

Contents

Preface

Introduction LEARNING TO LEARN

Objectives

Learning Online

Why Study Environmental Science

How Can I Get an A in This Class?

Develop Good Study Habits

Recognize and Hone Your Learning Styles

Use This Textbook Effectively

Will This Be on the Test?

Thinking About Thinking

Approaches to Truth and Knowledge

What Do I Need to Think Critically?

Applying Critical Thinking

Some Clues for Unpacking an Argument

Avoiding Logical Errors and Fallacies

Using Critical Thinking in Environmental Science

Concept Maps

What Do You Think? Don't Believe Everything You See on the Internet

How Do I Create a Concept Map?

PART ONE

PRINCIPLES FOR UNDERSTANDING OUR ENVIRONMENT

Chapter 1 UNDERSTANDING OUR ENVIRONMENT

Objectives

Learning Online

Measuring Sustainability and Ecological Footprints

What Is Environmental Science?

A Brief History of Conservation and Environmentalism

Historic Roots of Nature Protection

Pragmatic Resource Conservation

Moral and Aesthetic Nature Preservation

Modern Environmentalism

Global Concerns

Current Conditions

A Marvelous Planet

Environmental Dilemmas

Exploring Science What's Happening to Frogs?

Signs of Hope

Rich/Poor: A Divided World

Human Development

A Fair Share of Resources?

Economic Progress

Sustainable Development

Can Development Be Truly Sustainable?

The 20:20 Compact for Human Development

Indigenous People

Chapter 2 ENVIRONMENTAL PHILOSOPHY, ETHICS, AND SCIENCE

Objectives

Learning Online

Sharkless Seas?

Environmental Ethics and Philosophy

Are There Universal Ethical Principles?

Values, Rights, and Obligations

Religious and Cultural Perspectives

Buddhism, Shamanism and Nature-Based Religions

Christianity, Judaism, and Islam

Ecofeminism

Environmental Justice

Environmental Racism

Dumping Across Borders

Science as a Way of Knowing

Cooperation and Insight in Science

Scientific Design

Deductive and Inductive Reasoning

Hypotheses and Theories

Modeling and Natural Experiments

Statistics and Probability

Intuition and Inspiration

Paradigms and Scientific Consensus

Pseudoscience and Baloney Detection

Chapter 3 MATTER, ENERGY, AND LIFE

Objectives

Learning Online

Measuring Energy Flows in Cedar Bog Lake

Elements of Life

Matter, Atoms, Molecules, and Compounds

Chemical Bonds

CASE STUDY: A “*Water Planet*”

Ions, Acids, and Bases

Organic Compounds

Cells: The Fundamental Units of Life

Energy

Energy Types and Qualities

Thermodynamics and Energy Transfers

Energy for Life

Solar Energy: Warmth and Light

How Does Photosynthesis Capture Energy

From Species to Ecosystems

Populations, Communities, and Ecosystems

Food Chains, Food Webs, and Trophic Levels

Ecological Pyramids

Material Cycles and Life Processes

The Hydrologic Cycle

The Carbon Cycle

Exploring Science Remotes Sensing, Photosynthesis, and Material Cycles

The Nitrogen Cycle

The Phosphorus Cycle

The Sulfur Cycle

Chapter 4 BIOLOGICAL COMMUNITIES AND SPECIES INTERACTIONS

Objectives

Learning Online

Why Trees Need Salmon

Who Lives Where, and Why?

Critical Factors and Tolerance Limits

Natural Selection, Adaptation, and Evolution

The Ecological Niche

Species Interactions

Exploitation: Predation and Parasitism

Keystone Species

Competition

What Do You Think? Understanding Competition

Symbiosis

Defensive Mechanisms

Community Properties

Productivity

Abundance and Diversity

Complexity and Connectedness

Resilience and Stability

Edges and Boundaries

CASE STUDY: *Where Have All the Songbirds Gone?*

Communities in Transition

Ecological Succession

Introduced Species and Community Change

What Can You Do? Working Locally for Ecological Diversity

Chapter 5 BIOMES: GLOBAL PATTERNS OF LIFE

Objectives

Learning Online

Integrity, Stability, and Beauty of the Land

Terrestrial Biomes

Deserts

Grasslands: Prairies and Savannas

Tundra

Conifer Forests

Broad-Leaved Deciduous Forests

Mediterranean/Chaparral/Thorn Scrub

Tropical Moist Forests

Tropical Seasonal Forests

Marine Ecosystems

Open Ocean

Shallow Coasts: Coral Reefs and Mangroves

Tidal Environments and Barrier Islands

Freshwater Ecosystems

Lakes

Wetlands

Human Disturbance

Chapter 6 POPULATION BIOLOGY

Objectives

Learning Online

How Many Fish in the Sea?

Dynamics of Population Growth

Exponential Growth and Doubling Times

Biotic Potential and Carrying Capacity

Population Oscillations and Irruptive Growth

Growth to a Stable Population

What Do You Think? Too Many Deer?

Strategies of Population Growth

Factors That Increase or Decrease Populations

Natality, Fecundity, and Fertility

Immigration

Mortality and Survivorship

Emigration

Factors That Regulate Population Growth

Density-Independent Factors

Density-Dependent Factors

Conservation Biology

Island Biogeography

Conservation Genetics

Population Viability Analysis

Metapopulations

PART TWO

PEOPLE IN THE ENVIRONMENT

Chapter 7 HUMAN POPULATIONS

Objectives

Learning Online

A Billion People and Growing

Population Growth

Human Population History

Limits to Growth: Some Opposing Views

Malthusian Checks on Population

What Do You Think? Looking for Bias in Graphs

Malthus and Marx Today

Can Technology Make the World More Habitable?

Can More People Be Beneficial?

Human Demography

How Many of Us Are There?

Fertility and Birth Rates

Mortality and Death Rates

Population Growth Rates

Life Span and Life Expectancy

CASE STUDY: *Family Planning in Iran*

Live Longer: Demographic Implications

Emigration and Immigration

Population Growth: Opposing Factors

Pronatalist Pressures

Birth Reduction Pressures

Birth Dearth?

Demographic Transition

Development and Population

An Optimistic View

A Pessimistic View

A Social Justice View

An Ecojustice View

Women's Rights and Fertility

Family Planning and Fertility Control

Traditional Fertility Control

Current Birth Control Methods

New Developments in Birth Control

The Future of Human Populations

What Can You Do? The 34 Million Friends of the UNFPA

Chapter 8 ENVIRONMENTAL HEALTH AND TOXICOLOGY

Objectives

Learning Online

The Cough Heard Round the World

Environmental Health

Global Disease Burden

Emergent and Infectious Diseases

Funding Health Care

Ecological Diseases

Antibiotic and Pesticide Resistance

Toxicology

What Can You Do? Tips for Staying Healthy

Diet

Movement, Distribution, and Fate of Toxins

Solubility and Mobility

Exposure and Susceptibility

Bioaccumulation and Biomagnification

What Do You Think? Children's Health

Persistence

Chemical Interactions

Mechanisms for Minimizing Toxic Effects

Metabolic Degradation and Excretion

Repair Mechanisms

Measuring Toxicity

Animal Testing

Toxicity Ratings

Acute versus Chronic Doses and Effects

Detection Limits

Risk Assessment and Acceptance

Understanding Risks

Accepting Risks

Establishing Public Policy

Chapter 9 FOOD AND AGRICULTURE

Objectives

Learning Online

Blue Revolution

Food and Nutrition

Chronic Hunger and Food Security

Acute Food Shortages

Malnutrition and Obesity

Eating a Balanced Diet

Key Food Sources

Major Crops

Meat and Dairy

Seafood

Farm Policy

Soil: A Renewable Resource

Soil Composition

Soil Organisms

Soil Profiles

Soil Types

Ways We Use and Abuse Soil

Land Resources

Land Degradation

Erosion: The Nature of the Problem

Mechanisms of Erosion

Erosion Hotspots

CASE STUDY: *Shade-Grown Coffee and Cocoa*

Other Agricultural Resources

Water

Fertilizer

Energy

New Crops and Genetic Engineering

Green Revolution

Genetic Engineering

Pest Resistance and Weed Control

Is Genetic Engineering Safe?

Sustainable Agriculture

Soil Conservation

Low-Input Sustainable Agriculture

Chapter 10 PEST CONTROL

Objectives

Learning Online

The Promise and Perils of DDT

Pests and Pesticides

Early Pest Controls

Current Pesticide Use

Pesticide Types

Pesticide Benefits

Disease Control

Crop Protection

Pesticide Problems

Effects on Nontarget Species

Pesticide Resistance and Pest Resurgence

Exploring Science Endocrine Disrupters

Creation of New Pests

Persistence and Mobility in the Environment

Human Health Problems

What Can You Do? Controlling Pests

Alternatives to Current Pesticide Uses

Behavioral Changes

Biological Controls

Integrated Pest Management

CASE STUDY: *Organic Farming in Cuba*

Reducing Pesticide Exposure

Regulating Pesticides

Is Organic the Answer?

A Personal Plan

PART THREE

UNDERSTANDING AND MANAGING LIVING SYSTEMS

Chapter 11 BIODIVERSITY

Objectives

Learning Online

Saving Seahorses

Biodiversity and the Species Concept

What Is Biodiversity

What Are Species?

How Many Species Are There?

Biodiversity Hot Spots

How Do We Benefit from Biodiversity?

Food

Drugs and Medicines

Ecological Benefits

Aesthetic and Cultural Benefits

Exploring Science Diversity and Ecological Stability

What Threatens Biodiversity?

Natural Causes of Extinction

Human-Caused Reductions in Biodiversity

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

Endangered Species Management and Biodiversity Protection

Hunting and Fishing Laws

The Endangered Species Act

Recovery Plans

Private Land and Critical Habitat

Reauthorizing the Endangered Species Act

Habitat Protection

International Wildlife Treaties

Captive Breeding and Species Survival Plans

Saving Rare Species in the Wild

Chapter 12 LAND USE: FORESTS AND GRASSLANDS

Objectives

Learning Online

Saving an African Eden

World Land Uses

World Forests

How Much Forest Is There?

Forest Products

Non-Timber Forest Benefits

Forest Management

CASE STUDY: *Forestry for the Seventh Generation*

Tropical Forests

Diminishing Forests

Swidden Agriculture

Logging and Land Invasions

Forest Protection

Debt-for-Nature Swaps

Temperate Forests

Ancient Forests of the Pacific Northwest

Wilderness and Wildlife Protection

Harvest Methods

What Do You Think? Regulations and Property Rights

U.S. Forest Management

Fire Management

Forest Policy and The Bush Administration

Sustainable Forestry and Non-Timber Forest Products

What Can You Do? Lowering Our Forest Impacts

Grasslands

Range Management

Overgrazing and Land Degradation

Forage Conversion by Domestic Animals

Harvesting Wild Animals

Rangelands in the United States

Rotational Grazing

Landownership and Land Reform

Who Owns How Much?

Land Reform

Indigenous Lands

Chapter 13 PRESERVING AND RESTORING NATURE

Objectives

Learning Online

The World's Biggest Restoration Project

Parks and Nature Preserves

Park Origins and History

Trouble in Our Parks and Monuments

New Parks and Monuments

Wildlife in Parks

What Do You Think? Reintroducing Wolves to Yellowstone

Wilderness Areas and Wildlife Refuges

Wilderness Areas

Wildlife Refuges

Refuge Management

World Parks and Preserves

Paper Parks?

Conservation and Economic Development

CASE STUDY: *Ecotourism on the Roof of the World*

Indigenous Communities and Biosphere Reserves

International Wildlife Preserves

Transboundary Peace Parks

Preserving Functional Ecosystems and Landscapes

Exploring Science GIS and Landscape Ecology

Patchiness and Heterogeneity

Landscape Dynamics

Size and Design of Nature Preserves

Restoration Ecology

Defining Some Terms

Tools of Restoration

Letting Nature Heal Itself

Back to What?

Creating Artificial Ecosystems

Preserving Ecosystem Services: Wetlands and Floodplains

Wetland Conservation and Mitigation

Floodplains and Flood Control

Ecosystem Management

A Brief History of Ecosystem Management

Principles and Goals of Ecosystem Management

Conflicting Views of Restoration and Ecosystem Management

PART FOUR

PHYSICAL RESOURCES AND ENVIRONMENTAL SYSTEMS

Chapter 14 GEOLOGY AND EARTH RESOURCES

Objectives

Learning Online

Conflict Diamonds

A Dynamic Planet

A Layered Sphere

Tectonic Processes and Shifting Continents

Rocks and Minerals

Rock Types and How They Are Formed

Economic Geology and Mineralogy

Metals

Nonmetal Mineral Resources

What Do You Think? Should We Revise Mining Laws?

Environmental Effects of Resource Extraction

Mining

Processing

Conserving Geologic Resources

Recycling

Steel and Iron Recycling: Minimills

Substituting New Materials for Old

Geologic Hazards

Earthquakes

Volcanoes

Mass Wasting

Chapter 15 AIR, WEATHER, AND CLIMATE

Objectives

Learning Online

Is Antarctica Melting?

The Atmosphere and Climate

Energy and the “Greenhouse Effect”

Convection and Atmospheric Pressure

Why Does It Rain?

The Coriolis Effect and Jet Streams

Ocean Currents

Seasonal Winds and Monsoons

Frontal Weather

Cyclonic Storms

Weather Modification

Climate

Climate Catastrophes

Driving Forces and Patterns in Climatic Changes

El Niño/Southern Oscillations

Human-Caused Global Climate Change

Climate Skeptics

Exploring Science Uncertainty in Climate Change

Sources of Greenhouse Gases

Current Evidence of Climate Change

Winners and Losers

International Climate Negotiations

Controlling Greenhouse Emissions

What Can You Do? Reducing Carbon Dioxide Emissions

Chapter 16 AIR POLLUTION

Objectives

Learning Online

Killer Smog

The Air Around Us

Natural Sources of Air Pollution

Human-Caused Air Pollution

Primary and Secondary Pollutants

Conventional or “Criteria” Pollutants

Unconventional Pollutants

Indoor Air Pollution

CASE STUDY: *Indoor Air*

Climate, Topography, and Atmospheric Processes

Inversions

Dust Domes and Heat Islands

Long-Range Transport

Stratospheric Ozone

Effects of Air Pollution

Human Health

Plant Pathology

Acid Deposition

Air Pollution Control

Reducing Production

What Can You Do? Saving Energy and Reducing Pollution

Clean Air Legislation

Clear Skies

Current Conditions and Future Prospects

Air Pollution in Developing Countries

Signs of Hope

Chapter 17 WATER USE AND MANAGEMENT

Objectives

Learning Online

China’s South-to-North Water Diversion Project

Water Resources

The Hydrologic Cycle

Balancing the Water Budget

Regions of Plenty and Regions of Deficit

Major Water Compartments

Oceans

Glaciers, Ice, and Snow

Groundwater

Rivers and Streams

Lakes, Ponds, and Wetlands

The Atmosphere

Water Availability and Use

Water-Rich and Water-Poor Countries

Types of Water Use

Quantities of Water Used

Agricultural Water Use

CASE STUDY: Water Wars on the Klamath

Domestic and Industrial Water Use

Freshwater Shortages

A Precious Resource

Depleting Groundwater

Increasing Water Supplies

Seeding Clouds and Towing Icebergs

Desalination

Dams, Reservoirs, Canals, and Aqueducts

Environmental Costs

What Do You Think? Should We Remove Dams?

Water Management and Conservation

Watershed Management

Domestic Conservation

What Can You Do? Saving Water and Preventing Pollution

Recycling and Water Conservation

Price Mechanisms and Water Policy

Chapter 18 WATER POLLUTION

Objectives

Learning Online

A Flood of Pigs

Water Pollution

What Is Water Pollution?

Types and Effects of Water Pollution

Infectious Agents

Oxygen-Demanding Wastes

Plant Nutrients and Cultural Eutrophication

Toxic Tides

Inorganic Pollutants

Organic Chemicals

Sediment

Thermal Pollution and Thermal Shocks

CASE STUDY: *Arsenic in Drinking Water*

Water Quality Today

Surface Waters in the United States and Canada

Surface Waters in Other Countries

Groundwater and Drinking Water Supplies

Ocean Pollution

Water Pollution Control

Source Reduction

Nonpoint Sources and Land Management

CASE STUDY: *Watershed Protection in the Catskills*

Human Waste Disposal

Water Remediation

Water Legislation

The Clean Water Act

Clean Water Act Reauthorization

Other Important Water Legislation

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

PART FIVE

ISSUES AND POLICY

Chapter 19 CONVENTIONAL ENERGY

Objectives

Learning Online

What a Tangled Web We Weave

What Is Energy and Where Do We Get It?

A Brief Energy History

Current Energy Sources

Per Capita Consumption

How Energy Is Used

Coal

Coal Resources and Reserves

Mining

Air Pollution

Oil

Oil Resources and Reserves

Oil Imports and Domestic Supplies

Oil Shales and Tar Sands

Natural Gas

Natural Gas Resources and Reserves

Unconventional Gas Sources

What Do You Think? Coal-Bed Methane

Nuclear Power

How Do Nuclear Reactors Work?

Kinds of Reactors in Use

Alternative Reactor Designs

Breeder Reactors

Radioactive Waste Management

Ocean Dumping of Radioactive Waste

Land Disposal of Nuclear Waste

Decommissioning Old Nuclear Plants

Changing Fortunes of Nuclear Power

Nuclear Fusion

U.S. Energy Policy

Chapter 20 SUSTAINABLE ENERGY

Objectives

Learning Online

Sea Power

Conservation

Utilization Efficiencies

Energy Conversion Efficiencies

Transportation

What Do You Think? Hybrid Automobile Engines

Negawatt Programs

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

Cogeneration

Tapping Solar Energy

A Vast Resource

Passive Solar Heat

Active Solar Heat

High-Temperature Solar Energy

Solar Cookers

Promoting Renewable Energy

Photovoltaic Solar Energy

Storing Electrical Energy

Fuel Cells

Fuel Cell Types

Energy from Biomass

Burning Biomass

Fuelwood Crisis in Less-Developed Countries

Dung and Methane as Fuels

Alcohol from Biomass

Crop Residues, Energy Crops, and Peat

Energy from the Earth's Forces

Hydropower

Wind Energy

Geothermal Energy

Tidal and Wave Energy

Ocean Thermal Electric Conversion

What's Our Energy Future?

Chapter 21 SOLID, TOXIC, AND HAZARDOUS WASTE

Objectives

Learning Online

South Africa's "National Flower"?

Solid Waste

The Waste Stream

Waste Disposal Methods

Open Dumps

Ocean Dumping

Landfills

Exporting Waste

Incineration and Resource Recovery

Shrinking the Waste Stream

Recycling

What Do You Think? Environmental Justice

Composting

Energy from Waste

Demanufacturing

Reuse

Producing Less Waste

What Can You Do? Reducing Waste

Hazardous and Toxic Wastes

What Is Hazardous Waste?

Hazardous Waste Disposal

Superfund Sites

Exploring Science Cleaning Up Toxic Waste with Plants

Options for Hazardous Waste Management

What Can You Do? Alternatives to Hazardous Household Chemicals

Chapter 22 URBANIZATION AND SUSTAINABLE CITIES

Objectives

Learning Online

Chattanooga, A Model Sustainable City

Urbanization

What Is a City?

World Urbanization

Causes of Urban Growth

Immigration Push Factors

Immigration Pull Factors

Government Policies

Current Urban Problems

The Developing World

The Developed World

What Do You Think? People for Community Recovery

Garden Cities and New Towns

New Urbanist Movement

Designing for Open Space
Sustainable Development in the Third World
CASE STUDY: *Curitiba: An Environmental Showcase*

Chapter 23 ECOLOGICAL ECONOMICS

Objectives

Learning Online

Creating Another Earth

Economic Worldviews

Classical Economics

Neoclassical Economics

Ecological Economics

Resources, Capital, and Reserves

Resource Types

Economic Resource Categories

Communal Property Resources

Population, Technology, and Scarcity

Market Efficiencies and Technological Development

Increasing Environmental Carrying Capacity

Economic Models

Why Not Conserve Resources?

Natural Resource Accounting

Gross National Product

Measuring Real Progress

Measuring Nonmarket Values

Cost-Benefit Analysis

Market-Based Mechanisms for Environmental Protection

Intergenerational Justice and Discount Rates

Internal and External Costs

Trade, Development, and Jobs

International Trade

International Development

Green Business

CASE STUDY: *Eco-efficient Carpeting from Interface, Inc.*

Design for the Environment

Green Consumerism

Jobs and the Environment

What Can You Do? Personally Responsible Consumerism

Chapter 24 ENVIRONMENTAL POLICY, LAW, AND PLANNING

Objectives

Learning Online

Is NEPA an Impediment?

Environmental Policy

Political Decision Making

The Policy Cycle

Environmental Rights

Environmental Law

A Brief Environmental History

Statutory Law: The Legislative Branch

Case Law: The Judicial Branch

Administrative Law: The Executive Branch

What Do You Think? Restoring Balance or Promoting Radical Ideology?

International Treaties and Conventions

Globalization and Environmental Governance

Dispute Resolution and Planning

Wicked Problems and Adaptive Management

Resilience in Ecosystem and Institutions

The Precautionary Principle

Arbitration and Mediation

Collaborative Approaches to Community-Based Planning

Green Plans

Chapter 25 WHAT THEN SHALL WE DO?

Objectives

Learning Online

Citizen Science and the Christmas Bird Count

Living in an Uncertain World

Environmental Education

Environmental Literacy

Citizen Science

Environmental Careers

Individual Accountability

How Much Is Enough?

Lohas and Cultural Creatives

Green Washing and Confusing Choices

Blue Angels and Green Seals

What Can You Do? Reducing Your Impact

Limits of Green Consumerism

Collective Actions

Student Environmental Groups

Mainline Environmental Organizations

Broadening the Environmental Agenda

Deep or Shallow Environmentalism?

Cooperation and Compromise

Radical Environmental Groups

Wise Use Movement

What Do You Think? Evaluating Extremist Claims

Sustainability

International Nongovernmental Organizations

Green Politics

What Can Individuals Do?

The Earth Charter

