

**SEVENTH EDITION**

*An Introduction to Environmental Science*

# **Living in the Environment**

**G. TYLER MILLER, JR.**

Wadsworth Publishing Company  
Belmont, California  
A Division of Wadsworth, Inc.

000051



SCIENCE EDITOR: Jack Carey  
 EDITORIAL ASSISTANT: Kathy Shea  
 PRODUCTION EDITOR: Vicki Friedberg  
 MANAGING DESIGNER: Cynthia Schultz  
 TEXT DESIGNERS: James Chadwick/Cynthia Schultz  
 PRINT BUYER: Barbara Britton  
 ART EDITOR: Donna Kalal  
 PERMISSIONS EDITOR: Peggy Meehan  
 COPY EDITOR: Carole Crouse  
 PAGE MAKE-UP: Wendy Calmenson  
 PHOTO RESEARCHER: Stephen Forsling  
 TECHNICAL ILLUSTRATORS: Darwin and Vally Hennings,  
 Tasa Graphic Arts, Inc., John and Judith Waller, Marjorie Leggitt,  
 Guy Magellenes, Susan Breitbard, Joan Carol, Raychel Ciemma,  
 Florence Fujimoto, Linda Harris, Victor Royer, Jeanne M.  
 Schreiber, and Kathryn W. Werhane.  
 COMPOSITOR: Thompson Type/San Diego, CA  
 COLOR SEPARATOR: Accu-color/St. Louis, MO  
 PRINTER: Arcata Graphics/Kingsport, TN  
 COVER DESIGN: Cynthia Schultz  
 PART OPENING PHOTOGRAPHS:  
*Part 1:* Brian Parker/Tom Stack & Associates  
*Part 2:* Los Angeles Convention & Visitors Bureau  
*Part 3:* United Nations  
*Part 4:* Errol Andrew/FPG International  
*Part 5:* California Energy Commission  
*Part 6:* Thomas Kitchin/Tom Stack & Associates  
*Part 7:* Sam Kittner/SIPA Press

COVER PHOTOGRAPH: Short-tailed weasel (ermine) in winter,  
 Grand Teton National Park, Wyoming, © 1985 Tom Mangelsen.  
 The ermine, which helps control rodent population, was  
 selected as the cover image for this book not only because of  
 its striking beauty but also because it is a part of Earth's vital  
 biodiversity, which we are severely reducing. The ermine  
 symbolizes the ecological and ethical issues we face every day.  
 As you look into the eyes of this animal, ask yourself: Would you  
 kill this animal or have it killed to make a fur coat?

© 1992 by Wadsworth, Inc. All rights reserved. No part of this  
 book may be reproduced, stored in a retrieval system, or  
 transcribed, in any form or by any means, without the prior  
 written permission of the publisher, Wadsworth Publishing  
 Company, Belmont, California 94002.

1 2 3 4 5 6 7 8 9 10 — 96 95 94 93 92

Library of Congress Cataloging-in-Publication Data  
 Miller, G. Tyler (George Tyler), 1931—

*Living in the environment : an introduction to  
 environmental science* / G. Tyler Miller, Jr. — 7th ed.

p. cm.

Includes bibliographical references and index.

ISBN 0-534-16560-5

1. Human ecology. 2. Environmental policy. I. Title.

GF41.M54 1992

363.7—dc20

91-35584

## BOOKS IN THE WADSWORTH BIOLOGY SERIES

*Environmental Science*, 3rd, Miller  
*Resource Conservation and Management*, Miller  
*Biology: Concepts and Applications*, Starr  
*Biology: The Unity and Diversity of Life*, 6th, Starr and Taggart  
*Biology of the Cell*, 2nd, Wolfe  
*Cell Ultrastructure*, Wolfe  
*Dimensions of Cancer*, Kupchella  
*Evolution: Process and Product*, 3rd, Dodson and Dodson  
*Introduction to Cell Biology*, Wolfe  
*Oceanography: An Introduction*, 4th, Ingmanson and Wallace  
*Plant Physiology*, 4th, Devlin and Witham  
*Exercises in Plant Physiology*, Witham et al.  
*Plant Physiology*, 4th, Salisbury and Ross  
*Plant Physiology Laboratory Manual*, Ross  
*Plants: An Evolutionary Survey*, 2nd, Scagel et al.  
*Psychobiology: The Neuron and Behavior*, Hoyenga and Hoyenga  
*Sex, Evolution, and Behavior*, 2nd, Daly and Wilson

World Report asked leaders of 10 conservation groups and 10 business and trade groups to grade the Bush administration's environmental efforts. The conservation leaders gave him a grade of D; the business leaders gave him a C+.

Environmentalists have been especially disappointed by his failure to provide leadership in reducing energy waste and to phase in solar and other perpetual and renewable forms of energy as a way to withdraw from our wasteful addiction to oil and other fossil fuels and to reduce our emissions of greenhouse gases. Instead

of leading the global effort to deal with projected global warming, he has undermined international efforts and willingness to begin dealing with this urgent problem by calling for more research instead of action. He has also not taken the lead in halting tropical deforestation or the clear-cutting of ancient forests in the national forests of the Pacific Northwest, both of which are major causes of the rapid loss of Earth's precious biodiversity.

On April 22, 1990, the twentieth Earth Day took place. An estimated 200 million people in 141 nations on all 7 continents participated—the largest global

## GUEST ESSAY A New Environmentalism for the 1990s and Beyond



Peter Montague

Peter Montague is senior research analyst for Greenpeace and director of the Environmental Research Foundation in Washington, D.C. The Foundation conducts studies of environmental problems and provides the general public with information about environmental problems and the technologies and policies that might contribute to their solution. Montague has served as manager of a technology computer information center and project administrator of a hazardous waste research program at Princeton University. Prior to that he taught undergraduate and graduate courses in environmental impact analysis at the School of Architecture and Planning at the University of New Mexico. He has coauthored two books on toxic heavy metals in the natural environment and is editor of Rachel, a highly informative and readable newsletter on environmental problems, with an emphasis on hazardous waste.

Environmentalism as we have known it for the past 20 years is dead. The environmentalism of the 1970s advocated strict numerical controls on releases of dangerous wastes (any unwanted or uncontrolled materials that can harm living things or disrupt ecosystems) into the environment. Industry's ability to create new hazards, however, quickly outstripped government's ability to establish adequate controls and enforcement programs.

After 20 years of effort by government and by concerned citizens (the environmental movement), the over-

whelming majority of dangerous chemicals are still not regulated in any way. Even those few that are covered by regulations have not been adequately controlled.

In sum, the pollution management approach to environmental protection has failed and stands discredited; pollution prevention is the way of the future and is our only hope. An ounce of prevention really is worth a pound of cure.

Here, in outline form, is the new environmentalism that is emerging:

1. All waste disposal—landfilling, incineration, deep well injection—is intrinsically polluting because disposal means dispersal into the environment. Once wastes are created they cannot be contained or controlled because of the scientific laws of matter and energy [Chapter 3]. The old environmentalism failed to recognize this important truth, and thus squandered enormous resources trying to achieve the impossible. We in the United States presently spend about \$90 billion per year on pollution control. Yet, the global environment is increasingly threatened by a buildup of heat because of heat-trapping gases we emit into the atmosphere. At least half the surface of the planet is being subjected to an influx of damaging ultraviolet radiation from the sun as a result of ozone depleting chemicals we have discharged into the atmosphere, and vast regions of the United States, Canada, and Europe are suffering from loss of forests, crop productivity, and fish as a result of acid rain (caused by releases of sulfur and nitrogen compounds, chiefly by power plants and automobiles) and other air pollutants. Soil and water are dangerously polluted at thousands of locales where municipal garbage and industrial wastes have been (and continue to be) dumped or incinerated; thousands of such sites remain to be discovered, according to U.S. government estimates.
2. The inevitable result of our reliance on waste treatment and disposal systems has been an unrelenting buildup of exotic synthetic toxic materials in humans and in other forms of life worldwide. For example, breast milk of women in industrialized countries like the United

demonstration in history. Its main goals were to reach out to minorities and the poor struggling daily for survival throughout the world; make people everywhere aware of the difference their actions could make in sustaining the earth by acting locally and thinking globally (summarized in its slogan: Who Says You Can't Change the World?); and get people involved in making every day Earth Day. If only 5% of the people who took part in Earth Day 1990 stay actively involved in the race to sustain the earth, that would be 10 million people—an enormous force for change.

Dealing with the environmental and resource problems we face will not be easy or cheap. It will involve much controversy and require us to make some trade-offs and significant changes in our worldview, economic and political systems, and lifestyles.

Specific actions environmentalists believe are needed to help sustain the earth are presented throughout this book.

Emphasis will have to shift from pollution cleanup to pollution prevention (see Guest Essay on p. 46), from

States is so contaminated with pesticides and industrial hydrocarbons that if human milk were bottled and sold commercially, it would be subject to ban by the Food and Drug Administration (FDA) as unsafe for human consumption. Another illustrative example: If a whale today beaches itself on the shores of the United States and dies, legally, its body must be treated as a "hazardous waste" because whales contain PCBs (polychlorinated biphenyls—a class of industrial toxins) at levels that exceed threshold concentrations for classifying a waste as legally "hazardous." Soon polar bears in their natural habitat are likely to join whales in the "hazardous waste" category because their PCB levels are steadily rising.

3. The ability of humans and other forms of life to adapt to changes in their chemical environment is strictly limited by the genetic code each form of life inherits. Continued contamination occurring hundreds of times faster than we can adapt will drive humans to increasingly widespread sickness, to degradation of the species, and ultimately to extinction.
4. Damage to humans (and to other forms of life) is abundantly documented. Birds, fish, and humans in industrialized countries like the United States are enduring steadily rising levels of cancer and other serious disorders attributable to pollution. An astonishing 88% of children under six years old in the United States have sufficient toxic lead in their blood to cause them to perform below par on standardized tests of physical, mental, and emotional development. If we will but look, the handwriting is on the wall everywhere.

To deal with these problems, industrial societies must abandon their reliance on waste treatment and disposal and on the regulatory system of numerical standards created by government to manage the damage that results from relying on waste disposal instead of waste prevention. We must quickly move the industrialized and industrializing countries to new technical approaches

accompanied by new industrial goals—namely clean production or zero discharge systems.

"Clean production" involves industrial systems that avoid or eliminate dangerous wastes and dangerous products and minimize the use of raw materials, water, and energy. Goods manufactured in a clean production process must not damage natural ecosystems throughout their entire life cycle, including (a) raw materials selection, extraction, and processing; (b) product conceptualization, design, manufacture, and assemblage; (c) materials transport during all phases; (d) industrial and household usage; and (e) reintroduction of the product into industrial systems or into the environment when it no longer serves a useful function.

Clean production does not include "end-of-pipe" pollution controls such as filters or scrubbers or chemical, physical, or biological treatment. Measures that pretend to reduce the volume of waste by incineration or concentration, mask the hazard by dilution, or transfer pollutants from one environmental medium to another are also excluded from the concept of "clean production."

A new industrial pattern, and a new environmentalism, is thus emerging. It insists that the long-term well-being of humans and other species must be factored into our production and consumption plans. These new requirements are not optional; human survival depends on our willingness to make, and pay for, the necessary changes.

#### Guest Essay Discussion

1. Do you agree with the author that the *pollution management* approach to environmental protection practiced during the past 20 years has failed and must be replaced with a *pollution prevention* approach? Explain.
2. List key economic, health, consumption, and lifestyle changes you might experience as a consequence of switching from pollution management to pollution prevention. What changes might the next generation experience?