RESOURCE CONSERVATION *Fifth Edition*

An Ecological Approach

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Preface

Natural Resource Conservation is written for the introductory resource conservation course. The first edition of this book was published a year after the first Earth Day in 1970. To many observers, Earth Day marked the beginning of the formal environmental movement in the United States. Since that time, impressive gains have been made in air and water pollution control and species protection.

Despite this progress, many environmental problems still remain. Many others have actually grown worse. In 1970, for instance, the world population hovered around 3 billion. Today, it is over 5 billion and growing by nearly 90 million people a year. Hunger and starvation have become a way of life in the Third World nations. An estimated 42 million people die each year of starvation or of disease worsened by hunger and malnutrition.

Species extinction continues as well. Today, one species of vertebrate becomes extinct every nine months. Add the plants, insects, and microorganisms to the list and the rate of extinction climbs to one species a day.

In the United States and abroad, soil erosion and rangeland deterioration continue. One third of America's topsoil has been washed or blown away in the past 100 years and a large proportion of our public and private rangelands are in poor or only fair condition.

Added to the list of growing problems are a whole host of new ones that have cropped up along the way, such as groundwater pollution, ozone depletion, global warming, and growing mountains of urban trash. Solving these many problems will not be easy.

We think there is good reason for hope. But to address these problems in meaningful ways, dramatic changes are needed in the way we live and work. Many observers argue the need to create a new and sustainable relationship with the environment. This new relationship will require us to practice conservation and to recycle virtually everything we can. It will mean a shift to the use of renewable resources such as solar energy and wind. And, more than anything, it will mean stabilizing world population. Conservation, recycling, renewable resources, and population control are the operating principles of a sustainable society. They could ensure an enduring relationship with nature.

These operating principles, however, must be complemented by a change in our attitudes. We can no longer afford to view the Earth as an infinite source of materials for exclusive human use. Many of the Earth's resources upon which human beings depend are finite. The Earth has a limited supply of these resources. We ignore this fact at our own risk.

Many observers believe that we need an attitude that seeks the cooperation rather than the domination of nature. Our efforts to dominate and control nature are often in vain, whereas cooperation may be one of the keys to our long-term success.

Finally, it is time to rethink our position in the ecosystem. We are not apart from nature, but a part of it. Our lives are dependent on the environment. What we do to the environment we do to ourselves. The logical extension of this simple truth is that planet care is the ultimate form of self care.

Humans are not the crowning achievement of nature, but rather members of a club comprised of all Earth's living creatures. To achieve a sustainable relationship, many observers argue that it is time to recognize and respect the rights of other species to exist and thrive alongside human culture. In this sense, natural resources may be viewed as the Earth's endowment to all species. Such a view may mean curbing our demands

and finding new ways to live on the planet. In the long run, such changes will benefit all of us.

Focus on Principles, Problems, and Solutions

This book describes many important principles of ecology and resource management, concepts that will prove useful throughout a student's life. It also outlines many of the national and international environmental problems and offers a variety of solutions. These solutions take three basic forms: legislative (new laws and regulations), technological (applying existing, new, and improved technologies), and methodological (changing our methods). Applying these solutions falls to all of us, not just government officials. Therefore, the authors think that individuals, educators, business people, and government officials all have an important role to play in solving the environmental crisis and in building a sustainable society.

On the personal level, what we do or what we fail to do can have a remarkable impact on the future, and we encourage you to take active steps to find ways to help rather than harm.

Improvements in the Fifth Edition

This fifth edition of *Natural Resource Conservation* has undergone a substantial revision. We have updated our material and expanded our coverage of pressing issues to bring you the latest in natural resource issues. Given the growing importance of global warming, ozone depletion, and acid deposition, we have added a new chapter on international and global air pollution. We have expanded our coverage of fisheries management, and added material on coastlands and estuaries to our coverage of the ocean. Back by popular demand is a chapter on range management.

Many new photographs and drawings have been added to the fifth edition. The new design and the addition of color make this edition particularly appealing and more useful.

Learning Aids

To help students focus on key terms and concepts, we have included in each chapter three learning aids: key words and phrases, chapter summaries, and discussion questions.

Key Words and Phrases. At the end of each chapter is a list of key words and phrases. We recommend that students read this list before reading the chapter. Afterward, take a few moments to define the terms and phrases.

Rapid Review. Each chapter in the book also contains a summary of important facts and concepts, the Rapid Review. Summaries will help students review material before tests. Before reading the chapter, we think it is a good idea for students to read through the summary or study the major headings and subheadings for orientation.

Discussion Questions. Discussion questions at the end of each chapter also provide a way of focusing on important material and reviewing concepts and crucial facts. We have written many questions to encourage students to tie information together and to draw on personal experience.

Furthering Your Education

To help students deepen and broaden their knowledge, we have provided a number of case studies and suggested readings.

Case Studies. Case studies delve into controversial issues or detailed information that may be of interest to students pursuing a career in natural resource management.

Suggested Readings. The Suggested Readings list articles and books that we think are worthwhile reading for students who want to learn more about the environment.

Acknowledgments

This book is the result of the hard work of many people whom we would like to thank heartily. Numerous reviewers graciously gave of their time to comment on the manuscript and suggested many useful changes. We thank Wanna D. Pitts, San Jose State University; Conrad S. Brumley, Texas Tech University; Eric Fritzell, University of Missouri; Frederick A. Montague, Jr., Purdue University; Jim Merchant, University of Kansas; Gary Nelson, Des Moines Area Community College; and Ray DePalma, William Rainey Harper College.

Many thanks to the staff at Macmilllan, especially our long-time editor and close friend, Bob Rogers, who has pushed hard to make this book the best it could be and who has always offered friendly advice and encouragement. We would also like to thank Mary Dersch, who generated the new artwork for this edition; our photo researcher, Yvonne Gerin, for her hard work and good natured persistence in researching photographs; and Helen Greenberg, who edited the manuscript. The production staff at Publication Services, especially Don DeLand, deserves a large debt of gratitude for their hard work, attention to detail, and cheerfulness despite a tight production schedule.

Finally, we would like to thank our wives for their love and support during the writing and production of this book.

O. S. O.
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1

Introduction

The late Aldo Leopold, the senior author's ecology professor, once defined **conservation** as "a state of harmony between man and the land." For Leopold, conservation required equal portions of reflection and action. He wrote: "The real substance of conservation lies not in the physical projects of government, but in the mental processes of citizens." Leopold believed strongly that effective conservation depends primarily on a basic human respect for natural resources. He called such respect a **land ethic**. Each of us, he said, is individually responsible for maintaining "the health of the land." A healthy land has "the capacity for self-renewal." "Conservation," he concluded, "is our effort to understand and preserve that capacity." It is this concept of conservation that has guided and influenced the writing of this book.

THE CRISIS ON PLANET EARTH

Effective conservation in the United States and other countries is becoming more and more urgent, for human society is rapidly degrading the natural environment. The damage is so severe that many experts believe that the long-term future of society is in jeopardy. Ironically, humankind prides itself on conquering outer space and on its many new technologies that make space exploration and modern medicine possible. Yet, after two centuries of technological progress, we still fail to manage well the space around us here on planet Earth (Figure 1-1). This has led to an environmental crisis resulting from three interrelated problems: (1) rapid population increase, (2) excessive consumption of resources, and (3) pollution.

Population Increase

At the current rate of growth, global population will surge from nearly 5.2 billion in 1989 to roughly 8 billion by 2020 (Figure 1-2). This cancerous growth of the human population clouds the future of planet Earth and is an underlying cause of our resource-environmental crisis. An increase in population means an increase in the pollution of air, water, and land. It means an accelerated depletion of natural resources, many of which are already in short supply or are declining in quality. It means that massive starvation, as in Africa today, will spread to other parts of the world. It means that greater numbers of people, living in overcrowded conditions, will suffer from increasing emotional stress and will make increasing demands on wilderness and recreation areas in order to "get away from it all." Drug abuse, mental illness, crime, and suicide will be more common. Each surge in population will bring a corresponding decline in our overall standard of living. Unless population growth is halted within the very near future, even the most soundly conceived and effectively implemented conservation and environmental practices will be to no avail.

After nearly 4 million years of human history, global population has turned the bend of the J-curve and is now moving almost straight up. By this time tomorrow, there will be 234,000 more people on this planet; by next week, 1.6 million more; and by next year, an additional 87 million. On Memorial Day, our nation honors the memory of those Americans who have given their lives for their country on the world's battlefields. The fatalities have indeed been numerous—57,000 in the Vietnam War alone. Yet the rate of pop-

FIGURE 1-1 Despite their extraordinary mental abilities, humans are directly responsible for many serious environmental problems.

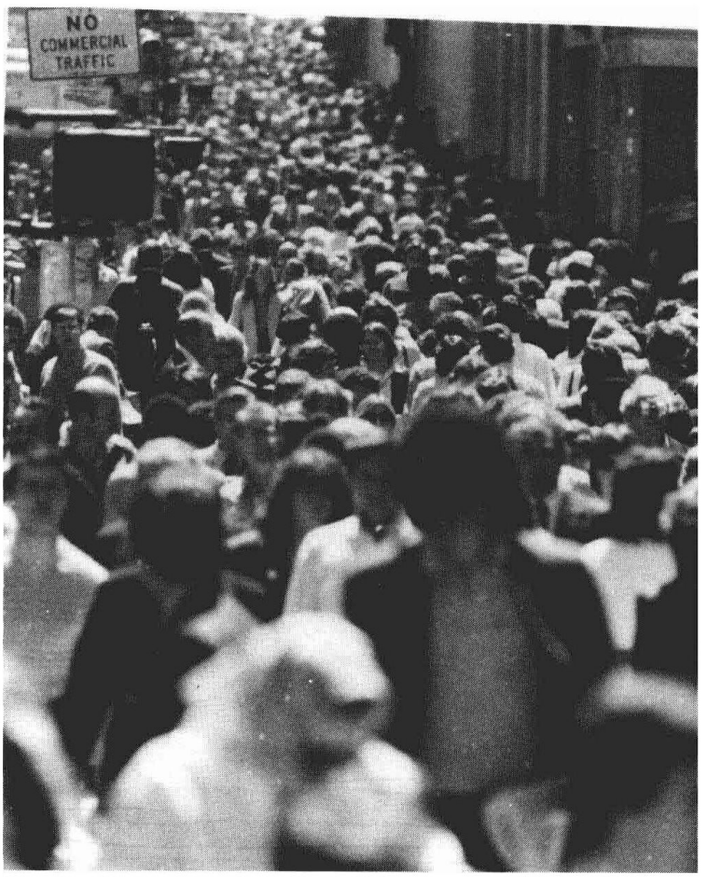

FIGURE 1-2 Rapidly growing global population strains the limits of our resources. Urban populations concentrate millions of people in limited space, resulting in elevated pollution levels.

ulation growth is so high that all the battlefield deaths of soldiers the world over since the discovery of America by Christopher Columbus will have been replaced in only 6 months.

The people added to the world's population each year must be fed. For a number of political, social, economic, and ecological reasons, however, food is not available. During the hour it takes the average American family to polish off its Thanksgiving turkey (and cranberry sauce, and apple pie, and so on), 4,000 people took their last breath—dying either directly or indirectly from a lack of food. One year from now, an estimated 12 million people will have starved—a population nearly equal to that of Pennsylvania and Kentucky combined. Another 30 million will have died from infectious and parasitic diseases worsened by malnutrition.

Excessive Resource Consumption

The world's industrialized nations are consuming nonrenewable resources (coal, oil, gas, copper, zinc, and cobalt, for example) at an accelerating pace. The United States ranks first in per capita consumption. *Although our nation has only 5 percent of the global population, it consumes 30 percent of the world's resources.*

Many demands made by Americans on natural resources are excessive and do not contribute substantially to human happiness. Americans are the most overfed, overhoused, overclothed, overmobilized, and overentertained people in the world. Our enormous consumption of cars, color television sets, dishwashers, air conditioners, golf carts, home computers, swimming pools, speed boats, and video cassette recorders certainly does not stem from need.

Through such excessive production and consumption, called **throughput** by economists, the United States and other highly industrialized nations are accelerating the depletion of our planet's resources.

Pollution

The United States, the world's most *affluent* nation, has also become the most *effluent* (Figures 1-3 and 1-4). Like other industrialized nations, we have degraded our environment with an enormous variety and volume of contaminants. We have polluted lakes, streams, oceans, and groundwater with sewage, industrial wastes, radioactive materials, heat, detergents, fertilizers, pesticides, and plastics. Millions of tons of sulfur dioxide and carbon dioxide are spewed into the air each year from the combustion of fossil fuels, such as

FIGURE 1-3 America has polluted her lakes and streams with sewage, industrial wastes, radioactive materials, heat, detergents, agricultural fertilizers, and pesticides. Massive fish kills have been the result.

coal and oil, and are causing serious climatic effects—not only in the United States, but in other nations as well. Our increasing dependence on nuclear power, as well as on nuclear arms, has led to the accumulation of large amounts of radioactive waste, some of which threatens human health and life.

QUALITY OF HUMAN LIFE ON PLANET EARTH

Can planet Earth support the reasonably high standard of living many of us now enjoy, by the year 2050? Or by the year 2100? This important question is almost impossible to answer with any degree of certainty. The problem is that there are so many interacting variables: population levels, resource availability, degree of environmental pollution, climatic patterns, industrial production, national and international politics, social attitudes, changing patterns of war and peace, and so on. In fact, the task we face in maintaining a reasonably high standard of living is much more formidable than that of developing the atomic bomb or putting a person on the moon!

Some years ago, a research group at the Massachusetts Institute of Technology published a book entitled *The Limits to Growth*. This book summarized their computer studies of the projected future of humans on Earth. The scientists wanted to determine the changes in environmental quality that might take

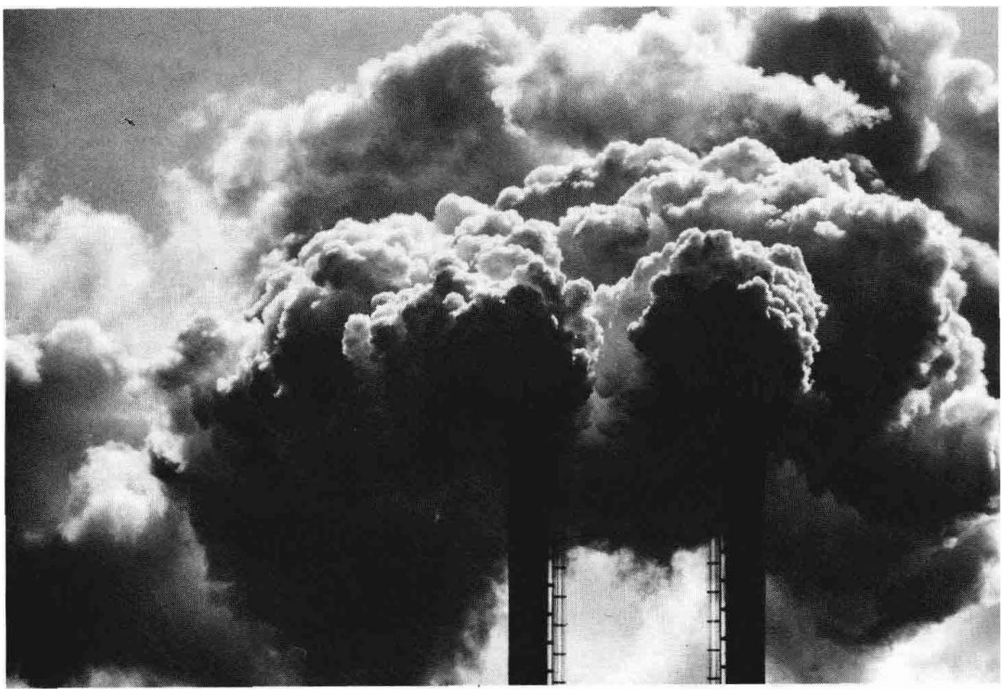

FIGURE 1-4 Industrial smokestacks have spewed large volumes of pollutants into our nation's atmosphere.

place through the year 2100, assuming that population growth, resource depletion, pollution, industrial production, and so on continue at exponential rates—in other words, moving almost straight up the J-curve. The graphed projections that appeared on their computer printout sheets are of extreme interest, and highly disturbing.

Figure 1-5 shows that the global population climbs until about 2050. Food production per capita, however, drops long before population peaks. Industrial output per capita follows a similar pattern. By the year 2030, the quality of human life has deteriorated. Several decades later, many natural resources will either be so severely depleted (fertile soil, oil, and metals) or so seriously polluted (air, water, and land) that both food and industrial production drop off sharply. Aggravating the problem then will be the continuing upsurge of global population. Eventually, after the year 2050, well within the lifetime of your children, there will be a massive reduction in the human population, primarily as the result of starvation. The prospects for human survival beyond 2100 appear poor, simply because the global stock of natural resources, upon which humans have depended during their 4-million-year tenure on this planet, will have reached the point of exhaustion.

Viewpoint of the Optimists

These somber projections have been criticized by those who believe that technology will solve our resource and environmental problems. History is full of examples showing that necessity is the mother of invention. The optimists suggest that the Western world is on the brink of another technological revolution. After all, isn't the current crisis the greatest in human history? If small crises result in small innovations, then certainly today's composite population-resources-pollution dilemma may be the necessary stimulus for the greatest technological breakthroughs of all time. These optimists confidently claim that "a breakthrough a day will keep the crises at bay." Wherever something has gone awry, technology will provide a "fix." Athelstan Spilhaus of the University of Minnesota is a leading spokesperson for this school of thought. He has suggested, for example, that "energy is the ultimate currency of civilization"; in other words, if enough cheap energy is available, all things can be accomplished, pollution will be controlled, food will be available for all, and clothing and shelter for the needy millions will be provided. Indeed, the nuclear power enthusiasts are predicting unlimited energy supplies once the breeder reactor has been perfected (see Chapter 21). To increase food production, the optimists suggest a variety of schemes ranging from fish farming to synthesizing food in test tubes; from yeast and algal culture to irrigating deserts; from draining swamplands to using genetic engineering to produce miracle wheats and supercorn. We can derive oil from worn-out rubber tires, say the optimists, refine methane gas from manure, and obtain construction materials from broken glass and fly ash. According to these optimists, we can always depend on human ingenuity and skill to "pull another rabbit out of our technological hat."

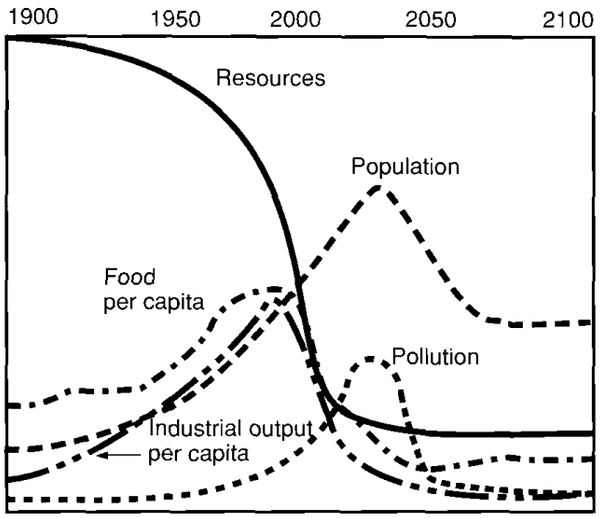

FIGURE 1-5 Computer predictions of different variables (food, population, industrial output, pollution, resources) if current trends continue. This graph shows that if population continues to grow, resources will decline dramatically. Pollution levels will increase. The combined effect is a decline in human population and considerable environmental damage.

Viewpoint of the Pessimists (or Realists?)

Unfortunately, say the pessimists, technology will not solve all of our problems. For one, there isn't enough time to find technological fixes to problems that need solutions today.

Why is time so crucial? The key to the answer is the word **exponential**. Remember the J-curve? It represents exponential growth—of population, of resource depletion rates, of pollution. Such growth increases *geometrically*, as symbolized by the numerical sequence 1, 2, 4, 8, 16, and so on. This is in contrast to *arithmetic* growth, which is symbolized as 1, 2, 3, 4, 5, 6, and so on. The rapidity of exponential growth is best understood through an analogy.

Suppose that there is a cancerous tumor in the windpipe that carries oxygen to your lungs—a tumor that doubles in size each day. Assume that it will take only 30 days for this cancer to close off your windpipe completely and cause your death from suffocation. On Day 29 you are rushed to the hospital for emergency surgery. The surgeon examines the tumor and discovers that it

has blocked off half of your windpipe. Now, if he is unfamiliar with the dynamics of exponential growth, he will probably suppose that he has plenty of time to remove the tumor and save your life. Wrong. He has just one day left.

In this analogy, the windpipe represents the fragile and highly vulnerable life support systems for humans. The cancerous tumor represents the exponentially growing global population, resource consumption, and pollution. Even though the world's best scientists, technologists, ecologists, sociologists, and economists struggle valiantly to remove this rapidly growing environmental cancer, it will be too late. *Day 29 is rapidly approaching!*

Viewpoint of the Moderates

Which viewpoint, optimistic or pessimistic, is closer to the truth? Unfortunately, we cannot be sure. Perhaps, however, as in many other instances, a moderate viewpoint is more correct. The moderates view our current resource-environmental posture with justifiable concern. Yet they feel that there is still sufficient time, if we start *now* to shift from today's **spendthrift society** to a **sustainable society**—one that is much less damaging to resources and the environment.

Many political scientists, sociologists, economists, and ecologists are convinced that eventually our lifestyles will simplify. We can achieve a sustainable society shown in Figure 1-6, with an emphasis on cultural, intellectual, moral, and spiritual values rather than on material wealth. Lifestyles in this sustainable society, which can be attained by 2025, would be much simpler than those of today. The average American, for example, would get along without some of the traditional status symbols, such as a large, energy-wasteful home, a second or third family car, a recreational vehicle, and a speed boat. This lifestyle, however, would be ecologically sound rather than ecologically suicidal and probably might offer us a better chance of finding real happiness. Attaining a sustainable society may ultimately depend on sharing knowledge and, possibly, on a redistribution of our planet's limited resources so that all of its inhabitants get their *fair share*. This idea, admittedly, is not without its critics (Chapter 6).

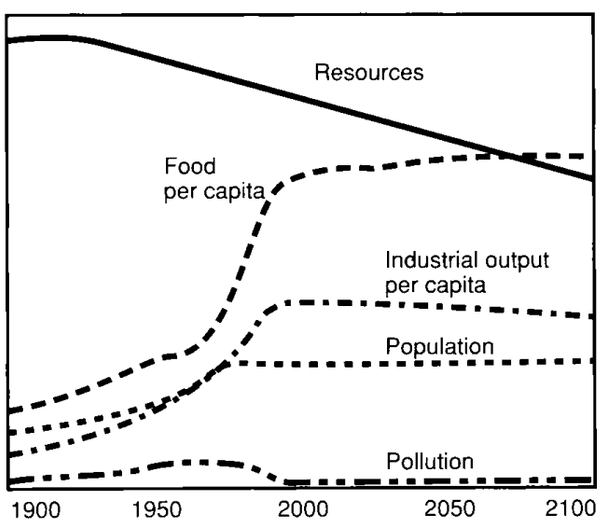

FIGURE 1-6 If strenuous attempts are made now to stabilize population size (1990–1995), a sustainable, steady-state type of society may be achieved by 2025. The finite resource base will continue to fall, however, suggesting the need for renewable resource use.

If resource redistribution is not brought about, it is likely that the frustrated hopes of the poor nations will lead to more political unrest, riots, revolution, and even nuclear war. The British philosopher Bertrand Russell noted that "nothing is more likely to lead to an H-bomb war than the threat of universal destitution through overpopulation." Newspaper columnist Smith Hempstone makes the following somber prediction: "Neither democracy nor peace will survive in areas where the roots of both are weak. Governments will fall like tenpins and hungry nations will go to war in an effort to seize what they cannot produce." A nuclear exchange, of course, could impose a *simple* life on humankind. However, it would not be characterized by happines, but rather by a primitive level of existence, with remnant populations literally scratching for survival on what is left of planet Earth.

Our task—to achieve a true sustainable, spaceship type of society—is difficult and challenging. It requires the dedicated, highly coordinated, and long-sustained efforts of many different types of people, from factory workers to business executives, from college students to farmers, from scientists to politicians, from food specialists to geographers. It requires imaginative and inspirational leadership from government leaders at all levels, from small-town mayors to presidents of the United States and commissars of the Soviet Union, from village tribal chiefs in Africa to benevolent despots in South America. Some of the required changes have already begun.

A BRIEF HISTORY OF THE RESOURCE CONSERVATION AND ENVIRONMENTAL MOVEMENTS

Conservation in the Nineteenth Century

Although progress toward conservation was relatively slow in the 19th century, several notable advances in the United States were made. In the early 1800s, George Washington and Thomas Jefferson used effective methods to control soil erosion on their farms. In 1864

the diplomat-naturalist George Perkins Marsh authored *Man and Nature*—a book that did much to draw attention to the fragile nature of our resources and how they can be abused by humans. It served as a catalyst for the fledgling conservation movement. Congress established three national parks: Yellowstone, the world's first, in 1872, followed by Yosemite and Sequoia in 1890. In 1891, 28 forest reserves were established—later to be designated as the nation's first national forests. In 1892 the noted naturalist John Muir founded the Sierra Club, an organization that today is one of our country's most politically active conservation groups.

Conservation in the Twentieth Century

By far the most significant advances in natural resource conservation have been made in this century. They have occurred primarily in three "waves." The first (1901–1909) developed under the dynamic and forceful leadership of President Theodore Roosevelt; the second (1930s) occurred during the presidency of Franklin D. Roosevelt; and the third (1970–1980) was given impetus by the Nixon, Ford, and Carter administrations (Table 1-1).

The First Wave (1901–1909). The White House Conference on Natural Resources called by President "Teddy" Roosevelt in 1908 was a high-water mark for the cause of conservation (Figure 1-7). Several developments influenced Roosevelt's decision to call the conference. Among them were (1) the deep concern among scientists over the severe depletion of timber in the Great Lakes states; (2) the study of arid western lands by Major J. W. Powell in the 1870s, which had stimulated great interest in the possibilities of irrigation farming and converting deserts to vegetable gardens; (3) the 1907 report by the Inland Waterways Commission pointing out that the excessive use of water would inevitably have a negative impact on other resources, such as timber, soils, and wildlife; and (4) a growing apprehension in 1908 that our nation's resources were being grossly mismanaged and that severe economic hardship would be the inevitable result.

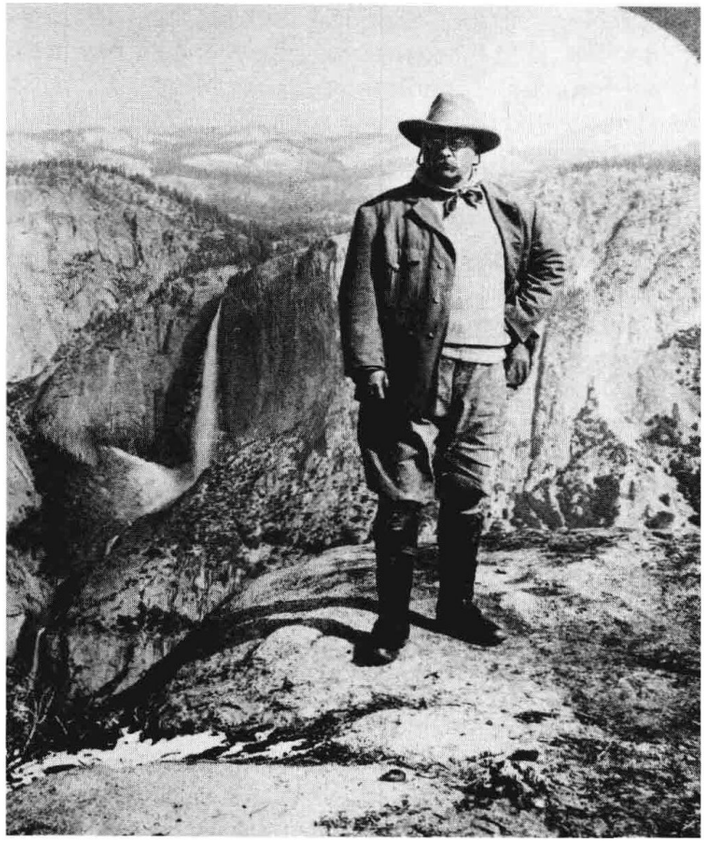

FIGURE 1-7 President Theodore Roosevelt, outdoorsman, big-game hunter, and ardent conservationist, at Yosemite National Park.

Invited to the White House conference were governors, congressional leaders, scientists, anglers, hunters,

Table 1-1 The Three Waves of Conservation Progress

	First Wave (1901–1909)	Second Wave (1933–1941)	Third Wave (1962–1980)
Presidents	Theodore Roosevelt	Franklin D. Roosevelt	Richard Nixon, Gerald Ford, and Jimmy Carter
Constructive Action	Report of the Inland Waterways Commission	Prairie States Forestry Project	Wilderness Act of 1964
	White House Conference on Natural Resources of 1908	Establishment of shelter belts	Clean Air Act of 1965
	National Conservation Commission established	National Resources Board established	Solid Waste Disposal Act of 1966
	First *Natural Resources Inventory*	Second *Natural Resources Inventory*	Species Conservation Act of 1966
		Civilian Conservation Corps established	Wild and Scenic River Act of 1968
		Soil Conservation Service established	National Environmental Policy Act of 1969
		Tennessee Valley Authority established	Environmental Teach-In (1970)
		First North American Wildlife and Resources Conference	Legislation of the Decade of the Environment (Table 1-2)

and resource experts from several foreign nations. As a result of the conference, a 50-member National Conservation Commission was formed, composed of scientists, legislators, and businessmen; inspirational leadership was provided by Gifford Pinchot, a professional forester. The commission completed our nation's first comprehensive **Natural Resources Inventory**. The White House conference also resulted indirectly in the formation of 41 state conservation departments, almost all of which are still operating vigorously today.

The Second Wave (1933–1941). Franklin D. Roosevelt is a notable example of "the right man in the right place at the right time." When he assumed the presidency in 1933, there was an urgent need for an imaginative program to create jobs. Roosevelt's administration not only created employment, it solved many natural-resource problems plaguing our nation. Here are some examples:

1. The **Prairie States Forestry Project** was begun in 1934. Its goal was to establish shelter belts of trees and shrubs in farmland along the one-hundredth meridian extending from the Canadian border of North Dakota south to Texas. This project did much to reduce soil erosion.
2. The National Resources Board appointed by Roosevelt completed our nation's second comprehensive **Natural Resources Inventory** in 1934. In its report, the board identified serious resource problems plaguing the country, and described methods for solving them as well.
3. The **Civilian Conservation Corps** (CCC), which was established in 1933 and functioned until 1949, was organized into 2,652 camps of 200 men each. Many were located in the national parks and forests. The forest workers constructed fire lanes, removed fire hazards, fought forest fires, controlled pests, and planted millions of trees. The park workers constructed bridges, improved roads, and built hiking trails. In addition, the CCC made lake and stream improvements and participated in flood-control projects.
4. In 1935 the **Soil Conservation Service** (SCS) was established. The time was ripe for such a program. The frequent occurrence of severe dust storms over the Dust Bowl of the Great Plains bore testimony to the vulnerability of the nation's soils. The SCS conducted soil conservation demonstrations to show farmers the techniques and importance of erosion control.
5. The establishment of the **Tennessee Valley Authority** (TVA) in 1933 was a bold experiment, unique in conservation history, to integrate the use of the resources (water, soil, forests, wildlife) of an entire river basin. Although highly controversial at the time, it has received international acclaim and has served as a model for similar projects in India and other nations.
6. The **North American Wildlife and Resources Conference** was convened by President Roosevelt in 1936. Attended by wildlife management specialists, hunters, anglers, and government officials, it set out to develop an inventory of the nation's wildlife resources, and a statement of wildlife and other conservation problems, including policies by which those problems might be solved. This conference meets annually to this day.

The Third Wave (1960–1980). During the 1960s the U.S. conservation and environmental movement really "took off." Several highly influential books and essays were written during this time that sensitized the general public to the gravity of the nation's problems. Rachel Carson's *Silent Spring* (1962), a runaway best seller, alerted the general public to the potentially harmful effects of pesticides, such as DDT, on both wildlife and humans. Noted ecologist Paul Ehrlich, of Stanford University, authored *The Population Bomb*, which warned of the environmental degradation that would result if society could not control the worldwide surge of population. Garrett Hardin's classic essay, "The Tragedy of the Commons," proposed that any resource shared by many people would eventually be exploited and degraded.

In 1969 Senator Gaylord Nelson (D-Wis.) called for a nationwide "environmental teach-in" in an attempt to marshall the energies of the nation's college students "to halt the accelerating pollution and destruction of the environment." Ever sensitive to public opinion, Congress responded by enacting so many important laws to upgrade our resources and control pollution from 1970 to 1980 that this period has been called *the decade of the environment*. A partial list of these acts is shown in Table 1-2.

We must remember, of course, that the mere existence of a law—to control air pollution, for example—does not mean that we will automatically have clean air. Even the most superbly orchestrated act must be *enforced* if its purpose is to be realized. And effective enforcement requires money for personnel and equipment.

AN ENVIRONMENTAL BLUEPRINT FOR PRESIDENT GEORGE BUSH AND THE U.S. CONGRESS FOR 1989–1993

Shortly after President George Bush was elected, a number of leading conservationists and environmentalists

Table 1-2 Major Environmental Acts Passed During the Decade of the Environment (1970–1980)

Air Quality
Clean Air Act of 1970, 1977

Control of Noise
Noise Control Act of 1972
Quiet Communities Act of 1978

Control of Toxic Substances
Toxic Substances Control Act of 1976
Resource Conservation and Recovery Act of 1976

Control of Solid Wastes
Solid Waste Disposal Act of 1965
Resources Recovery Act of 1970

Energy
National Energy Act of 1978

Land Use
National Coastal Zone Management Act of 1972
Forest Reserves Management Acts of 1974, 1976
Federal Land Policy Management Act of 1976
National Forest Management Act of 1976
Surface Mining Control and Reclamation Act of 1977
Endangered American Wilderness Act of 1978

Water Quality
Federal Water Pollution Control Act of 1972
Ocean Dumping Act of 1972
Safe Drinking Water Act of 1974
Toxic Substances Control Act of 1976
Clean Water Act of 1977

Wildlife
Federal Insecticide, Fungicide, and Rodenticide Control Act of 1972
Marine Protection, Research and Sanctuaries Act of 1972
Endangered Species Act of 1973

presented him with a *Blueprint for the Environment*—an 800-page document prepared by 18 of the country's foremost environmental organizations. It was hoped that President Bush would respond by asserting strong leadership in tackling the crucial environmental problems facing our nation and the world. Of course, an equal commitment by the Democratic-controlled Congress is just as essential if appropriate environmental legislation is to be crafted. Both Republicans and Democrats must form a working partnership in this crucial effort. Among the items in the *Blueprint for the Environment* are the following:

1. *Air pollution*
   a. Promote international agreements for control of global warming (greenhouse effect), acid rain, and the thinning of the stratospheric ozone layer.
   b. Press for passage of a reauthorized Clean Air Act.
   c. Develop a coordinated program to monitor and regulate indoor pollution.
2. *Population problem*: Support an international agreement to reduce the rate of population growth by 50 percent by the year 2000.
3. *Soil erosion*: Develop creative strategies for the control of soil erosion, a crucial problem in at least 25 percent of the country's cropland.
4. *Water pollution*: Develop a unified national program to control the ever-increasing contamination of our groundwater.
5. *Forests*
   a. Block a proposal to build 580,000 miles of roads in our national forests by 2030. Such road construction would be highly destructive to the environment and would subsidize the operations of private logging firms at the expense of American taxpayers.
   b. Provide financial and technical assistance to Third World countries in the reforestation of 320 million acres. Such a project would have multiple benefits, one of which would be the slowing up of global warming due to the greenhouse effect.
6. *Wildlife*: Halt the destruction of wetland habitats, indispensable for waterfowl and marsh birds.
7. *Pesticide problem*: Speed up the EPA's review and certification of more than 600 basic pesticide ingredients now in use and being widely dispersed in the human and wildlife environments.
8. *Ocean pollution*: Ban all ocean dumping of domestic and industrial wastes.
9. *Hazardous waste problem*: Accelerate the cleanup of hazardous waste dumps (under the Superfund Act of 1980) to protect our groundwater from toxic contamination.
10. *Council of Environmental Quality (CEQ)*: Restore the influence the CEQ enjoyed in the 1970s. The CEQ advises the president on the nation's environmental condition, and informs him of programs by which it can best be improved.

CLASSIFICATION OF NATURAL RESOURCES

Conservationists recognize two major kinds of resources: renewable and nonrenewable (Table 1-3). **Renewable resources** include soils, rangelands, forests, fish, wildlife, air, and water. Although these resources can be renewed by natural processes, they can also be depleted due to overuse by humans. Renewal can be facilitated or managed by humans. Some resources may be renewed much more rapidly than others. For example, it may take 1,000 years for just 1 inch of fertile topsoil to form. A pine forest may develop from the

Table 1-3 Classification of Natural Resources

Renewable

Resources whose continued harvest or use depends on proper human planning and management. Improper use and/or management results in impairment or exhaustion, with resulting harmful social and economic effects.

1. **Fertile soil.** The fertility of soil can be renewed, but the process is expensive and takes time.

2. **Products of the land.** Resources grown in or dependent on the soil.
   a. Agricultural products. Vegetables, grains, fruits, and fibers.
   b. Forests. Source of timber and paper pulp. Valuable as a source of scenic beauty, as an agent in erosion control, as recreational areas, and as wildlife habitat.
   c. Rangeland. Sustains herds of cattle, sheep, and goats for the production of meat, leather, and wool.
   d. Wild animals. Provide aesthetic values, hunting sport, and food. Examples are deer, wolves, eagles, bluebirds, and fireflies.

3. **Products of lakes, streams, and oceans.** Black bass, lake trout, salmon, cod, mackerel, lobsters, oysters, and seaweed.

Nonrenewable

Amount of resource is finite. When destroyed or consumed, such as the burning of coal, the resource cannot be replaced.

1. **Fossil fuels.** Produced by processes that occurred millions of years ago. When consumed (burned), heat, water, and gases (carbon monoxide, carbon dioxide, and sulfur dioxide) are released. The gases may pose serious air pollution problems.

2. **Nonmetallic minerals.** Phosphate rock, glass sand, and salt. Phosphate rock is of crucial importance as a source of fertilizer.

3. **Metals.** Gold, platinum, silver, cobalt, lead, iron, zinc, and copper. Without these, modern civilization would be impossible. Zinc is used in galvanized iron to protect it from rusting; tin is used in toothpaste tubes; and iron is used in cans, auto bodies, and bridges.

seedling stage to maturity in 100 years. On the other hand, a herd of deer, under optimal conditions, could build up from 6 head to 1,000 head in only 10 years!

Nonrenewable resources occur in a fixed amount. They cannot be renewed by natural processes rapidly enough to be usable by current human society. They include fossil fuels (coal, oil, natural gas), nonmetallic minerals (phosphates, magnesium, etc.), and metallic minerals (copper, aluminum, etc.).

APPROACHES TO NATURAL RESOURCE MANAGEMENT

During the past two centuries, four resource management approaches have been used in the United States: (1) exploitation, (2) preservation, (3) the utilitarian approach, and (4) the ecological or sustainable approach.

Exploitation

The exploitation management approach suggests that a given resource should be used as intensively as possible to provide the greatest profit to the user. This philosophy prevailed early in our nation's history. No concern was given to such adverse effects as soil erosion, water pollution, or wildlife depletion. For example, the slogan of the early loggers of the 1800s who exploited our primeval forests was: "Get in, log off the trees, and get out." When the trees were gone, the loggers moved westward and repeated the process. Why not? The nation's forests seemed inexhaustible.

Preservation

The preservation management approach suggests that resources should be preserved, set aside, and protected. A forest, for example, should not be used as a source of timber. It should be preserved in its natural state as a wilderness. In the 1880s, the naturalist John Muir, who founded the Sierra Club, proposed that federal lands of unique beauty should be withdrawn from exploitation by timber, grazing, and mining interests and converted into national parks. As such, they would be preserved virtually unchanged for the enjoyment of future generations. Partly as a result of Muir's influence, Congress established Yosemite and Sequoia National Parks in 1890.

Utilitarian Approach

The utilitarian approach to resource management began during the 1930s. One important utilitarian concept is that of **sustained yield**. This concept suggests that renewable resources (soil, rangelands, forests, wildlife, fisheries, and so on) should be managed so that they will never be exhausted, but will be replenished and thus will be able to serve future generations. When a forest has been logged off, the site must be reseeded naturally or artificially so that a new forest can develop. Similarly, when fish are harvested from a lake or stream, they must be replaced either by natural reproduction or by stocking with hatchery-reared fish.

Ecological Approach

Ecology is the study of the interrelationships between organisms and their environment. Modern conservation strategies often operate within an ecological framework. More than 100 years ago, the American diplomat-naturalist George Perkins Marsh observed how humans had abused agricultural lands in Europe and Asia. He further observed how this abuse resulted in soil erosion, dust storms, water pollution, and the erosion of a nation's economic well-being. Upon returning to the United States, Marsh wrote *Man and Nature* (1864), mentioned earlier. In it he argued that humans cannot degrade one part of the environment without harming other parts. Marsh argued that although highly varied and infinitely complex, our natural environment is