

Brief Contents

Detailed Contents v

Preface for Instructors ix

Learning Skills xvii

HUMANS AND SUSTAINABILITY: AN OVERVIEW

- 1 Environmental Problems, Their Causes, and Sustainability 1

SCIENCE, ECOLOGICAL PRINCIPLES, AND SUSTAINABILITY

- 2 Science, Matter, Energy, and Systems 18
- 3 Biodiversity and Evolution 48
- 4 Community Ecology, Population Ecology, and the Human Population 66

SUSTAINING BIODIVERSITY

- 5 Sustaining Biodiversity: The Species Approach 91
- 6 Sustaining Biodiversity: The Ecosystem Approach 110

SUSTAINING NATURAL RESOURCES

- 7 Food Production and the Environment 132
- 8 Water Resources and Water Pollution 156
- 9 Nonrenewable Energy Resources 188
- 10 Energy Efficiency and Renewable Energy 207

SUSTAINING ENVIRONMENTAL QUALITY

- 11 Environmental Hazards and Human Health 228
- 12 Air Pollution, Climate Change, and Ozone Depletion 246
- 13 Urbanization and Solid and Hazardous Waste 271

SUSTAINING HUMAN SOCIETIES

- 14 Economics, Politics, Worldviews, and Sustainability 305

Appendix Measurement Units A1

Glossary A2

Index A14

Detailed Contents

Learning Skills xvii

HUMANS AND SUSTAINABILITY: AN OVERVIEW

1 Environmental Problems, Their Causes, and Sustainability 1

KEY QUESTIONS AND CONCEPTS 1

- 1-1 What Are Some Principles of Sustainability? 2
- 1-2 How Are Our Ecological Footprints Affecting the Earth? 7
- CASE STUDY** China's New Affluent Consumers 10
- 1-3 Why Do We Have Environmental Problems? 11
- 1-4 What Is an Environmentally Sustainable Society? 15

SCIENCE, ECOLOGICAL PRINCIPLES, AND SUSTAINABILITY

2 Science, Matter, Energy, and Systems 18

KEY QUESTIONS AND CONCEPTS 18

- 2-1 What Do Scientists Do? 19
- SCIENCE FOCUS** Statistics and Probability 21
- 2-2 What Is Matter, and What Happens When It Undergoes Change? 22
- 2-3 What Is Energy, and What Happens When It Undergoes Change? 26
- 2-4 What Keeps Us and Other Organisms Alive? 28
- SCIENCE FOCUS** Have You Thanked the Insects Today? 30
- 2-5 What Are the Major Components of an Ecosystem? 32
- SCIENCE FOCUS** Many of the World's Most Important Organisms Are Invisible to Us 34
- 2-6 What Happens to Energy in an Ecosystem? 35
- 2-7 What Happens to Matter in an Ecosystem? 39

3 Biodiversity and Evolution 48

KEY QUESTIONS AND CONCEPTS 48

- 3-1 What Is Biodiversity, and Why Is It Important? 49
- INDIVIDUALS MATTER** Edward O. Wilson: A Champion of Biodiversity 50
- 3-2 Where Do Species Come From? 50
- SCIENCE FOCUS** Earth Is Just Right for Life to Thrive 53
- 3-3 How Do Speciation, Extinction, and Human Activities Affect Biodiversity? 53
- SCIENCE FOCUS** Changing the Genetic Traits of Populations 54
- 3-4 What Are Biomes, and How Have Human Activities Affected Them? 55
- 3-5 What Are Aquatic Life Zones and How Have Human Activities Affected Them? 59

4 Community Ecology, Population Ecology, and the Human Population 66

KEY QUESTIONS AND CONCEPTS 66

- 4-1 What Roles Do Species Play in an Ecosystem? 67
- CASE STUDY** The Giant Panda—A Highly Endangered Specialist 67
- CASE STUDY** Why Should We Protect Sharks? 68
- SCIENCE FOCUS** Why Are Amphibians Vanishing? 69
- 4-2 How Do Species Interact? 70
- 4-3 How Do Communities and Ecosystems Respond to Changing Environmental Conditions? 73
- 4-4 What Limits the Growth of Populations? 75
- 4-5 What Factors Influence the Size of the Human Population? 77
- CASE STUDY** The U.S. Population—Third-Largest and Growing 79
- SCIENCE FOCUS** Projecting Population Change 82
- CASE STUDY** The American Baby Boom 83
- CASE STUDY** The AIDS Tragedy 84

- 4-6 How Can We Slow Human Population Growth? 85
CASE STUDY India's Attempts to Slow Its Population Growth 88
CASE STUDY Slowing Population Growth in China: the One Child Policy 88

SUSTAINING BIODIVERSITY

5 Sustaining Biodiversity: The Species Approach 91

KEY QUESTIONS AND CONCEPTS 91

- 5-1 What Are the Trends in Species Extinction? 92
CASE STUDY The Passenger Pigeon: Gone Forever 92
SCIENCE FOCUS Estimating Extinction Rates 93
- 5-2 Why Should We Care about the Rising Rate of Species Extinction? 96
SCIENCE FOCUS Where Have All the Honeybees Gone? 97
- 5-3 How Do Humans Accelerate Species Extinction? 98
CASE STUDY Burmese Pythons Eating Their Way through the Florida Everglades 101
CASE STUDY Polar Bears and Climate Change 102
CASE STUDY A Disturbing Message from the Birds 104
- 5-4 How Can We Protect Wild Species from Extinction Resulting from Our Activities? 105
CASE STUDY The U.S. Endangered Species Act 105

6 Sustaining Biodiversity: The Ecosystem Approach 110

KEY QUESTIONS AND CONCEPTS 110

- 6-1 What Are the Major Threats to Forest Ecosystems? 111
CASE STUDY Many Cleared Forests in the United States Have Grown Back 113
- 6-2 How Should We Manage and Sustain Forests? 116
INDIVIDUALS MATTER Wangari Maathai and the Green Belt Movement 117
- 6-3 How Should We Manage and Sustain Parks and Nature Reserves? 118
CASE STUDY Stresses on U.S. Public Parks 118
SCIENCE FOCUS Reintroducing the Gray Wolf to Yellowstone National Park 119
CASE STUDY Costa Rica—A Global Conservation Leader 121

- 6-4 What Is the Ecosystem Approach to Sustaining Terrestrial Biodiversity and Ecosystem Services? 122
CASE STUDY Madagascar: An Endangered Center of Biodiversity 122
CASE STUDY The Blackfoot Challenge—Reconciliation Ecology in Action 124
- 6-5 How Can We Protect and Sustain Marine Biodiversity? 125
SCIENCE FOCUS Ocean Acidification: the Other CO₂ Problem 126
- 6-6 How Should We Protect and Sustain Freshwater Biodiversity? 127
CASE STUDY Can the Great Lakes Survive Repeated Invasions by Alien Species? 128
- 6-7 What Should Be Our Priorities for Sustaining Terrestrial and Aquatic Biodiversity? 129

SUSTAINING NATURAL RESOURCES

7 Food Production and the Environment 132

KEY QUESTIONS AND CONCEPTS 132

- 7-1 What Is Food Security, and Why Is It Difficult to Attain? 133
- 7-2 How Is Food Produced? 134
SCIENCE FOCUS Soil Is the Base of Life on Land 136
CASE STUDY Industrialized Food Production in the United States 137
- 7-3 What Environmental Problems Arise from Food Production? 140
- 7-4 How Can We Protect Crops from Pests More Sustainably? 144
INDIVIDUALS MATTER Rachel Carson 145
SCIENCE FOCUS Pesticides Do Not Always Reduce Crop Losses 147
- 7-5 How Can We Improve Food Security and Produce Food More Sustainably? 149
CASE STUDY Organic Agriculture Is On the Rise 152

8 Water Resources and Water Pollution 156

KEY QUESTIONS AND CONCEPTS 156

- 8-1 Will We Have Enough Usable Water? 157
CASE STUDY Freshwater Resources in the United States 158
SCIENCE FOCUS Water Footprints and Virtual Water 159
CASE STUDY Water Conflicts in the Middle East: a Preview of the Future? 160

- 8-2 How Can We Increase Water Supplies? 162
CASE STUDY How Dams Can Kill an Estuary 163
CASE STUDY The Aral Sea Disaster 165
- 8-3 How Can We Use Water More Sustainably? 167
- 8-4 How Can We Reduce the Threat of Flooding? 170
CASE STUDY Living Dangerously on Floodplains in Bangladesh 171
- 8-5 What Are the Causes and Effects of Water Pollution? 172
- 8-6 What Are the Major Water Pollution Problems in Streams and Lakes? 174
CASE STUDY Pollution in the Great Lakes 175
- 8-7 What Are the Major Pollution Problems Affecting Groundwater and Other Drinking Water Sources? 177
CASE STUDY Is Bottled Water a Good Option? 179
- 8-8 What Are the Major Water Pollution Problems Affecting Oceans? 179
CASE STUDY Chesapeake Bay—An Estuary in Trouble 180
- 8-9 How Can We Best Deal with Air Pollution? 182
CASE STUDY U.S. Experience with Reducing Point-Source Pollution 182
SCIENCE FOCUS Treating Sewage by Working with Nature 185

9 Nonrenewable Energy Resources 188

KEY QUESTIONS AND CONCEPTS 188

- 9-1 What Is Net Energy, and Why Is It Important? 189
- 9-2 What Are the Advantages and Disadvantages of Using Oil? 191
SCIENCE FOCUS Removing Oil and Natural Gas by Drilling Sideways and Fracking 193
- 9-3 What Are the Advantages and Disadvantages of Using Natural Gas? 195
- 9-4 What Are the Advantages and Disadvantages of Using Coal? 196
- 9-5 What Are the Advantages and Disadvantages of Nuclear Energy? 199
CASE STUDY High-Level Radioactive Wastes in the United States 202
CASE STUDY The 2011 Nuclear Power Plant Accident in Japan 204

10 Energy Efficiency and Renewable Energy 207

KEY QUESTIONS AND CONCEPTS 207

- 10-1 Why Is Energy Efficiency an Important Energy Resource? 208
CASE STUDY Saving Energy and Money with a Smarter Electrical Grid 209
SCIENCE FOCUS The Search for Better Batteries 211
- 10-2 What Are the Advantages and Disadvantages of Using Solar Energy? 213
- 10-3 What Are the Advantages and Disadvantages of Using Hydropower? 216
- 10-4 What Are the Advantages and Disadvantages of Using Wind Power? 217
- 10-5 What Are the Advantages and Disadvantages of Using Biomass as an Energy Source? 219
CASE STUDY Is Ethanol a Promising Fuel? 220
- 10-6 What Are the Advantages and Disadvantages of Using Geothermal Energy? 221
- 10-7 What Are the Advantages and Disadvantages of Using Hydrogen as an Energy Source? 222
- 10-8 How Can We Make the Transition to a More Sustainable Energy Future? 223

SUSTAINING ENVIRONMENTAL QUALITY

11 Environmental Hazards and Human Health 228

KEY QUESTIONS AND CONCEPTS 228

- 11-1 What Major Health Hazards Do We Face? 229
- 11-2 What Types of Biological Hazards Do We Face? 229
SCIENCE FOCUS Genetic Resistance to Antibiotics Is Increasing 231
CASE STUDY The Growing Global Threat from Tuberculosis 231
CASE STUDY The Global HIV/AIDS Epidemic 232
CASE STUDY Malaria—The Spread of a Deadly Parasite 232
- 11-3 What Types of Chemical Hazards Do We Face? 235
SCIENCE FOCUS Mercury's Toxic Effects 236
- 11-4 How Can We Evaluate Chemical Hazards? 236
- 11-5 How Do We Perceive Risks, and How Can We Avoid the Worst of Them? 239
CASE STUDY Death from Smoking 240

12 Air Pollution, Climate Change, and Ozone Depletion 246

KEY QUESTIONS AND CONCEPTS 246

- 12-1 What Is the Nature of the Atmosphere? 247
- 12-2 What Are the Major Outdoor Air Pollution Problems? 249
CASE STUDY Lead Can Be a Highly Toxic Pollutant 251
- 12-3 What Is Acid Deposition and Why Is It a Problem? 252
- 12-4 What Are the Major Indoor Air Pollution Problems? 255
CASE STUDY Radioactive Radon Gas 255
- 12-5 How Should We Deal with Air Pollution? 257
CASE STUDY U.S. Air Pollution Laws Can Be Improved 258
- 12-6 How Might the Earth's Temperature and Climate Change in the Future? 261
SCIENCE FOCUS How Valid Are IPCC Conclusions? 263
INDIVIDUALS MATTER Konrad Steffen: Studying Melting Ice in Greenland 265
- 12-7 What Can We Do to Slow Projected Climate Change? 268
SCIENCE FOCUS Is Capturing and Storing CO₂ the Answer? 269
- 12-8 How Have We Depleted Ozone in the Stratosphere and What Can We Do about It? 273
INDIVIDUALS MATTER Sherwood Rowland and Mario Molina—A Scientific Story of Expertise, Courage, and Persistence 273

13 Urbanization and Solid and Hazardous Waste 278

KEY QUESTIONS AND CONCEPTS 278

- 13-1 What Are the Major Population Trends and Problems in Urban Areas? 279
CASE STUDY Urbanization in the United States 280
CASE STUDY Mexico City 283
- 13-2 How Does Transportation Affect Urban Environmental Impacts? 283
- 13-3 How Can Cities Become More Sustainable and Livable? 286
CASE STUDY Curitiba Strives to Be an Eco-city 287
- 13-4 What Are Solid Waste and Hazardous Wastes, and What Problems Do They Present? 288
CASE STUDY Solid Waste in the United States 288
- 13-5 How Should We Deal with Solid Waste? 290
CASE STUDY We Can Use Refillable Containers and Other Items 291

CASE STUDY Recycling Plastics 292

SCIENCE FOCUS Bioplastics 293

- 13-6 How Should We Deal with Hazardous Waste? 297

CASE STUDY Hazardous Waste Regulation in the United States 298

- 13-7 How Can We Make the Transition to a More Sustainable Low-Waste Society? 300

CASE STUDY Industrial Ecosystems: Copying Nature 301

SUSTAINING HUMAN SOCIETIES

14 Economics, Politics, Worldviews, and Sustainability 305

KEY QUESTIONS AND CONCEPTS 305

- 14-1 How Are Economic Systems Related to the Biosphere? 306
- 14-2 How Can We Use Economic Tools to Deal with Environmental Problems? 308
INDIVIDUALS MATTER Ray Anderson 311
- 14-3 How Can Reducing Poverty Help Us to Deal with Environmental Problems? 311
CASE STUDY Muhammad Yunus and Microloans for the Poor 312
- 14-4 How Can We Make the Transition to More Environmentally Sustainable Economies? 313
- 14-5 What Is Environmental Policy and How Is It Made? 315
SCIENCE FOCUS Science and Politics—Principles and Procedures 318
CASE STUDY Managing Public Lands in the United States—Politics in Action 319
CASE STUDY U.S. Environmental Laws and Regulations Have Been under Attack 320
INDIVIDUALS MATTER Anjali Appadurai: A College Student Who Electrified a United Nations Conference 322
- 14-6 How Can We Improve Global Environmental Security? 323
- 14-7 What Are Some Major Environmental Worldviews? 325
- 14-8 How Can We Live More Sustainably? 326
INDIVIDUALS MATTER Aldo Leopold's Environmental Ethics 328

Appendix: Measurement Units A1

Glossary A2

Index A14