Managing Our Natural Resources

6TH EDITION

William G. Camp | Betty Heath-Camp

Managing Our Natural Resources

Cengage Learning®
is proud to support
FFA activities

Managing Our Natural Resources

6TH EDITION

William G. Camp, PhD
Professor Emeritus, Virginia Tech

Betty Heath-Camp, PhD
Professor Emerita, Virginia Tech

Contributions by **Al D. Stokes**
Waddell Mariculture Research and Development Center,
South Carolina Department of Natural Resources

CENGAGE Learning

Detroit • New York • San Francisco • New Haven, Conn • Waterville, Maine • London

CENGAGE Learning®

Managing Our Natural Resources, 6th Edition

William G. Camp and Betty Heath-Camp

VP, General Manager, Skills and Planning: Dawn Gerrain

Product Director: Matthew Seeley

Senior Director, Development, Skills and Computing: Marah Bellegarde

Product Team Manager: Erin Brennan

Senior Product Development Manager: Larry Main

Associate Product Manager: Nicole Sgueglia

Senior Content Developer: Jennifer Starr

Product Assistant: Jason Koumourdas

Marketing Manager: Scott Chrysler

Senior Director, Production, Skills and Computing: Wendy Troeger

Director, Production, Trades and Health Care: Andrew Crouth

Senior Content Project Manager: Betsy Hough

Senior Art Director: Benjeman Gleeksman

Senior Art Director: David Arsenault

Library of Congress Control Number: 2014946317

ISBN-13: 978-1-285-83507-5

Cengage Learning
200 First Stamford Place, 4th Floor
Stamford, CT 06902
USA

Cengage Learning is a leading provider of customized learning solutions with office locations around the globe, including Singapore, the United Kingdom, Australia, Mexico, Brazil, and Japan. Locate your local office at: **www.cengage.com/global**

Cengage Learning products are represented in Canada by Nelson Education, Ltd.

To learn more about Cengage Learning, visit **www.cengage.com**

Purchase any of our products at your local college store or at our preferred online store **www.cengagebrain.com**

Printed in the United States of America
Print Number: 01 Print Year: 2014

This book is dedicated to the children of the next and future generations. It is for them that we advocate the wise management of our natural resources.

Contents

PREFACE

Managing Our Natural Resources is designed for high school and postsecondary students enrolled in an agriculture program with a natural resources, conservation, forestry management, environmental science, or wildlife management course.

It is the purpose of this book to present a balanced viewpoint of the place of humans in the world as long-term residents. We discuss soil formation, erosion, reclamation, and conservation; water use and improvement; and air quality. We examine endangered species of wildlife; hunting game animals; fishing; and safety in boating, hiking, and other forms of outdoor recreation. We study conservation farming; land-use planning; construction practices that minimize the impact of exploitation on the environment; energy resources use, abuse, conservation, and alternatives; mineral use and recycling; and career opportunities in each of those diverse fields.

For this sixth edition, we worked to present the most current and relevant events, statistics, and topics. Our intention is that readers become informed of the natural resource management issues of today.

Managing natural resources itself is a very broad topic, and a book that attempts to deal with it cannot go into great depth in any of the areas considered. Therefore, this book should be used as a survey of many broad areas rather than as a definitive treatment of any one area of study.

Why We Wrote This Book

Managing Our Natural Resources was written because we perceived a need for a book that takes a broad look at the whole panorama of preservation, exploitation, and conservation of natural resources from a balanced perspective. There are many books on soils, for instance, but such books do not treat soil management as it relates to other disciplines, such as wildlife management and fisheries development. We have attempted to take just such an approach in this book. We hope it will lead students into at least one area of study that will pique their appetite to learn more and that will lead them to conduct their own research and further study in that area.

New to This Edition

The sixth edition was thoroughly revised to reflect the changing landscape of natural resource management:

- Statistics throughout the book were updated and checked for accuracy.
- Changes in technology and the economy and how they have affected the energy production sector in drastic ways are discussed.
- The emergence of the widespread use of hydraulic fracturing (fracking) is described.
- Recent events, such as the nuclear accident in Fukushima, Japan, and Superstorm Sandy along the East coast of the United States are discussed.
- United Nations population growth forecasts, indicating a leveling off of the human population over the next several centuries, are reviewed.
- Web sites in Appendix A and safety certification programs in Appendix B were updated and checked for accuracy.

Supplement to This Book

A set of resources to facilitate the teaching and learning experience are available for the sixth edition of *Managing Our Natural Resources*.

Instructor's Manual

The printed Instructor's Manual includes Lesson Plans with PowerPoint® correlations for each chapter and Answers to the Review and Discussion Questions in the book and the questions in the accompanying workbook, to ensure that the instructor is prepared for classroom instruction and evaluation.

Classmaster CD-ROM

The Classmaster CD-ROM is an integrated tool that contains many useful resources for the instructor:

- Instructor's Manual – an electronic version of the printed Instructor's Manual, including Lesson Plans with PowerPoint® correlations for each chapter, and the Answers to the Review and Discussion Questions in the book and workbook, is available for reference.
- PowerPoint® presentations – visually-robust with photos and illustrations, each presentation maps out the key points contained within a chapter and correlates to the Lesson Plans that are included in the Instructor's Manual.
- A link to new flexible online testing system powered by Cognero provides instructors with the ability to:
  - author, edit, and manage test bank content from multiple resources
  - create multiple test versions in an instant
  - deliver tests from instructor/institution-specific LMS or classrooms

The link will direct you to CengageBrain.com at http://login.cengagage.com. Follow the prompts for obtaining access to this secure site.

Also Available on the CD are versions of the same tests that appear online in a Microsoft Word® format. This option is for instructors who prefer to use the questions as provided, while still having the flexibility to edit or print the tests.

- An Image Gallery, containing all the images from the book, enables instructors to enhance classroom presentations or review key concepts and information.

New! Companion Site

Instructor resources on the ClassMaster CD-ROM are also available online, including the new flexible online testing system powered by Cognero. Please visit CengageBrain.com at http://login.cengagage.com and follow the prompts for obtaining access to this secure site.

Student Workbook

Newly revised to reflect the sixth edition, the student workbook includes activities, questions and job exercises for each chapter and unit in the book.

New! Coursemate

Another new online option for the fourth edition, this course is designed for students and combines the *Managing Our Natural Resources, 6th Edition* ebook with additional features to enhance learning for the student. It includes the PowerPoint® presentations, additional quizzing, glossary, interactive games and activities and other helpful resources related to the lessons in the book. Also featured is an Engagement Tracker that allows instructors to monitor time on task for each individual student.

ACKNOWLEDGMENTS

Acknowledgments are due to a number of people who assisted in the development of this book.

Cengage Learning

First, we would like to express our special thanks to the editorial staff of Cengage Learning.

- A special "thank you" goes to:
  - Laura Stewart, senior content developer
  - Jennifer Starr, senior content developer
  - Nicole Sgueglia, associate product manager
  - Scott Royael, product assistant
  - Betsy Hough, senior content project manager
  - Dave Arsenault, art director

Without all of your guidance, encouragement, and help, this revision would have been impossible.

Reviewers

Trevor Cummings
Agriculture education teacher
Cabell Midland High School
Ona, WV

Dana A. Fisher
Agriculture education instructor
Central High School
Woodstock, VA

John Jackson
Agriculture teacher
Martinsville High School
Martinsville, IN

Susan Wilder
Agriculture teacher
Clintwood High School
Clintwood, VA

Photography Credits

Cover images: Sunset on the Beach: © iStockPhoto.com/cmcderm1; Aerial view of water carrying aqueduct in Outer Los Angeles: © iofoto/Shutterstock.com; School of tropical Twinspot snapper, blue background: © Anna segeren/Shutterstock.com; Plowed ground, with brown stones and loose soil: © refleXtions/Shutterstock.com; summer river, © Yuriy Kulik/Shutterstock.com; Glacier Bay National Park on the West Coast of Alaska above the Inside Passage: © JNB Photography/Shutterstock.com; Nordic pine forest in evening light. Short depth-of-field: © Stocksnapper/Shutterstock.com; landscape by the lake in the early morning: © M. Pellinni/Shutterstock.com; Waterfall Kayak Jump, Sangay National Park, Ecuador: © Ammit Jack/Shutterstock.com

Unit Opener images:

Unit I: © Cengage Learning, Source: US Fish and Wildlife Service., Source: US National Park Service

Unit II: Source: Photo by Gary Kramer, USDA Natural Resources Conservation Service., Source: USDA, Agriculture Research Service, photo by Jack Dykinga., Source: Photo by Jeff Vanuga, USDA Natural Resources Conservation Service

Unit III: Source: Photo by Jeff Vanuga, USDA Natural Resources Conservation Service, Source: US Bureau of Reclamation, Dept. of Interior, © Cengage Learning

Unit IV: © Kletr/Shutterstock.com. Source: USDA, Agricultural Research Service, photo by Stephen Asmus, Source: US Fish and Wildlife Service.

Unit V: Source: USDA Agriculture Research Service, photo by Stephen Asmus., Source: Peter J Carboni/US Fish and Wildlife Service, Source: Donna Dewhurst/ US Fish and Wildlife Service

Unit VI: Source: Bureau of Land Management, Source: Steve Maslowski/US Fish and Wildlife Service, Source: Bureau of Land Management/Wyoming

Unit VII: © huyangshu/Shutterstock.com, © Hand Shiffman/Shutterstock.com, © Wade H. Massie/Shutterstock.com

Unit VIII: Source: US National Park Service, Source: Gary Zahn/US Fish and Wildlife Service, © Alexandra GI/Shutterstock.com;

ABOUT THE AUTHORS

William G. Camp

Dr. Camp is a Professor Emeritus at Virginia Tech and retired from Cornell University in 2010. As a high school and middle school agriculture teacher he taught, among other things, natural resources management. He holds a BS and M.Ed. from the University of Georgia and an Ed.S. and PhD from Georgia State University. He has authored over 230 scholarly publications and had directed projects totaling over $3.3 million. He has two adult children and seven grandchildren.

Betty Heath-Camp

Dr. Heath-Camp is a Professor Emerita at Virginia Tech and retired from Cornell University in 2010. She was a high school teacher and assistant state supervisor of Marketing and Distributive Education in Kentucky and later a school administrator with the Ohio Department of Corrections. During her career as an educator, she contributed to her profession through leadership roles, publications, and national research presentations. Dr. Heath-Camp holds a BS in business education and an MS in education from Murray State University, and a PhD in education from The Ohio State University.

Contributing Author for This Edition:

- Al Stokes, director of the Waddell Mariculture Research Center, South Carolina Department of Natural Resources, Bluffton, SC, made major contributions to Chapter 26, Marine Fisheries Management and Chapter 27, Freshwater Fisheries Management.

Contributing Authors to Previous Editions:

- Thomas B. Daugherty, agriculture teacher at Maconaquah High School in Bunker Hill, Indiana, was the coauthor on the first edition and assisted in the revisions for the second edition.
- Carla A. Kirts, PhD, Dean of Student Services Emerita and Associate Professor Emerita, University of Alaska, provided input to the first edition.
- Susan Wilder (formerly Aksamit) wrote sections of the fourth edition.
- Andrea Kavleski wrote the case studies on zebra mussels and Asian longhorned beetles.
- Heidi Martin, agriculture teacher in Virginia, contributed to several case studies in the fourth edition and wrote the case study on genetic modification.

HOW TO USE THIS TEXT

How This Book Is Organized

This book provides an overview of a wide range of topics in natural resources management. The book is organized into eight major units to help students logically progress through each of the subject areas. Each unit includes one or more chapters as well as a concluding case study that represents a current issue that is relevant to the chapters included within that unit. In addition, six of the eight units include chapters that enable students to explore careers relevant to the topic of the unit.

Features

Each chapter is organized to help guide students along a learning path:

- **Objectives** can help students organize thoughts as they read the chapter—they tell the student what to expect.
- **Terms to Know** are highlighted in the chapter to help define key points. All the terms are also defined in the **Glossary** at the end of the book.

Our Natural Resources

OBJECTIVES

After reading this chapter, you should be able to
- define and discuss the concept of natural resources
- list and describe the major categories of natural resources in the United States
- explain what makes something a natural resource

TERMS TO KNOW

natural resource
topsoil
usable water
vertebrate
noncommercial forest
mature forest
minerals
recreational resources

- **Review Questions** help students determine if they are able to recall basic facts of the chapter.
- **Discussion questions** encourage students to reflect more deeply and think about what they have learned in the chapter
- **Suggested activities** are intended to go beyond the content of the chapter and give you a chance to apply the content of the chapter to your own life

40 UNIT I Introduction

The human population level on this planet has grown so rapidly in the last century that there is cause for concern. We will probably number over 9 billion by the year 2100! Managing our natural resources in a sustainable way to care for such vast numbers of people will be your challenge.

NOTES

[1]The UN report on Human Population to 2300, published in 2004.
[2]U.S. Environmental Protection Agency, http://www.epa.gov/osw/conserve/materials/basicinfo.htm
[3]http://www.nutmegpaper.com/homepage/MAY2011/

REVIEW QUESTIONS

1. True or false? Water is a renewable resource because we can use it, treat it, and then use it again.
2. True or false? Forests are a good example of a nonrenewable resource because they grow back after we use them.
3. Iron is an exhaustible resource. Does that mean we will run out of iron soon?
4. Is nature ever really "balanced"?
5. Which is more complex, a food chain or a food web?
6. What term is used to identify a "species that is non-native and that causes environmental or economic harm"?
7. What term is used to identify the maximum number of any given plant or animal that a given area can support?
8. The United Nations predicts that the world's human population will stabilize at around how many billions over the next three centuries?
9. What management system uses a single resource (like a forest) for more than one use (such as wood production, hiking, hunting, and water control)?
10. If we use a natural resource carefully and in such a way that we should not "run out" of it in the foreseeable future, we are practicing _____.

DISCUSSION QUESTIONS

1. Define nonexhaustible natural resources. Give examples.
2. Define renewable natural resources. Give examples.
3. Define exhaustible natural resources. Give examples.
4. Describe an ecosystem.
5. Describe humankind's ecosystem and explain why it has expanded.
6. Is there an accurate balance in nature? What would an accurate balance in nature mean?
7. Discuss some ways that nature is balanced.
8. Describe a food chain.
9. Define carrying capacity.
10. Describe the trends of human population growth over the past 8,000 years.
11. Describe the difference between conservation and preservation.
12. Compare and contrast sustainability and the "green movement."

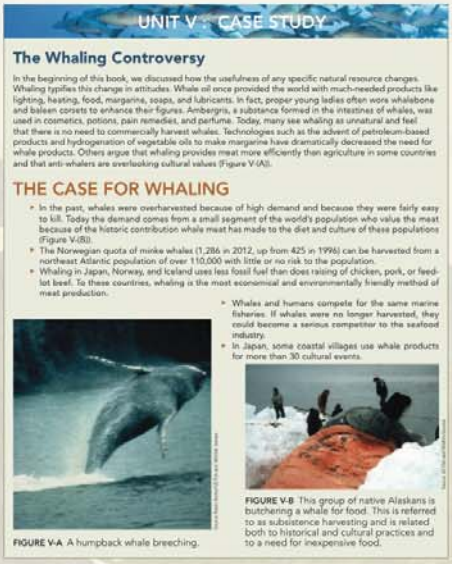
172 UNIT III Water and Air Resources

SUGGESTED ACTIVITIES

1. Keep an account of all the water you use in one day. Look at the list and evaluate the areas where you might have saved water.
2. Make a report of the major water-using industries in your area. Compare this to the water resources available. Answer this question: "Is there a water shortage in my area?"
3. Do an Internet search for "video of hydrologic cycle" to find several short clips explaining the water cycle. Both NASA and NOAA have interesting YouTube videos.
4. Here are some ideas for several research projects to examine rates of evaporation and sublimation in several settings:
   a. Weigh a chunk of ice and place it in an open container in a frost-free freezer. Weigh a similar quantity of water and place it in an identical open container in an open room at the same time. Weigh the ice and water a week later to compare the water-loss rates.
   b. Compare evaporation rates between a wide-mouthed glass bowl and a glass bottle with a small opening.
   c. Compare evaporation rates between identical containers of water, one sitting in the shade and one sitting in direct sunlight, in the same room.
   d. Add dark food coloring to one container of water and leave the another container of water clear. Then place both containers in direct sunlight. Do the containers reach the same temperature? Do they evaporate at different rates?

Units II through VI end with chapters on careers relevant to the unit content. Each unit also concludes with a case study:

- Unit 1 – *Eyes in the Night: The Debate over Wolf Reintroduction in North America* examines the precarious status of the wolf and their reintroduction into the United States.
- Unit 2 – *Let's Go to the Beach* discusses the pros and cons of coastal development.
- Unit 3 – *The Tale of the Pesky Mollusk* describes the invasion of the zebra mussel, brought on by human activity, in the waters of North America.
- Unit 4 – *Hey! Don't Eat My Trees!* describes the introduction of another pesky invader, the Asian long-horned beetle, into the United States, an event brought on by shipping and trade with other countries.
- Unit 5 – *The Whaling Controversy* examines the history and current attitudes on whaling and how values, economics and cultural beliefs can factor into the debate.
- Unit 6 – *Forest and Foes* investigates the two philosophies behind forest management—the perspectives of the preservationist and the conservationist.
- Unit 7 – *To Regulate or Not to Regulate—That Is the Question* examines the controversy over federal government involvement within the energy sector.


UNIT V CASE STUDY

The Whaling Controversy

In the beginning of this book, we discussed how the usefulness of any specific natural resource changes. Whaling typifies this change in attitudes. Whale oil once provided the world with much-needed products like lighting, heating, food, margarine, soaps, and lubricants. In fact, proper young ladies often wore whalebone and baleen corsets to enhance their figures. Ambergris, a substance formed in the intestines of whales, was used in cosmetics, potions, pain remedies, and perfume. Today, many see whaling as unnatural and feel that there is no need to commercially harvest whales. Technologies such as the advent of petroleum-based products and hydrogenation of vegetable oils to make margarine have dramatically decreased the need for whale products. Others argue that whaling provides meat more efficiently than agriculture in some countries and that anti-whalers are overlooking cultural values (Figure V-A).

THE CASE FOR WHALING

- In the past, whales were overharvested because of high demand and because they were fairly easy to kill. Today the demand comes from a small segment of the world's population who value the meat because of the historic contribution whale meat has made to the diet and culture of these populations (Figure V-B).
- The Norwegian quota of minke whales (1,286 in 2012, up from 425 in 1996) can be harvested from a northeast Atlantic population of over 110,000 with little or no risk to the population.
- Whaling in Japan, Norway, and Iceland uses less fossil fuel than does raising of chicken, pork, or feedlot beef. To these countries, whaling is the most economical and environmentally friendly method of meat production.
- Whales and humans compete for the same marine fisheries. If whales were no longer harvested, they could become a serious competitor to the seafood industry.
- In Japan, some coastal villages use whale products for more than 30 cultural events.

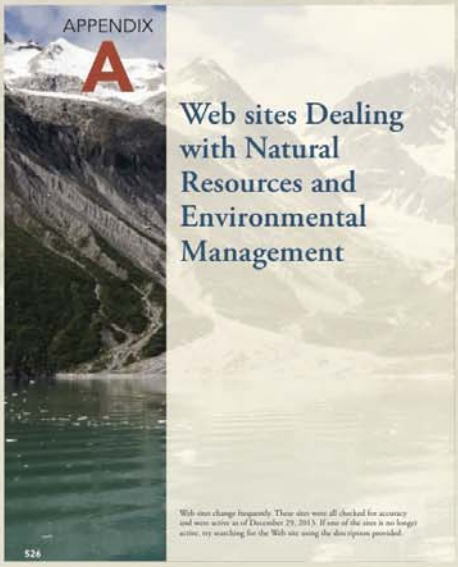
FIGURE V-A A humpback whale breeching.

FIGURE V-B This group of native Alaskans is butchering a whale for food. This is referred to as subsistence harvesting and is related both to historical and cultural practices and to a need for inexpensive food.

- Unit 8 – *GMOS and the Environment: Where Do We Draw the Line?* investigates the pros and cons of genetic engineering.

In addition, the **Appendices** included at the back of the book provide a wealth of information for further study:

- **Appendix A** provides a list of links to authoritative Web sites that can be trusted to provide accurate information.
- **Appendix B** describes several Safety Certification programs that may be of interest: Hunter Safety, Boating Safety, and others.
- **Appendix C** provides a method for improving the safety of your school laboratory or workplace.
- **Appendix D** offers suggested Supervised Agricultural Experience Programs that might be valuable to you.
- **Appendix E** includes several additional case studies in addition to those at the ends of the units.


APPENDIX A

Web sites Dealing with Natural Resources and Environmental Management

Web sites change frequently. These sites were all checked for accuracy and were active as of December 29, 2013. If one of the sites is no longer active, try searching for the Web site using the site tipsies provided.

526

INTRODUCTION

There are many different ways to look at the management of our natural resources. Three different perspectives that must be considered are those of the preservationist, the exploiter, and the conservationist.

If we view the world as preservationists, nature is something that should be left intact as much as possible. From that perspective, humankind is a great destroyer and pillager, and we have no right to destroy the land or tear the earth apart. To a preservationist, managing nature is a foreign concept because nature is something to be left alone and not managed. The preservationist would stop the construction of a pipeline needed by our economy to move Alaskan or Canadian oil because he or she believes it will make the landscape ugly and endanger the migratory habits of wildlife. From that perspective, almost all development is inherently bad. A preservationist would protect a rare 150-year-old tree simply because it is a 150-year-old tree.

If we take the viewpoint of the exploiter, natural resources are merely a source of wealth and power. They represent something that is there for the taking and for our own use. From that perspective, nature is something to be reshaped for our economic benefit, with little regard for other creatures in the ecosystem. The exploiter would build a dam to supply electricity even if, by doing so, the habitat of a small, rare fish would be destroyed. The exploiter would harvest a rare 150-year-old tree because the wood could be used to make expensive furniture.

The conservationist viewpoint is somewhere between those two. From that perspective, nature provides resources that should be used sustainably for our collective economic benefit. The conservationist would encourage the harvesting of forests to produce wood and paper as long as the trees are replaced by other trees having economic value, but not necessarily the same kind of tree harvested originally. The conservationist would allow the strip mining of coal as long as the land is restored to a balanced, natural state when the mining is completed and as long as no meaningful collateral environmental damage occurred during the process. The conservationist would consider whether to harvest the rare 150-year-old tree in light of the impact on the area. If he or she decided to harvest the tree, several tree seedlings compatible with that location would be planted to replace it.

Which viewpoint is right, and which is wrong? There is no simple answer to such a question. If there were a right answer, there would not be such divergent viewpoints. Consensus among the different factions would be possible. What we can say for certain is that the world is not a very large place, and there are many people. As the number of people on earth continues to increase, the pressure applied by humans to the environment also increases. It is clear that we cannot follow the exploiter's approach forever, but by the same token, a world human population of over 7 billion cannot exist without affecting the shape and condition of the environment.

It is not the purpose of this book to convince you that any one of these three divergent perspectives is the right one. We will try to make the preservationist argument that such creatures as the bald eagle and the sea turtle have legitimate rights to exist on earth. At the same time, it is difficult to argue convincingly that the people of a village in India should be forced to live in constant danger of being killed and eaten by tigers to safeguard the tiger population. We believe also that without the exploiters, our nation would never have grown into the powerful

and rich society it is today but that sometimes exploitation of nature can go too far. We believe that our natural resources should be conserved by wise use in a sustainable way. Yet it was conservationists who gave us kudzu (a vine imported from China) to prevent road-bank erosion, and now much of the South is overgrown with the rapidly spreading plant. It is obvious that members of all three groups are both right and wrong in many ways.

As noted earlier, it is our goal to present a balanced viewpoint of the place of humans in the world as long-term residents. Where do you stand? What do you believe? *You* decide.

UNIT

I

Introduction

CHAPTER

1

Our Natural Resources

OBJECTIVES

After reading this chapter, you should be able to

- define and discuss the concept of natural resources
- list and describe the major categories of natural resources in the United States
- explain what makes something a natural resource

TERMS TO KNOW

natural resource
topsoil
usable water
vertebrate
noncommercial forest
mature forest
minerals
recreational resources

In earlier times, people did not have the technology to see beyond the horizon. As a result, distant places were more mysterious to people than they are today and many feared to go beyond the boundaries of the land that they knew. The apparently limitless nature of the world led people to believe that our natural resources were endless, boundless, and inexhaustible. In reality, when there were fewer people and when our technology was limited to human and animal power, we had very limited ability to use the natural resources that were available. When our technology did not allow us to change the face of the earth so dramatically, nature actually did provide resources almost beyond the capacity of humans to use them. But now our machines allow one person to do things that armies of workers could not in ancient times.

More importantly, the world population of humans has surged in the past couple of centuries. According to the U.S. Census Bureau, the human population first reached 1 billion in 1804. Reaching the first billion mark took many thousands of years of human history. A total population of two billion was reached in 1927. That second billion took only 127 years. According to the United Nations, the world's population exceeded 6 billion on about October 12, 1999. That figure was estimated at just over 7.1 billion on November 30, 2013—just 14 years after the 6 billion mark was reached. According to United Nations estimates, the world population should exceed 8 billion by 2025 and then grow more slowly to about 9 billion by 2100 and begin to level after that. See Chapter 3 for a more detailed discussion on human population. Everything has changed in the past couple of centuries. Yet, many people continue to treat nature's gifts as endless, boundless, and inexhaustible. This cannot continue. It is to help you appreciate that dilemma that this book was written.

Special Features to Look for in This Book

To guide you along the learning path, each chapter begins with a list of **objectives** and **terms to know** and ends with **review questions**, **discussion questions**, and **suggested activities**. Each unit ends with a **Case Study** intended to help you dig deeper into some part of the unit.

The Appendices also can be very helpful:

- Appendix A provides links to authoritative web sites.
- Appendix B describes Hunter Safety, Boating Safety, and other safety programs.
- Appendix C outlines a safety program for school laboratories and SAE work sites.
- Appendix D offers ideas for Supervised Agricultural Experience (SAE) Programs.
- Appendix E includes several additional case studies.

WHAT IS A NATURAL RESOURCE?

One authority defines a natural resource as any form of energy that can be used by humans. Others would tell us that natural resources are objects people use. In an ecological sense, anything that was not produced by humans and that is or can be useful in our lives is a natural resource.

For the purposes of this book, we will use the ecological approach. Natural resources can be defined as all those things that have not been created by humans with which people come into contact and that can be used to perform any useful function. This includes all energy forms that can be harnessed by human ingenuity. It includes objects, creatures, and materials that can be moved, shaped, built upon, built with, or manipulated for any useful purpose. It includes those things that inspire, relax, or strengthen humans as individuals or groups.

Clearly, this approach covers too many areas for any single book to deal with in detail, so we must limit our discussion. We will look at only those natural resources used on a large scale and in an organized way. These include our soil, water, fish and wildlife, forests, metals and minerals, fossil fuels, other major energy sources, and recreational resources.

This leads us to a working definition of natural resources: **Natural resources** are objects, materials (including soil, water, and air), creatures, or energy that are found in nature and that can be used by humans.

Usefulness Changes

This is a difficult concept, but the potential of an item to "be used by humans" is not constant. Usefulness changes over time and from one place or society to another. Many factors affect our definition of usefulness. Religion affects Hindu attitudes toward cattle, for instance. Custom affects most Western attitudes toward dogs as a food source. Technology and science affect our use of outer space as a communication medium.

In particular, the usefulness of many resources changes over time as our science and technology improve. For instance, the natural resources humans have used to provide light have changed many times. For thousands of years, humans burned wood to provide light at night. Later, people learned that wood torches could be dipped into animal fat and made to burn longer, and so fat from animals became a source of light. Still later, people learned that whale oil could be used to burn in lamps, and whales became a natural resource used to produce light.

Over a century ago, we learned that petroleum could be refined to produce products that could be burned to produce light, and a new natural resource was born. We learned to capture natural gas and use that to generate light. In the twentieth century, falling water and nuclear energy (among other things) were harnessed to produce electricity to provide light. None of these resources was new. Animal fat, whale oil, petroleum, natural gas, falling water, and nuclear energy have existed all along, but their usefulness has changed because developments in our technology have meant that we could use resources that have existed all along in new ways.

Many of the things we consider to be resources today were not resources at all in earlier times. Nuclear energy, gasoline, most metal alloys, electricity from falling water, deep groundwater—these and many more—were not natural resources when the first Native Americans settled in this land, or even later when the first permanent European settlers came to America. They were not natural resources because they were not useful to humans.

Our situation changed too. When the first permanent English settlement in America was established in 1607 on the James River in what is now Virginia, the settlers faced many problems. One of the most serious was the number of trees. Certainly, a few trees were needed for building and to be used as fuel for heating and cooking, but once those needs were met, forests were a liability to settlers. The forests seemed to be dark and endless. In that sense, forests were a hindrance rather than a natural resource. The same situation remained true for the many years that followed, during which European settlers made their way across the continent (Figure 1-1).

United States Army

FIGURE 1-1 A reconstruction of Fort Clatsop is located in the Lewis and Clark National Historical Park near Astoria, Oregon. Dense forest had to be cleared to make way for the safety of a log fort.

With this working definition of natural resources as useful to humans in mind, let's continue. The remainder of this chapter will briefly examine the major categories of natural resources.

SOIL RESOURCES

Land Area

The United States has a total land area of 3,675,545 square miles in its 50 states. That equates to 2.26 billion acres. The surface of our country ranges from 282 feet below sea level in Death Valley to 20,320 feet above sea level on Mt. McKinley. This vast area is covered by rocks, sand, water, organic matter, parent material, subsoil, and soil as well as man-made structures. It is from the **topsoil**, the uppermost layer of soil, that we must get almost all of our food and natural fibers; it is also where we, for the most part, live, work, and play. Someone has said that *"Man, despite his artistic pretensions, his sophistication and many accomplishments, owes the fact of his existence to a six-inch layer of topsoil and the fact that it rains."*

Of the land in this country in 1607, there seemed to be no practical limit. There was more land than it seemed possible to use. Even 100 years later, there was more land than we could settle. Today, that is no longer true.

In the early twenty-first century, almost one-third of our land area is not suitable for farming. Another 8 percent is covered by cities, factories, homes, highways, and other artificial structures. The remaining 60 percent is useful for food and fiber production. Of that, only about 385 million acres, or 17 percent of the total, is usable for crop production. An even smaller percentage is prime farmland, and much of that is of only marginal value because of its location.

The soil's major enemy has been erosion. In the years since our nation began, we have lost one-third of our topsoil to erosion. Only one-fourth of our cropland remains undamaged by this menace. Another problem we are beginning to face is

FIGURE 1-2 Land is being converted into a large housing development near Bluffton, South Carolina.

the conversion of agricultural land to urban or other uses. Once an acre of prime corn-belt land is covered by concrete or asphalt, it is, to say the least, hard to grow corn there (Figure 1-2).

Urban expansion, industrialization, highway construction, and other alternative uses for our land surface are becoming increasingly important. This is not necessarily bad. Land is an important natural resource for many purposes—food and fiber production is only one purpose. Unfortunately, this expansion tends too often to occur on our best land for farm production. Land-use planning is more important now than ever. We must, as a nation, establish our priorities for land use. We must then allocate our land and soil resources based on those priorities. It would seem that, with the world population explosion, food production must rank very high in those priorities. Nevertheless, manufacture of other products, transportation, processing, and distribution are also critical to our way of life.

Managing our soil and land resources is a complex problem. Hard decisions need to be made, both now and in the future.

WATER RESOURCES

"Water, water, everywhere" was the wail of the old sailor in *The Rime of the Ancient Mariner* by Samuel Taylor Coleridge. Indeed, this resource is abundant. Why worry about managing our water resources when 70 percent of the earth's surface is covered by it?

However, the ancient mariner continued his lament with, *"nor any drop to drink."* There is a great difference between water and **usable water**. Remember our definition of natural resource: Water is a natural resource only when it can be put to use by humans. The oceans provide us with marine products and a medium in which ships can travel. They contain minerals and metals, and tide flows can be harnessed for electrical generation. The ocean floors contain vast deposits of oil and minerals (Figure 1-3).