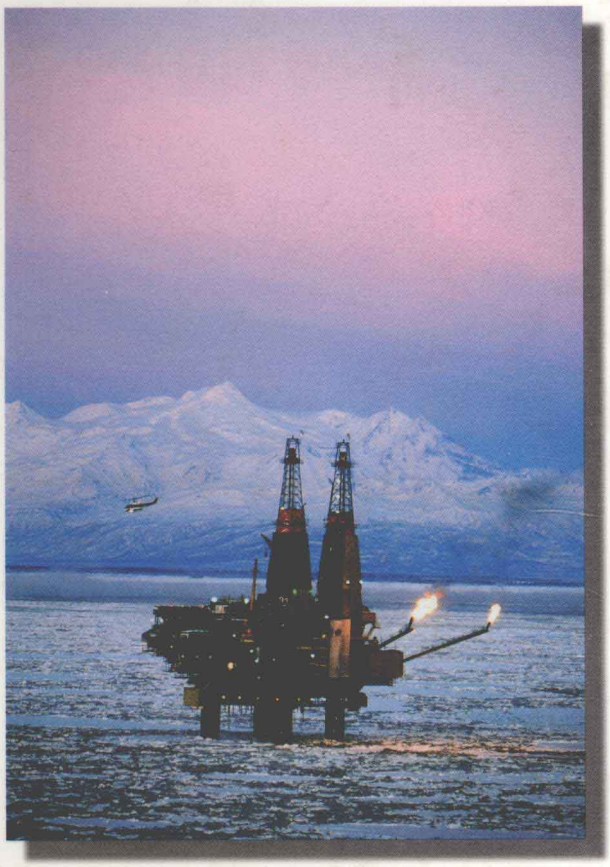
ENVIRONMENTAL SCIENCE

EIGHTH EDITION

TOWARD A SUSTAINABLE FUTURE



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Environmental Science

Toward a Sustainable Future

Eighth Edition

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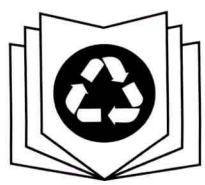

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Preface

As we plunge into a new century and a new millennium, the environment is being called on to satisfy the growing needs of an expanding human population in the developing countries and increasing affluence in the developed countries. In many areas, we are already taking more from Earth's systems than they can provide in a sustainable fashion—and there are still billions of people who are not adequately housed, fed, or provided with health care or a paying job. Yet we must, as soon as possible, make a transition to a sustainable civilization, one in which a stable human population recognizes the finite limits of Earth's systems to produce resources and absorb wastes, and acts accordingly. This is hard to picture at present, but it is the only future that makes any sense. If we fail to achieve it by our deliberate actions, the natural world will impose it on us in highly undesirable ways.

Environmental science stands at the interface between humans and Earth and explores the interactions and relations between them. This relationship will need to be considered in virtually all future decision making. Our text considers a full spectrum of views and information in an effort to establish a solid base of understanding and a sustainable formula for the future.

You may already be informed about some of the issues we cover in the book, such as global warming, the extinction of species, air pollution, toxic wastes, overpopulation, recycling, and the destruction of tropical rain forests. However, what you have in your hands is a readable guide and up-to-date source of information that will help you to explore the issues in more depth. It will also help you to connect them to a framework of ideas and values that will equip you to become part of the solution to many of the environmental problems confronting us.

As the field of environmental science evolves and continues to change, so has this text. In this new edition, we hope to continue to lead the change in environmental science and have made every effort to address each of the following objectives:

- To write in a style that makes learning about environmental science both interesting to read and easy to understand, without overwhelming the student with details.
- To present well-established scientific principles and concepts that form the knowledge base for an understanding of our environment.
- To organize the text in a way that promotes sequential learning, yet allows individual chapters to stand on their own.
- To address all of the major environmental issues that confront our society and help to define the subject matter of environmental science.
- To present the latest information available by making full use of the resources of the World Wide Web.
- To give an assessment of options or progress in solving environmental problems.
- To support the text with excellent supplements for the instructor and the student that strongly enhance the teaching and learning processes.

Because we believe that learning how to live in the environment is one of the most important subjects in any student's educational experience, we have made every effort to put in your hands a book that will help the study of environmental science come alive.

A Guide to the Eighth Edition of Environmental Science

Overview

The **seventh edition**, published in 2000, involved the following major changes in the text, as the authorship shifted entirely to one author (Wright):

- Introduction of three central themes: sustainability, sound science, and stewardship.
- Reorganization into six parts instead of four.
- Addition of "Environment on the Web" essays at the end of each chapter.
- Two new chapters added (Chapter 16, "Environmental Hazards and Human Health," and Chapter 23, "Economics, Public Policy, and the Environment"), and two older chapters condensed into existing or new chapters.
- Completely updated and revised art program.
- Every chapter opening with a case study, to bring the subject matter into focus.

The **eighth edition** builds on the strengths of the seventh. The unifying themes of sustainability, sound science, and stewardship are retained and continue to provide important threads linking the different subjects and chapters of the text. In the eighth edition, I continue to provide a balance between pure science and the political, social, and historical perspectives of environmental affairs. I am also careful

to reflect differences in interpretation of environmental concerns where they exist, while maintaining the standard of sound science for judging those concerns.

Most important, the eighth edition reflects the changing environmental scene in the United States, as well as in the rest of the world. Information from new books, journal articles, and Web-based reports from governmental and nongovernmental organizations has been incorporated into every chapter. New artwork has been introduced—51 new photos, 35 new diagrams, and seven new tables.

As in the seventh edition, each chapter opens with a case study or an illustrative story. Because of their relevance, a majority of these have been retained, while 10 have been replaced with new opening studies. Throughout, the high readability that the text has been known for has been maintained and strengthened. And the emphasis on science has continued, to the point where the text is more solidly grounded than ever in the physical and biological sciences as the bases for understanding every environmental issue.

Introduction

Chapter 1 provides an introduction to the rest of the book by discussing present global environmental concerns; **ecosystem decline** has been added as one of the most important of these. The chapter introduces the three themes that will provide the unifying threads throughout the book: **sustainability**—the practical goal that our interactions with the natural world should be working toward; **stewardship**—the ethical and moral framework that should inform our public and private actions (a **new ethics essay** explores this theme); and **sound science**—the basis for our understanding of how the world works and how human systems interact with it. I include in my coverage of sound science information on **the nature of science** and the **scientific method** in order to help students distinguish sound science from "junk" science (of which I give a prime example) as they encounter controversy over scientific information.

Part I. Ecosystems and How They Work

Part I (Chapters 2–5) explores natural ecosystems—what they are, how they function, how balances are maintained, and how they evolve and change. This examination, in addition to providing an appreciation of how the natural world functions, brings out **five basic sustainability principles** that keep ecosystems going. A new principle—**resilience**—is introduced and illustrated. The five principles serve as benchmarks to evaluate the sustainability of various courses of action presented in the rest of the text.

Part II. The Human Population

Part II (Chapters 6 and 7) first looks at the dynamics of the human population. The pressures on natural systems as a result of the growth of that population are examined, with a focus on the **demographic transition**—the shift from high birth and death rates to low birth and death rates that has brought stable populations to the industrialized world. Then, the developing countries' difficulties through this transition are considered, and steps that are being taken on the part of the international community to address the needs of those countries are discussed. The eighth edition presents new population pyramids, the latest on **debt relief**, and the recent appraisal of the five-year anniversary of the International Conference on Population and Development, as well as completely updated population growth statistics.

Part III. Renewable Resources

Part III (Chapters 8–12) addresses the science of our natural resources of soil, water, and wildlife. Issues concerning the use of such resources in food production, forest growth, and fisheries management are examined in light of increasing population growth and increasing pressure on those resources: again, we all the while keep our eyes on sustainability. Some examples of issues receiving a **new emphasis** are (a) how erosion is measured and why the way it is measured is problematic, (b) dryland ecosystems and desertification, (c) the work of the World Water Forum, (d) the controversy surrounding **genetically modified food**, and (e) **restoration ecology** at work.

Part IV. Energy

Part IV (Chapters 13–15) presents the energy resources currently available and the consequences each can have on the environment. We learn how our past choices of energy sources to fuel the global economy have affected the environment on a global scale. The outlook regarding the impact on sustainability of the U.S. reliance on crude oil and the obvious prospects for renewable energy are presented in view of the most recent statistics and developments. Included is a discussion of the impact of **new standards** for appliances on energy conservation. Also examined is the option of nuclear power, despite the problems of its cost, the difficulty of nuclear waste storage and disposal, and the inherent dangers associated with nuclear power. Renewable energy is also discussed in light of its pros and cons; new information is presented on **fuel cells** and how they work.

Part V. Pollution and Prevention

Part V (Chapters 16–22) begins with a chapter on environmental health. The **precautionary principle** is introduced here and is discussed in connection with risk-based public policy. The text goes on to investigate the pollution of water, land, and air that results from human activities and our interactions with the environment that were discussed in earlier chapters. The coverage ranges from the use of pesticides to protect our

crops, through sewage treatment and contamination of water, to municipal and hazardous wastes, and on to major atmospheric changes and more local and regional air pollution. Examples of some new issues introduced in this edition are (a) the controversy over **DDT for malaria control**, (b) the **dead zone** in the Gulf of Mexico, (c) the "**dirty dozen**" persistent organic pollutants (**POPs**), (d) the use of **MTBE** in gasoline, and (e) the **consequences of climate change**.

Part VI. Toward a Sustainable Future

Part VI (Chapters 23 and 24) directly addresses the relationship that exists among economics, public policy, and the environment, focusing especially on our present environmental concerns. A new box discusses the **World Trade Organization** as an environmental issue. The text then goes on to examine how inner cities have deteriorated as a result of migration to the suburbs and urban sprawl. Some communities are working toward renewal and sustainability with a plan called **Smart Growth**. Part VI closes with a look at personal involvement, lifestyles, and values as vital components of our efforts to enjoy a sustainable future.

Individual Text Elements

Essays: Environmental Science features four kinds of essays: "Earth Watch," "Ethics," "Global Perspective," and "Career Link." Lists of essays are found at the end of the outline for each chapter.

"**Earth Watch**" essays provide further information that enhances the student's understanding of particular aspects of the topic being covered.

"**Ethics**" essays focus on the fact that many environmental issues do not involve clear-cut rights or wrongs, but present ethical dilemmas.

"**Global Perspective**" essays help the student appreciate the global nature and extent of the topic in question.

"**Career Link**" essays present an individual who has chosen to work in some area of environmental concern. The essays discuss how the person got into his or her career.

Making a Difference: I believe that no amount of text-based learning about the environment truly becomes useful until students challenge themselves and those around them to begin making a difference. With this in mind, each of the six parts of the text concludes with a section that suggests courses of action that each student can take to bring about the needed changes to foster sustainability.

Chapter Opening: Each chapter begins with a set of "**Key Issues and Questions**"—succinct statements regarding key aspects of the issue being covered and questions inviting the student to explore those issues.

Chapter Outline: Chapter outlines may be found in the **Table of Contents**. Importantly, the text of each chapter is organized according to a logical outline of first-, second-, and third-order headings to assist student outlining, note taking, and learning.

Review Questions: Each chapter concludes with a set of "**Review Questions**" addressing each aspect of the topic covered. Of course, these questions may serve as learning objectives, as test items, or for review.

Thinking Environmentally: A set of questions, "**Thinking Environmentally**," is included at the end of each chapter. These questions invite the student to make connections between knowledge gleaned from the chapter and other areas of the environmental arena and to apply knowledge gained to specific environmental problems. The questions may be used also for testing or to focus class discussion.

Vocabulary: Each new term will be found in boldface type where it is first introduced and defined. All such items are found in the glossary at the end of the book.

Video Case Studies: Selected from the archives of ABC news, these timely and relevant video segments offer students an overview of a particular environmental issue or controversy. Case study material is found directly after the end of the text, but has direct application to particular chapters. A brief synopsis of each video, as well as a list of interesting questions, is included, in the hopes of stimulating healthy classroom debate and discussion of the various topics. Since videos from earlier volumes are also made available to instructors who adopt the eighth edition of Environmental Science, a list of these case studies is also provided.

Appendices: At many points in the text, reference is made to the work being done by various environmental organizations. A listing of major national environmental organizations is given in **Appendix A**. Most of these organizations and agencies have a home page on the Internet and can be located via the Web site that supports this text.

A conversion chart for various English and metric units is found in **Appendix B**.

For students who need some grounding in chemistry, a discussion of atoms, molecules, atomic bonding, and chemical reactions is provided in **Appendix C**.

Bibliography and Additional Reading: An updated listing of articles and books dealing with environmental topics follows the appendices, which are organized according to chapter, following a short list of general references. Also listed are virtually all of the newer references used in preparing this new edition of the text.

Glossary and Index: A comprehensive glossary provides definitions of virtually all of the special terms, treaties, legis-

lation, and programs identified in the text in boldface type. The index gives page references for all of these terms and for thousands of other topics and issues dealt with in the text.

For the Instructor

Instructor's Resource Manual (0-13-091379-0)
By Nancy Ostiguy (Pennsylvania State University)
This thorough resource manual features a chapter outline, instructional goals, concepts and connections, a suggested lecture format, and answers to the chapter-opening "Key Issues and Questions," as well as creative discussion questions, activities, and labs.

Test Item File (0-13-091389-8)
By Steve Ailstock (Anne Arundel Community College) and Shari Snitovsky (Skyline College)
Contains over 1,800 test questions, including multiple-choice, short-answer, and essay questions.

Prentice Hall Custom Test
Available in formats for both Windows (0-13-091388-X) and Macintosh (0-13-091387-1) computers, and based on the powerful testing technology developed by Engineering Software Associates, Inc. (ESA), Prentice Hall Custom Test allows instructors to create and tailor exams to their own needs. With this on-line testing program, exams can be administered on-line and data can be automatically transferred for evaluation. A comprehensive desk reference guide is included along with on-line assistance.

Transparency Pack (013-091384-7)
A selection of 164 full-color transparencies of images from the text, as well as 87 black-and-white transparency masters.

Slides (013-091383-9)
A selection of the same 164 images presented on the transparencies, available in slide format.

The ABC News/Prentice Hall Video Library, Volume V (013-091386-3)
This unique video series contains segments from award-winning shows such as "*World News Tonight*," "*Nightline*," and "*Good Morning America*." Selected from the archives of ABC News, each video includes a written summary that ties the segment to particular sections of the text, making it easier to enhance your classroom presentation with timely and relevant video programs.

Environmental Science
Digital Image Gallery (0-13-091934-9).
This unique image bank contains all of the illustrations from the eighth edition of *Environmental Science*, as well as animations and videos in a digitized format for use in the classroom. The CD-ROM includes a navigational tool to allow instructors to browse easily through the images. The files are ideal for those professors who use PowerPoint® or a comparable presentation software for their classes or for professors who create text-specific Web sites for their students.

For the Student

Study Guide (013-091391-x)
By Clark Adams (Texas A & M University)
This study guide helps students identify the important points from the text and then provides them with review exercises, study questions, self-check exercises, and vocabulary review. In addition, the author has included PowerPoint® presentations for student review and for the professor to go over in class.

Environmental Science World Wide Web Home Page http://www.prenhall.com/wright. This unique tool is designed to launch student exploration of environmental science resources on the World Wide Web. The home page is regularly updated and linked specifically to chapters in the text. In addition to providing a juried guide to many interesting Web-based resources, the site features review exercises (from which the students receive immediate feedback), updates of environmental issues by region, a guide to environmental careers, and a guide to help students learn how to start making a positive difference for Earth's environment.

Science on the Internet: A Student's Guide
By Andrew T. Stull.
The perfect guide to help students take advantage of the Environmental Science Web site. This unique resource gives clear steps for accessing the regularly updated Environmental Science resource area, as well as an overview of general navigation and research strategies.

Course Management
Prentice Hall is proud to partner with many of the leading course management system providers on the market today. These partnerships enable us to combine our market-leading on-line content with the powerful course management tools Blackboard and WebCT, as well as with our proprietary course management system, CourseCompass. Visit our demo site, www.prenhall.com/demo, for more information, or contact your local Prentice Hall representative, who can provide a live demonstration of these exciting tools.

Reviewers

I offer my sincere thanks to those who reviewed the seventh edition and previous editions of this text. Their comments, suggestions, and constructive criticisms have all been carefully considered and in many instances have led to significant improvements in the text. I thank the following people:

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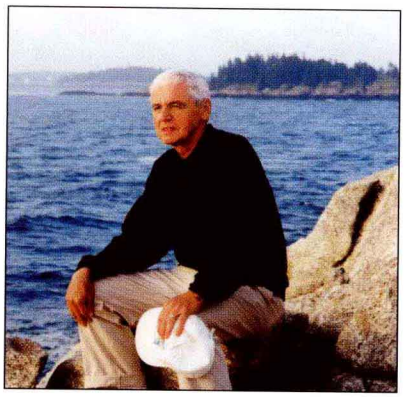
Ten years ago, Prentice Hall editor David Brake asked me if I would be interested in helping Bernard Nebel write the fourth edition of his environmental science text. Because of my longtime concern about environmental issues and my interest in writing, I accepted the offer. As the years passed, my commitment to environmental stewardship and deep concerns about our society's interactions with the environment have led me to direct more and more of my energy and ability to writing and speaking about environmental issues.

As I have accepted more of the responsibility for writing this text, I have realized what an amazing job Bernie did in producing the first three editions alone while also teaching full time. He did it because he was frustrated with existing environmental science texts and was convinced he could produce a more readable and effective book—and he did! Bernie Nebel and I share very similar philosophical and educational values and have enjoyed collaborating over the years. Although I alone have been responsible for the seventh and eighth editions, I am deeply indebted to Bernie for his wonderful sense of organization and beautiful and clear prose that still form an important part of the book. Both of us have offered this book in its successive editions as our contribution to the students who are now entering this new century, in the hope that they will join us in helping to bring about the environmental revolution that must come—hopefully sooner than later.

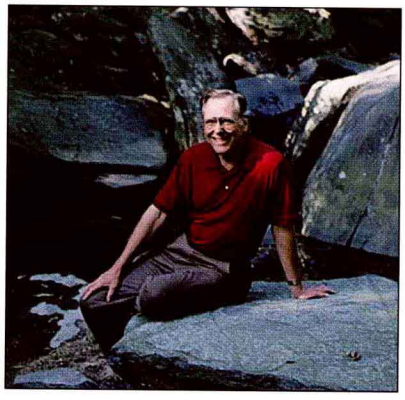
I wish to offer some very personal thanks to my wife, Ann, who has been with me since the beginning of my work in biology and has provided the emotional base and companionship without which I would be far less of a person and a biologist. Her love and patience have sustained me in immeasurable ways. Finally, I offer my gratefulness to God, who is the author of the amazing Creation I love so much. I count it a privilege to be involved in promoting the care of His Creation.

Richard T. Wright

About the Authors



Richard T. Wright is Professor Emeritus of Biology at Gordon College in Massachusetts, where he taught environmental science for 28 years. He earned a B.A. from Rutgers University and a M.A. and Ph.D. in biology from Harvard University. For many years Wright received grant support from the National Science Foundation for his work in marine microbiology and, in 1981, he was a founding faculty member of Au Sable Institute of Environmental Studies in Michigan, where he also served as Academic Chairman for 11 years. He is a Fellow of the American Association for the Advancement of Science, and in 1996 was appointed a Fulbright Scholar to Kenya. He is a member of many environmental organizations, including the Nature Conservancy, Habitat for Humanity, the Union of Concerned Scientists, Massachusetts Audubon, and others, and is a supporting member of the Trustees of Reservations. Wright is involved full time in writing and speaking about the environment, and spends his spare time gardening, fishing, hiking, birding and enjoying his 7 grandchildren.



Bernard J. Nebel is Professor Emeritus of Biology at Catonsville Community College in Maryland. He earned his Bachelor of Arts from Earlham College and his Ph.D. from Duke University. Nebel was one of the first college professors to develop a comprehensive environmental science course and write a text for the subject. Nebel has recently developed an elementary (K-5) science curriculum designed to help children understand the world, their place in it, and their responsibility toward it. Nebel is a member of the American Association for the Advancement of Science, the American Institute of Biological Sciences, the American Solar Energy Society, and the National Association of Science Teachers. He strives to make a difference in the environment in his personal life; his urban backyard is a small ecosystem complex of pond, fruit trees, and garden that is supported by composted wastes. He is an active supporter of Freedom From Hunger, Habitat for Humanity, the World Wildlife Fund, Conservation International, and other environmental organizations.

Brief Contents

Essays

EARTH WATCH

ETHICS

GLOBAL PERSPECTIVE

CAREER LINK

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