



Chapter 1

Studying the State of Our Earth

Studying The State of Our Earth

Environmental Science Offers Important Insights Into Our World and how We Influence It

- Environment- a sum of all the conditions surrounding us that influence life.
- Environmental science- the field that looks at interactions among humans and nature.
- System- a set of interacting components that influence one another by exchanging energy or materials.
- Ecosystem- the living and non-living components of a particular place on earth.

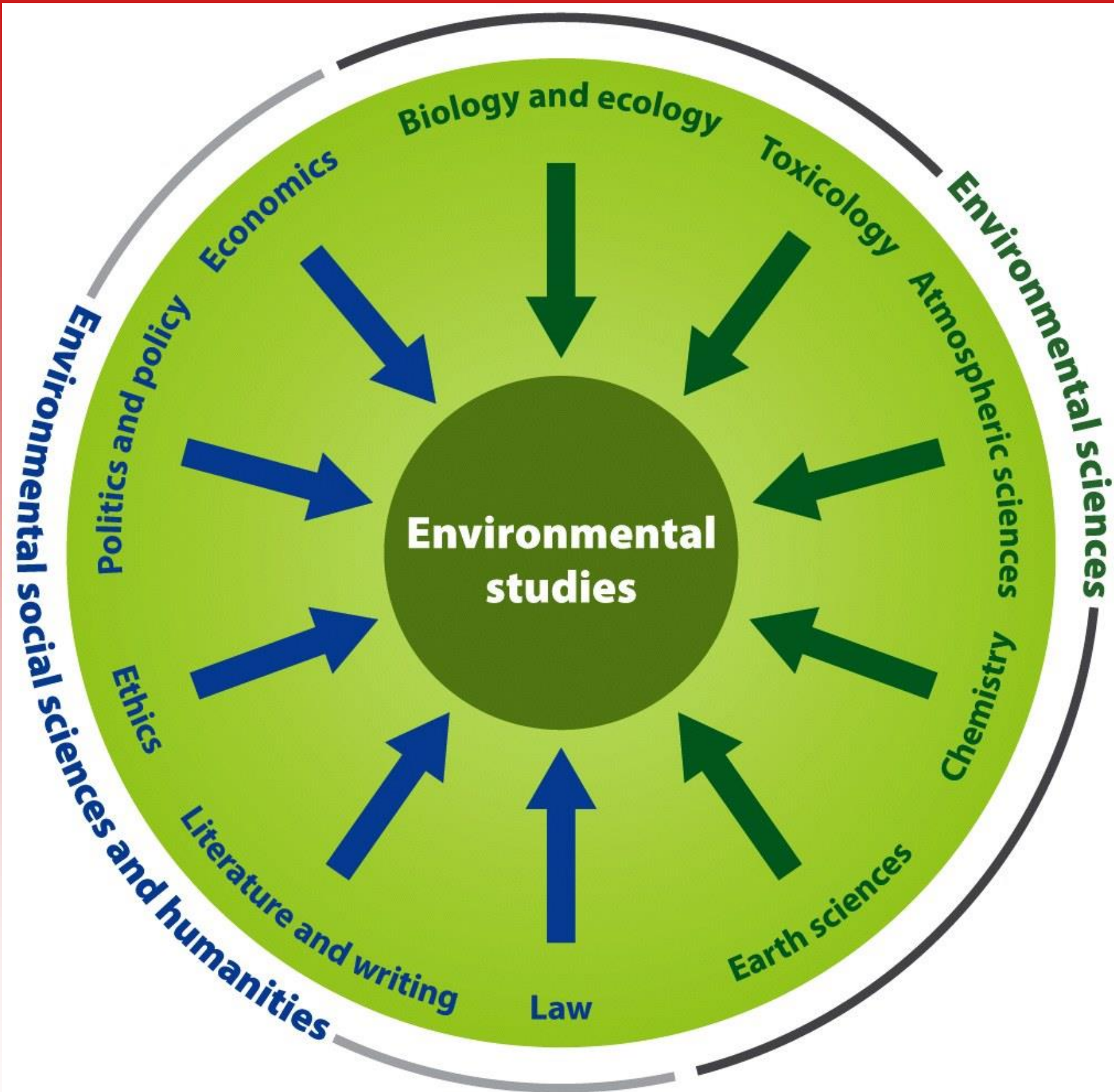


Figure 1.1

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- Biotic- the living part of the Earth (animals, plants)
- Abiotic- the non-living part of the Earth (soil, air, water)
- Environmental studies- includes environmental science, the study of interactions among human systems and those found in nature along with other subjects such as environmental policy, economics, literature and ethics.



Figure 1.2

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Humans Alter Natural Systems

- Humans manipulate their environment more than any other species.

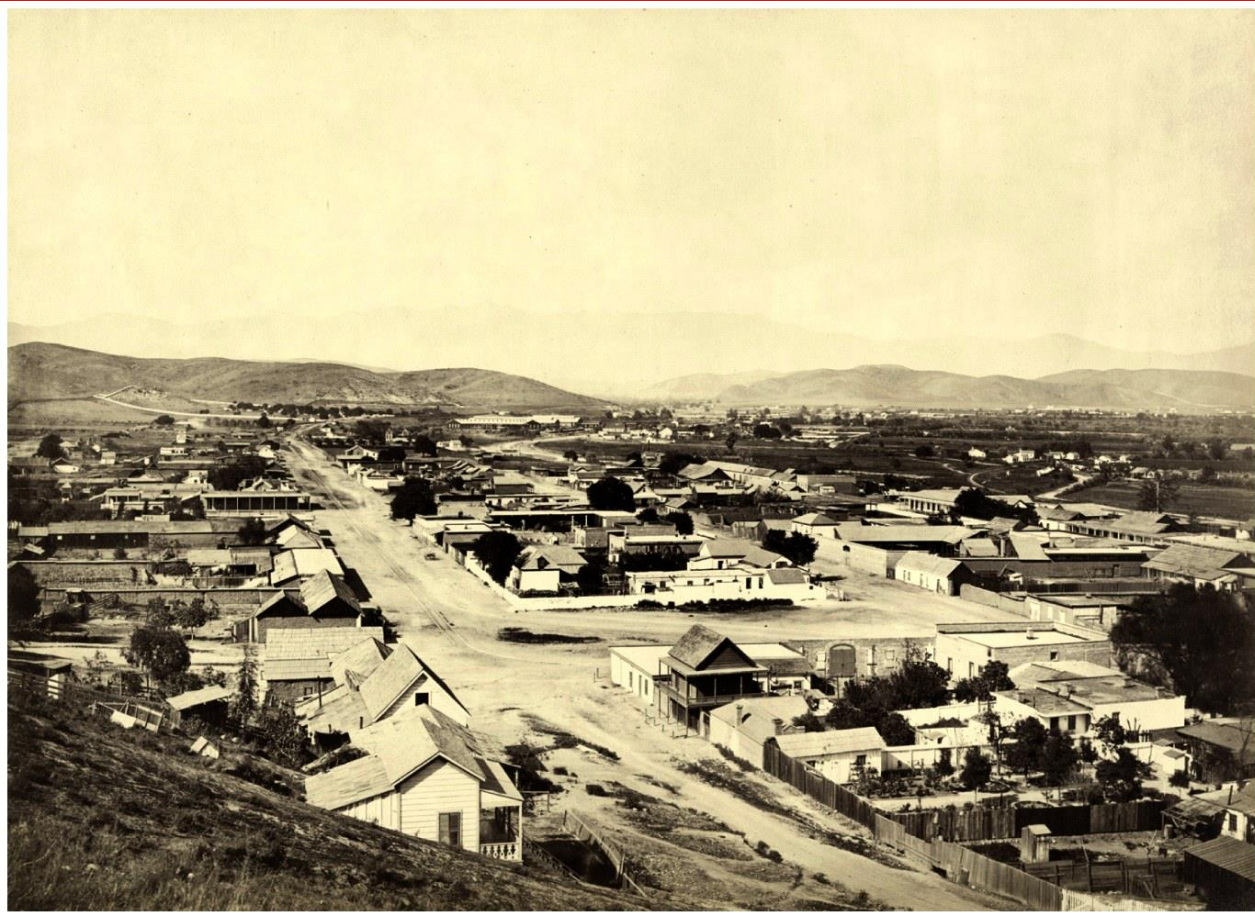


Figure 1.3a
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Figure 1.3b
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Environmental Scientists Monitor Natural Systems for Signs of Stress

- Ecosystem services- environments provide life supporting services such as clean water, timber, fisheries, crops.
- Environmental indicators- describe the current state of the environment.
- Sustainability- living on the Earth in a way that allows us to use its resources without depriving future generations of those resources.

TABLE 1.2 Five key global environmental indicators

Indicator	Recent trend	Outlook for future	Overall impact on environmental quality
Biological diversity	Large number of extinctions, extinction rate increasing	Extinctions will continue	Negative
Food production support	Per capita production possibly	Unclear leveling off	May affect the number of people Earth can
Average global surface temperature and CO ₂ concentrations	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 are also a factor	Negative
Resource depletion	Many resources are being depleted at rapid rates. But human ingenuity frequently develops "new" resources, and efficiency of resource use is increasing in many cases	Unknown	Increased use of most resources has negative effects

Table 1.2*Environmental Science*

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

Biological diversity

Food production

Average global surface temperature and carbon dioxide concentrations in the atmosphere

Human population

Resource depletion

Biological Diversity

- Biodiversity- the diversity of life formed in an environment
- Biological diversity includes genetic, species and ecosystem 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

- The number of species in a region or in a particular type of habitat.
- Species- a group of organisms that is distinct from other groups in form, behavior or biochemical properties. Individuals in a species can breed and produce fertile offspring.

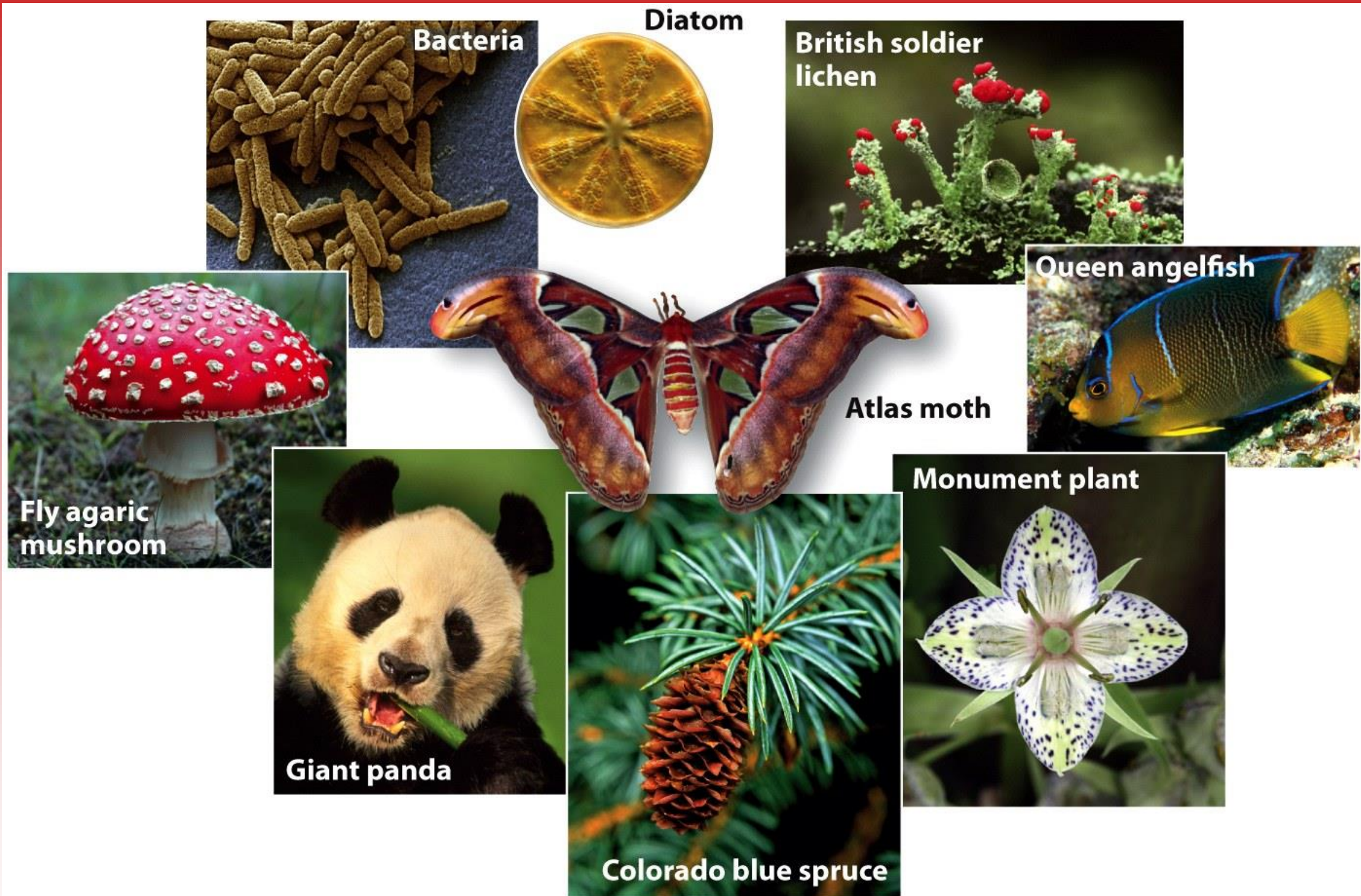


Figure 1.4

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Ecosystem Diversity

- A measure of the diversity of ecosystems or habitats that exist in a particular region.

Food Production

- 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.

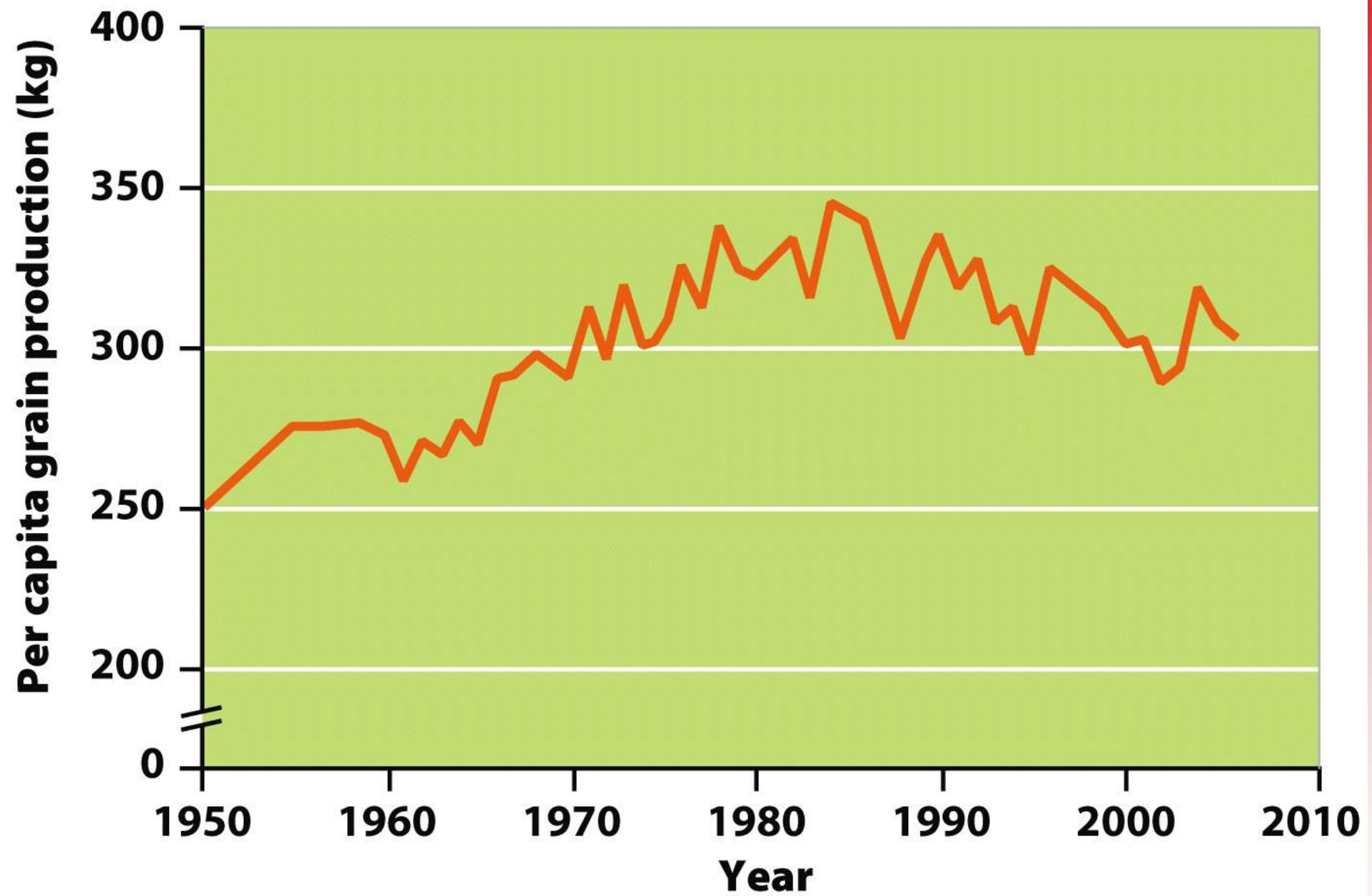
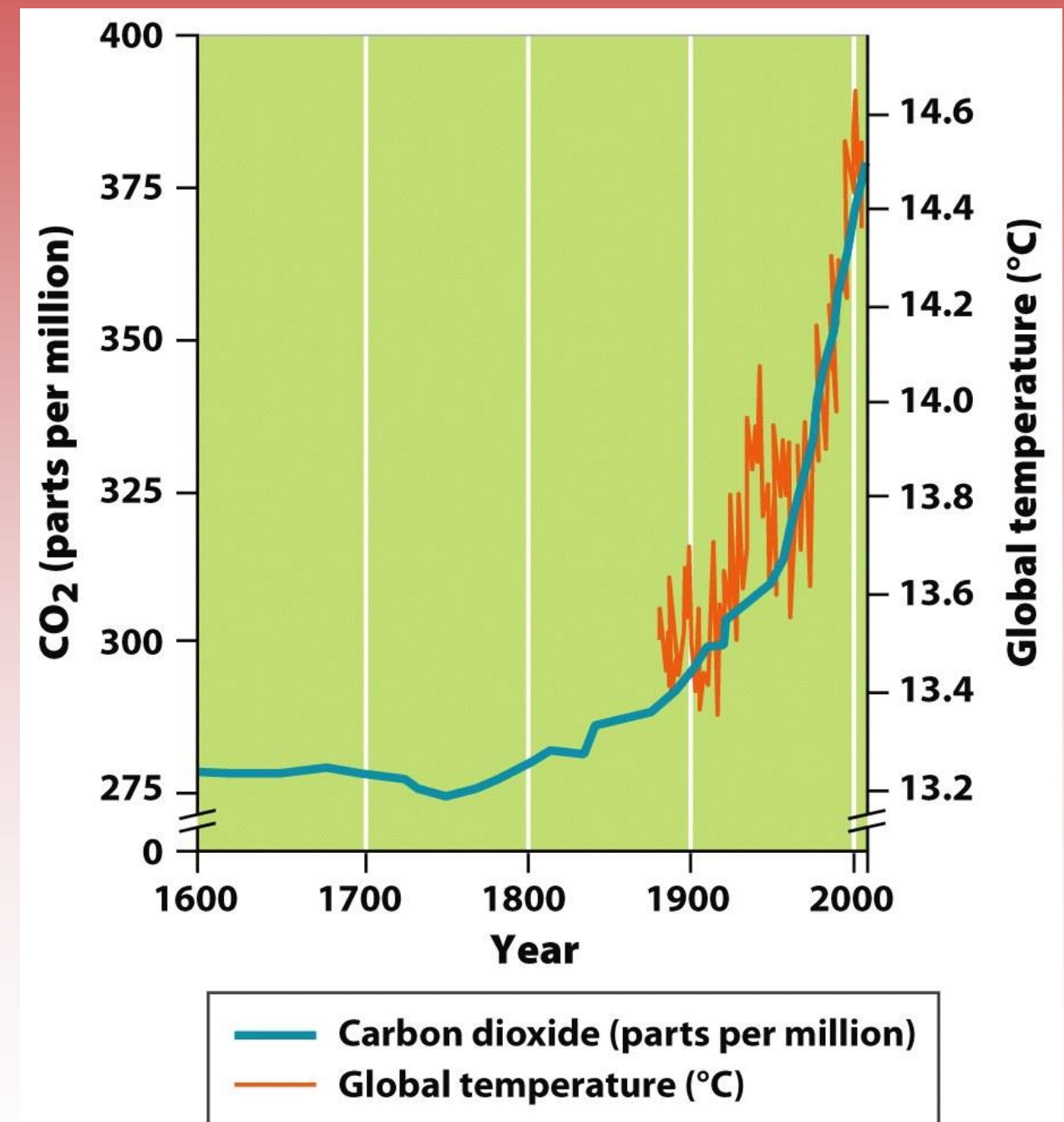
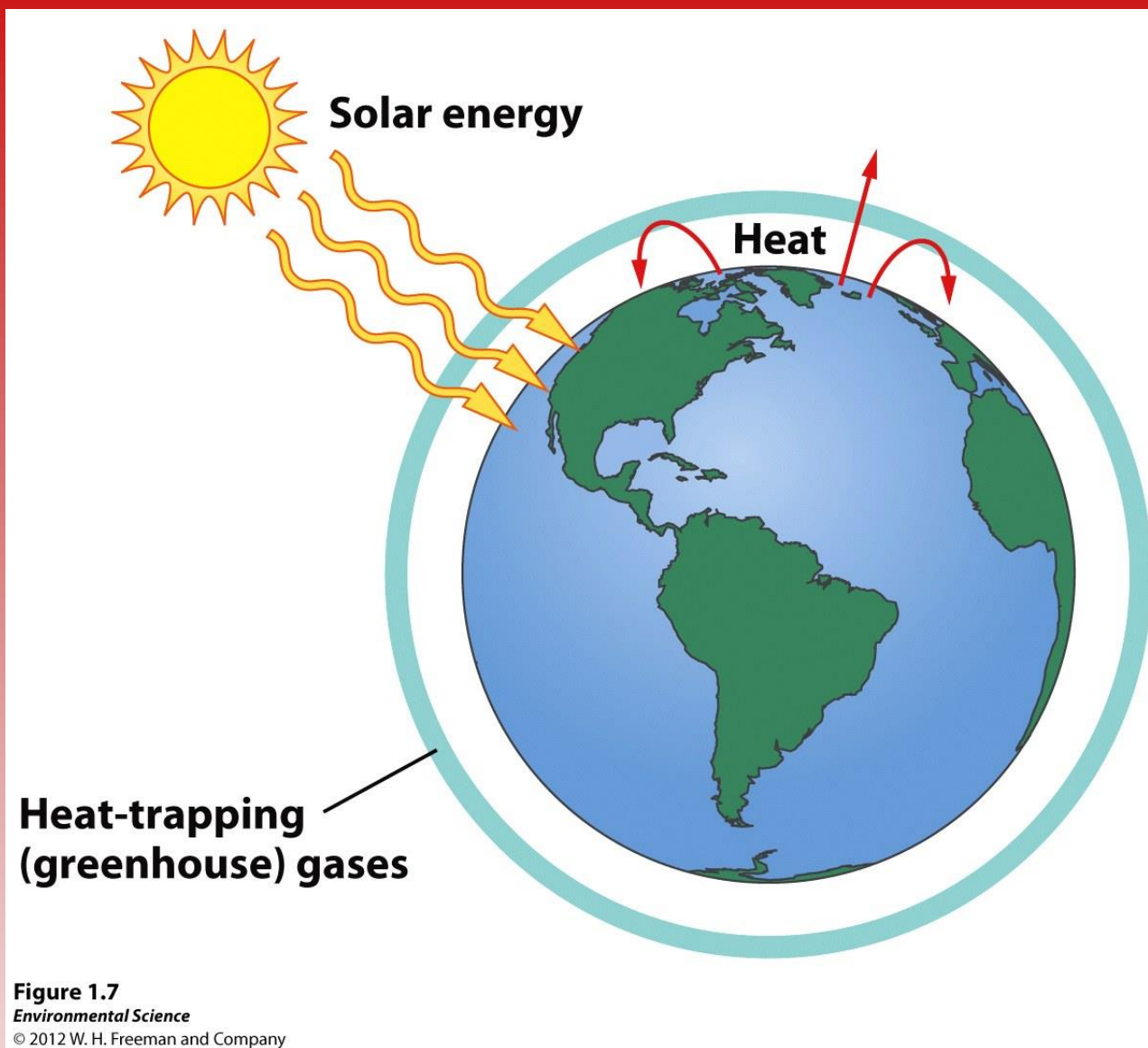


Figure 1.6
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Average Global Surface Temperatures and Carbon Dioxide Concentrations

- Greenhouse gases- gases in our planets atmosphere that act like a blanket, trapping heat near Earth's surface.
- The most important greenhouse gas is carbon dioxide.
- Anthropogenic- caused by human activities.



Human Population

- The current human population is 6.8 billion.
- Over a million additional people is added to the Earth every 5 days.



Figure 1.9

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Resource Depletion

- As the human population grows, the resources necessary for our survival become increasingly depleted.
- Some natural resources such as coal, oil and uranium are finite and cannot be renewed or reused.
- Other natural resources like aluminum or copper, also exist in finite amounts but can be recycled.

Resource Depletion

- Development- improvement in human well-being through economic advancement. As economies develop, resource consumption also increases.

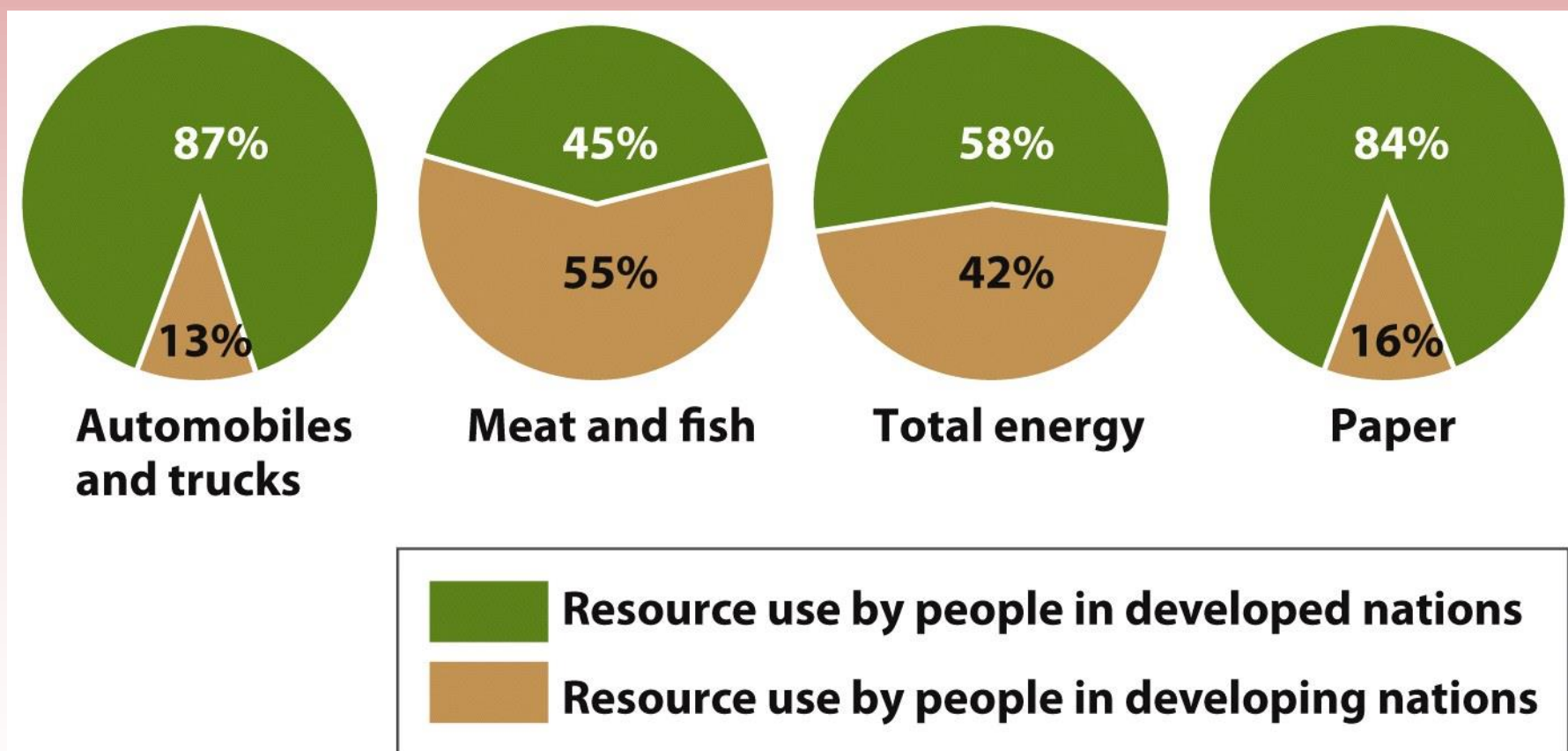


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Figure 1.11

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Human Well-Being Depends on Sustainable Practices

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



Figure 1.12

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Human Well-Being Depends on Sustainable Practices

- In order to live sustainably:
 - 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.

Defining Human Needs

- People in developed nations might say that they "need" electricity.
- People in the developing world have never heard of this modern convenience.
- Basic human needs- air, water, food and shelter.

The Ecological Footprint

- A measure of how much a person consumes, expressed in area of land.

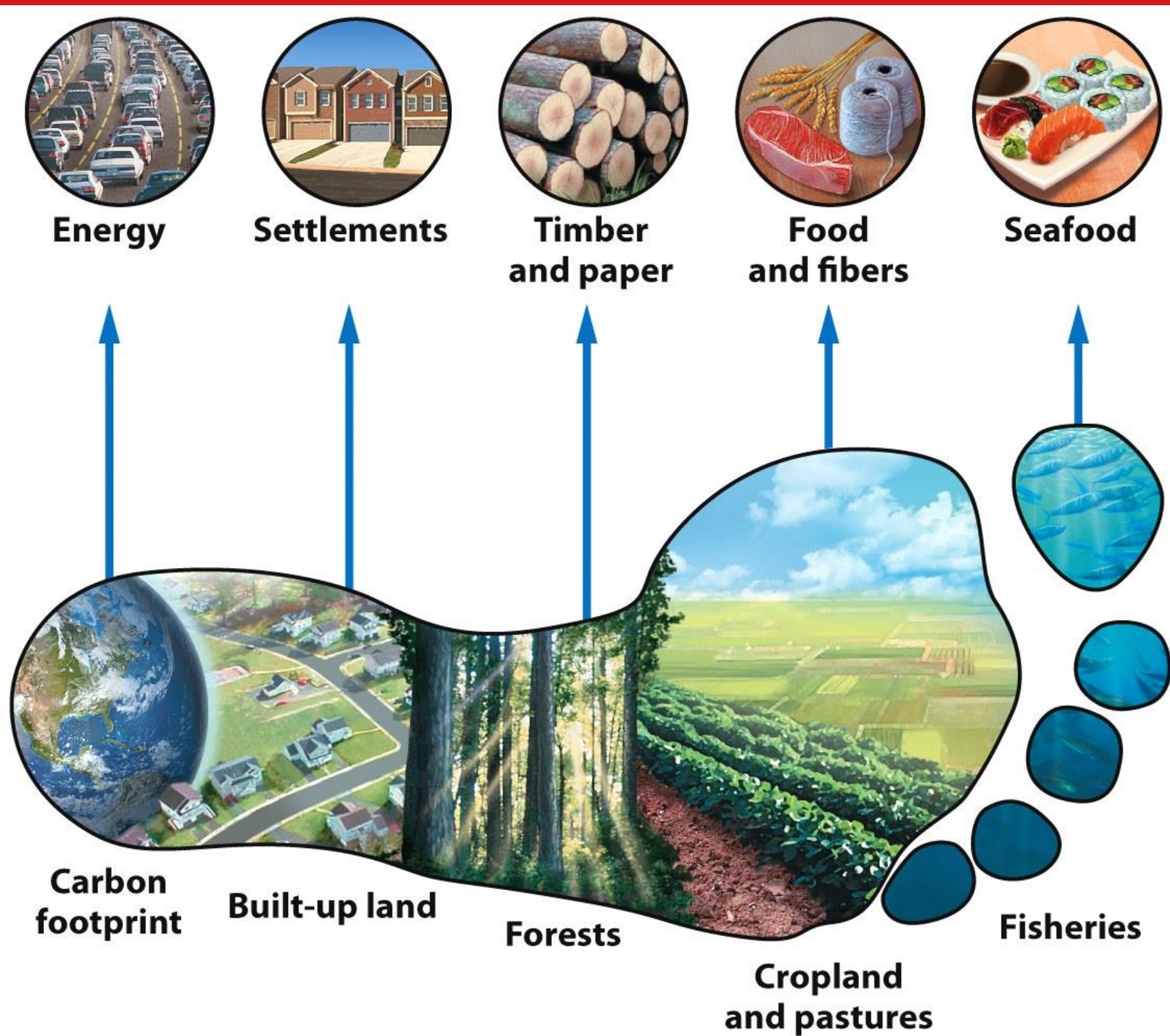


Figure 1.14

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**Present-day
footprint of
global human
population**



**Footprint of global
population if all
had average U.S.
lifestyle**

Figure 1.15

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Science is a Process

The Scientific Method

- Observations and questions
- Hypothesis
- Collecting data
- Interpreting results
- Disseminating findings

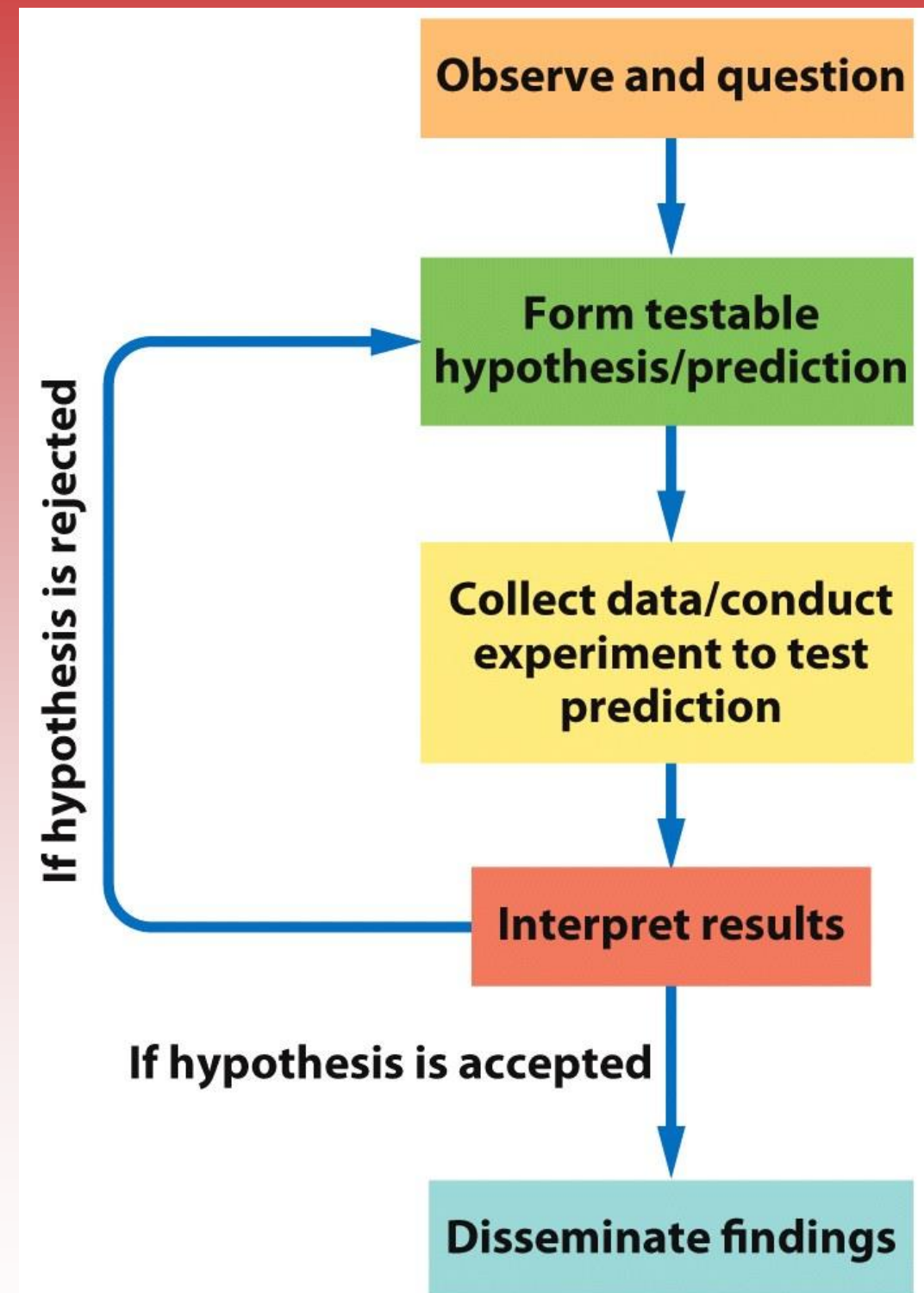


Figure 1.16

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Observations and Questions

- Observing and questioning is the first step of the scientific process.

Hypothesis

- An educated guess that can be proved or disproved through controlled experimentation.
- A null hypothesis is a statement that can be proved wrong.

Collecting Data

- Replication- repeating the measurement many times
- Sample size- the number of times the measurement is repeated.
- Accuracy- how close a measured value is to the actual or true value.
- Precision- how close to one another the repeated measurements are.
- Uncertainty- how much the measure differs from the true value.

Interpreting Results

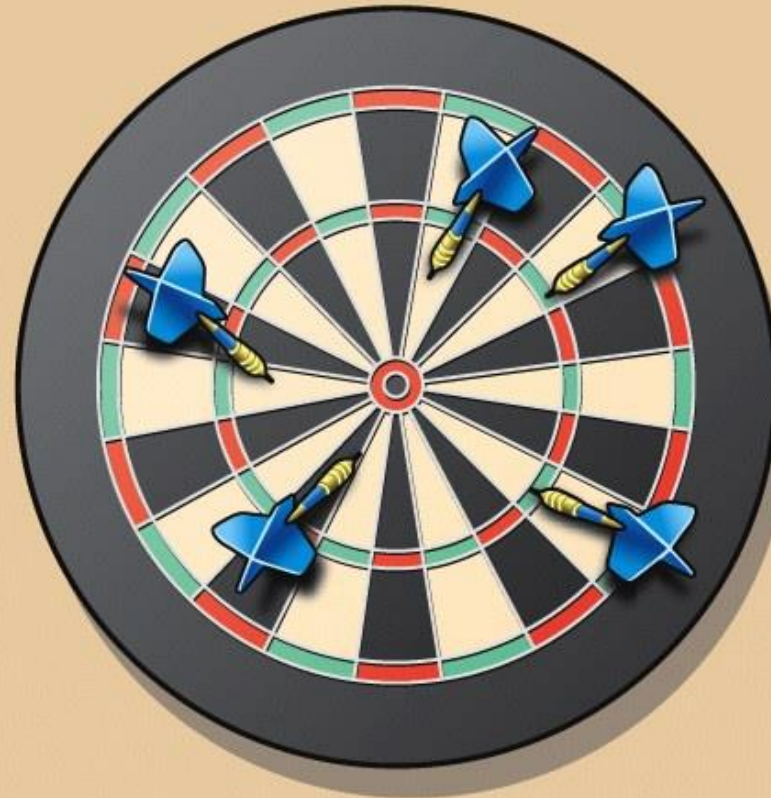
- Once results have been obtained, analysis of the data begins. This process involves two types of reasoning, inductive and deductive.
- Inductive reasoning- the process of making general statements from specific facts or examples.
- Deductive reasoning- the process of applying a general statement to specific facts or situations.

Disseminating 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.



**Low accuracy
High precision**



**High accuracy
Low precision**



**High accuracy
High precision**

Figure 1.17

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- Theory- a hypothesis that has been repeatedly tested and confirmed by multiple groups of researchers and is widely accepted.
- Natural law- When a theory has been tested multiple times and there are no known exceptions. Ex. Law of gravity and laws of thermodynamics.

Controlled Experiments and Natural Experiments

Controlled Experiments and Natural Experiments

- Controlled experiment- an experiment conducted in the controlled conditions of a laboratory.

Question: Do organophosphate pesticides have detrimental effects on the central nervous system?

Null hypothesis: Chlorpyrifos has no observable negative effects on the central nervous system.

Conduct experiment:

1 mg/kg
chlorpyrifos



Experimental group



**Control group
(normal food)**

Measure enzyme activity in order to test for the effect of chlorpyrifos on the brain.

Results (enzyme activity):

Reduced

Normal

Interpret results: Under these conditions, feeding chlorpyrifos to young rats reduces the activity of a key brain enzyme. The null hypothesis is disproved.

Figure 1.18

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Controlled Experiments and Natural Experiments

- Natural experiments- when a natural event, such as a volcano, acts as an experimental treatment in an ecosystem.



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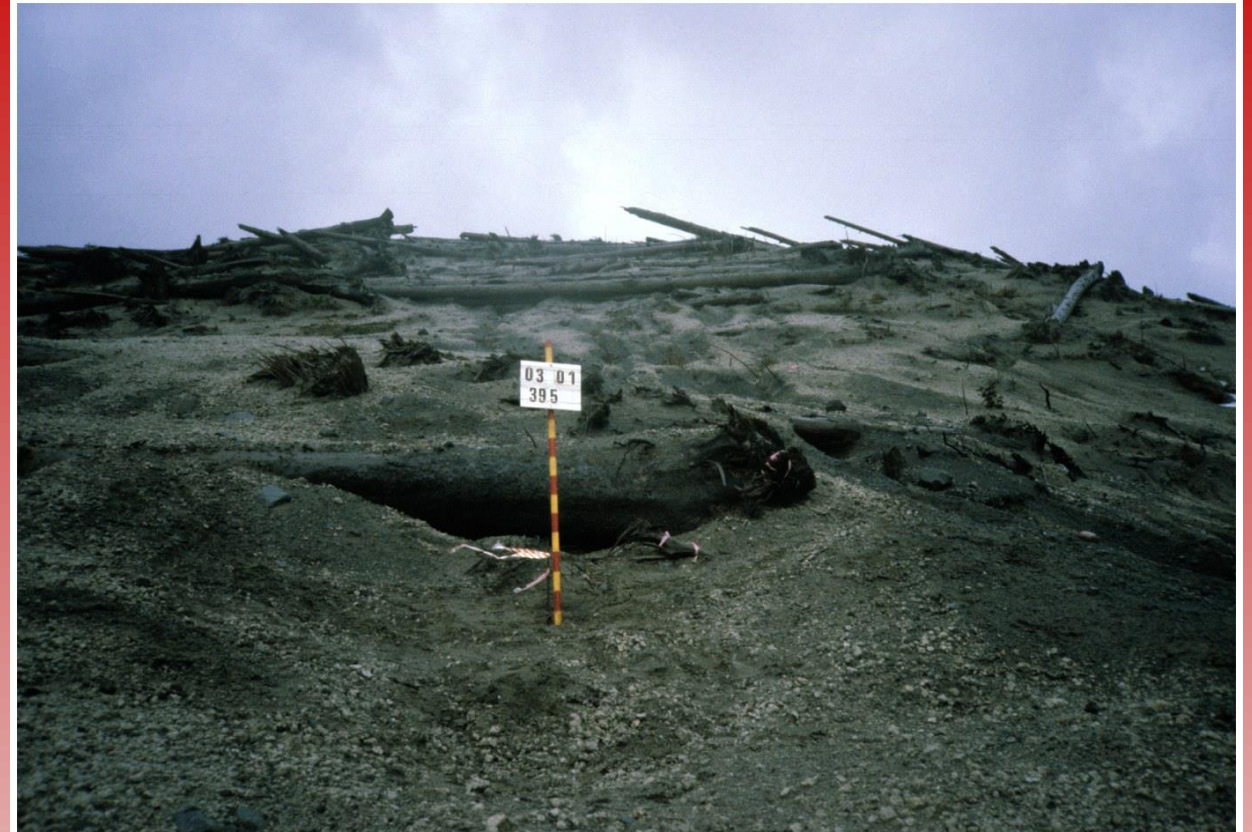


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Figure 1.19c
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Experimental Science Presents Unique Challenges

- There is no "control" planet to compare the Earth with.
- It is difficult to decide what is better or worse for the environment than something else.
- Environmental science has so many interacting parts, it is not easy to apply one system to another.
- Human well-being is a concern because people that are unable to meet their basic needs are less likely to be interested in saving the environment.



Figure 1.21
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