Chapter 1
Environmental Science: Studying the State of Our Earth

Module 1
Environmental Science

Watch the Slideshow

- part one name as many conditions surrounding the animals as you can, include both living and nonliving components.

- part two name as many human impacts as you can, include the effects that it might have on a condition(s) from part one

Module 1
Environmental Science

- Have you heard of “fracking”?
- When or where did you hear about “fracking”?

- What know or think you know about “fracking”?

Read the Chapter 1 Opener

Module 1
Environmental Science

Chapter 1 Opener Review Points

- The dilemma of fracking illustrates the inherent **Trade-offs** that are part of every environmental issue

- Information in popular press is not always reliable or objective

- environmental science takes a scientific, objective approach

Module 1
Environmental Science

After reading this module you should be able to

- define the field of environmental science and discuss its importance.
- identify ways in which humans have altered and continue to alter our environment.

Environmental Science

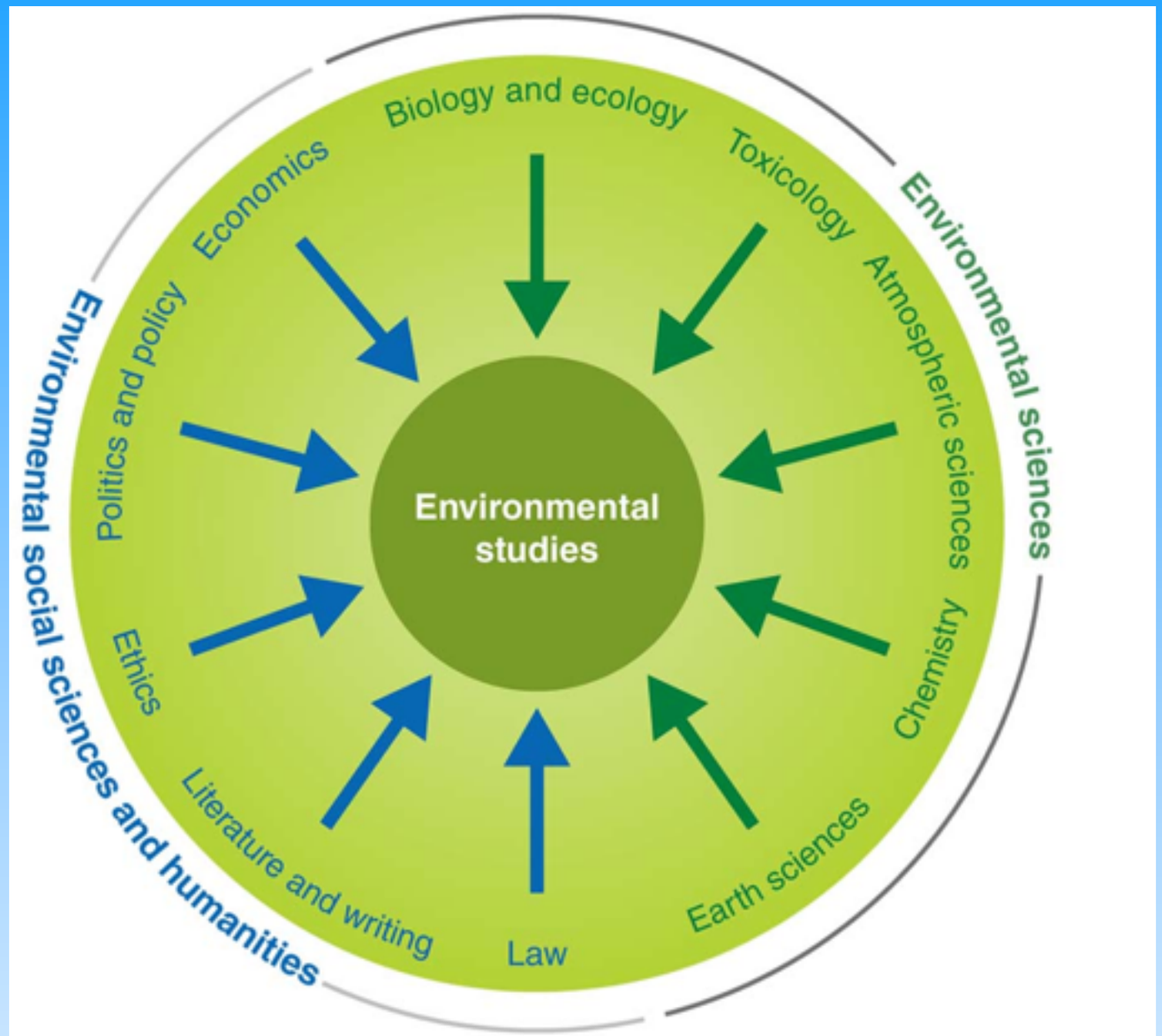

Figure 1.1
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Environmental studies. The study of environmental science uses knowledge from many disciplines.

Environmental science offers important insights into our world and how we influence it

- **Environment** The sum of all the conditions surrounding us that influence life.

- **Environmental science** The field that looks at interactions among humans and those found in nature.

- **Ecosystem** A particular location on Earth with interacting biotic and abiotic components.

Environmental Science

- **Environmentalist** A person who participates in environmentalism, a social movement that seeks to protect the environment through lobbying, activism, and education.

- **Environmental studies** The field of study that includes environmental science and additional subjects such as environmental policy, economics, literature, and ethics.

Read (p.4) compare an environmental scientist to an environmental activist

Humans alter natural systems

Humans manipulate their environment more than any other species.

In what ways do humans change their environment?

Read (p.5) and focus on how humans have caused the extinction of past animals

Module 1
Environmental Science

Do Module 1 review questions

Module 2
Environmental Indicators and Sustainability

After reading this module you should be able to

- identify key environmental indicators and their trends over time.

- define sustainability and explain how it can be measured using the ecological footprint.

Module 2
Environmental Indicators and Sustainability

- What services and products does nature provide for us.
- Determine if we can or can not live with out each one of them.

Module 2
Ecosystem Services

- **Ecosystem services** The processes by which life-supporting resources such as clean water, timber, fisheries, and agricultural crops are produced.

Environmental scientists monitor natural systems for signs of stress

- **Environmental indicator** An indicator that describes the current state of an environmental system.

Environmental Indicators

Environmental indicators help us describe the current state of an environmental system. The five key global environmental indicators are:

- Biological diversity
- Food production
- Average global surface temperature and CO_2 concentrations in the atmosphere
- Human population
- Resource depletion

Environmental Indicators

TABLE 2.2 Five key global indicators

Indicator	Recent trend	Outlook for the future	Overall impact on environmental quality
Biological diversity	Large number of extinctions, extinction rate increasing	Extinctions will continue	Negative
Food production	Per capita production possibly leveling off	Unclear	May affect the number of people Earth can support
Average global surface temperature and CO_2 concentration	CO_2 concentrations and temperatures increasing	Probably will continue to increase, at least in the short term	Effects are uncertain and varied but probably detrimental
Human population	Still increasing, but growth rate slowing	Population leveling off; resource consumption rates also a factor	Negative
Resource depletion	Many resources being depleted at rapid rate, but human ingenuity develops "new" resources, and efficiency of resource use is increasing in many cases	Unknown	Increased use of most resources has negative effects

Table 2.2
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Biodiversity

Key Global Environmental Indicator 1: Biological Diversity

- **Biodiversity** The diversity of life forms in an environment

Biodiversity exists on three scales:

- Genetic
- Species
- Ecosystem

Biodiversity

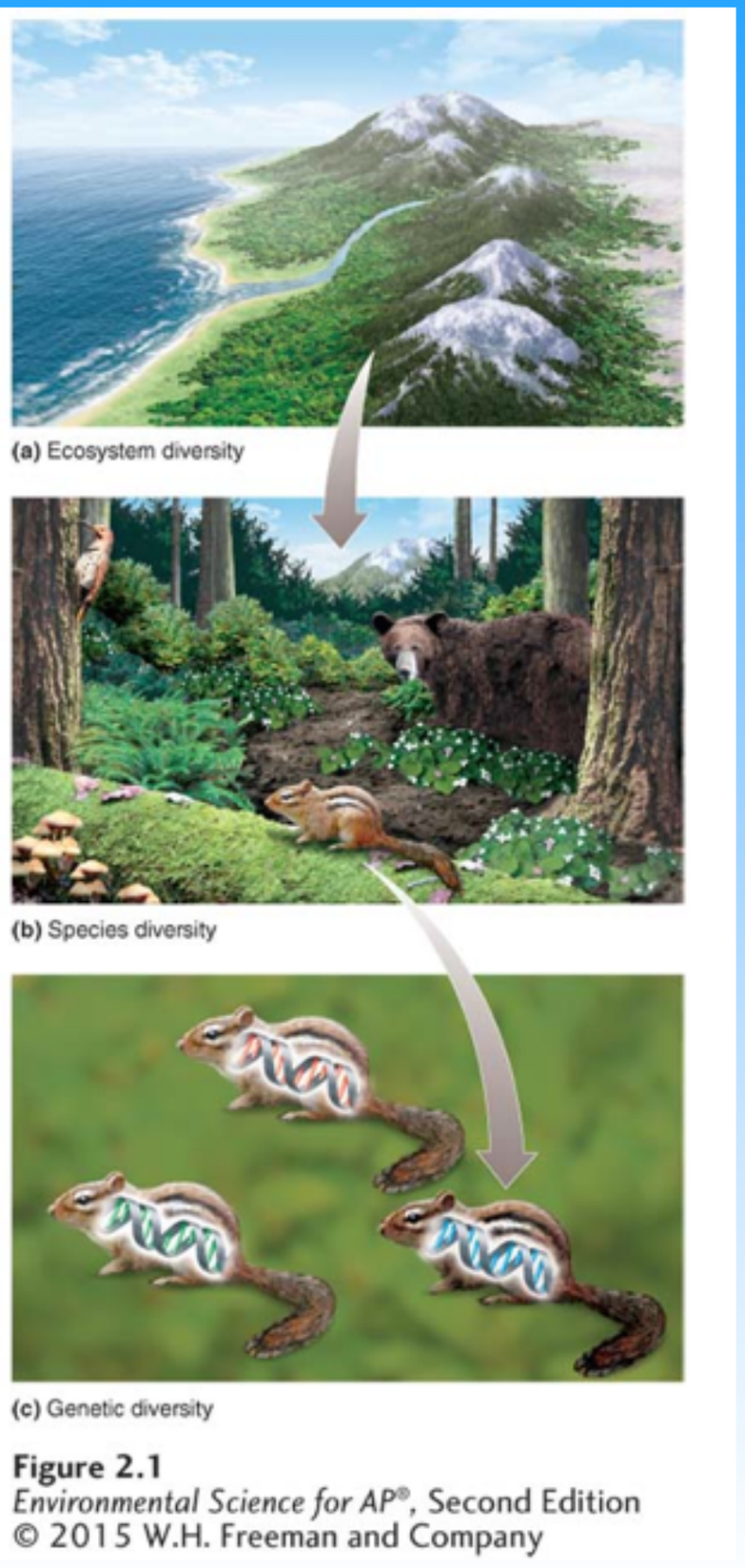

Figure 2.1
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Levels of biodiversity. Biodiversity exists at three scales.

(a) Ecosystem diversity is the variety of ecosystems within a region.

(b) Species diversity is the variety of species within an ecosystem.

(c) Genetic diversity is the variety of genes among individuals of a species.

Genetic Diversity

- **Genetic Diversity** A measure of the genetic variation among individuals in a population

- Populations with high genetic diversity are better able to respond to environmental change than populations with lower genetic diversity.

Species Diversity

- **Species** A group of organisms that is distinct form other groups in its morphology (body form and structure), behavior, or biochemical properties.

- **Species diversity** The number of species in a region or in a particular type of habitat.

- **Speciation** The evolution of new species.

- **Background extinction rate** The average rate at which species become extinct over the long term.

Ecosystem Diversity

Ecosystem diversity is a measure of the diversity of of ecosystems of habitats in that exist in a given region.

Food Production

Key Global Environmental Indicator 2: Food Production

- Food production is our ability to grow food to nourish the human population.

- We use science and technology to increase the amount of food we can produce on a given area of land.

Food Production

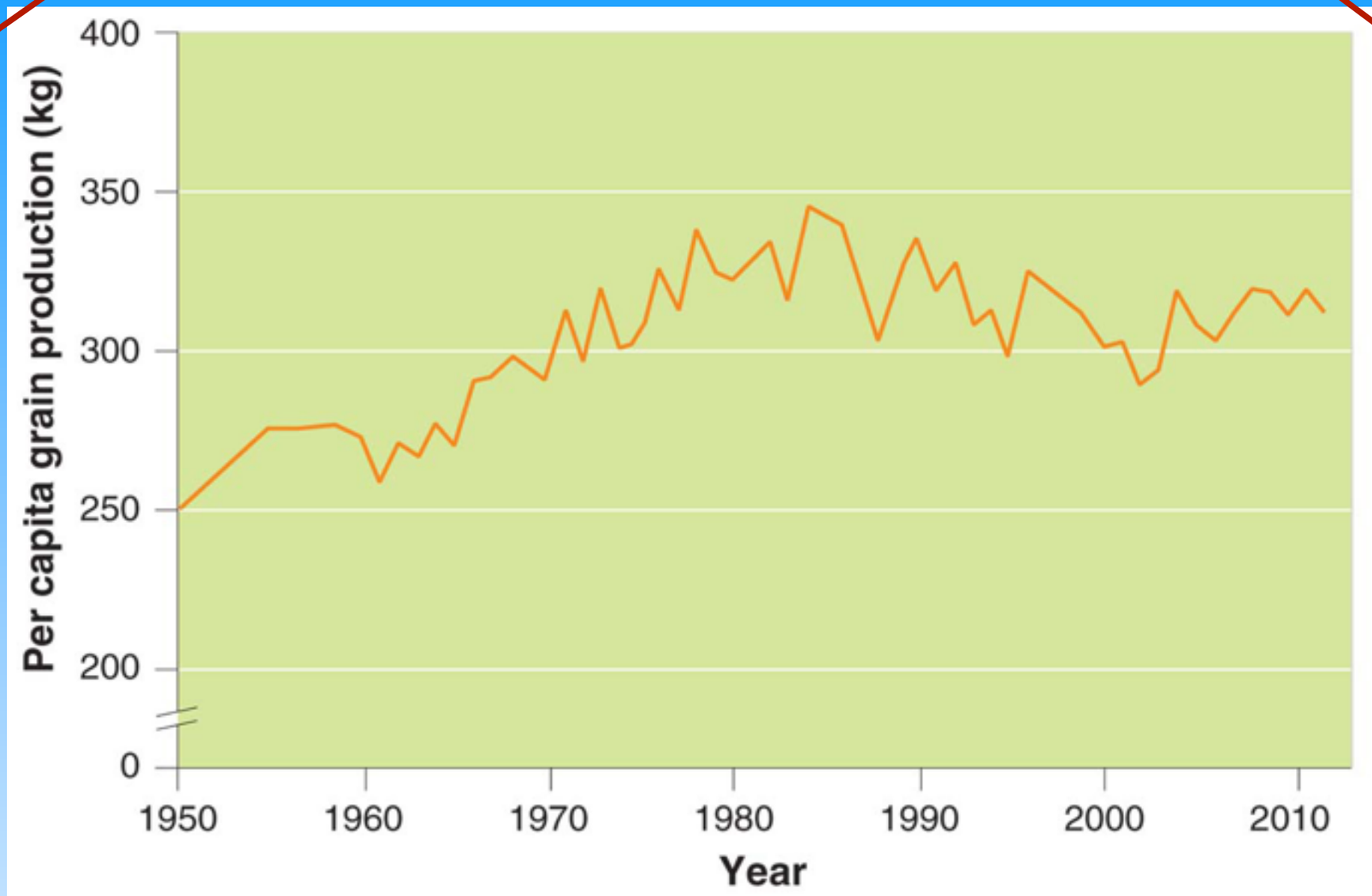

Figure 2.3
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After http:// www.earth-policy.org/index.php?/indicators/C54

World grain production per person. Grain production has increased since the 1950s, but it has recently begun to level off. Why? and...What the factors were responsible for food shortages in 2008

?

do the **math**

Converting Between Hectares and Acres

In the metric system, land area is expressed in hectares. A hectare (ha) is 100 meters by 100 meters. In the United States, land area is most commonly expressed in acres. There are 2.47 acres in 1 ha. The conversion from hectares is relatively easy to do without a calculator; rounding to two significant figures gives us 2.5 acres in 1 ha. If a nature preserve is 100 ha, what is it size in acres?

100 ha × 2.5 acres = 250 acres

Your Turn A particular forest is 10,000 acres. Determine its size in hectares.

Surface Temperature and CO_2 Concentration

Key Global Environmental Indicator 3: Average Global Surface Temperature and CO_2 Concentration

- **Greenhouse gases** Gases in Earth's atmosphere that trap heat near the surface.
- The most significant greenhouse gas is carbon dioxide (CO_2).
- **Anthropogenic** Derived from human activities.

Surface Temperature and CO_2 Concentration

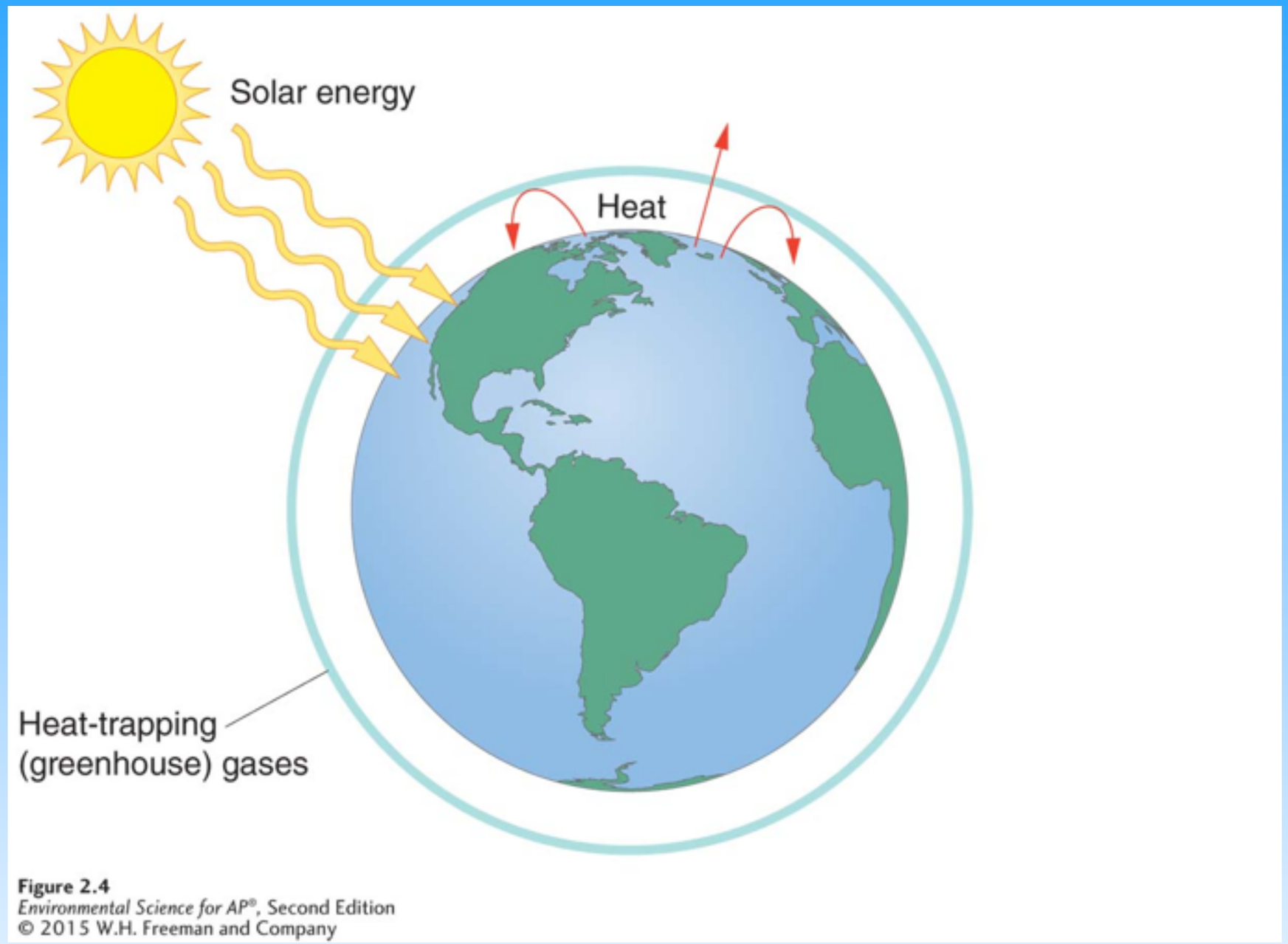

Figure 2.4
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The Earth-surface energy balance. Earth's surface is warmed by the Sun, radiating heat outward. Heat-trapping gases absorb the outgoing heat, reradiating some back to Earth.

Greenhouse Effect

Surface Temperature and CO_2 Concentration

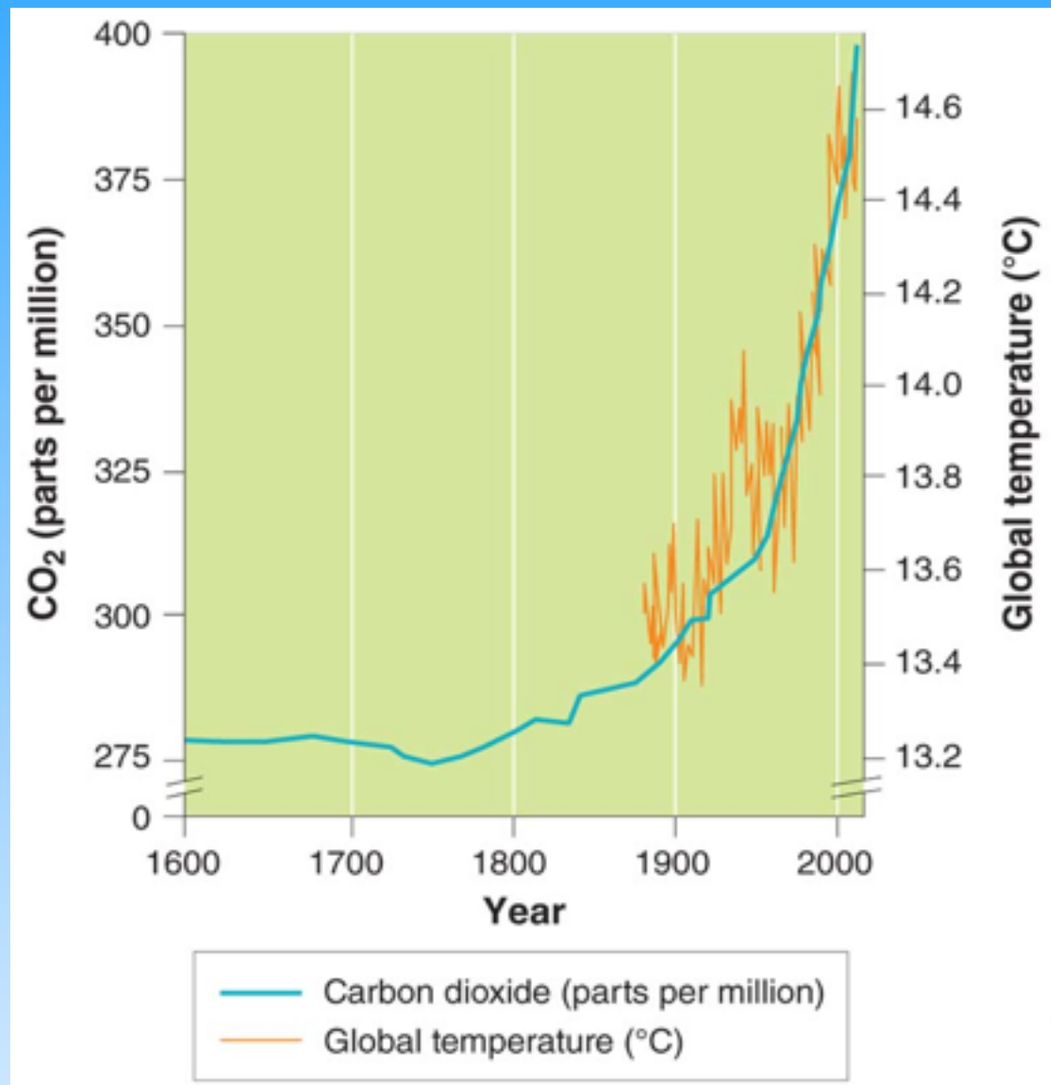

Figure 2.5
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Data from http://data.giss.nasa.gov/gistemp/graphs_v3/ and http://www .esrl.noaa.gov/gmd/ccgg/trends/#mlo_full

Do the data shown surprise you? Why or Why not?

Changes in average global surface temperature and atmospheric CO_2 concentrations. Earth's average global surface temperature has increased steadily for at least the past 100 years.

Human Population

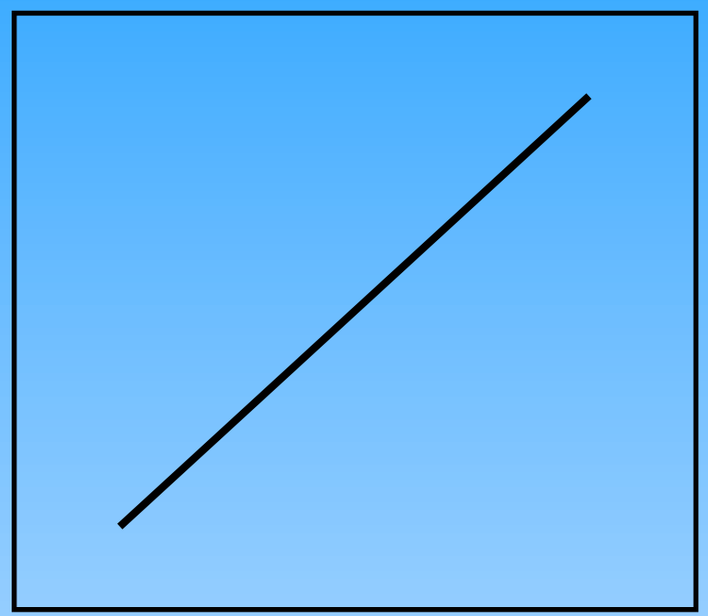
Key Global Environmental Indicator 4: Human Population

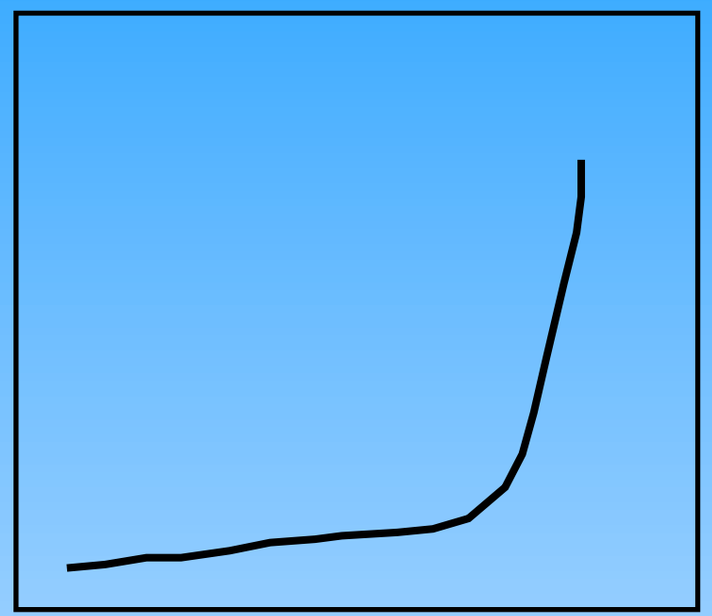
- The current human population is 7.2 billion and growing.

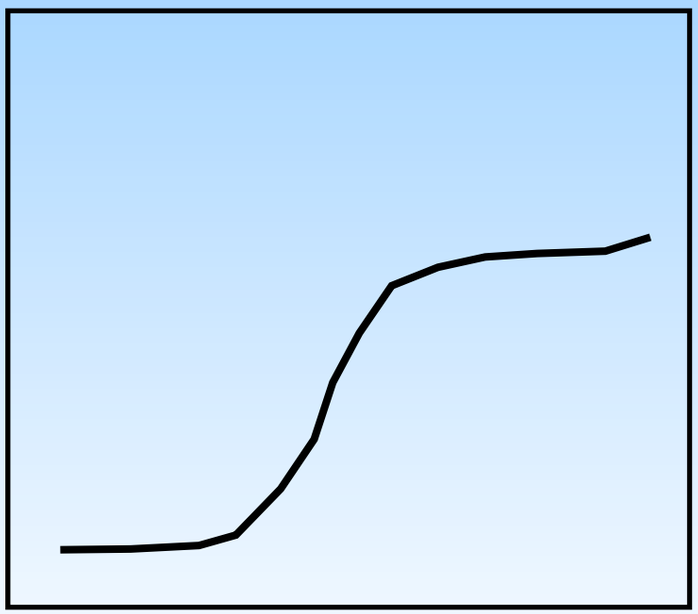
- Population scientists project the human population will reach 8.1-9.6 billion by 2050 and stabilize between 7.1-10.5 billion by 2100.

Human Population Last 2000 years?

?







Resource Depletion

Key Global Environmental Indicator 5: Resource Depletion

- Some natural resources, for example, coal, oil, and uranium are finite and cannot be renewed or reused.

- Other natural resources, for example aluminum or copper, also exist in finite amounts but can be recycled.

- As the human population grows, it places greater demand on finite resources.

Label the following as renewable or non renewable resources: coal, copper, tidal energy, timber, wind energy, oil, uranium, biofuels

Answers

Renewable	Non Renewable
tidal energy	coal
timber	copper
wind energy	oil
biofuels	uranium

Are resources always either renewable or non-renewable?

?

Patterns of Resource Consumption

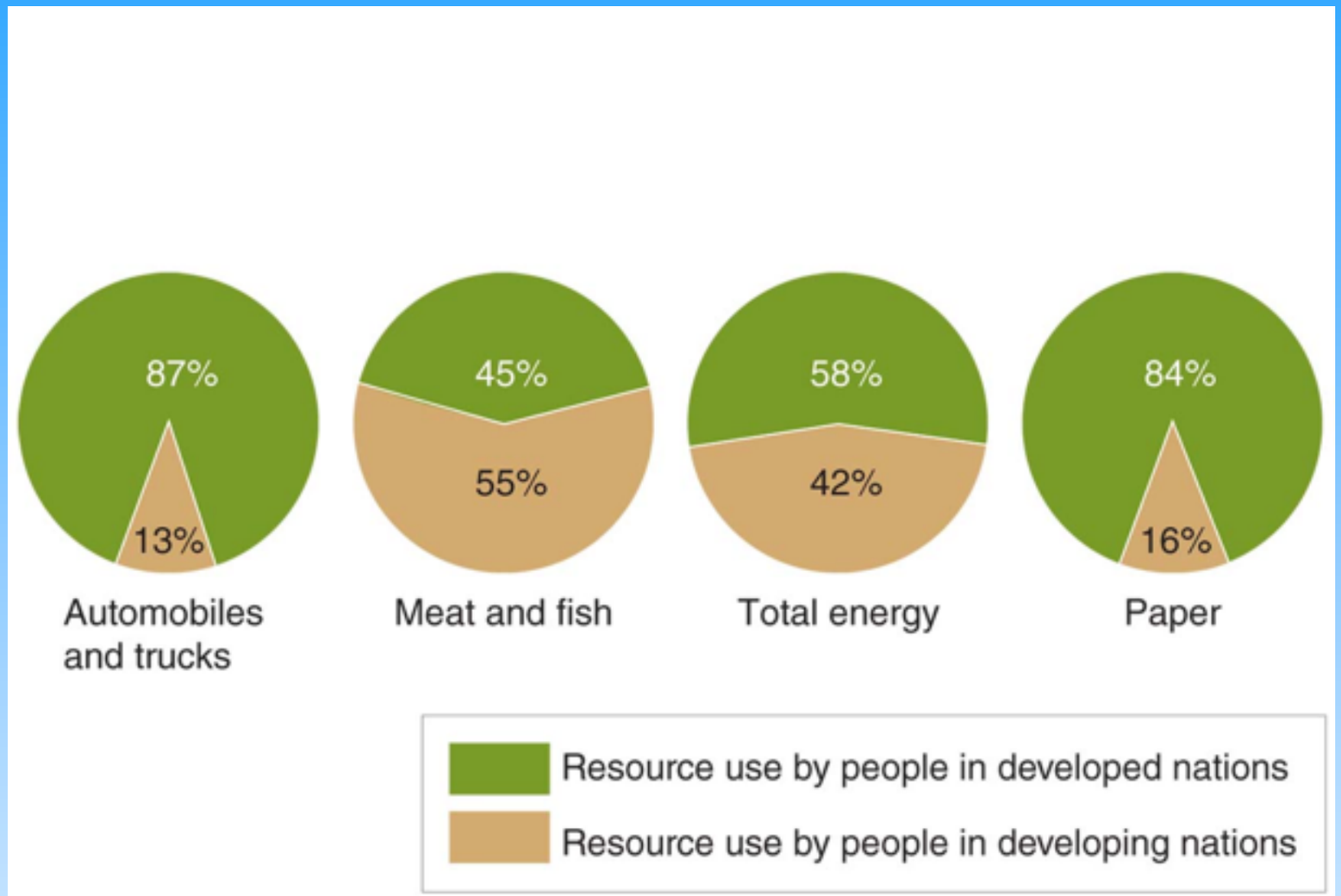


Figure 2.7
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Resource use in developed and developing countries. Only 20 percent of the world's population lives in developed countries, but that 20 percent uses most of the world's resources. The remaining 80 percent of the population lives in developing countries and uses far fewer resources per capita.

Name 5 global-scaled environmental indicators.

?

How do human activities contribute to changes in the 5 global-scaled environmental indicators.

Human well-being depends on sustainable practice

- **Sustainability** Living on Earth in a way that allows humans to use its resources without depriving future generations of those resources.

- **Sustainable development** Development that balances current well-being and economic advancement with resource management for the benefit of future generations.

Sustainable Practices

- Environmental systems must not be damaged beyond their ability to recover.
- Renewable resources must not be depleted faster than they can regenerate.
- Nonrenewable resources must be used sparingly.
- **Biophilia** Love of life.

do the **math**

Rates of Forest Clearing

A Web search of environmental organizations yielded a range of estimates of the amount of forest clearing that is occurring worldwide:

Estimate 1: 1 acre per second

Estimate 2: 80,000 acres per day

Estimate 3: 32,000 ha per day

Convert the first two estimates into hectares per year and compare them.

There are 2.47 acres per hectare (see "Do the Math: Converting Between Hectares and Acres"). Therefore, 1 acre = 0.40 ha.

Estimate 1: 1.0 acre/second × 0.40 ha /acre

= 0.40 ha/second 0.40 ha /second × 60 seconds/minute × 60 minutes/hour × 24 hours/day × 365 days/year

= 12,614,400 ha cleared per year

Estimate 2: 80,000 acres/day × 0.40 ha/acre = 32,000 ha cleared per day

Your Turn Notice that Estimate 2, when converted to hectares, is identical to Estimate 3. Now convert the estimate of 32,000 ha/day into the amount cleared per year. How much larger is Estimate 1 than Estimate 2? Why might environmental organizations, or anyone else, choose to present similar information in different ways?

The Ecological Footprint

- **Ecological footprint** A measure of how much an individual consumes, expressed in an area of land.

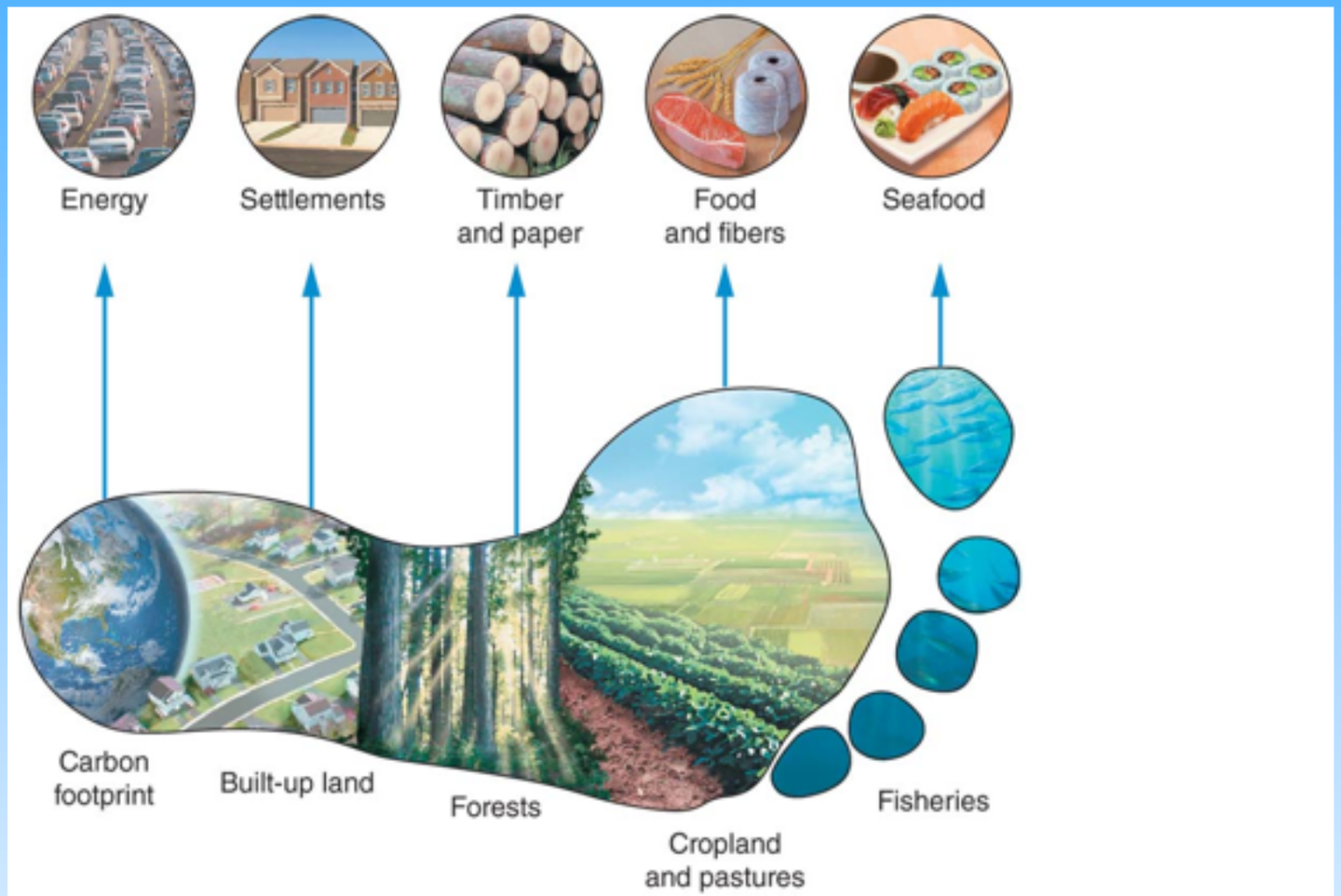

Figure 2.11
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The ecological footprint. Some of the many factors that go into the calculation of the footprint are shown here.

Sustainable Practices

- Pick an object in the room.
- Describe the resources used to make it.
- Discuss the items connection to land.
- **Notice that every object in our life originated from earth**

Module 3
Scientific Method

After reading this module you should be able to

- explain the scientific method and its application to the study of environmental problems.

- describe some of the unique challenges and limitations of environmental science.

Science is a process

- **Scientific method** An objective method to explore the natural world, draw inferences from it, and predict the outcome of certain events, process, or changes.

Scientific Method

- Observe and question
- Form testable hypothesis/ prediction
- Collect data/ conduct experiment to test prediction
- Interpret results
- Disseminate findings

Scientific Method

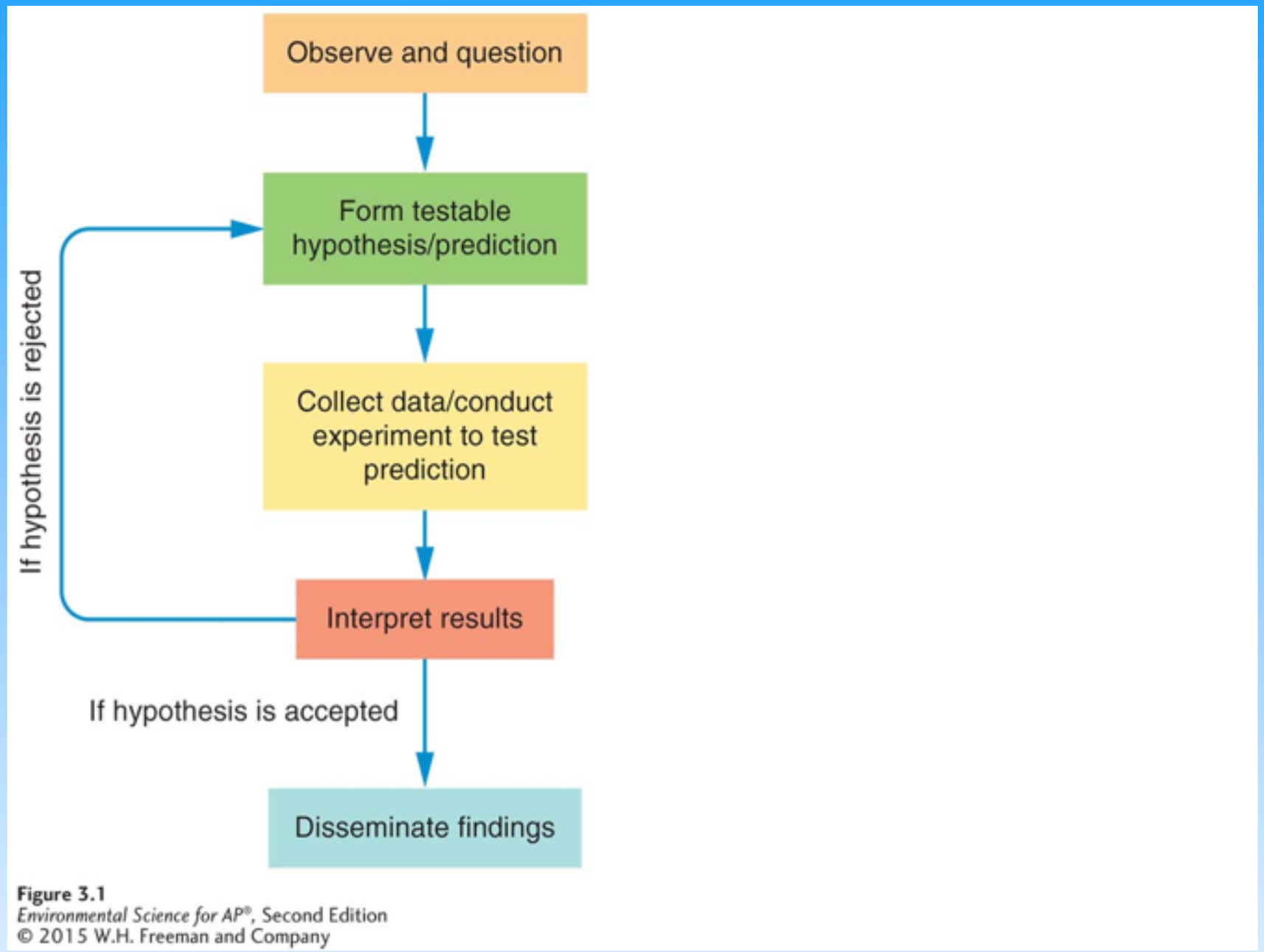

Figure 3.1
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The scientific method. In an actual investigation, a researcher might reject a hypothesis and investigate further with a new hypothesis, several times if necessary, depending on the results of the experiment.

Hypothesis

- **Hypothesis** A testable conjecture about how something works

- **Null hypothesis** A prediction that there is no difference between groups or conditions, or a statement or idea that can be falsified, or proven wrong.

Collect Data

- **Replication** The data collection procedure of taking repeated measurements.

- **Sample size (*n*)** The number of times a measurement is replicated in data collection.

- **Accuracy** How close a measured value is to the actual or true value.

- **Precision** How close the repeated measurements of a sample are to one another.

Collect Data

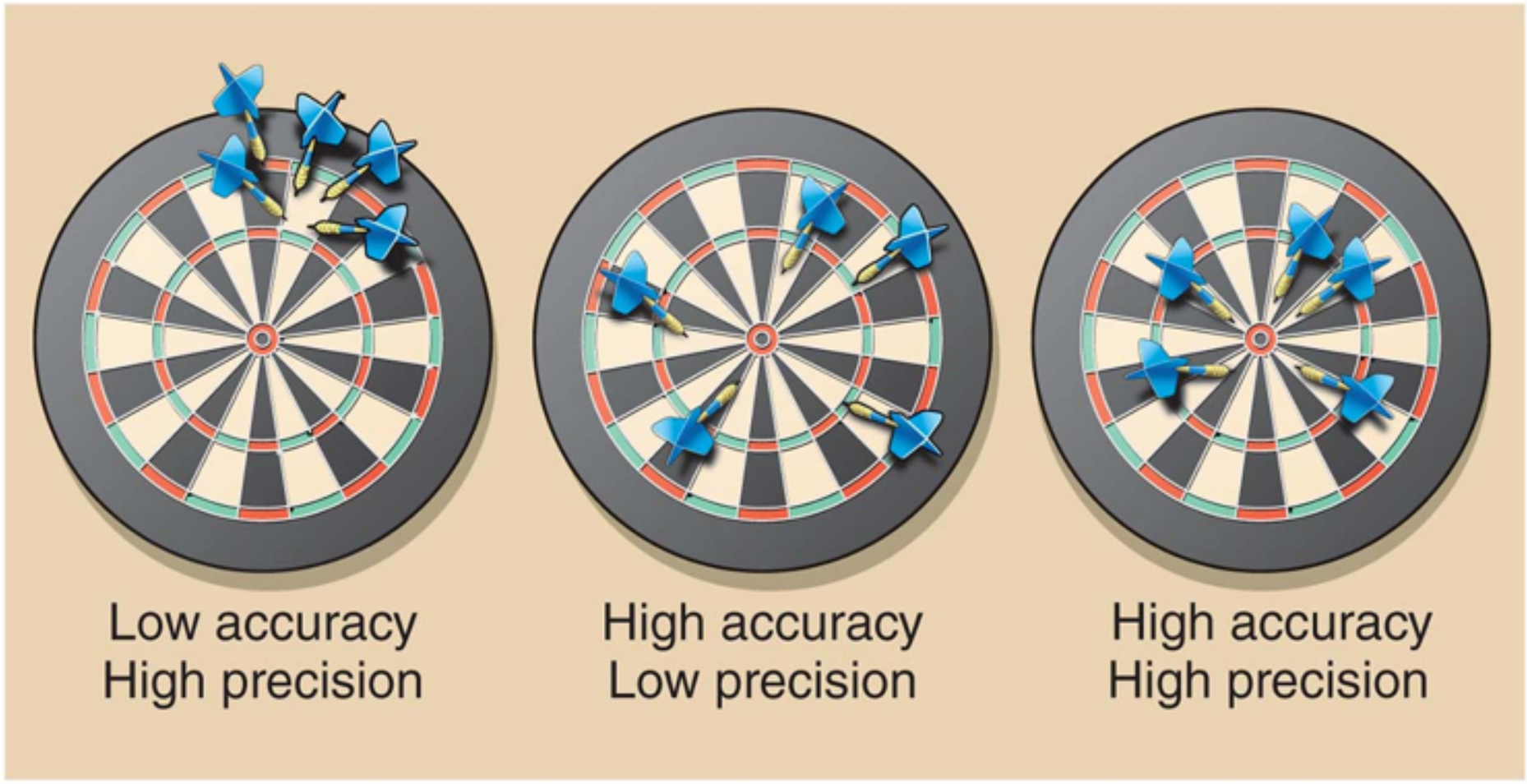

Figure 3.2
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Accuracy and precision. Accuracy refers to how close a measured value is to the actual or true value. Precision is how close repeated measurements of the same sample are to one another.

Interpret Results

- Once results have been obtained, analysis of the data begins. This process involves two types of reasoning, inductive and deductive.

- Inductive reasoning is the process of making general statements from specific facts or examples.

- Deductive reasoning is the process of applying a general statement to specific facts or situations.

- Scientists maintain multiple working hypotheses.

- Scientists reject or accept a hypothesis based on what the data show and begin to generate conclusions based on their results.

Disseminate Findings

- Scientists present papers at conferences and publish the results of their investigations. This allows other scientists to repeat the original experiment and verify or challenge the results. This can lead to a hypothesis eventually becoming a theory.

- **Theory** A hypothesis that has been repeatedly tested and confirmed by multiple groups of researchers and has reached wide acceptance.

Controlled Experiments

- Controlled experiments take place in a laboratory.
- **Control group** In a scientific investigation, a group that experiences exactly the same conditions as the experimental group, except for the single variable under study.

Controlled Experiments

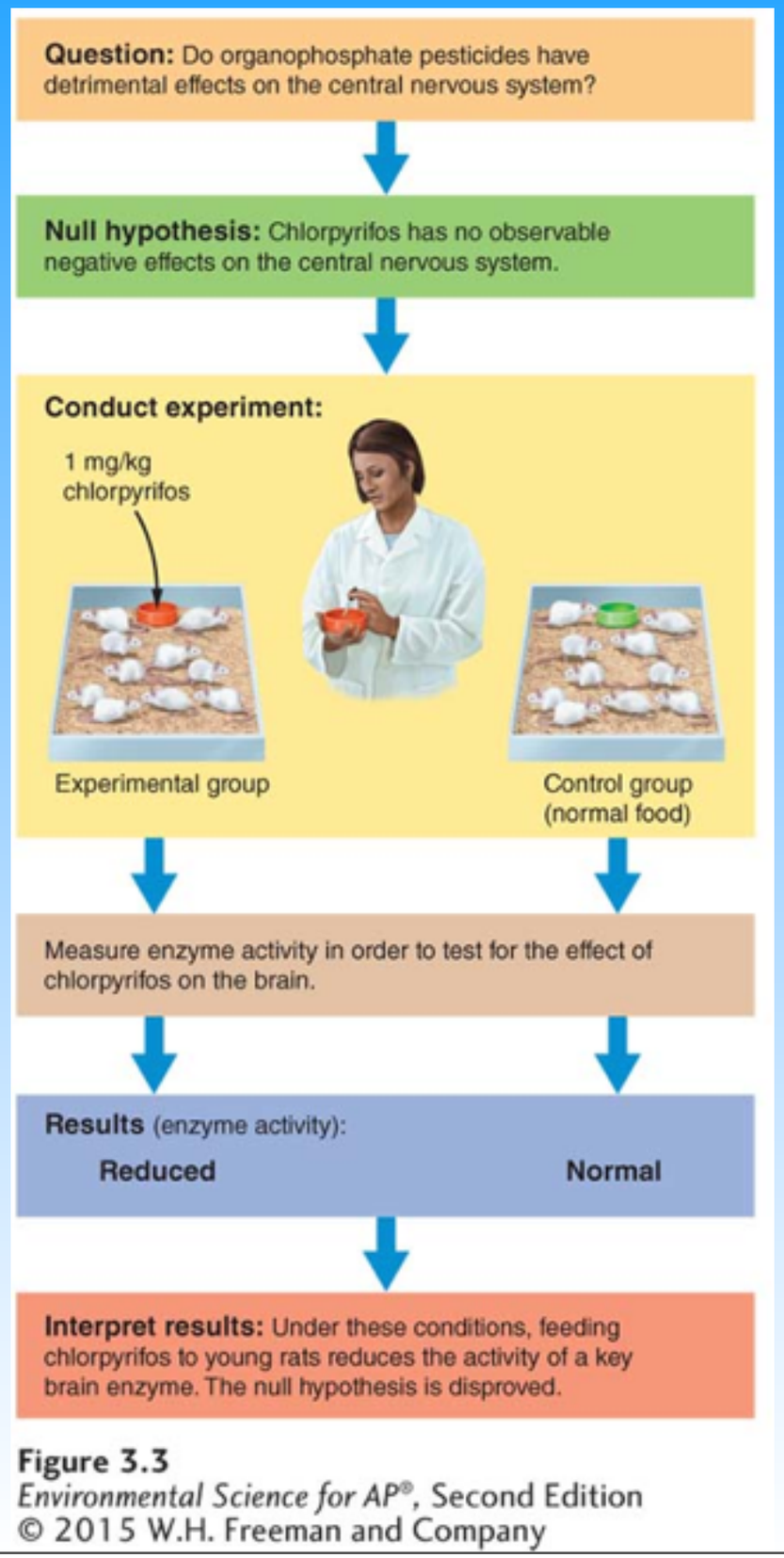

Figure 3.3
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A typical experimental process. An investigation of the effects of chlorpyrifos on the central nervous system illustrates how the scientific method is used.

Natural Experiments

- **Natural experiment** A natural event that acts as an experimental treatment in an ecosystem.

Environmental Science Presents Unique Challenges

- There is no control planet with which we can compare Earth.
- It is difficult to determine what is better or worse for the environment.
- Environmental science has so many interacting parts, it is not easy to apply one system to another.
- When people are unable to meet their basic needs, they are less likely to be interested in protecting the environment.

Human Well Being

- The principle of environmental equity - the fair distribution of earth's resources - adds a moral issue to questions raised by environmental science .

- Environmental justice is a social movement and a field of study that works towards equal enforcement of environmental laws and eliminates disparities whether intended or unintended