

Environmental Science

— Seventh Edition

Bernard J. Nebel • Richard T. Wright



Environmental Science

The Way the World Works



Seventh Edition

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Catonsville Community College

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Gordon College

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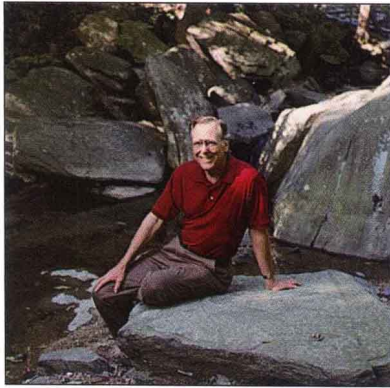
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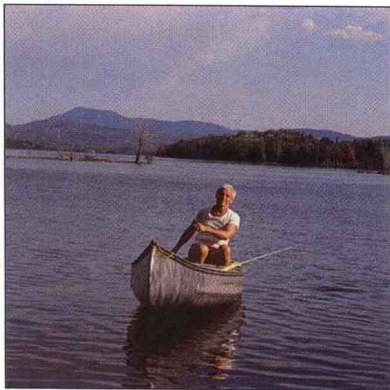
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About the Authors



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 is now interested in developing and writing an elementary (K–5) science curriculum designed to help children develop an understanding of 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 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.



Richard T. Wright is Professor Emeritus of Biology at Gordon College in Massachusetts, where he taught an environmental science course for 28 years. He earned a Bachelor of Arts from Rutgers and a Master of Arts and Ph.D. from Harvard University. For many years Wright received research grants from the National Science Foundation for his work in marine microbiology and, in 1981, 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 National Wildlife Federation, Bread for the World, Habitat for Humanity, the Union of Concerned Scientists, and others, and is a supporting member of the Trustees of Reservations. In his personal life, Wright is involved full time in speaking and writing about the environment, and strives to keep his environmental impact at a minimum by recycling, planting trees and vegetables in his yard, and working with numerous environmental organizations.

Preface

At the start of the millenium, civilization has reached a crossroads. Unable to halt the technologies that continue to exploit Earth's resources, and facing the prospect of a continuing rise in the human population, we seem to be on a stage on which an enormous human-environment experiment is being played. Playing the role of critic of this unfolding drama, environmental science stands at the interface between humans and Earth and explores the interactions and relations between them.

You may already be well informed on some of the issues we cover in this book, like global warming, species extinction, air pollution, toxic wastes, overpopulation, recycling, and tropical rain forest loss. However, what you have in your hands is a readable guide and an 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 at the turn of the century.

The seventh edition of *Environmental Science: The Way the World Works* has been built on the solid foundation of six previous editions. 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 these following objectives:

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

Changes in the Seventh Edition

- The introduction of three central themes throughout the book: sustainability, stewardship, and sound science.
- New organization of the book into six parts instead of four: I. Ecosystems and How They Work; II. The Human Population; III. Renewable Resources; IV. Energy; V. Pollution and Prevention; and VI. Toward a Sustainable Future.
- The addition of an *Environment on the Web* essay at the end of each chapter. This essay introduces the student/reader to additional environmental issues that appear on the book's web site (<http://www.prenhall.com/nebel>). The exercises on the web-site help students explore environmental issues of concern on the World Wide Web by allowing the students to collect and analyze real world data using the readily available resources on the Internet. The exercises challenge the students' problem-solving skills while helping to develop their critical thinking on matters related to environmental science.
- A new chapter (Chapter 16) on environmental hazards and human health.
- A new chapter (Chapter 23) on economics, public policy, and the environment.
- Every chapter opens with a story or case study that brings the chapter subject immediately into focus.
- A completely updated and revised art program.

A Guide to the Seventh Edition of *Environmental Science*

Introduction

Chapter 1 provides an introduction to the rest of the book by discussing present global environmental concerns. Next, this chapter introduces and explores the three themes that will provide the unifying threads throughout the book. The

themes are: **Sustainability**—the practical goal that our interactions with the natural world should be working towards; **Stewardship**—the ethical and moral framework that should inform our public and private actions; and **Sound Science**—the basis for our understanding of how the world works and how human systems interact with it. Second, we include in our 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 as they encounter controversy over scientific information.

Part I. Ecosystems and How They Work

After the introductory chapter that establishes a foundation for the text, Part One (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 four basic principles that underlie sustainability. These 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

In Part Two (Chapters 6 and 7), we first look at the dynamics of the human population. We examine the pressures on natural systems as a result of this growth, and focus especially 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. We then consider the developing countries’ difficulties through this transition, and steps that are now being taken on the part of the international community to address this need.

Part III. Renewable Resources

In Part Three (Chapters 8–12), we will address the science of renewable resources of soil, water, and wildlife. We will also study issues concerning the use of such resources in food production, forest growth, and fisheries management. In this section we look at all of these renewable resources in light of increasing population growth and increasing pressure on them while again keeping our eyes on sustainability.

Part IV. Energy

In this part (Chapters 13–15), we present 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 for the sustainability of U.S. reliance on crude oil and the obvious prospects for renewable energy are presented in view of the most recent statistics and developments in these chapters. We also discuss

the option of nuclear power despite the problems of fuel availability, cost, nuclear waste storage and disposal, lack of fuel processing and inherent danger. Renewable energy is also discussed in light of its pros and cons.

Part V. Pollution and Prevention

Part Five (Chapters 16–22), begins with a new chapter on environmental health. We then investigate the pollution of water, land, and air that result from human activities and our interactions with the environment discussed in earlier chapters. Our coverage ranges from the use of pesticides to protect our crops, through sewage treatment and contamination of water, municipal and hazardous wastes, to major atmospheric changes and more local and regional air pollution. By devoting a full chapter to each of six major categories of pollution, the student is given an understanding of sources, consequences, legislation, and control strategies related to different pollution problems.

Part VI. Toward a Sustainable Future

In Part Six, (Chapters 23 and 24), we directly address the relationship between economics and public policy with the environment and present environmental concerns. We then focus on how inner cities have deteriorated as a result of migration to the suburbs and urban sprawl. We present some communities that are working toward renewal and sustainability. Then we close 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 three kinds of essays: *Earth Watch*, *Ethics*, and *Global Perspective*. Lists of essays are found at the end of the chapter 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 understand the global nature and extent of specific environmental concerns.

Making a Difference: We 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.

Video Case Studies: Selected from the archives of ABC News, each of these timely and relevant video segments offers 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 in the text. We have provided a brief synopsis of each video and a list of discussion questions in the hopes of stimulating healthy classroom debate and discussion of these topics. Since videos from earlier volumes are also made available to instructors who adopt the seventh 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. Remember that 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.

A discussion of atoms, molecules, atomic bonding, and other basic elements of chemistry is provided in Appendix C.

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

For the Instructor

Instructor's Resource Manual (0-13-013110-5)

By Nancy Ostiguy (Pennsylvania State University)

This thorough resource manual features a chapter outline, instructional goals, concepts and connections, a suggested lecture format, answers to the chapter opening Key Issues and Questions as well as creative discussion questions, activities, and labs.

Test Item File (0-13-013121-0)

By Steve Ailstock (Anne Arundel Community College) and Shari Snitovsky (Skyline College)

Contains over 1800 test questions, including multiple choice, short answer, and essay questions.

Prentice Hall Custom Test Win (0-13-013122-9)

Prentice Hall Custom Test Mac (0-13-013123-7)

Prentice Hall Custom Test is based on the powerful testing technology developed by Engineering Software Associates, Inc. (ESA). Available for Windows and Macintosh, Prentice Hall Custom Test allows educators to create exams especially for their own needs. With the Online Testing option, exams can also be administered online and data can then be automatically transferred for evaluation. A comprehensive desk reference guide is included, along with online assistance.

Transparency Pack (0-13-013125-3)

A selection of 150 four-color transparencies of images from the text as well as 50 black- and-white transparency masters.

Slides (0-13-013126-1)

A selection of 150 slides. Same images as transparency acetates available in a slide format.

The ABC News/ Prentice Hall Video Library, Volume IV (0-13-013127-X)

This unique video series contains nine new (3–10 minute) segments from award-winning shows such as *World News Tonight*, the *American Agenda*, *Nightline*, and *Prime Time Live*. Selected from the archives of ABC News, each video includes a written summary that ties the video segment to particular sections of the text, making it easier to enhance your classroom presentation with timely and relevant video segments.

Volume I (0-13-285578-7), **Volume II** (0-13-381450-5), and **Volume III** (0-13-769498-9). Thirty-seven video segments from the previous editions are also available.

Environmental Science Presentation Manager 3.0 (0-13-013124-5)

This unique image bank contains all of the illustrations from the seventh 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 customize lecture presentations. Additional features include keyword searches and the ability to incorporate lecture notes based on custom presentations. The Microsoft Internet Explorer is included on the Presentation Manager CD-ROM for instructors to browse the Web.

For the Student

The New York Times Themes of the Times Supplement (0-13-022461-8)

Coordinated by Chris Schadler (University of New Hampshire)

This unique newspaper-format supplement brings together a collection of recent environmental articles from the pages of *The New York Times*. This free supplement, available in quantity through your local sales representative, encourages students to make connections between the classroom and the world around them.

Study Guide (0-13-013120-2)

By Clark Adams (Texas A & M University)

An excellent review tool offering both concept and content review exercises.

Environmental Science World Wide Web Home Page (<http://www.prenhall.com/nebel>)

This unique tool is designed to launch student exploration of environmental science resources on the Web. This page is regularly updated and linked specifically to text chapters.

Science on the Internet: A Student's Guide

(0-13-021308-X)

By Andrew T. Stull

The perfect guide to help your students take advantage of our *Environmental Science* home page on the World Wide Web. This unique resource gives clear steps to access the regularly updated *Environmental Science* resource area as well as an overview of general navigation and research strategies.

Reviewers

I wish to thank all those who reviewed all or various chapters of this edition and previous editions of the text, and offered comments, suggestions, and constructive criticisms, all of which have been carefully considered.

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Eight years ago Prentice Hall editor David Brake asked me if I would be interested in helping Bernard Nebel in

writing the fourth edition of his environmental science text. Because of my long-time 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 Nebel 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. Bernie and I share very similar philosophical and educational values and have enjoyed collaborating over the years. I am deeply indebted to Bernie for his wonderful sense of organization and beautiful and clear prose, which still form the major part of the book. Both of us have offered this book in its successive editions as our contribution to the students of the '80s and '90s, in the hope that they will join us in helping to bring about the environmental revolution that must come—hopefully sooner rather 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 the care of his Creation.

Richard T. Wright

You Can Make a Difference

Simply by purchasing this text you can have a positive impact on the environment. The authors of this text are pleased to contribute a portion of their royalties to one of the environmental organizations listed below. We are proud that together we can make a difference.

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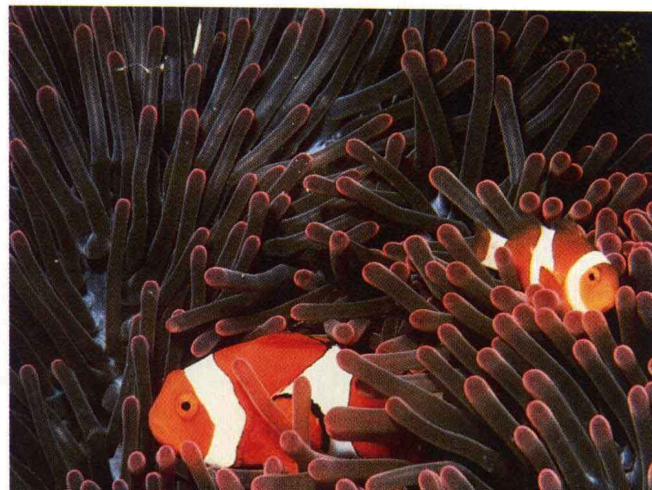
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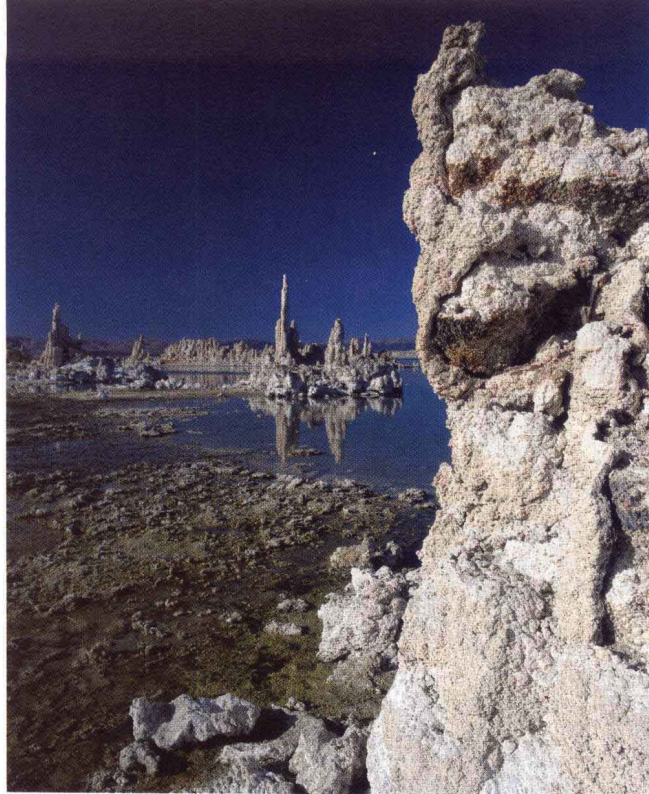
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