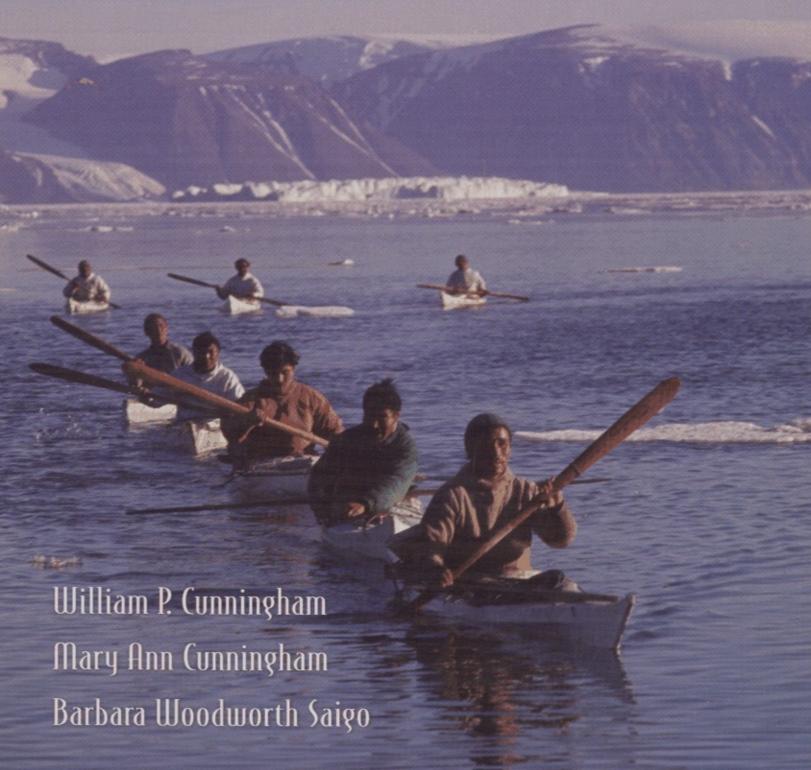
ENVIRONMENTAL SCIENCE AGLOBAL CONCERN



Contents

Preface xiii
Guided Tour xvii

Learning to Learn 2 Case Study: Why Study Environmental Science? 3

How Can I Get an A in This Class? 4

Develop good study habits 4
Recognize and hone your learning styles 6
Use this textbook effectively 6
Will this be on the test? 7

Thinking About Thinking 8

Approaches to truth and knowledge 8 What do I need to think critically? 9

What Do You Think? Bon't Believe Everything You See or Hear on the News 10

Applying critical thinking 11 Some clues for unpacking an argument 11 Avoiding logical errors and fallacies 12 Using critical thinking in environmental science 12

Concept Maps 12

How do I create a concept map? 13

PART ONE PRINCIPLES FOR UNDERSTANDING OUR ENVIRONMENT



Understanding Our Environment 16 Case Study: Is the Arctic Melting? 17

What Is Environmental Science? 18

A Brief History of Conservation and Environmentalism 18

Nature protection has historic roots 18
Resource waste inspired pragmatic, utilitarian conservation 19
Ethical and aesthetic concerns inspired the preservation movement 20
Rising pollution levels led to the modern environmental movement 20
Global interconnections have expanded environmentalism 21

Current Conditions 21

We live on a marvelous planet 22 We face many environmental problems 22 There are also many signs of hope 23

What Do You Think? Calculating Your Ecological Footprint 24

Human Dimensions of Environmental

Science 25

Where do the rich and poor live? 26

What is a fair share of resources? 27 Recent progress is encouraging 27

Sustainable Development 28

Can development be truly sustainable? 28 Would you donate 0.7 percent? 29 Indigenous people are important guardians of nature 30

Frameworks for Understanding: Science, Systems, and Ethics 34 Case Study: Should we save the sharks? 35

What Is Science? 36

Science depends on skepticism and accuracy 36
Deductive and inductive reasoning are both useful 37
Testable hypotheses and theories are essential tools 37
Understanding probability helps reduce uncertainty 38
Statistics can calculate the probability that your results were random 38
Experimental design can reduce bias 38
Models are an important experimental strategy 39

Cooperation and Consensus in Science 40

Detecting pseudoscience relies on independent, critical thinking 41

Is environmental science the same as environmentalism? 42

Systems 42

System characteristics 42

Environmental Ethics and Worldviews 44

Who (or what) has moral value? 44

What Do You Think? Worldviews and Values 45

Living things can have intrinsic or instrumental value 45 Ecofeminism promotes justice and cooperation 46

Religious and Cultural Perspectives 46

Many faiths support environmental conservation 46

Environmental Justice 47

Environmental racism 48 Dumping across borders 48

Matter, Energy, and Life 52 Case Study: Why Trees Need Salmon 53

Elements of Life 54

Matter is made of atoms, molecules, and compounds 54 Chemical bonds hold molecules together 54 Electrical charge is an important chemical characteristic 55

Exploring Science: A "Water Planet" 56

Organic compounds have a carbon backbone 56 Cells are the fundamental units of life 58

Energy 58

Energy occurs in different types and qualities 58 Thermodynamics regulates energy transfers 59

Energy for Life 59

Extremophiles live in severe conditions 59 Green plants get energy from the sun 60 How does photosynthesis capture energy? 61

From Species to Ecosystems 62

Organisms occur in populations, communities, and ecosystems 62 Food chains, food webs, and trophic levels link species 63 Ecological pyramids describe tropic levels 65

Material Cycles and Life Processes 66

The hydrologic cycle moves water around the earth 66 Carbon moves through the carbon cycle 67 Nitrogen moves via the nitrogen cycle 69

Exploring Science: Remote Sensing, Photosynthesis, and Material Cycles 70

Phosphorus is an essential nutrient 71 Sulfur also cycles 72

4

Evolution, Biological Communities, and Species Interactions 76 Case Study: Darwin's Voyage of Discovery 77

Evolution and Speciation 78

Critical limits determine the distribution of plants and animals 78 Evolution depends on existing variation 79 Selective pressure can modify organisms in a variety of ways 80 Isolation results in speciation 80

Exploring Science: The Cichlids of Lake Victoria 82

Evolution is still at work 83

Does acceptance of evolution preclude belief in a God? 83 Ecological niches describe how organisms live 84

Species Interactions 85

Predators and parasites prey on other organisms 85
Keystone species play crucial roles in communities 86
Competition is an important form of natural selection 86
Symbiosis is the living together of two unrelated species 87
Defensive mechanisms protect against predation and parasitism 88

Community Properties 88

Productivity is a measure of biological activity 89

What Can You Do? Working Locally for Ecological Diversity 90

Abundance and diversity measure the number and variety of organisms 90 Community structure describes spatial distribution of organisms 90 Complexity and connectedness are important ecological indicators 91 Resilience and stability make communities resistant to disturbance 91 Edges and boundaries are the interfaces between adjacent communities 92

What Do You Think? Where Have All the Songbirds Gone? 93

Communities in Transition 94

Ecological succession occurs on new or disturbed habitat 94 Introduced species can cause profound community change 96

5

Biomes: Global Patterns of Life 100 Case Study: Living Jewels in a Coral Reef 101

Terrestrial Biomes 102

Tropical moist forests are warm and wet year-round 102 Tropical seasonal forests have annual dry seasons 104

Tropical savannas and grasslands are dry most of the year 104
Deserts are hot or cold, but always dry 104
Temperate grasslands have rich soils 105
Temperate shrublands have summer drought 105
Temperate forests can be ever

Boreal forests lie north of the temperate zone 106

Tundra can freeze in any month 107

Marine Ecosystems 108

Open-ocean communities can be shallow or deep 108 Shallow coasts support coral reefs and mangroves 109 Tidal environments and barrier islands 110

Freshwater Ecosystems 111

Lakes 111 Wetlands 112

Human Disturbance 113

6

Population Biology 118 Case Study: How Many Fish in the Sea? 119

Dynamics of Population Growth 120

Biological populations can grow exponentially 120 Populations can go through boom and bust cycles 120 Populations can grow to a stable size 121 Many factors limit population growth 121 Species can be either *K*-adapted or *r*-adapted 122

Factors That Increase or Decrease Populations 122

What Do You Think? Too Many Deer? 123

Natality, fecundity, and fertility are measures of birth rates 123 Immigration adds to populations 124 Mortality and survivorship measure longevity 124 Emigration removes members of a population 125

Factors That Regulate Population Growth 125

Population factors can be density-independent 126 Population factors also can be density-dependent 126 Case Study: A Plague of Locusts 127

Conservation Biology 128

Island biogeography describes isolated populations 128 Conservation genetics is important in survival of endangered species 128

Population viability analysis calculates chances of survival 129 Metapopulations are important interconnections 130

PART TWO PEOPLE IN THE ENVIRONMENT

7

Human Populations 134 Case Study: A Billion People and Growing 135

Population Growth 136

Human populations grew slowly until relatively recently 136

Limits to Growth: Some Opposing Views 137

Malthus and Marx debated population questions 200 years ago 137 Population issues continue to be debated 138 Can technology make the world more habitable? 138

What Do You Think? Looking for Bias in Graphs 139

Can more people be beneficial? 140

Human Demography 140

How many of us are there? 140

Fertility measures the number of children born to each woman 141 Mortality is the other half of population growth rates 143

What Do You Think? Family Planning in Iran 144

Life span and life expectancy describe our potential longevity 144 Living longer has demographic implications 145 Emigration and immigration are important population factors 145

Population Growth: Opposing Factors 147

Many factors increase our desire for children 147 Many factors discourage reproduction 147 Could we have a birth dearth? 148

Demographic Transition 148

Economic and social development play important roles 148 There are reasons to be optimistic about population 149 Many people remain pessimistic about population growth 149 Social justice is an important consideration 150 Women's rights affect fertility 151

Family Planning and Fertility Control 151

Fertility control has existed throughout history 151 Current family planning methods give us many options 151 New developments in family planning offer promise 152

The Future of Human Populations 152

The United States is increasingly isolated in its population policies 153

Environmental Health and Toxicology 158 Case Study: The Next Pandemic? 159

Environmental Health 160

The global disease burden is changing 160 Infectious diseases are still important threats 161 Conservation medicine attempts to combine ecology and medicine 163 Resistance to antibiotics and pesticides is increasing 165 Who should pay for health care? 165

Toxicology 166

How do toxins affect us? 166

What Can You Do? Tips for Staying Healthy 168

Case Study: Poisoning Bhopal 169 Diet affects health 169

Movement, Distribution, and Fate of Toxins 169

Solubility and mobility determine where and when chemicals move 170 Exposure and susceptibility determine how we respond 170 Bioaccumulation and biomagnification increase concentrations of chemicals 171

What Do You Think? Children's Health 172

Persistence makes some materials a greater threat 172 Chemical interactions can increase toxicity 173

Mechanisms for Minimizing Toxic Effects 173

Metabolic degradation and excretion eliminate toxins 174 Repair mechanisms mend damage 174

Measuring Toxicity 174

We usually test toxins on lab animals 174 There is a wide range of toxicity 175 Acute versus chronic doses and effects 175 Detectable levels aren't always dangerous 176

Risk Assessment and Acceptance 176

Risk perception is not always rational 177 Risk acceptance depends on many factors 177

Establishing Public Policy 178

Food and Agriculture 182

Case Study: A Sovbean Revolution 183

Food and Nutrition 185

Millions of people don't have enough to eat 185 Famines are acute food emergencies 186 We need the right kinds of food 187 Eating a balanced diet is essential for good health 188

Key Food Sources 189

A few major crops supply most of our food 189 Meat and dairy are important protein sources 189 Seafood is another important protein source 190

Farm Policy 191

Soil: A Renewable Resource 192

Soil is a complex mixture 192 Living organisms create unique properties of soil 192 Soils are layered 194 Soils are classified according to their structure and composition 194

Ways We Use and Abuse Soil 194

Arable land is unevenly distributed 195 Land degradation reduces agricultural potential 195 Soil erosion is widespread 196 Wind and water are the main agents that move soil 196 Deserts are spreading around the world 198

Other Agricultural Resources 198

All plants need water to grow 198 Plants need fertilizer 199 Farming consumes energy 199

New Crops and Genetic Engineering 200

The "green revolution" produced dramatic increases in crop yields 200 Genetic engineering uses molecular techniques to produce new crop varieties 201

Most GMOs have been engineered for pest resistance or weed control 202 Is genetic engineering safe? 202

What Do You Think? Shade-Grown Coffee and Cocoa 203

Sustainable Agriculture 204

Soil conservation is essential 204

Low-input agriculture can be good for farmers and their farms 206

Pest Control 210

Case Study: Expecting the Unexpected: Pollinators and Pesticides 211

Pests and Pesticides 212

People have always known of ways to control pests 212 Modern pesticides provide benefits, but also create problems 212 There are many types of pesticides 213

Pesticide Benefits 215

We have made dramatic progress in controlling many insect-borne

Without pesticides, we might lose two-thirds of conventional crops 215

Pesticide Problems 216

Pesticides often poison nontarget species 216 Pesticide resistance is often rapid and widespread 216

Exploring Science Endocrine Disrupters 217

Pesticide misuse can create new pests 218 Persistent pesticides can move long distances in the environment 218 Pesticides cause human health problems 219

Alternatives to Current Pesticide Uses 221

We can change our behavior 221 Useful organisms can help us control pests 221

What Can You Do? Controlling Pests 221

Integrated pest management uses a combination of techniques to fight pests 222

What Do You Think? Organic Farming in Cuba 224

Reducing Pesticide Exposure 224

Who regulates pesticides? 225 Is organic the answer? 226 You can reduce your own risks 227

PART THREE UNDERSTANDING AND . MANAGING LIVING SYSTEMS

11 Biodiversity 230

Case Study: Diversity and Ecological Stability 231

Biodiversity and the Species Concept 232

What is biodiversity? 232 . What are species? 232

Molecular techniques are revolutionizing taxonomy 232

How many species are there? 233

Exploring Science Bar-Coding Life 234

Hot spots have exceptionally high biodiversity 234

How Do We Benefit from Biodiversity? 235

All of our food comes from other organisms 235 Living organisms provide us with many useful drugs and medicines 236

Biodiversity provides ecological benefits 237

Biodiversity also brings us many aesthetic and cultural benefits 237

What Threatens Biodiversity? 237

Extinction is a natural process 237

We are accelerating extinction rates 238

Island ecosystems are particularly susceptible to invasive species 240

What Can You Do? Don't Buy Endangered Species Products 243

Endangered Species Management and Biodiversity Protection 244

Hunting and fishing laws have been effective 244
Endangered species acts are key to biodiversity protection 244
Recovery plans rebuild populations of endangered species 245
Private land is essential in endangered species protection 246
The endangered species act itself is threatened 247
Habitat protection is essential 247
International wildlife treaties 248

Captive Breeding and Species Survival Plans 248 We need to save rare species in the wild 249

Land Use: Forests and Grasslands 252 Case Study: Saving an African Eden 253

World Land Uses 254

World Forests 254

How much forest is there? 254

Wood is part of more economic activity than any other commodity 256 Preserving forests protects watersheds and wildlife habitat 257 Forests can be managed for sustainable yield 257

Tropical Forests 258

Tropical forests are disappearing around the world 258

Exploring Science Protecting Forests to Preserve Rain 259

Swidden agriculture can be sustainable 260 There are encouraging examples of forest protection 261 Debt-for-nature swaps preserve forests 261

Temperate Forests 262

Temperate rainforests contain more biomass than any other biome 262 Forests provide wildlife habitat 262 Harvest methods have very different effects 263

U.S. Forest Management 264

Fire management is controversial 264

Consumer preferences can encourage sustainable forestry 265

Grasslands 266

Traditional pastoralists have managed grasslands sustainably 266 Current management practices are causing overgrazing and land degradation 267

What Can You Do? Lowering Our Forest Impacts 267

Both wild and domestic animals can utilize rangelands efficiently 268 Range conditions in the United States are often poor 268 Grazing fees on federal lands are low 269 Rotational grazing can improve range quality 269

Exploring Science Finding Common Ground on the Range 270

Landownership and Land Reform 271

Who owns how much? 271

Landownership is often inequitable 271

Recognizing indigenous land rights is both equitable and ecologically important 272

Preserving and Restoring Nature 276 (ase Study: The World's Biggest Restoration Project 277

Parks and Nature Preserves 278

We have a long history of setting aside special lands 278 Some parks and monuments are in trouble 279 Protecting wildlife in parks can be controversial 280

Wilderness Areas and Wildlife Refuges 281

Wilderness is a uniquely American idea 281

What Do You Think? Reintroducing Wolves to Yellowstone 282

Wildlife refuges have many purposes 282

Global Parks and Preserves 283

Some biomes are relatively well protected, while others are underrepresented 284

Do people belong in parks? 285

Marine ecosystems need greater protection 285

Conservation and economic development can work together 286 Transboundary peace parks can aid conservation and development 286

Preserving Functional Ecosystems and Landscapes 287

What Do You Think? Ecotourism on the Roof of the World 288

Patchiness and heterogeneity exist in most landscapes 288 Landscape dynamics describe change over time and space 289 Size and design of nature preserves influence their effectiveness 289

Exploring Science 61S and Landscape Ecology 290

Restoration Ecology 290

There are many degrees of restoration 291

Restoration uses many tools and strategies 292 Restoration can mean letting nature heal itself 293 The goals of restoration can be uncertain 293 Sometimes we can create artificial ecosystems 293

Preserving Ecosystem Services: Wetlands and Floodplains 294

Wetland conservation and mitigation aim to reduce wetland losses 294 Floodplains absorb flood water 295

Ecosystem Management 295

Ecosystem management has evolved and grown 296 Principles and goals of ecosystem management 296 There are conflicting views of restoration and ecosystem management 296

PART FOUR PHYSICAL RESOURCES AND ENVIRONMENTAL SYSTEMS

Geology and Earth Resources 300 Case Study: Run for the Hills 301

A Dynamic Planet 302

The earth is a layered sphere 302

Tectonic processes move continents and cause earthquakes 302

Rocks and Minerals 304

The rock cycle creates and recycles rocks 305

Economic Geology and Mineralogy 306

Metals and mineral resources are essential in a modern economy 306

What Do You Think? Should We Revise Mining Laws? 308

Environmental Effects of Resource Extraction 309

Mining can have very serious environmental impacts 309 Processing ores also has negative impacts 310

Conserving Geologic Resources 311

Recycling extends geologic resources 311

New materials can be substituted for old 312

Geologic Hazards 312

Earthquakes can be very destructive 314

Exploring Science Radioactive Waste Disposal at Yucca Mountain 315

Volcanoes eject gas and ash, as well as lava 316 Landslides are examples of mass wasting 317

Air, Weather, and Climate 320 Case Study: Is Antarctica Melting? 321

The Atmosphere and Climate 322

The sun warms our world 323

Water stores energy, and winds redistribute it 324

Why does it rain? 325

Large-scale winds don't move in a straight line 325

Ocean currents modify climate 326

Seasonal winds and monsoons have powerful effects 326

Frontal systems create local weather 327

Cyclonic storms can cause extensive damage 328

Climate 330

Climates have changed dramatically throughout history 330

What causes catastrophic climatic swings? 331

El Niño/Southern Oscillations are powerful cycles 332

Our actions are now causing global climate change 333

Greenhouse gases have many sources 333

Evidence of climate change is becoming overwhelming 334

Who wins, and who loses? 335

The Kyoto Protocol attempts to slow climate change 336

Exploring Science Carbon-Enrichment Studies 337

How can we control greenhouse emissions? 339

What Can You Do? Reducing Carbon Dioxide Emissions 339

16 Air Pollution 344

Case Study: How Should We Control Mercury Pollution? 345

The Air Around Us 346

Natural Sources of Air Pollution 346

Human-Caused Air Pollution 347

We have different ways to describe pollutants 347

Unconventional pollutants also are important 353 Indoor air is more dangerous for most of us than outdoor air 353

Climate, Topography, and Atmospheric Processes 354

Temperature inversions trap pollutants 354

Cities can create dust domes and heat islands 355

Wind currents carry pollutants intercontinentally 355

Exploring Science Indoor Air 356

Stratospheric ozone is declining 357

We have made progress in controlling some pollution 358

Effects of Air Pollution 358

Polluted air is unhealthy 358

Plants are susceptible to pollution damage 360

Acid deposition has many negative effects 361

Smog and haze reduce visibility 362

Air Pollution Control 363

The most effective strategy for controlling pollution is to minimize production 363

What Can You Do? Saving Energy and Reducing Pollution 363

Clean Air Legislation 364

Air regulations are controversial 364

Current Conditions and Future Prospects 365

Air pollution remains a problem in developing countries 366 There are signs of hope 366

17

Water Use and Management 370

Case Study: China's South-to-North Water Diversion Project 371

Water Resources 372

The hydrologic cycle distributes water in our environment 372 Water supplies are unevenly distributed 373

Major Water Compartments 373

Oceans hold 97 percent of all water on earth 373

Glaciers, ice, and snow contain most fresh water 375

Groundwater stores most fresh, liquid water 375

Surface water collects in rivers, lakes, and wetlands 377

The atmosphere is among the smallest compartments 377

Water Availability and Use 378

Water-poor countries have low rainfall and large populations 378

Water consumption is less than withdrawal 379

Water use is increasing 379

Agriculture is the greatest water consumer 379

Domestic and industrial water use are greatest in wealthy countries 381

What Do You Think? Water Wars on the Klamath 382

Freshwater Shortages 383

Developing countries often lack access to clean water 383 Groundwater is depleted when withdrawals exceed recharge 384

Increasing Water Supplies 385

Desafination and diversion increase supplies locally 385

Dams and water diversions eliminate other water uses 385

Dams and diversions displace human populations 386

The main problem with dams is inefficiency 386

Loss of free-flowing rivers is controversial 387

Water Management and Conservation 387

What Do You Think? Should We Remove Dams? 388

Watershed management integrates multiple problems and solutions 388 Domestic conservation can save water and have little impact on life styles 389

What Can You Do? Saving Water and Preventing Pollution 389

Recycling can reduce consumption 390

Prices and policies have often discouraged conservation 390

Water Pollution 394 Case Study: The Dead Zone 395

Water Pollution 396

Water pollution is anything that degrades water quality 396

Types and Effects of Water Pollution 397

Infectious agents are the main waterborne threat to human health 397

Bacteria are detected by examining oxygen levels 398

Nutrient enrichment leads to cultural eutrophication 400

Eutrophication can cause toxic tides 400

Inorganic pollutants include metals and salts 400

Exploring Science Arsenic in Drinking Water 402

Synthetic organic chemicals include pesticides, pharmaceuticals, and plastics 402

Sediment 403

Thermal pollution and thermal shocks 403

Water Quality Today 404

Most surface waters are improving in the United States and Canada 404

The Clean Water Act has greatly reduced point source pollution 404

Nonpoint source pollution remains a problem 406

Waters are improving in wealthier countries but not in poorer ones 406

Groundwater is hard to monitor and clean 408

There are few controls on ocean pollution 409

Water Pollution Control 411

Source reduction is the cheapest way to control pollution 411 Controlling nonpoint sources requires land management 411

What Do You Think? Watershed Protection in the Catskills 412

Human waste disposal occurs naturally when concentrations are low 412

Water remediation may involve containment, extraction, or phytoremediation 416

Water Legislation 417

The Clean Water Act was ambitious, bipartisan, and largely successful 417

What Can You Do? Steps You Can Take to Improve Water Quality 418

Clean Water Act reauthorization remains contentious 418 Other important water legislation 418

PART FIVE ISSUES AND POLICY

19 Conventional Energy 422 Case Study: Coal-Bed Methane 423

What Is Energy and Where Do We Get It? 424 Energy use is changing 424

How Energy Is Used 426

Coal 427

Coal resources are vast 427 Coal mining is a dirty, dangerous business 428 Burning coal releases many pollutants 428

Oil 420

Oil resources are concentrated in a few places 429 Oil shales and tar sands contain huge amounts of petroleum 431

Natural Gas 431

What Do You Think? Oil Drilling in ANWR 432

Most of the world's known natural gas is in a few countries 433. There may be vast unconventional gas sources 434.

Nuclear Power 434

How do nuclear reactors work? 435

There are many different reactor designs 435

Some alternative reactor designs may be safer 437

Breeder reactors could extend the life of our nuclear fuel 438

Radioactive Waste Management 438

What will we do with radioactive wastes? 438

Decommissioning old nuclear plants is expensive 439

Changing Fortunes of Nuclear Power 441

Nuclear Fusion 442

U.S. Energy Policy 442

20 Sustainable Energy 446 Case Study: Sea Power 447

Conservation 448

There are many ways to save energy 448 Transportation could be far more efficient 450

What Do You Think? Hybrid Automobile Engines 451

Negawatt programs save money 452

Cogeneration produces both electricity and heat 452

What Can You Do? Some Things You Can Do to Save Energy 453

Tapping Solar Energy 453

Solar collectors can be passive or active 453

High-Temperature Solar Energy 455

Simple solar cookers can save energy 455

Utilities are promoting renewable energy 456 Photovoltaic cells capture solar energy 456 Electrical energy is difficult and expensive to store 457

Fuel Cells 458

Several different electrolytes can be used in fuel cells 460

Energy from Biomass 460

We can burn biomass 461 Fuelwood is in short supply in less-developed countries 461 Dung and methane can be fuels 462 Fuels can be produced from crop plants 463

Energy from the Earth's Forces 464

Falling water has been used as an energy source since ancient times 464 Wind energy is our fastest growing renewable source 466 Geothermal energy can supplement other sources 468 Tidal and wave energy are available in some places 469 Ocean thermal electric conversion might be useful 470

What's Our Energy Future? 470

21 Solid, Toxic, and Hazardous Waste 474 Case Study: South Africa's "National Flower"? 475

Solid Waste 476

The waste stream is everything we throw away 476

Waste Disposal Methods 477

Open dumps release hazardous materials into the air and water 477 Ocean dumping is nearly uncontrollable 478 Landfills receive most of our waste 478 Exporting waste exposes villagers to hazards 479 Incineration creates energy but causes pollution 479

What Do You Think? Environmental Justice 481

Shrinking the Waste Stream 482

Recycling captures resources from garbage 482 Recycling saves money, materials, energy, and space 483 Commercial-scale recycling and composting is an area of innovation 484 Demanufacturing is necessary for appliances and e-waste 484 Reusing is even more efficient than recycling 485 Reducing waste is often the cheapest option 486

What Can You Do? Reducing Waste 486

Hazardous and Toxic Wastes 486

Hazardous waste must be recycled, contained, or detoxified 486 Superfund sites are those listed for federal cleanup 488

Exploring Science Cleaning Up Toxic Waste with Plants 489

Brownfields present both liability and opportunity 490 Hazardous waste must be processed or stored permanently 491

What Can You Do? Alternatives to Hazardous Household Chemicals 491

22 Urbanization and Sustainable Cities 496 Case Study: The Architecture of Hope 497

Urbanization 498

Cities have specialized functions as well as large populations 498 Cities are growing globally 499

Why Do Cities Grow? 501

Immigration is driven by push factors and pull factors 501 Government policies can drive urban growth 502

Urban Challenges in the Developing World 502

Traffic congestion and air quality are growing problems 502

Insufficient sewage treatment causes water pollution 503 Many cities lack sufficient housing 503

Urban Challenges in the Developed World 504

What Do You Think? People for Community Recovery 505

Urban sprawl consumes land and resources 506 Expanding suburbs force long commute times 507

Smart Growth 508

Garden cities and new towns were early examples of smart growth 508 New urbanism advanced the ideas of smart growth 509 Green urbanism promotes ecological cities 510 Designing for open space 511

Sustainable Development in Poorer Countries 512

What Do You Think? Environmental Innovations in Curitiba, Brazil 513

23 Ecological Economics 516 Case Study: How Economists Can Control Climate Change 517

Economic Worldviews 518

Ecology and economics have common concerns 518 Capital and resources are fundamental ideas 518 Classical economics examines supply and demand 520 Neoclassical economics emphasizes growth 521 Ecological economics incorporates principles of ecology 521 Communal property resources are a classic problem in ecological economics 522

Population, Technology, and Scarcity 523

Scarcity can lead to innovation 523 Carrying capacity is not necessarily fixed 524 Economic models compare growth scenarios 525 Why not conserve resources? 526

Natural Resource Accounting 526

Gross national product is our dominant measure of growth 526 Alternative measures account for well-being 526 New approaches measure nonmarket values 527 Cost-benefit analysis aims to optimize resource use 528 Market-based mechanisms can reduce pollution 529 Discount rates decide the value of saving resources 530

Trade, Development, and Jobs 530

International trade helps growth but externalizes costs 530 International development supports economic growth 530

Green Business 532

New business models follow concepts of ecology 532

What Do You Think? Eco-efficient Business Practices 533

Efficiency starts with design of products and processes 534 Green consumerism gives the public a voice 534 Environmental protection creates jobs 535

What Can You Do? Personally Responsible Consumerism 535

24 Environmental Policy, Law, and Planning 538 Case Study: The Snail Darter versus Tellico Dam 539

Environmental Policy 540

How is policy created? 540 Policy formation follows predictable steps 541 Is a clean, healthy environment a basic human right? 541

Environmental Law 542

A brief environmental history 542

Statutory law: The legislative branch 543 What Do You Think? Does NEPA Need an Overhaul? 544

Case law: The judicial branch 546

Administrative law: The executive branch 549

International Treaties and Conventions 551

Will globalization bring environmental governance? 553

Dispute Resolution and Planning 553

Wicked problems don't have simple answers 554 Resilience is important in ecosystems and institutions 555 The precautionary principle urges institutional caution 555 Arbitration and mediation can help settle disputes 556 Community-based planning can help solve environmental problems 557 Some nations have developed green plans 558

?.5 What Then Shall We Do? 562

Case Study: Citizen Science and the Christmas Bird Count 563

A Common Agenda 564

Environmental Education 564

Environmental literacy means understanding our environment 564 Citizen science encourages everyone to participate 565 Environmental careers range from engineering to education 566 Green business and technology are growing fast 566

Individual Contributions 567

How much is enough? 567

We can choose to reduce our environmental impact 567

What Can You Do? Reducing Your Impact 568

"Green washing" can mislead consumers 568 Certification identifies low-impact products 569 Green consumerism has its limits 569

Collective Actions 570

Student environmental groups can have lasting effects 570 Mainline organizations are influential but sometimes complacent 572

Radical groups capture attention and opposition 573 The wise use movement developed to defend resource use 574

What Do You Think? Evaluating Extremist Claims 575

Cooperation and compromise can lead to progress 576

Global Action 576

Sustainability is a global challenge 576 Nongovernmental organizations promote development 578

Green Politics 578

Individuals can influence policy 579 The Earth Charter 580

Glossary 584 597 Credits Subject and Internet Index 600