health. Lower wage rates and less strict environmental laws have influenced some industries to move to Mexico for economic reasons. Mexico and many other developing nations are struggling to improve their environmental image and need the money generated by foreign investment to improve the conditions and the environment in which their people live.

Air pollutants produced in the major industrial regions of the United States drift across the border into Canada, where acid rain damages lakes and forests. A long-standing dispute exists between the United States and Canada over this issue. Canada claims that the United States should be doing more to reduce emissions that cause



**FIGURE 1.1 Environmental Science** The field of environmental science involves an understanding of scientific principles, economic influences, and political action. Environmental decisions often involve compromise. A decision that may be supportable from a scientific or economic point of view may not be supportable from a political point of view without modification. Often political decisions relating to the environment may not be supported by economic analysis.



# ENVIRONMENTAL CLOSE-UP

## Science Versus Policy

Scientific knowledge and government policy do not always agree. The scientific community can advise governments but cannot insist that certain policies be adopted. Governments may halt some scientific research because they control funding sources, or they may introduce regulations that make continuing the research difficult. For example, much federal money was spent on alternative energy research during the Carter presidency, but many of these projects were not in favor during the Reagan and Bush presidencies. Funding was reduced and much of the research into alternative fuels stopped. Conversely, the passage of the 1990 Clean Air Act during the Bush presidency mandated that alternative-fuel automobiles be used in some cities with severe air-pollution problems.

Government policy may be contrary to prevailing scientific opinion for economic or political reasons. For many years during the Rea-

gan administration, most scientists in the United States and Canada agreed that the burning of high-sulfur coal and other acid-producing fuels was responsible for acid rain, which was leading to the deaths of lakes in parts of Canada and the northeastern United States. The administration continued to insist that the information was not conclusive and that the problem should be studied in greater detail.

The Clinton administration faced a similar dilemma regarding the debate over global warming. While the scientific community strongly supported the position that global warming is for real and that it is due in large part to human causes, Clinton was cautious in moving too fast to reduce emissions in the United States. This is in part due to the potential economic consequences involved. It is difficult to separate scientific knowledge, governmental policy, and economic policy. Can you identify similar examples of this debate in your community?

## GLOBAL PERSPECTIVE

### Fish, Seals, and Jobs

In 1995, the Canadian government announced a moratorium on cod fishing along the east coast of Canada. The cod industry contributes \$700 million a year and 31,000 jobs to the Canadian economy, primarily in Newfoundland. At the same time, the government announced that it would begin a program to encourage the harvesting of harp seals by helping develop markets for seal products. Environmental groups opposed the harvesting of the seals.

How do all these pieces fit together? It is thought that the low numbers of cod in the North Atlantic are partially the result of an increasing population of harp seals. While overfishing, larger nets, and other factors have also contributed to the decline of the cod, it is true that harp seals feed on fish that could have been harvested. The current harp seal population along the Atlantic Coast has more than doubled since the 1970s to 4.8 million in 1997 and is projected to reach 6 million by 2000 if there are no hunts. The increase in harp seals is at least partly the result of actions during the 1970s by environmental groups that sought to stop the killing of seals because they considered the harvesting method inhumane. The traditional method involves clubbing the young seals to death. In 1996, the Canadian government increased the seal hunt quota from 186,000 to 287,000. In 1997 scientists from seven countries met in St. John's, Newfoundland to consider the inter-

actions between harp seals and fisheries in the Northwest Atlantic. The conclusions of the meeting supported the earlier findings of the dramatic population growth amongst the seals and also noted that the animals were now growing more slowly and the pregnancy rate is lower than in the 1980s. These are the effects you would likely see when food becomes more difficult to find.

The St. John's meeting reinforced the fact that the diet of harp seals in the nearshore waters of the Labrador-Newfoundland shelf is dominated by Arctic cod. It was not, however, determined whether or not harp seals were affecting commercial fishing stocks—and Atlantic cod, in particular—on the Labrador-Newfoundland shelf. This was because there is a need for an estimate of the amount of juvenile cod in both inshore and offshore areas, and for an assessment of the amounts of cod which are being taken by the other important predators such as Greenland halibut, whales, and seabirds.

It appears that what might be seen initially as a number of isolated and unrelated factors are really interrelated in a way that affects the economy of an entire region.



acid rain, and the United States claims it is doing as much as it can. In another example, farmers who use water from the Colorado River for irrigation reduce the quality and quantity of water entering

Mexico. This causes political friction between Mexico and the United States.

The issue of declining salmon stocks in the Pacific Northwest of the United States and British Columbia, Canada is

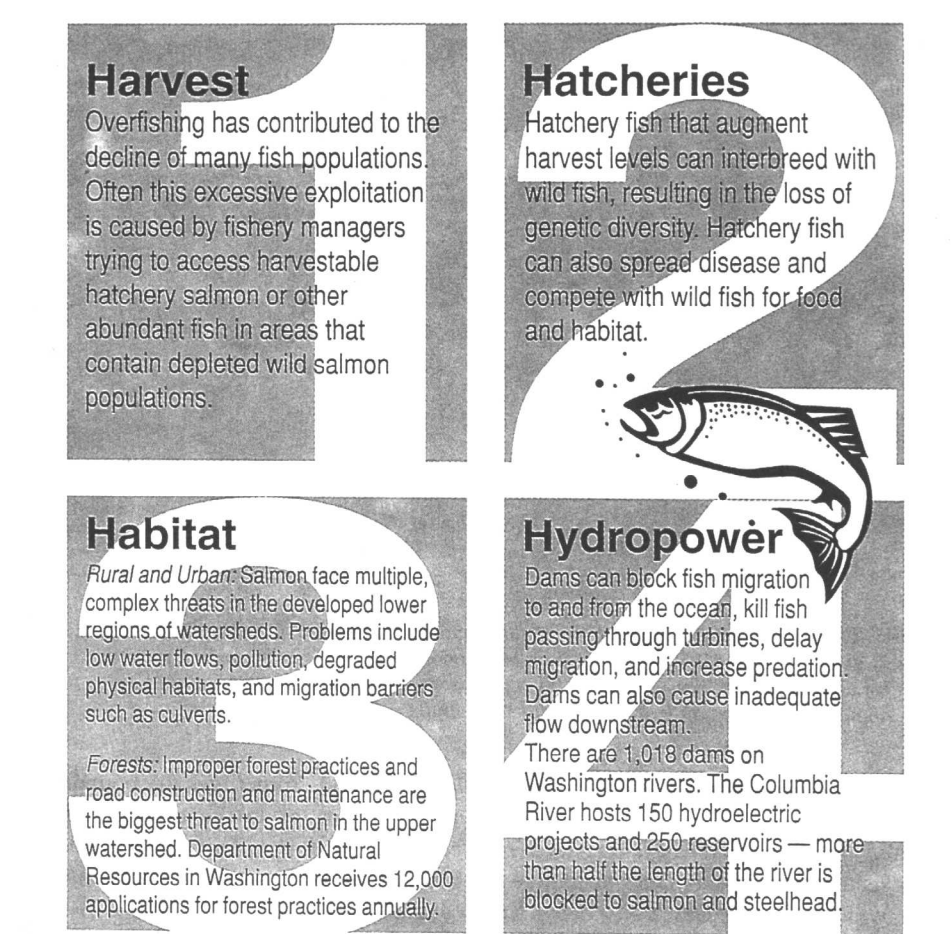
another example of political friction over a shared natural resource. It has been calculated that on the U.S. side of the salmon issue alone there are five federal Cabinet level departments, two federal agencies,

five federal laws in question as well as numerous Tribal treaties, commissions and court decisions. All of this is in addition to many state level departments, commissions, and rulings. If all of this was not sufficient you still have the international bodies such as the United Nations and the international treaties that impact the fate of the salmon. Considering all this attention, maybe it is not that surprising that the plight of the salmon is in such a dangerous state. (See figure 1.2.)

Because of all these political, economic, ethical, and scientific links, solving environmental problems is complex. The problems seldom have simple solutions. However, international organizations such as the International Joint Commission have had major bearing on the quality of the environment over broad regions of the world.

The International Joint Commission was established in 1909 when the Boundary Waters Treaty was signed between the United States and Canada. The treaty was established in part to provide that the "boundary waters and waters flowing across the boundary shall not be polluted on either side to the injury of health or property of the other." The Commission has been instrumental in identifying areas of concern and encouraging the cleanup of polluted sites that affect the quality of the Great Lakes and other boundary waters. In general, the two governments have listened to the Commission's advice and have responded by initiating cleanup activities.

The first worldwide meeting of heads of state directed to concern for the environment took place at the Earth Summit, formally known as the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro in 1992. Most countries have also signed agreements on sustainable development and biodiversity. In 1997, representatives from 125 nations met in Kyoto, Japan for the Third Conference of the United Nations Framework Convention on Climate Change. This conference, commonly referred to as the Kyoto Conference on Climate Change, resulted in commitments from the participating nations to reduce their overall emissions of six greenhouse gases (linked to global warming) by at least 5 percent



**FIGURE 1.2 The Four H's: Human Activities that Affect Wild Salmon Survival** The interrelated nature of environmental problems is evident with regards to concern about diminishing numbers of wild salmon in the Pacific Northwest of the United States and in British Columbia, Canada. This diagram portrays the plight of wild salmon in the State of Washington but the issue is region wide.

Source: Washington Department of Natural Resources Newsletter, Winter 1998, Department of Natural Resources, Washington, D.C.

below 1990 levels between 2008 and 2012. (See figure 1.3.) The Kyoto Protocol, as the agreement was called, was viewed by many as one of the most important steps to date in environmental protection and international diplomacy. It may be years before we will know if all countries that signed these agreements will meet their commitments to environmental improvement, but they have at least stated their intention to do so.

The United Nations, through the United Nations Educational, Scientific, and Cultural Organization (UNESCO) and the United Nations Environment Programme (UNEP), has supported many environmental programs. A recent undertaking is the International Environmental

Education Programme (IIEP). This program recognizes the need for both formal environmental education in schools and the informal education that occurs through the media and groups of interested citizens. Conferences on environmental education were first held during the 1970s and continue to the present.

## AN ECOSYSTEM APPROACH

The natural world is organized into interrelated units called ecosystems. An **ecosystem** is a region in which the organisms and the physical environment form