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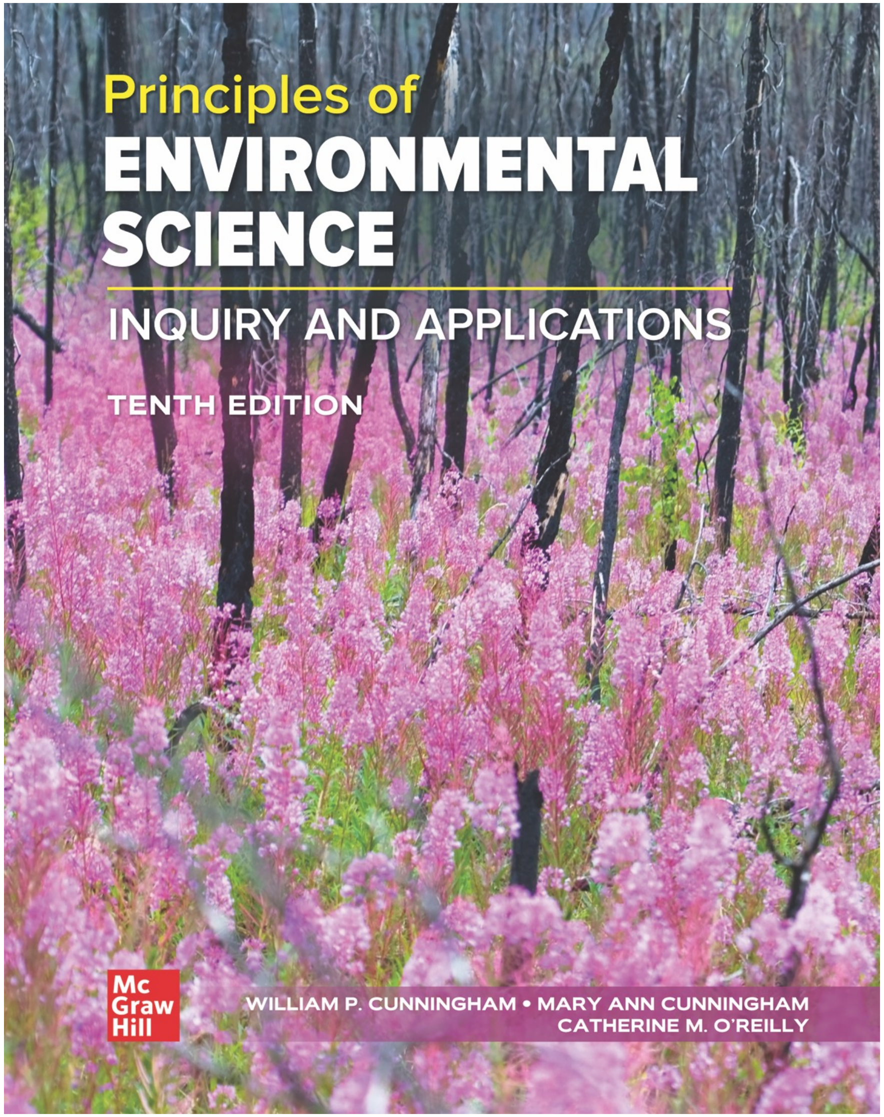
Chapter 1 Lecture Outline



Learning Outcomes

After studying this chapter, you should be able to answer the following questions:

Describe several important environmental problems facing the world.

List several examples of progress in environmental quality.

Explain the idea of sustainability and some of its aims.

Why are scientists cautious about claiming absolute proof of particular theories?

What is critical thinking, and why is it important in environmental science?

Why do we use graphs and data to answer questions in science?

Identify several people who helped shape our ideas of resource conservation and preservation—why did they promote these ideas when they did?

Today we are faced with a challenge that calls for a shift in our thinking, so that humanity stops threatening its life-support system.

–Wangari Maathai, winner of 2004 Nobel Peace Prize

Case Study: Can We Restore the Amazon?

Salparadis/Shutterstock

1.1 What Is Environmental Science? 1

In this chapter you will learn about many serious environmental problems.

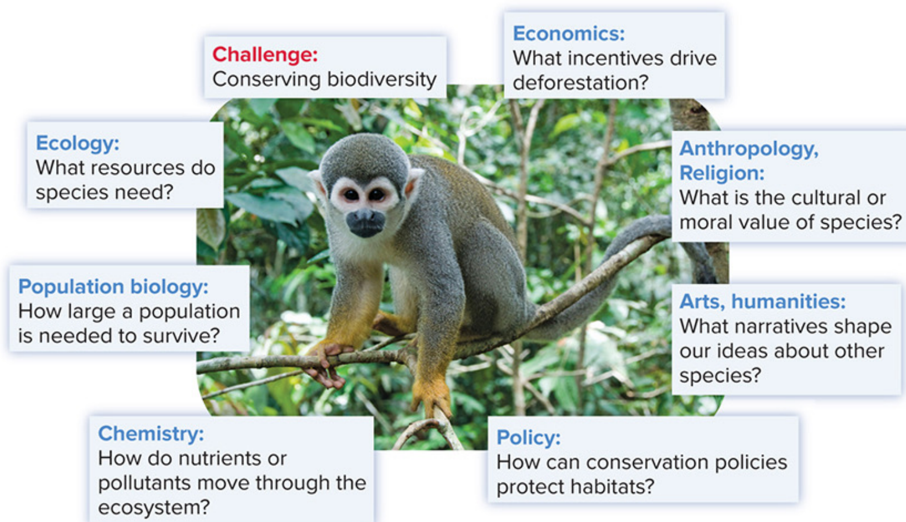
You will also read about promising, exciting solutions to many of these problems.

Source: National Aeronautics and Space Administration (NASA)

1.1 What Is Environmental Science? 2

Environmental science is the systematic study of our environment and our place in it.

As shown in Fig. 1.2, environmental science draws on many fields of knowledge to fully understand a problem and solve it.



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National Geographic Image Collection/Alamy Stock Photo

Environmental Science Is a Global Subject

There are many interdependencies between global and regional environmental systems.

Often the best way to learn environmental science is to study it in the context of real places.

Throughout this course you will be provided links to places you can see in Google Earth, so you can virtually visit places discussed.

We Inhabit a Remarkable Planet

Temperatures here are mild and relatively constant.

Plentiful supplies of clean air, fresh water, and fertile soil are regenerated by biogeochemical cycles and biological communities.

Source: National Aeronautics and Space Administration (NASA)

Our Planet Has an Amazingly Rich Diversity of Life

Millions of beautiful and intriguing species populate the earth and help sustain a habitable environment.

This vast multitude of life creates complex, interrelated communities.

Fuse/Getty Images

1.2 Major Themes in Environmental Science

The themes of environmental science include:

- Environmental quality.
- Human population and well-being.
- Natural resources.

There are serious problems in each, but they are also subjects of dramatic innovation.

Major Themes in Environmental Science– Environmental Quality

Environmental Quality includes subjects such as:

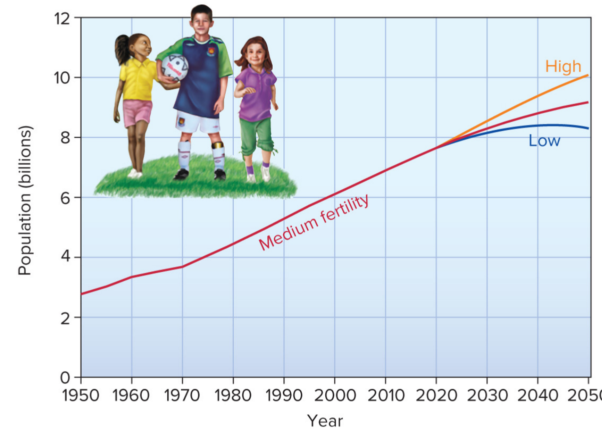
- Climate Change.
- Clean Water.
- Air Quality.

Jasper Chamber/Alamy Stock Photo

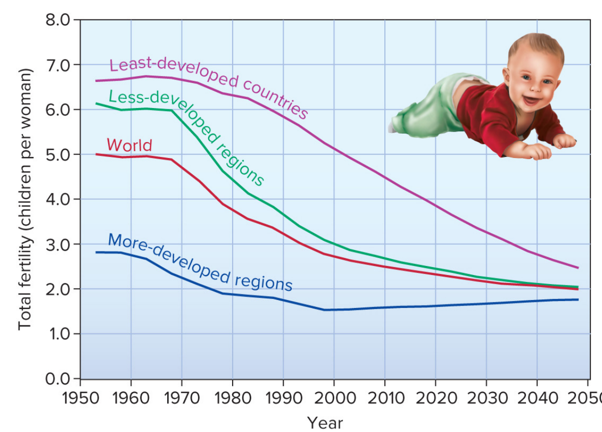
Major Themes in Environmental Science–Human Population & Well-Being

Human Population and Well-Being includes subjects such as:

- Population Growth.
- Hunger and Food.
- Information and Education.



(a) Possible population trends



(b) Fertility rates

Access the text alternative for slide images.

Source: United Nations Population Division, *World Population Prospects, 2019.*

Major Themes in Environmental Science– Natural Resources

Natural Resources includes subjects such as:

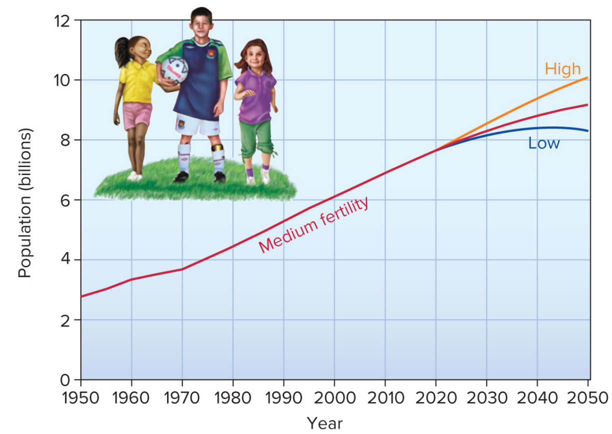
- Biodiversity Loss.
- Conservation of Forests and Nature Preserves.
- Marine Resources.
- Energy Resources.

Crisis and Opportunities

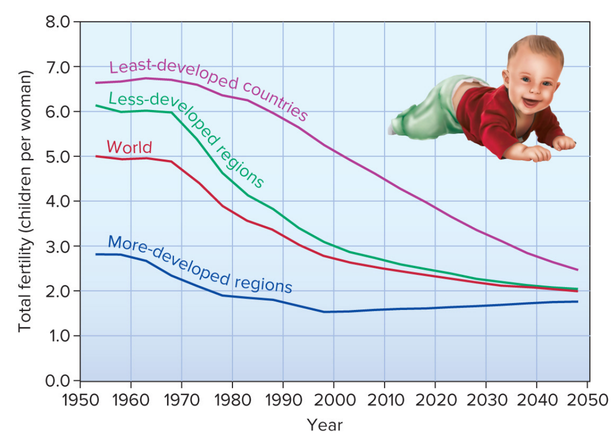
There are more than 7 billion people on earth with 80 million more each year.

Present trends project a world population between 8 and 10 billion by 2050.

The impact of that many people on our natural resources and ecological systems strongly influences many of the other problems we face.



(a) Possible population trends



(b) Fertility rates

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Source: United Nations Population Division, *World Population Prospects, 2019.*

Environmental and Political Challenges: Climate Change

Human activities have greatly increased concentrations of carbon dioxide and other “greenhouse” gases over the last 200 years.

Climate models indicate that by 2100, if current trends continue, global mean temperatures will probably warm between about 2 and 6 ℃.

Environmental and Political Problems: Clean Water

1.1 billion people lack access to safe drinking water.

Every year polluted water contributes to the death of more than 15 million people.

40 percent of the population live in countries where water demands now exceed supplies.

Environmental and Political Problems: Air Quality

Air quality has worsened dramatically in many areas, especially China and India.

Nobel laureate Paul Crutzen estimates that at least 3 million people die each year from diseases triggered by air pollution.

Worldwide, the United Nations estimates that more than 2 billion metric tons of air pollutants (not including carbon dioxide or wind-blown soil) are released each year.

Environmental and Political Problems: Hunger

Over the past century, global food production has increased faster than human population growth, but hunger remains a chronic problem.

At least 60 million people face acute food shortages due to weather, politics, or war.

(a): Dimas Ardian/Getty Images News/Getty Images; (b): Anjo Kan/Shutterstock; (c): kakteen/Shutterstock; (d): DOE Photo/Alamy Stock Photo

Environmental and Political Problems: Biodiversity Loss

Habitat destruction, overexploitation, pollution, and introduction of exotic organisms are eliminating species at a rate comparable to the great extinction that marked the end of the age of dinosaurs.

Environmental and Political Problems: Marine Resources

More than a billion people depend on seafood for their main source of animal protein.

According to the World Resources Institute, more than three-quarters of the 441 fish stocks for which information is available are severely depleted or in urgent need of better management.

Environmental and Political Problems: Energy Resources

Fossil fuels (oil, coal, and natural gas) presently provide around 80 percent of the energy used in industrialized countries.

Supplies of these fuels are diminishing, and there are many problems associated with their acquisition and use.

Investing in renewable energy and energy conservation measures could give us cleaner, less destructive options.

Signs of Progress: Population and Pollution

Pollution has been lowered and the population has stabilized in most industrialized countries and even in some very poor countries where democracy has been established.

- Since 1960, the average number of children born per woman worldwide has decreased from 5.0 to 2.45.
- The UN Population Division predicts that the world population will stabilize at about 8.9 billion by the year 2050.

Signs of Progress: Health

The incidence of life-threatening infectious diseases like smallpox and polio have been reduced sharply in most countries during the past century, while life expectancies have nearly doubled.

Dimas Ardian/Getty Images News/Getty Images

Signs of Progress: Renewable Energy

Encouraging progress is being made in a transition to renewable energy sources.

- Growth in wind energy, solar, and biomass power and improvements in efficiency are beginning to reduce reliance on fossil fuels.
- The cost of solar power has plummeted, and both solar and wind power are now far cheaper, easier, and faster to install than nuclear power or new coal plants.

Signs of Progress: Information and Education

Literacy and access to education are expanding in most regions of the world.

The Internet makes it easier to share environmental solutions.

Expanding education for girls is driving declining birth rates worldwide.

Signs of Progress: Conservation of Forests and Nature Preserves

Deforestation has slowed in Asia.

A former leader in deforestation, Brazil, is now working to protect forests.

13.5 percent of the world's land area is now in protected areas.

Signs of Progress: Protection of Marine Resources

Marine protected areas and better monitoring of provides for more sustainable management.

Marine reserves have been established in California, Hawaii, New Zealand, Great Britain, and many other areas.

1.3 Environmental Science

Aldo Leopold, one of the greatest thinkers on conservation, observed that the great challenges in conservation have less to do with managing resources than with managing people and our demands on resources.

In this section we'll review some key ideas that guide our understanding of human dimensions of environmental science and resource use.

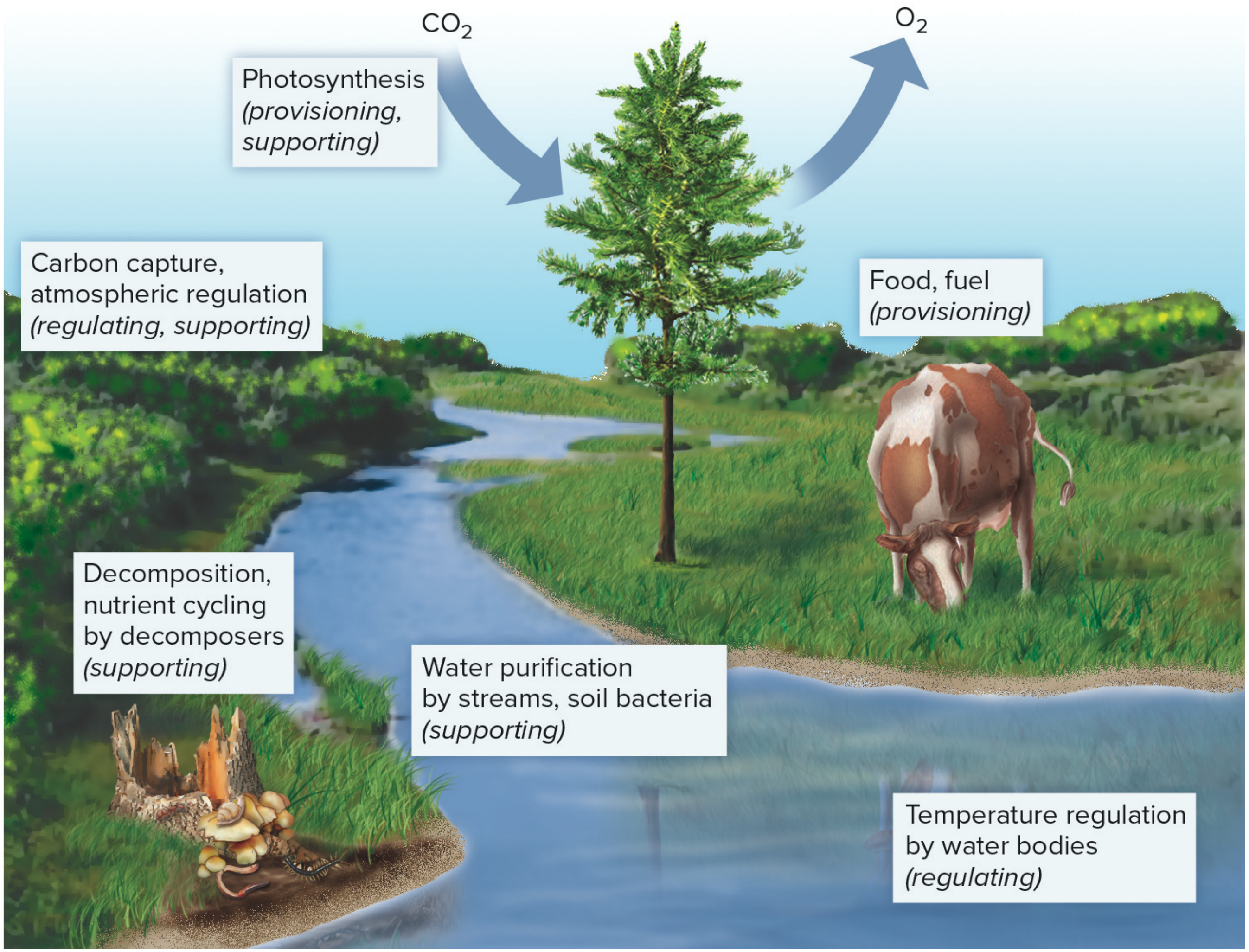
How Do We Describe Resource Use and Conservation?

When we consider resource consumption, an important idea is **throughput,** the amount of resources we use and dispose of.

Ecosystem services refers to the services or resources provided by environmental systems. Usually we rely on these resources without thinking about them.

The **tragedy of the commons** refers to how population growth inevitably leads to the overuse and destruction of common resources.

Ecosystem Services



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Environmental and Social Progress

Sustainability is a search for long term ecological stability and human progress.

World Health Organization director Gro Harlem Brundtland has defined **sustainable developmen**t as "meeting the needs of the present without compromising the ability of future generations to meet their own needs."

Fighting Poverty Helps Protect Our Shared Environment

Policy makers now recognize that eliminating poverty and protecting our common environment are inextricably interlinked.

Impoverished peoples are both the victims and the agents of environmental degradation.

Affluence Is a Goal and a Liability

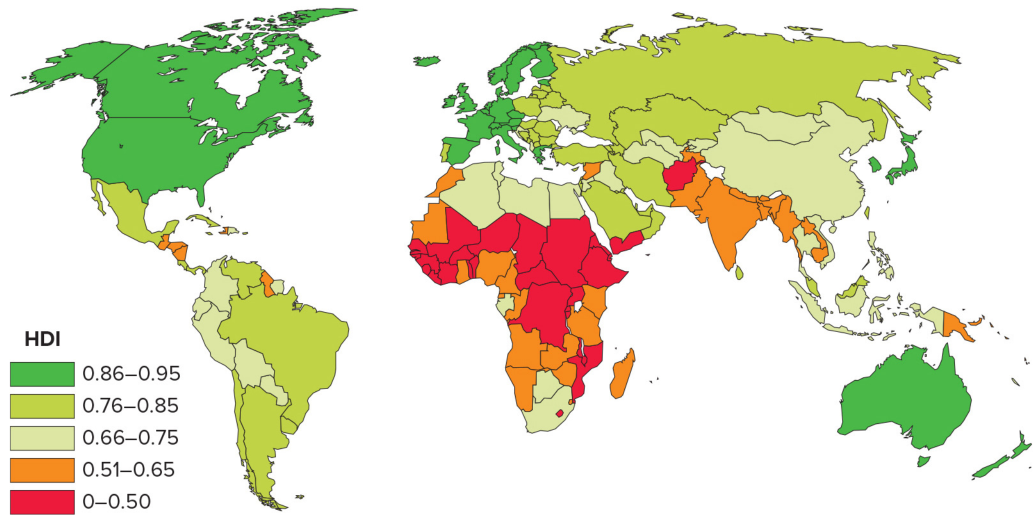
The U.S. with less than 5 percent of the world's total population, consumes about 1/4 of most commercially traded commodities, such as oil, and produces a ¼ to ½ of most industrial wastes, such as greenhouse gases, pesticides, and other persistent pollutants.

As the rest of the world seeks to achieve a similar standard of living, with higher consumption of conveniences and consumer goods, what will the effects be on the planet?

How Do We Know the State of Poverty?

Human Development Index (HDI)

Data sources like these provide a large-scale view of issues such as hunger, poverty, education, or health across space or time.



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Data Source: UNEP 2016.

Indigenous Peoples Safeguard Biodiversity

The 500 million indigenous people who remain in traditional homelands still possess valuable ecological wisdom and remain the guardians of little-disturbed habitats that are refuges for rare and endangered species and undamaged ecosystems.

1.4 Science Helps Us Understand Our World

What is science?

Science is a process for producing knowledge based on observations.

We develop or test theories (proposed explanations of how a process works) using these observations.

"Science" also refers to the cumulative body of knowledge produced by many scientists.

Science rests on the assumption that the world is knowable and that we can learn about it by careful observation and logical reasoning.

Basic Principles of Science

Empiricism: observations of real and observable phenomena can help us understand natural processes.

Uniformitarianism: Natural forces at work today are the same as those that shaped the world in the past.

Parsimony: The simpler of two explanations is preferable.

Uncertainty: Knowledge can be updated to be more precise and accurate as new evidence is collected.

Repeatability: Inquiries should be reproduceable

Proof is elusive: New evidence can always improve scientific knowledge so no theory is every considered finished.

Testable questions: Questions must be testable by experiments or observation with some form of evidence that can be collected to support or disprove a prediction.

Science Depends on Skepticism and Reproducibility

Ideally, scientists are skeptical. They are cautious about accepting proposed explanations until there is substantial evidence to support it.

Scientists aim to be methodical and unbiased.

Scientists demand **reproducibility.** Making an observation or obtaining a result just once doesn't count for much. You have to produce the same result consistently to be sure that your first outcome wasn't a fluke.

Science Uses Both Deductive and Inductive Reasoning

Scientists deduce conclusions from general laws that they know to be true.

This logical reasoning from general to specific is known as **deductive reasoning.**

Conversely, reasoning from many observations to produce a general rule is **inductive reasoning.**

Source: Dave Partee, Alaska Sea Grant, University of Alaska Fairbanks

Scientific Observations

A first step in understanding our environment is careful, detailed observation and evaluation of factors involved in pollution, environmental health, conservation, population, resources, and other issues.

Knowing about the world we inhabit helps us understand where our resources originate, and why.

The Scientific Method Is an Orderly Way to Examine Problems

*Make an observation and identify a question: Y*our flashlight doesn't light and you think to yourself: "what might be wrong?"

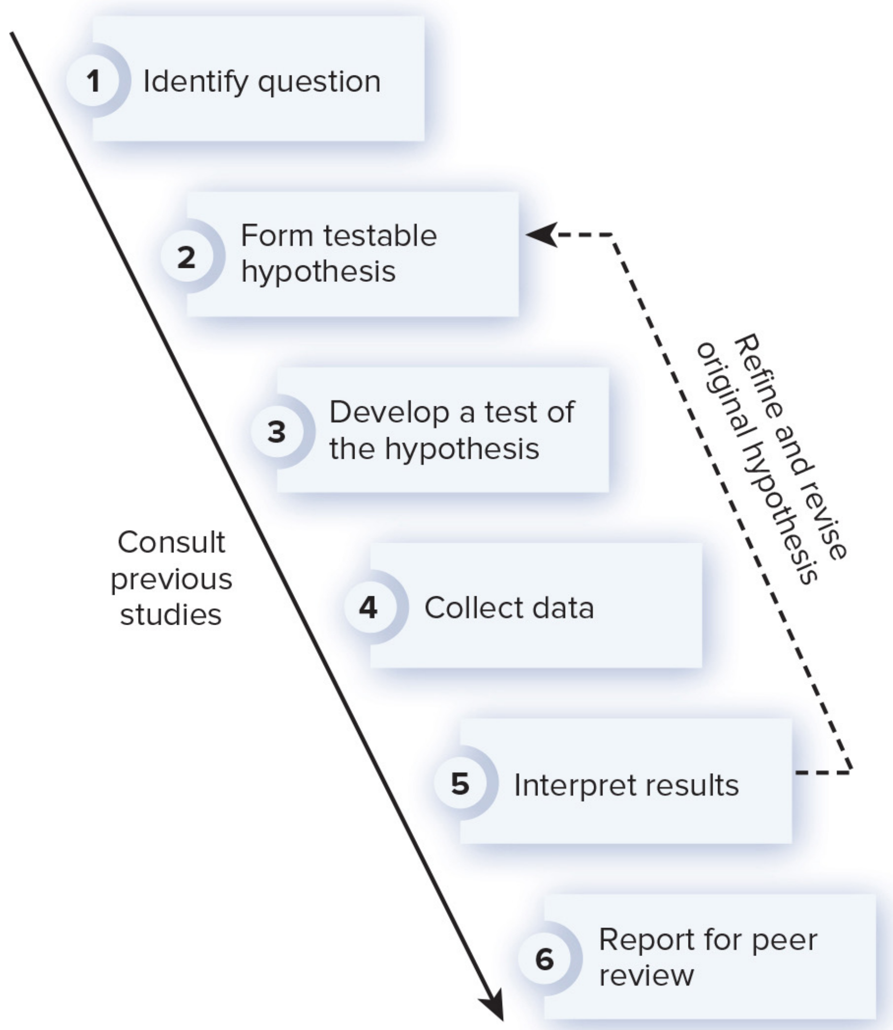
Propose a ***hypothesis****:* "The flashlight doesn't work because the batteries are dead."

Test your hypothesis: "If I replace the batteries then the flashlight should work."

Gather data from your test: After you replaced the batteries, did the light turn on?

Interpret your results: If the light works now, then your hypothesis was right; if not, then you should formulate a new hypothesis, perhaps that the bulb is faulty, and develop a new test for that hypothesis.

The Steps of Scientific Inquiry



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Understanding Probability Reduces Uncertainty

Probability is a measure of how likely something is to occur.

Probability does not tell you what *will* happen, but it tells you what is *likely* to happen.

If you hear on the news that you have a 20 percent chance of catching a cold this winter, that means that 20 of every 100 people are likely to catch a cold. This doesn't mean that you *will* catch one. In fact, it's *more likely,* an 80 percent chance, that you *won't* catch a cold.

Experimental Design Can Reduce Bias

A **natural experiment** is one that involves observation of events that have already happened.

Manipulative experiments have conditions deliberately altered, and all other variables are held constant or controlled.

Blind experiments are those in which the researcher doesn’t know which group is treated until after the data have been analyzed.

In health studies, such as tests of new drugs, **double-blind experiments** are used, in which neither the subject nor the researcher knows who is in the treatment group and who is in the control group.

In each of these studies there is one **dependent variable** and one, or perhaps more, **independent variables**.

Science Is a Cumulative Process

Good science is rarely carried out by a single individual working in isolation. Instead, a community of scientists collaborates in a cumulative, self-correcting process.

The idea of **consensus** is important in science.

Sometimes new ideas emerge that cause major shifts in scientific consensus. These great changes in explanatory frameworks were called **paradigm shifts**.

Science as a Cumulative Process

Sometimes new ideas emerge that cause major shifts in scientific consensus.

These great changes in explanatory frame-works were termed **paradigm shifts** by Thomas Kuhn (1967).

According to Kuhn, paradigm shifts occur when a majority of scientists accept that the old explanation no longer describes new observations very well.

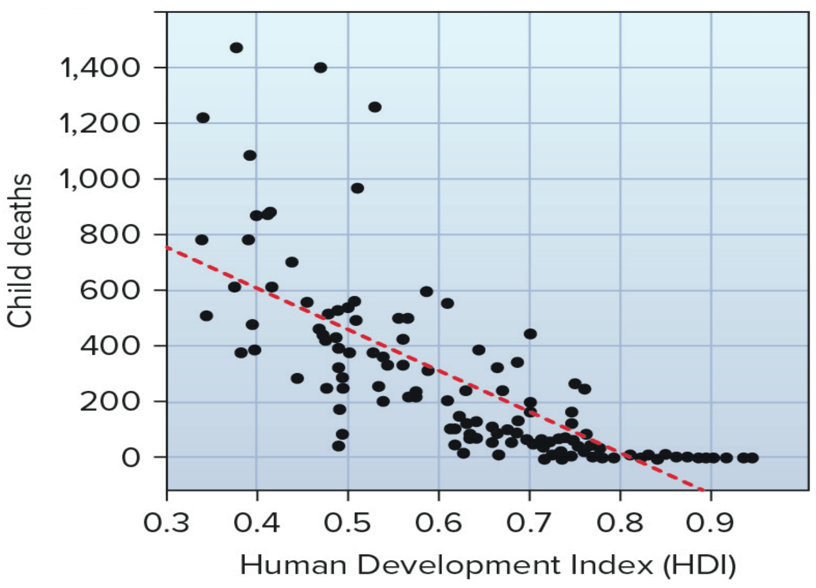
For example, two centuries ago geologists explained many of the earth's features in terms of Noah's flood. The best scientists held that the flood created beaches well above modern sea level, scattered boulders erratically across the landscape, and gouged enormous valleys where there is no water now.

Paradigm Shifts Change the Ways We Explain Our World

John A. Karachewski/McGraw Hill

What Is Sound Science?

How do you evaluate whether reports or news are sound science?



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1.5 Critical Thinking 1

An ability to think critically, clearly, and analytically about a problem may be the most valuable skill you can learn.

Critical thinking is a term we use to describe logical, orderly, analytical assessment of ideas, evidence, and arguments.

If you ask "How do I know that what I just said is true?" then you are practicing critical thinking.

1.5 Critical Thinking 2

What is the purpose of my thinking?

What precise question am I trying to answer?

Within what point of view am I thinking?

What information am I using?

How am I interpreting that information?

What concepts or ideas are central to my thinking?

What conclusions am I aiming toward?

What am I taking for granted; what assumptions am I making?

If I accept the conclusions, what are the implications?

What would the consequences be if I put my thoughts into action?

Paul, R. (1993). Critical Thinking. Foundation for Critical Thinking.

Critical Thinking Helps Us Analyze Information

There are many different aspects of critical thinking:

- **Analytical thinking** helps you break a problem down into its constituent parts.
- **Creative thinking** asks**, “**How might I approach this problem in new and inventive ways?”
- **Logical thinking** evaluates whether the structure of your argument make sense.
- **Reflective thinking** asks, “What does it all mean?”

Critical Thinking Helps You Learn Environmental Science

In this course you will have many opportunities to practice critical thinking.

When reading your textbook, hearing the news, or watching television, try to distinguish between statements of fact and opinion.

Watch for cases in which you need to think for yourself, and use your critical and reflective thinking skills to uncover the truth.

Critical thinking evaluates premises, contradictions, and assumptions.

1.6 Where Do Our Ideas About the Environment Come from?

Many of our current views on the environment are rooted in the writings of relatively recent environmental thinkers.

Their work can be grouped into 4 stages:

- Resource conservation for optimal use.
- Nature preservation for moral and aesthetic reasons .
- Concern over health and ecological consequences of pollution.
- Global environmental citizenship.

These stages are not mutually exclusive.

Nature Protection Has Historic Roots

Human misuse of nature is not unique to modern times.

Plato complained of environmental degradation in ancient Greece in 4 B.C.

Eighteenth-century French and British colonial administrators observed and understood the connections between deforestation, soil erosion, and local climate change.

Resource Waste Triggered Pragmatic Resource Conservation

Many historians consider the publication of *Man and Nature in 1864 by* George Perkins Marsh as the beginning of environmental protection in North America.

He warned of the ecological consequences to the waste and destruction of resources.

Largely because of his book, national forest reserves were established in the U.S. in 1873 to protect dwindling timber supplies and endangered watersheds.

Roosevelt & Pinchot Begin Pragmatic Utilitarian Conservation

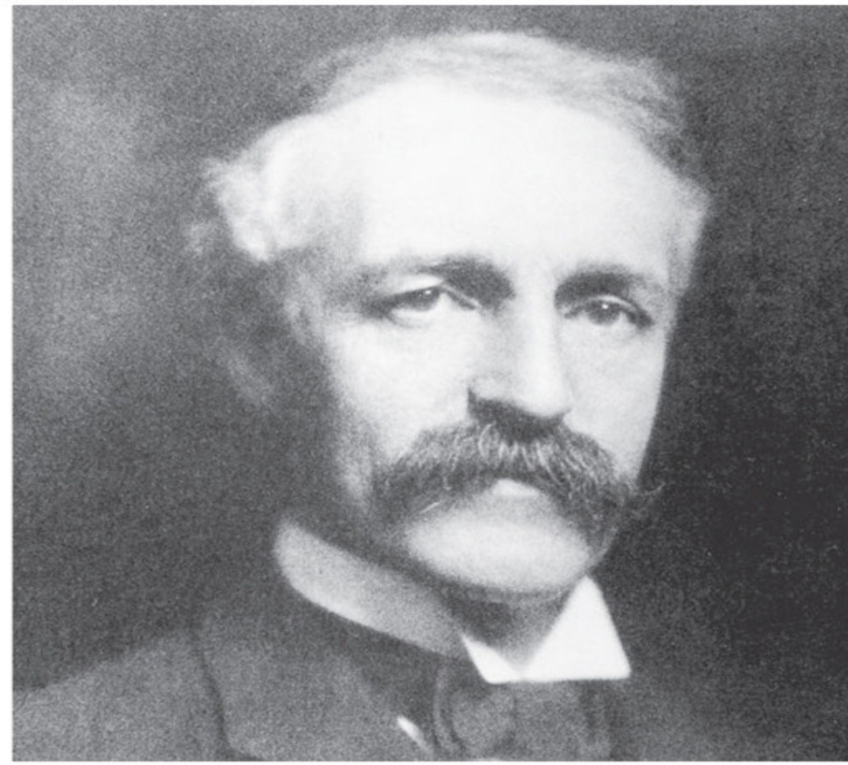
U.S. President Theodore Roosevelt and his chief conservation adviser, Gifford Pinchot, argued that the forests should be saved to provide homes and jobs for future generations.

Pinchot, was the first chief of the Forest Service. He put resource management on a rational and scientific basis for the first time in American history and helped John Muir and Roosevelt to establish the national forest, park, and wildlife refuge systems.

Utilitarian Conservationists

President Theodore Roosevelt

Conservation Advisor Gifford Pinchot



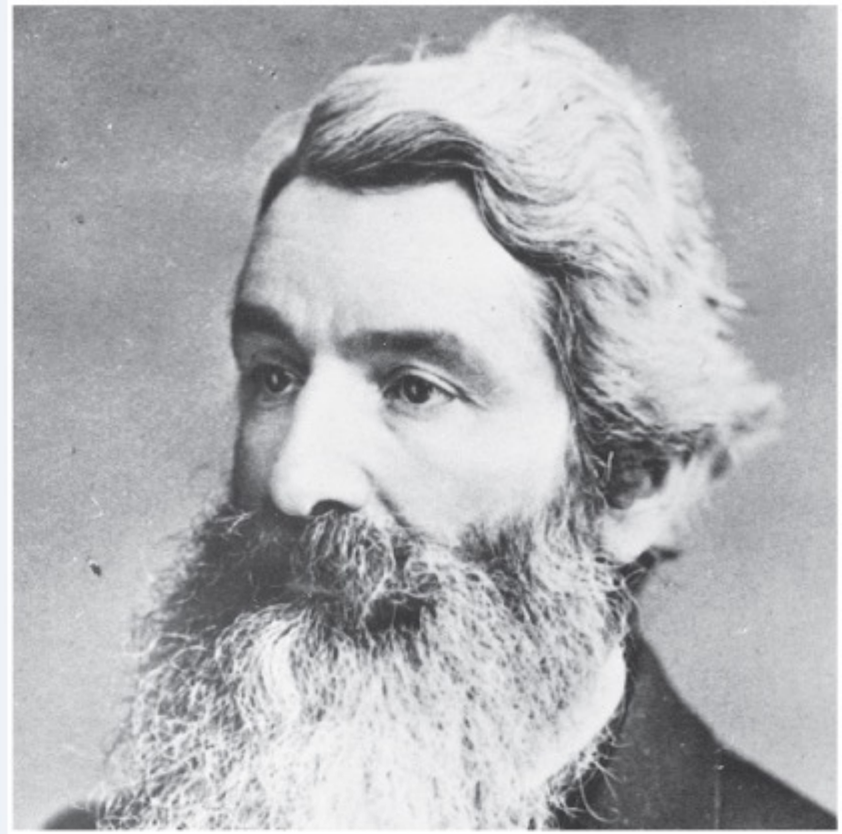
(Left Image): Source: Underwood & Underwood, Library of Congress Prints and Photographs Division [LC-USZC4-4698]; (Right Image): Courtesy of Grey Towers National Historic Landmark;

Ethical and Aesthetic Concerns Inspired the Preservation Movement

John Muir, the first president of the Sierra Club, opposed Pinchot's utilitarian policies.

He argued that nature deserves to exist for its own sake.

Aesthetic and spiritual values formed the core of his philosophy.



Bettmann/Getty Images

Preservation Emphasizes The Fundamental Right of Other Organisms

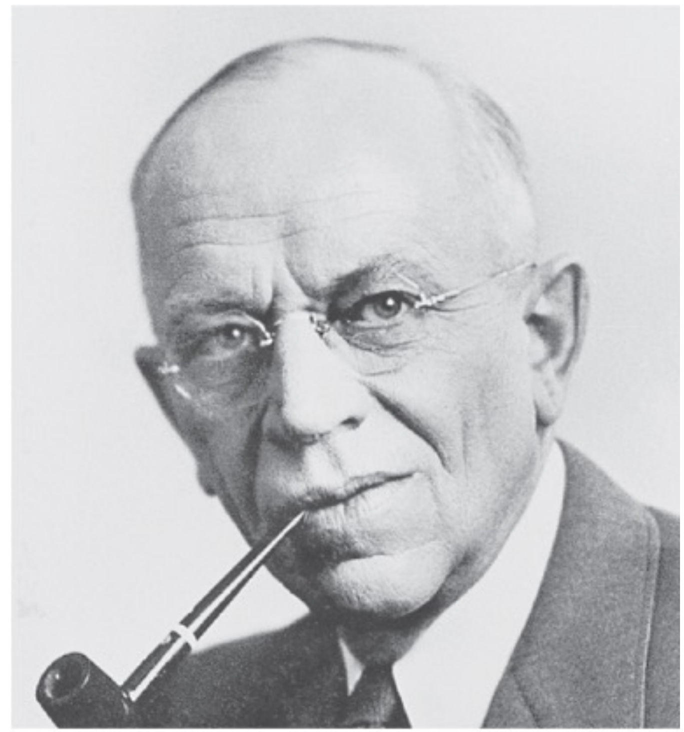
Altrendo Nature/Getty Images

Wildlife Ecologist Aldo Leopold

Formulated and advocated for a **land ethic**.

Aldo Leopold planted trees in a practical experiment aimed at restoring the health and beauty of the land.

He wrote a collection of environmental essays espousing a respect for the land and he also founded the Wilderness Society.



AP Images

Rising Pollution Levels Led to the Modern Environmental Movement

Poor air quality, due to the burning of coal in London, became an increasing problem, eventually resulting in the deaths of 12,000 people in the year 1952.

In response to pollution from the chemical industries after World War II, Rachel Carson published a book, *Silent Spring,* in 1962.

This book awakened the public to the threats of toxic chemicals to humans as well as other species and launched the modern environmental movement.

Environmental Activists 1

a) Rachel Carson

b) Bill McKibben

c) Van Jones

d) Wangari Maathai

(a): RHS/AP Images; (b): Cindy Ord/Getty Images; (c): Ryan Rodrick Beiler/Shutterstock; (d): s_bukley/Shutterstock

Environmental Activists Van Jones and Bill McKibben

Activist Van Jones promotes the idea of a “green-collar” economy in which jobs are created installing solar energy systems and upgrading homes for energy efficiency.

Bill McKibben is a writer and activist demanding political action on climate change.

Both activism and research remain hallmarks of the modern environmental movement.

Environmental Activists 2

Van Jones

Bill McKibben

(Left) Ryan Rodrick Beiler/Shutterstock; (Right) Cindy Ord/Getty Images

Environmental Quality Is Tied to Social Progress

Increasingly, environmental activists are making explicit the links between environmental quality and social progress on a global scale.

Today's environmental movement is pushing **sustainable development,** the idea that economic improvement for the world's poorest populations is possible without devastating the environment.

Dr. Wangari Maathai is a notable example who has supported sustainable development in Kenya, where she founded the Green Belt Movement.

Dr. Wangari Maathai

s_bukley/Shutterstock

Take-Away Points

Environmental science gives us useful tools and ideas for understanding both environmental problems and new solutions to those problems.

We face many persistent environmental problems, but we can also see many encouraging examples of progress.

Resolving these multiple problems together is the challenge for sustainability.

Science gives us an orderly, methodical approach to examining environmental problems.

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