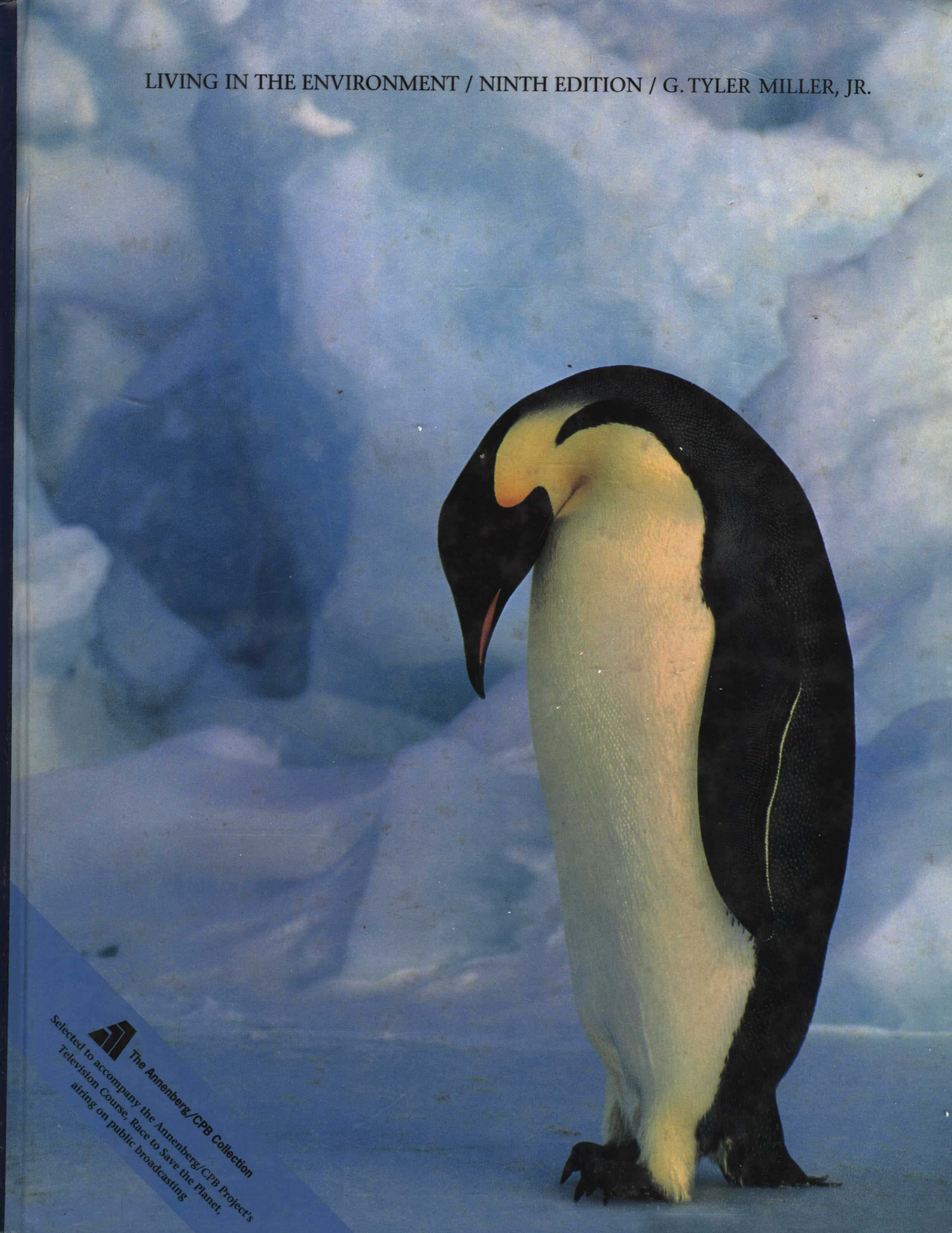
LIVING IN THE ENVIRONMENT / NINTH EDITION / G. TYLER MILLER, JR.



The Annenberg/CPB Collection

Selected to accompany the Annenberg/CPB Project's Television Course, Race to Save the Planet, airing on public broadcasting

Living in the Environment

Principles, Connections, and Solutions

NINTH EDITION

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For Instructors and Students

How I Became Involved In 1966 I heard a scientist give a lecture on the problems of overpopulation and environmental abuse. Afterward I went to him and said, "If even a fraction of what you have said is true, I will feel ethically obligated to give up my research on the corrosion of metals and devote the rest of my life to research and education on environmental problems and solutions. Frankly, I don't want to believe a word you have said, and I'm going into the literature to try to prove that your statements are either untrue or grossly distorted."

After six months of study I was convinced of the seriousness of these problems. Since then I have been studying, teaching, and writing about them. This book summarizes what I have learned in almost three decades of trying to understand environmental principles, problems, connections, and solutions.

My Philosophy of Education I agree with Norman Cousin's statement: "The first aim of education should not be to prepare young people for careers, but to enable them to develop a respect for life." In our lifelong pursuit of knowledge, I believe we should do three things. The first is to *question everything and everybody,* as any good scientist does. Second, each of us should *develop a list of principles, concepts, and rules to be used as guidelines in making decisions,* and to continually evaluate and modify this list as a result of experience. This is based on my belief that the purpose of our lifelong pursuit of education is to learn how to sift through mountains of facts and ideas to find the few that are most useful and worth knowing. We need an *Earth-wisdom revolution* not an information revolution.

This book is full of facts and numbers, but they are useful only to the extent that they lead to an understanding of ideas, laws, concepts, principles, and connections. Remember that most statistics and facts are impersonal; they may inform us about human beings, but with the tears wiped off, or they may describe with detachment living things whose lives we are threatening.

Third, *interact with what you read.* I do this by marking key sentences and paragraphs with a highlighter or pen. I put an asterisk in the margin next to something I think is important, and double asterisks next to something that I think is especially important. I write comments in the margins, such as *Beautiful, Confusing, Bull, Wrong,* and so on. I fold down the top corner of pages with highlighted passages and the top and bottom corners of especially important pages. This way, I can flip through a book and quickly review the key passages. I urge you to interact in such ways with this book.

Key Features This book is designed to be used in introductory courses on environmental science. It treats environmental science as an *interdisciplinary* study, combining ideas and information from natural sciences (such as biology, chemistry, and geology) and social sciences (such as economics, politics, and ethics) to present a general idea of how nature works and how things are interconnected. This study of *connections in nature* examines how the environment is being used and abused, and what individuals can do to protect and improve it for themselves, for future generations, and for other living things.

After major environmental problems are discussed, various solutions to them proposed by a variety of scientists, environmental activists, and analysts are given. A range of possible solutions—some of them highly controversial—is provided to encourage you to think critically and make up your own mind.

Each chapter begins with an *Earth Story,* a case study designed to capture interest and set the stage for the material that follows. In addition to these 27 case studies, more than 60 other case studies are found throughout the book; they provide a more detailed look at specific environmental problems and their possible solutions. Twenty-two *Guest Essays* present an individual researcher's or activist's point of view; two critical thinking questions follow each essay to facilitate evaluation of the material.

In this book I use scientific laws, principles, models, and concepts to help us understand environmental and resource problems and their possible solutions, and how these concepts, problems, and solutions are connected. I have introduced only those concepts and principles necessary for understanding the material in this book, and have tried to present them simply but accurately. The key principles and concepts used in this textbook are summarized inside the back cover.

My aim is to provide a readable and accurate introduction to environmental science without the use of mathematics or complex scientific information. To help ensure that the material is accurate and up-to-date, I have consulted more than 10,000 research sources in the professional literature. In writing this book I have also benefited from the more than 200 experts and teachers who have provided detailed reviews of the editions of this and my other four books in this field (see list on pp. xiii–xv).

I have not cited specific sources of information for two reasons. First, this is rarely done for an introductory-level text in any field. Second, it would result in an overload of information that would interrupt the flow of the material. Instead, the readings listed for each chapter at the end of the book provide backup for almost all of the information in this book.

The book is divided into eight major parts (see Brief Contents, p. xvii). After Parts I and II have been covered, the rest of the book can be used in almost any order. In addition, most chapters and many sections within these chapters can be moved around or omitted to accommodate courses with different lengths and emphases.

This book is an integrated study of environmental problems, connections, and solutions. The twelve integrating themes in this book are *biodiversity and Earth capital, pollution prevention and waste reduction, population, exponential growth and runaway feedback, science systems and technology, connections, solutions and sustainability, energy and energy efficiency, economics and environment, environmental politics and laws, individual action and Earth citizens, and uncertainty and controversy* (see p. xvi).

After you have read the Brief Contents, I urge you to look at the concepts and connections map inside the front cover. It is a summary of the key parts and concepts of environmental science and how they are connected to one another—in effect a map of the book. I also suggest that you read the list of principles given inside the back cover. In effect, it is a two-page summary of the key ideas in this book.

The book's 553 illustrations are designed to present complex ideas in understandable ways and to relate learning to the real world. They include 365 full-color diagrams (55 of them maps) and 188 carefully selected color photographs (14 of them satellite shots).

Instructors wanting shorter books covering this material with a different emphasis and organization can use one of my four other books written for various types of environmental science courses—*Environmental Science*, 5th edition (540 pages, Wadsworth, 1995); *Resource Management and Conservation* (546 pages, Wadsworth, 1990); *Sustaining the Earth: An Integrated Approach*, 2nd edition (325 pages, Wadsworth, 1996); and *Environment: Problems and Solutions* (150 pages, Wadsworth, 1994).

Major Changes in the Ninth Edition *This new edition is a major revision.* Major changes include:

- The addition of a new chapter on Science, Models, and Systems (Chapter 3). In addition to giving an expanded discussion of the nature and limitations of science, most of this chapter is devoted to introducing basic concepts of models and systems thinking as a way to analyze environmental problems and solutions. These systems concepts are then applied throughout the textbook.
- Introduction of *concept and connections mapping*. A concept and connections map of the entire book has been developed (see inside front cover), and Appendix 4 shows students how to develop such maps. For instructors wishing to use this method for organizing and clarifying ideas, an end-of-chapter project asks students to develop such maps for each chapter. Concept and connections maps for each chapter are provided in the instructor's manual and are available as overhead transparencies.
- A sharp reduction in the number of boxes and bulleted lists to improve flow and readability. Most of the material found in boxes in the previous edition is now incorporated into the main text. See the detailed contents (pp. xviii–xxv) for titles of the remaining boxes.
- Rearrangement of some topics. The two chapters on energy resources have become Part V, which makes it easier to treat this material earlier or later in the course, depending on instructor preference.
- Integrated discussion of minerals and soil in one chapter (Chapter 19).
- Integrated discussion of solid waste and hazardous waste in a new chapter (Chapter 20).
- A more integrated approach to treatment of resources and pollution in Part VI. Chapters on key resources (air, water, soil, and minerals) and those on the pollution and wastes produced as a result of resource use have been placed together (see Brief Contents, p. xvii). In addition, the chapter on pesticides now follows the chapter on food resources. Instructors wanting to treat pollution and wastes as a unit can easily do so by assigning Chapters 16, 18, 20, and 22 as consecutive readings.
- Expanded discussion of risk, toxicology, and human health (Chapter 15).
- Increased *scientific content* by the addition or the expansion of material on the nature of science; sustainability; models and systems thinking; grazing and detritial food webs in land ecosys-

tems; competitive exclusion; mutualism between mycorrihiza fungi and tree roots; rain shadow effect; components and interactions in temperate desert, tall-grass prairie, and evergreen coniferous forest biomes and in salt marsh ecosystems; adaptations to changes in environmental conditions and limits to adaptation; gene flow; genetic drift; ways natural selection can occur; role of disturbance in ecological succession; new thinking about ecological succession; types of ecosystems based on human alterations; toxicology; poisons; effects of chemicals on nervous, immune, and endocrine systems; effects of environmental estrogens; scientific and economic limits of toxicology; rise of genetically resistant infectious bacteria; spread of viral diseases; ranking risks; disruption of gaseous nutrient cycles; atmospheric processes affecting air pollution; expanded discussion of waste reduction and pollution prevention; new information on health effects of dioxins; health effects of some chlorine compounds; nature and importance of conservation biology.

- Addition or expansion of many topics, including history of the development of public health concerns in the United States; new techniques for reducing beach erosion; 1993 floods in the midwestern United States; population growth and environmental problems in California; controversy over immigration into the United States; 1994 UN Cairo Conference on Population and Development; cities and human health; ecocity (Curibita, Brazil); ownership of genetic information; environmental refugees; controversy regarding ozone depletion; 1993 Clinton plan for reducing greenhouse gas emissions; environmental security; straw-bale houses; negawatt revolution (demand-side electricity management); new and future ecocars; nonimaging optical solar concentrator; wind turbines and birds; reforms in electric utility industry; combined-cycle natural gas systems; coal burning in China; aboveground storage of low-level nuclear waste; radioactive contamination in the former Soviet Union; marketplace approaches to controlling air pollution; use and abuse of Columbia River Basin; threats to salmon and salmon-fishing industry; protecting Lake Baikal; wild birds and selenium-contaminated water; reforming the U.S. Mining Law of 1872; environment and the new gold rush; ecoindustrial revolution (clean production); economics of recycling, reuse, and waste reduction in Germany; reforming the Superfund law; feeding China's population; Delaney clause controversy; using hot water to kill insect pests; takings vs. property rights controversy; reducing wood waste; using kenaf to make paper; biosphere reserves; controversy regarding extinction crisis; controversy over elephant ivory ban; controversy over cutting off rhino horns; privatization of wildlife protection; butterfly farms; privatizing fishing rights; unfunded environmental mandates; environment and world trade agreements; Earth-sustaining economic systems; environmentalism on campuses; updating of anti-environmental movement; evaluating claims of environmentalists and anti-environmentalists; expanded discussion of types of human-centered and life-centered worldviews; four levels of environmental awareness; why we should care about future generations.
- Eight new Guest Essays.
- Addition of several new critical thinking questions and projects to most chapters.
- A new appendix (Appendix 5) that summarizes specific things individuals can do to work with the Earth.
- Upgrading most diagrams to improve the color, add more detail, and give a more realistic 3-D effect.
- Addition of 15 new color photos and 95 new color diagrams.
- Revision and updating of the *Instructor's Manual and Test Items*.
- Eight new supplements. They are marked with an asterisk in the list of supplements on pp. viii–ix.

Welcome to Uncertainty, Controversy, and Challenge There are no easy or simple solutions to the environmental problems and challenges we face. We will never have scientific certainty or agreement about what we should do because science provides us with probabilities, not certainties, and advances through continuous controversy. What is important is not what scientific experts disagree on (the frontiers of knowledge that are still being developed, tested, and argued about), but what they generally agree on—the *scientific consensus* on concepts, problems, and possible solutions. Despite considerable research, we still know relatively little about how nature works at a time when we are altering nature at an accelerating pace.

This uncertainty, and the complexity and importance of these issues to current and future generations of humans and other species, makes these issues highly controversial. Intense controversy also arises because environmental science is a dynamic blend of natural and social sciences that sometimes questions the ways we view and act in the world around us. This interdisciplinary attempt to mirror reality encourages us to evaluate our environmental worldviews, values,

and lifestyles, as well as our economic and political systems. This can often be a threatening process.

People with widely different worldviews, political persuasions, and ideas can work together to prevent damage to Earth's life-support systems for us and other species, and that is what counts. We are all in this together, and we need to respect our differences and work to to find a rainbow of solutions to the problems and challenges we face.

Rosy optimism and gloom-and-doom pessimism are traps; both usually lead to denial, indifference, and inaction. I have tried to avoid these two extremes and give a realistic—and yet hopeful—view of the future. This book is filled with stories of individuals who have acted to help sustain the Earth's life-support systems for us and for all life, and whose actions inspire us to do better. It's an exciting time to be alive as we struggle to enter into a new relationship with the planet that is our only home.

Study Aids Each chapter begins with a few general questions to reveal how the chapter is organized and what you will be learning. When a new term is introduced and defined, it is printed in **boldface type.** A glossary of all key terms is located at the end of the book.

Factual recall questions (with answers) are listed at the bottom of most pages. You might cover the answer (on the right-hand page) with a piece of paper and then try to answer the question on the left-hand page. These questions are not necessarily related to the chapter in which they are found.

Each chapter and guest essay ends with a set of questions designed to encourage you to think critically and to apply to your life what you have learned. Some ask you to take sides on controversial issues and to back up your conclusions and beliefs. The end-of-chapter questions are followed by several projects that individuals or groups can carry out. Many additional projects are given in the *Instructor's Manual* and in the *Green Lives, Green Campuses* supplement available with this book.

Readers who become especially interested in a particular topic can consult the list of Further Readings for each chapter, given in the back of the book. Appendix 1 contains lists of important publications, some key environmental organizations, and government and international agencies.

Help Me Improve This Book Let me know how you think this book can be improved; and if you find any errors, please send them to Jack Carey, Biology Publisher, Wadsworth Publishing Company, 10 Davis Drive, Belmont, CA 94002. He will send them on to me. Most errors can be corrected in subsequent printings of this edition, rather than waiting for a new edition.

Supplements The following supplements are available (those marked with an asterisk are *new* for this edition):

- *Instructor's Manual and Test Items*, written and updated by Jane Heinze-Fry (Ph.D. in Science and Environmental Education). For each chapter it has goals and objectives; one or more concept maps; key terms; teaching suggestions; multiple-choice test questions with answers; projects, field trips, and experiments; term-paper and report topics; and a list of audiovisual materials and computer software.
- *Green Lives, Green Campuses*, by Jane Heinze-Fry. This hands-on workbook for students contains projects to help them evaluate the environmental impact of their own lives and guide them in making an environmental audit of their campus.
- *Laboratory Manual*, by C. Lee Rockett (Bowling Green State University) and Kenneth J. Van Dellen (Macomb Community College).
- A set of 50 color acetates and over 600 black-and-white transparency masters for making overhead transparencies or slides of line art (including concept maps for each chapter), available to adopters.
- **Environmental Articles*, assembled by Jane Heinze-Fry. This is a collection of more than 200 articles that are indexed by topic and geographical location. Instructors may use the indexes to choose any combination of articles and have them bound as customized supplements for their courses.
- *Critical Thinking Software Tools and Workbook.* This special version of STELLA II® software , together with an accompanying workbook, demonstrates critical thinking exercises using models related to the text.
- **Computer Simulations Disk*, developed by David and Laura Peterson of Ventana Systems. These simulations are correlated with the new material on systems thinking found in Chapter 3 and applied throughout the book.
- **Environmental Ethics*, by Joseph R. Des Jardins (Wadsworth, 1993). A very useful survey of environmental ethics. Brief case studies and many specific examples are included.
- **Watersheds: Classic Cases in Environmental Ethics*, by Lisa H. Newton and Catherine K. Dillingham (Wadsworth, 1994). Nine balanced case studies that amplify material in this book.

- **Radical Environmentalism*, by Peter C. List (Wadsworth, 1993). A series of readings on environmental politics and philosophy.
- **A Beginner's Guide to Scientific Method*, by Stephen S. Carey (Wadsworth, 1994). A concise, hands-on introduction that helps students develop critical-thinking skills that are essential to understanding the scientific process.
- **The Game of Science*, 5th edition, by Garvin McCain and Erwin M. Segal (Brooks/Cole, 1988). An accurate, lively, and up-to-date view of what science is, who scientists are, and how they approach science.

Annenberg/CPB Television Course This textbook is being offered as part of the Annenberg/CPB Project television series *Race to Save the Planet*, a 10-part public television series and a college-level telecourse examining the major environmental questions facing the world today. The series takes into account the wide spectrum of opinion about what constitutes an environmental problem and discusses the controversies about appropriate remedial measures. It analyzes problems and emphasizes the successful search for solutions. The course develops a number of key themes that cut across a broad range of environmental issues, including sustainability, the interconnection of the economy and ecosystems, short-term versus long-term gains, and the trade-offs involved in balancing problems and solutions. A study guide and a faculty guide, both available from Wadsworth Publishing Company, integrate the telecourse and this text.

For further information about available television course licenses and duplication licenses, contact PBS Adult Learning Service, 1320 Braddock Place, Alexandria, VA 22314-1698 (1-800-ALS-AL5-8).

For information about purchasing videocassettes and print material, contact the Annenberg/CPB Collection, P.O. Box 2284, South Burlington, VT 05407-2284 (1-800-LEARNER).

Acknowledgments I wish to thank the many students and teachers who responded so favorably to the eight previous editions of *Living in the Environment*, the five editions of *Environmental Science*, and the first editions of *Resource Conservation and Management*, *Sustaining the Earth: An Integrated Approach*, and *Environment: Problems and Solutions*, and who offered many helpful suggestions for improvement and corrected errors. I am also deeply indebted to the reviewers, who pointed out errors and suggested many important improvements in this book. Any errors and deficiencies left are mine.

The members of Wadsworth's talented and dedicated production team, listed on the copyright page, have made vital contributions as well. Their labors of love are also gifts to help sustain the Earth. I especially appreciate the competence and cheerfulness of Production Editor Karen Garrison and Art Editor Nancy Spellman, and the superb inputs of two talented developmental editors, Mary Arbogast and Autumn Stanley. My thanks also go to Wadsworth's hard-working sales staff, to Kristin Milotich and Kerri Abdinoor for their help and cheerful efficiency, and to Alan Titche for superb copyediting (one of the best I have ever had). My deepest gratitude also goes to Kenneth J. Van Dellen as the primary author of Chapter 9 on Geologic Process; to David W. Peterson as the primary author of Chapter 3 on systems thinking and applications of these ideas throughout the book; to David and Laura Peterson for developing the computer simulations disk that explores the systems thinking discussed in the text; and to Jane Heinze-Fry for her insightful analysis, for being such a delight to work with, and for her outstanding work on the *Instructor's Manual*, concept mapping, *Green Lives, Green Campuses*, and the new collection of *Environmental Articles*. My thanks also go to C. Lee Rockett and Kenneth J. Van Dellen for developing the *Laboratory Manual* to accompany this book.

My deepest thanks go to Jack Carey, Biology Publisher at Wadsworth, for his encouragement, help, twenty-six years of friendship, and superb reviewing system. It helps immensely to work with the best and most experienced editor in college textbook publishing. I also wish to thank Peggy Sue O'Neal, my spouse and best friend, for her love and support of me and the Earth. I dedicate this book to her and to the Earth that sustains us all.

G. Tyler Miller, Jr.

What's New in the Ninth Edition

PART I

HUMANS AND NATURE: AN OVERVIEW

1 Environmental Problems and Their Causes

2 photos; 3 diagrams; expanded discussion of sustainability; Guest Essay, "Defining Sustainability," by Robert Costanza; 5 critical thinking questions; 3 projects

2 Brief History of Resource Use and Conservation

2 photos; 3 figures; new discussion of history of concern over public health in the United States; Individuals Matter, "Alice Hamilton"; Individuals Matter, "Rachel Carson"; update of major environmental events 1993–1994; Guest Essay, "Building an Environmental Democracy," by Carol M. Browner; 3 projects

PART II

SCIENTIFIC PRINCIPLES AND CONCEPTS

3 Science, Models, and Systems

New chapter written by Guest Author David W. Peterson; 1 photo; 17 diagrams; opening Earth Story, "Two Islands: Can We Make This One Different?"; Connections, "What's Harming the Robins?"; expanded discussion of the nature of science; new material on models and systems thinking; 10 Critical Thinking questions; 3 projects

4 Matter and Energy Resources: Types and Concepts

1 figure; material condensed somewhat; 3 critical thinking questions; 2 projects

5 Ecosystems and How They Work

3 photos; 4 diagrams; expanded discussion of grazing and detrital food webs in land ecosystems, pyramid of energy flow, competitive exclusion, mutualism between mycorrihiza fungi and tree roots; 5 critical thinking questions; 3 projects

6 Climate, Weather, and Life

5 diagrams; 1 improved diagram; discussion of rain-shadow effect; expanded material on components and interactions in temperate desert, tallgrass prairie, and evergreen coniferous forest biomes and in salt marsh ecosystems; new techniques for reducing beach erosion; 4 critical thinking questions; 2 projects

7 Changes in Populations, Communities, and Ecosystems

2 diagrams; discussion of reindeer herd population crash on Pribilof Islands; limits to adaptation; gene flow; genetic drift; ways natural selection can occur; role of disturbance in ecological succession; new thinking about ecological succession; types of ecosystems based on human alterations; background and mass extinction; expanded discussion of evolution, adaptation, and natural selection; 4 critical thinking questions; 4 projects

8 Geologic Processes: The Dynamic Earth

3 photos; 1 diagram; 2 improved diagrams; 1993 flooding in Midwest; expanded discussion of floodplains and flooding; 1 project

PART III

THE HUMAN POPULATION

9 Population Dynamics: Influencing Population Size

2 diagrams; updating of population data; population growth and environmental problems in California; 1994 UN Conference on Population and Development in Cairo, Egypt; expanded discussion of immigration problems in the United States; Guest Essay, "Dollar-a-Day Miracle," by Noel Perrin; 2 critical thinking questions; 3 projects

10 Population Distribution: Urban Living

1 diagram; human health in cities; Case Study: Curibita, Brazil; 3 critical thinking questions; 2 projects

PART IV

ULTIMATE GLOBAL PROBLEMS

11 Deforestation and Loss of Biodiversity

3 diagrams; Clinton plan for old-growth forests in Pacific Northwest; expanded discussion of deforestation in western Canada; ownership of genetic information; Guest Essay, "The War Against Species," by Vandana Shiva; 2 critical thinking questions; 4 projects

12 Global Warming and Ozone Loss

3 diagrams; 1 photo; environmental refugees from changed climate; Convention on Climate Change at 1992 Rio Earth Summit; 1993 Clinton plan for reducing greenhouse gas emissions; evaluation of evidence suggesting ozone depletion is a hoax; recent progress in reducing CFC emissions; updating of information and latest research findings; Guest Essay, "Environmental Security," by Norman Myers; 3 critical thinking questions; 3 projects

PART V

ENERGY RESOURCES

13 Energy Efficiency and Renewable Energy

5 diagrams; 1 improved diagram; 2 photos; Solutions, "Straw-Bale Houses"; negawatt revolution (demand-side electricity management); new and future ecocars; improving energy efficiency of computers; nonimaging optical solar concentrator; solar cookers; solar-electric window; problems with pumped storage; wind turbines and birds; expanded discussion of energy efficiency and natural cooling; Guest Essay, "Stepping Off the Bandwagon: Why Alternative Fuels Won't Work," by Jason Hoffman; 1 project

14 Nonrenewable Energy Resources

4 diagrams; Solutions, Combined-Cycle Natural Gas Systems; Connections, "Coal Burning and Destructive Synergies in China"; proposed international pipeline for natural gas; aboveground storage of low-level nuclear waste; radioactive contamination in the former Soviet Union; 3 critical thinking questions; 1 project

PART VI

RISKS, HEALTH, RESOURCES, AND POLLUTION

15 Risk, Toxicology, and Human Health

4 diagrams; effects of chemicals on nervous, immune, and endocrine systems; expanded discussion of toxicology; scientific and economic limits of toxicology; new threats from infectious bacteria because of genetic immunity; spread of viral diseases; ranking risks; expanded discussion of pros and cons of genetic engineering; setting risk levels for chemicals; Connections, "Are Environmental Estrogens a Health Threat?"; Connections, "Misperception Leads to Runaway Risk"; 4 critical thinking questions; 1 project

16 Air and Air Pollution

4 diagrams; discussion of nature of the atmosphere; disruption of gaseous nutrient cycles; four processes affecting air pollutants in the atmosphere; Solutions: "Can We Use the Marketplace to Control Pollution?"; 2 critical thinking questions; 3 projects

17 Water Resources

9 diagrams; 1 improved diagram; expanded discussion of causes of water scarcity; salmon fishery problems; Case Study: "Sustainable Use of the Columbia River Basin"; 4 critical thinking questions; 4 projects

18 Water Pollution

1 diagram; expanded discussion of contaminated drinking water; sustainable use of water resources; Case Study: "Protecting Lake Baikal"; Connections, "Selenium Poisoning of Wild Birds in California"; 1 critical thinking question; 2 projects

19 Minerals and Soil

Revised chapter combining soil and extraction of nonrenewable minerals from Earth's crust; 1 diagram; reforming the 1872 Mining Law; Case Study: "Environment and the New Gold Rush"; use of polyacrylamide (PAM) to slow erosion; 1 critical thinking question; 2 projects

20 Solid and Hazardous Waste

New chapter containing extensively revised and reorganized material; 4 diagrams; new ecoindustrial revolution; expanded discussion of need for waste reduction and pollution prevention and ways to reduce wastes and prevent pollution; distinction between primary and secondary recycling; economics of recycling; Spotlight, "Sometimes It Doesn't Pay to Do the Right Thing"; Case Study: "Recycling, Reuse, and Waste Reduction in Germany"; new information on health effects of dioxin; Case Study: "What Should We Do About Chlorine?"; reforming the Superfund law; 1 critical thinking question; 2 projects

PART VII

SUSTAINING BIODIVERSITY AND ECOLOGICAL INTEGRITY

21 Food Resources

4 figures, 2 improved figures; expanded discussion of environmental effects of food production; Case Study: "Feeding China's Population"; updated data on food production, fish catches, and overfishing; 2 critical thinking questions; 4 projects

22 Protecting Food Resources: Pesticides and Pest Control

1 diagram; controversy over modifying the Delaney Clause; spraying hot water to kill pests; 2 critical thinking questions; 2 projects

23 Sustaining Ecosystems: Forests, Rangelands, Parks, and Wilderness

2 diagrams; 1 photo; importance of preserving ecological integrity; nature and importance of conservation biology; expanded discussion of arguments over how public lands should be used; Case Study: "The Controversial Takings/Property Rights Movement"; reducing wood waste; using kenaf and other nonwood fibers to make paper; biosphere reserves; 4 critical thinking questions; 5 projects

24 Sustaining Wild Species

6 figures; are some species more important than others?; is there really an extinction crisis?; expanded discussion of habitat fragmentation; Case Study: "Will Cutting Off Their Horns Help Save Rhinos?"; Case Study: "How Should We Protect Elephants From Extinction?"; accidental introduction of citrus leaf miners; Case Study: "Should Wildlife Protection Be Turned Over to Private Interests?"; butterfly farms; expanded discussion of improving fishery management; pros and cons of privatizing fishing rights (international transferable quotas); 4 critical thinking questions; 1 project

PART VIII

ENVIRONMENT AND SOCIETY

25 Economics and Environment

2 figures; ecologically sustainable development; unfunded environmental mandates; expanded and updated discussion of pros and cons of global free trade (GATT); expanded and updated discussion of Earth-sustaining economy; Guest Essay, "Confronting the Environmental Debt," by F. H. Bormann; 1 project

26 Politics and Environment

1 diagram; environmentalism on campuses; expanded discussion of anti-environmental movement; evaluating claims of environmentalists and anti-environmentalists; 1 critical thinking question; 1 project

27 Environmental Worldviews, Ethics, and Sustainability

Expanded discussion of types of human-centered and life-centered worldviews; four levels of environmental awareness; are biocentrists and ecocentrists anti-human?; why should we care about future generations?; major components of an Earth-Wisdom Revolution; 6 critical thinking questions; 3 exercises

Appendix 5 Individuals Matter: Working with the Earth

This new appendix lists specific things that individuals can do to work with the Earth. These guidelines are grouped under the following headings: preserving biodiversity and protecting the soil, promoting sustainable agriculture and reducing pesticide use, saving energy, reducing outdoor air pollution, reducing exposure to indoor air pollutants, saving water, reducing water pollution, reducing solid waste and hazardous waste, and communicating with elected officials.

Guest Authors, Guest Essayists, and Reviewers

Guest Authors **David W. Peterson,** Chairman, Ventana Systems, Inc., is the primary author of Chapter 3 and developer of the systems models diagrams used throughout the book. He and Laura Peterson have also developed a computer disk with simulations of the systems models discussed in this textbook.

Kenneth J. Van Dellen, Professor of Geology and Environmental Science, Macomb Community College, is the primary author of Chapter 8.

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Integrating Themes

Twelve themes are used to integrate the material in this book. You might think of them as connecting threads woven through the material. To follow each thread use the page numbers listed after each theme.

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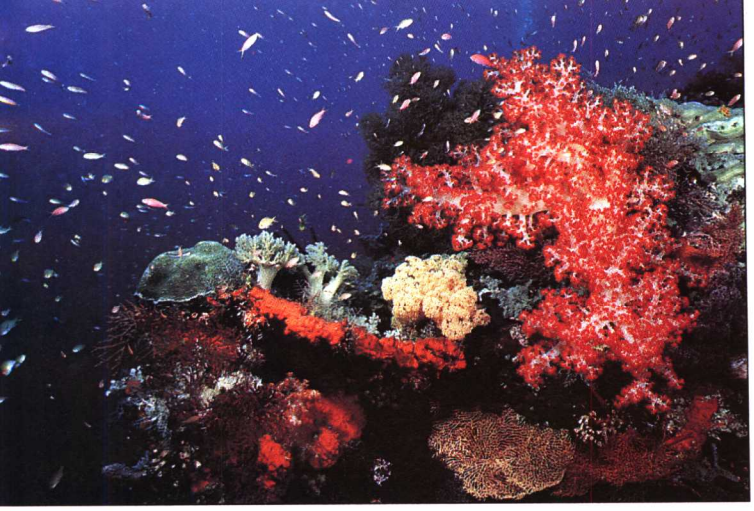
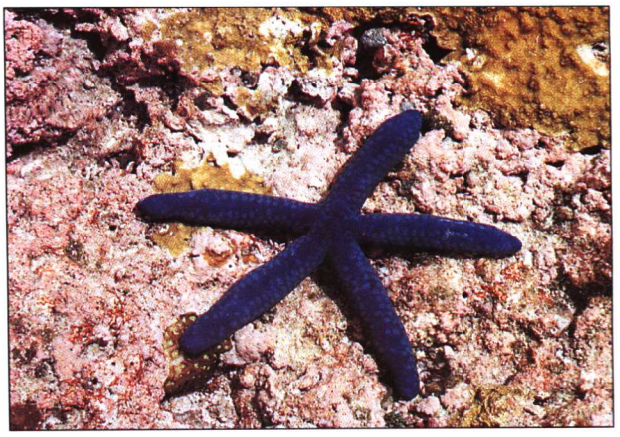


Coral reef in Philippines



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