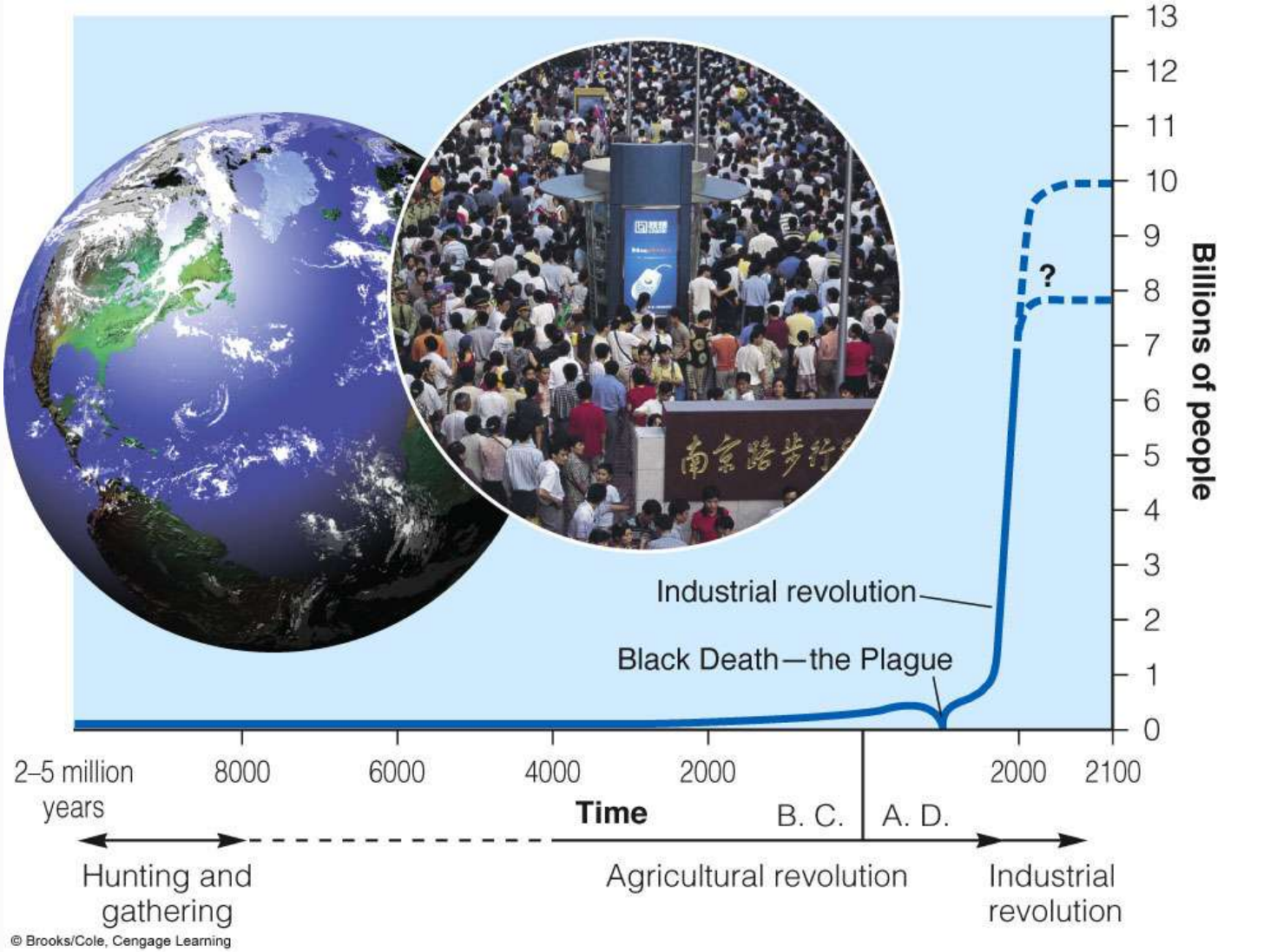
Environmental Problems, Their Causes, and Sustainability

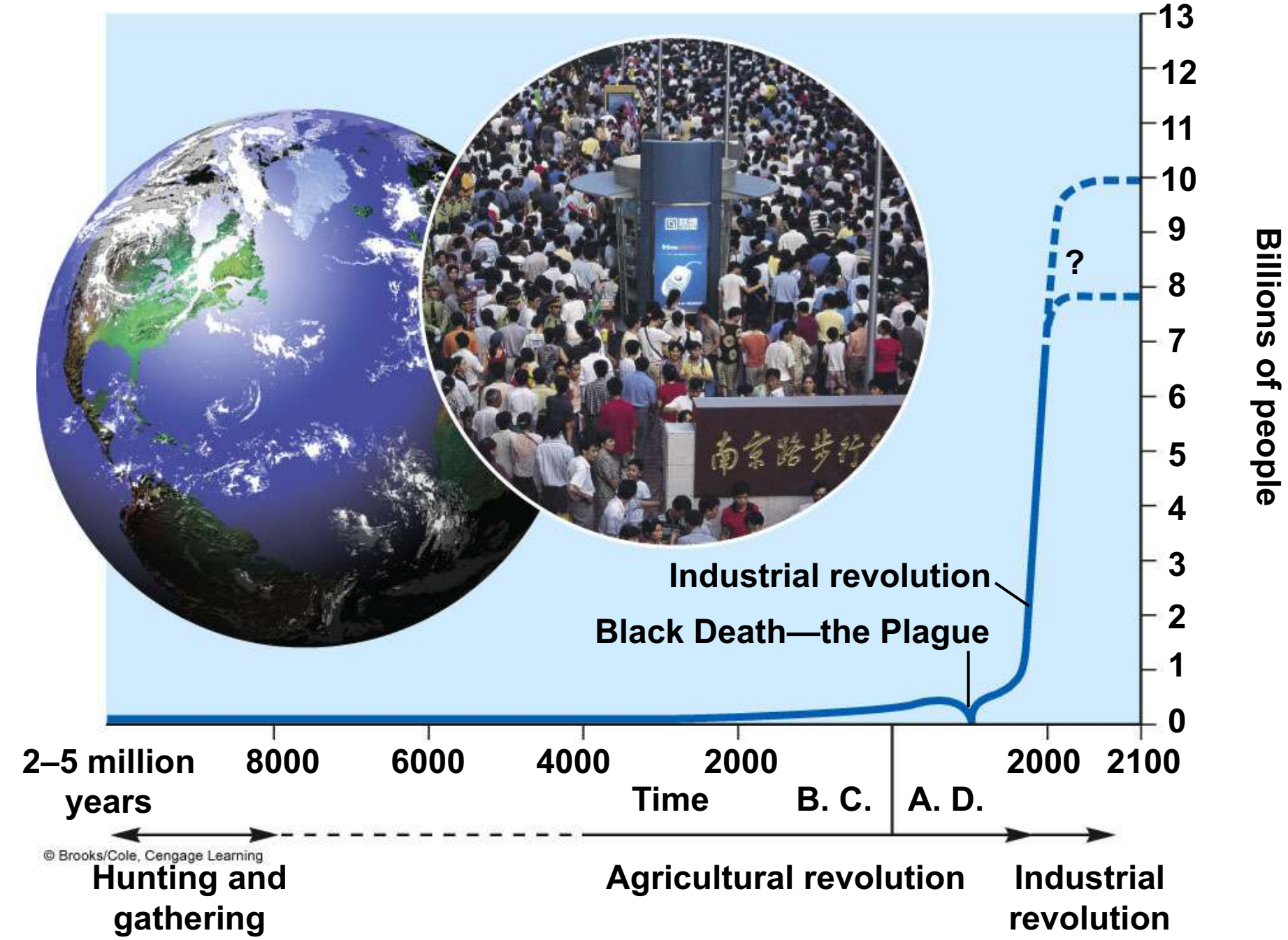
Chapter 1

Core Case Study: Living in an Exponential Age

- Impact of human exponential growth on
  - Loss of animal and plant species
  - Loss of resources

Exponential Growth




13
12
11
10
9
8
7
6
5
4
3
2
1
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Billions of people
?
Industrial revolution
Black Death—the Plague
2–5 million years
8000
6000
4000
2000
2000
2100
Time
B. C.
A. D.
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Hunting and gathering
Agricultural revolution
Industrial revolution

Fig. 1-1, p. 5

1-1 What Is an Environmentally Sustainable Society?

- ***Concept 1-1A*** *Our lives and economies depend on energy from the sun (solar capital) and on natural resources and natural services (natural capital) provided by the earth.*

- ***Concept 1-1B*** *Living sustainability means living off the earth's natural income without depleting or degrading the natural capital that supplies it.*

Environmental Science Is a Study of Connections in Nature (1)

- Interdisciplinary science connecting information and ideas from
  - Natural sciences, with an emphasis on ecology
  - Social sciences
  - Humanities

Environmental Science Is a Study of Connections in Nature (2)

- How nature works
- How the environment affects us
- How we affect the environment
- How to deal with environmental problems
- How to live more sustainably

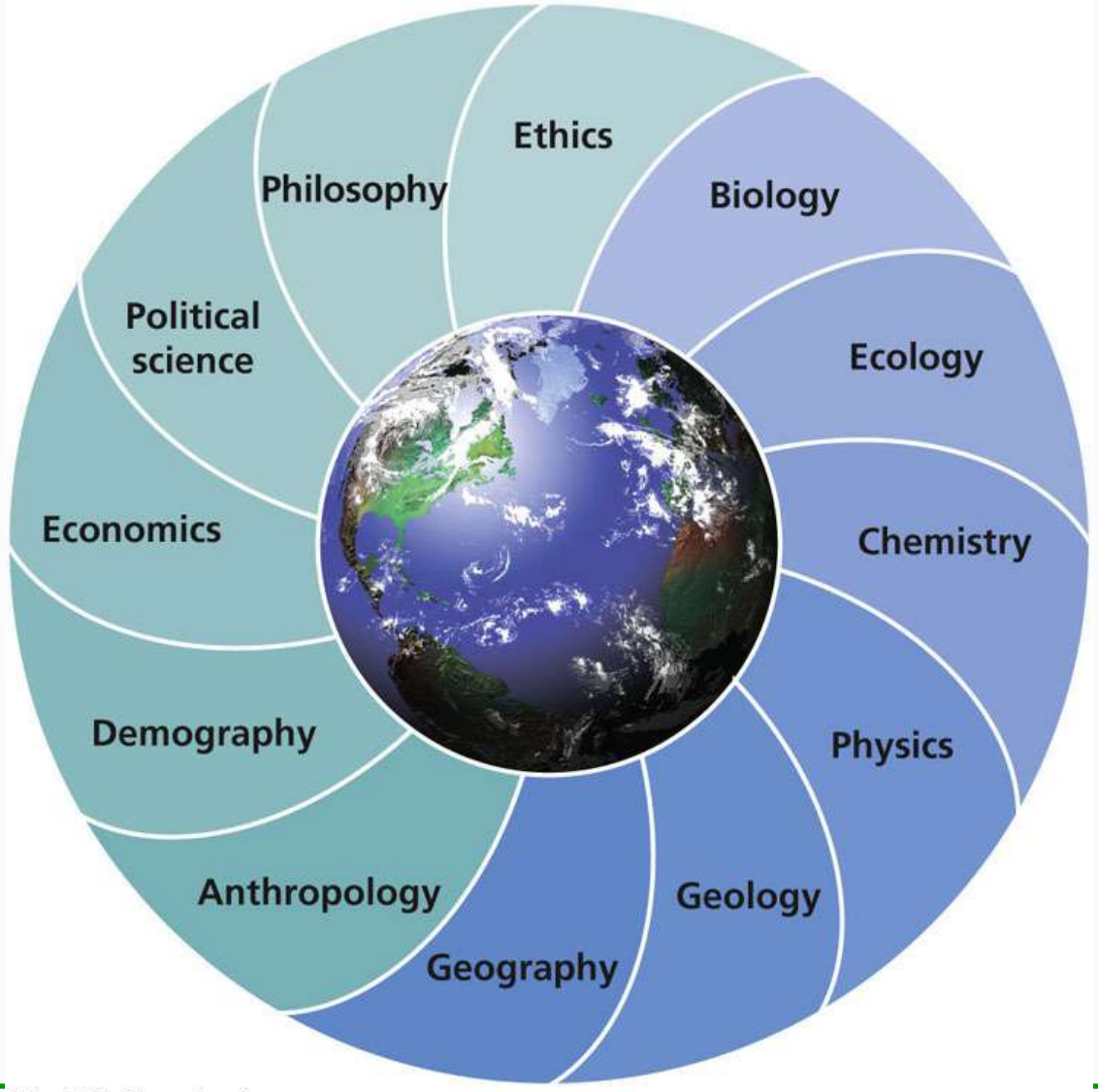
Major Fields of Study Related to Environmental Science

Table 1-1

Major Fields of Study Related to Environmental Science

Major Fields	Subfields
Biology: study of living things (organisms)	**Ecology:** study of how organisms interact with one another and with their nonliving environment
	Botany: study of plants
	Zoology: study of animals
Chemistry: study of chemicals and their interactions	**Biochemistry:** study of the chemistry of living things
Earth science: study of the planet as a whole and its nonliving systems	**Climatology:** study of the earth's atmosphere and climate
	Geology: study of the earth's origin, history, surface, and interior processes
	Hydrology: study of the earth's water resources
	Paleontology: study of fossils and ancient life
Social sciences: studies of human society	**Anthropology:** study of human cultures
	Demography: study of the characteristics of human populations
	Geography: study of the relationships between human populations and the earth's surface features
	Economics: study of the production, distribution, and consumption of goods and services
	Political Science: study of the principles, processes, and structure of government and political institutions
Humanities: study of the aspects of the human condition not covered by the physical and social sciences	**History:** study of information and ideas about humanity's past
	Ethics: study of moral values and concepts concerning right and wrong human behavior and responsibilities
	Philosophy: study of knowledge and wisdom about the nature of reality, values, and human conduct

Environmental Science Is an Interdisciplinary Study



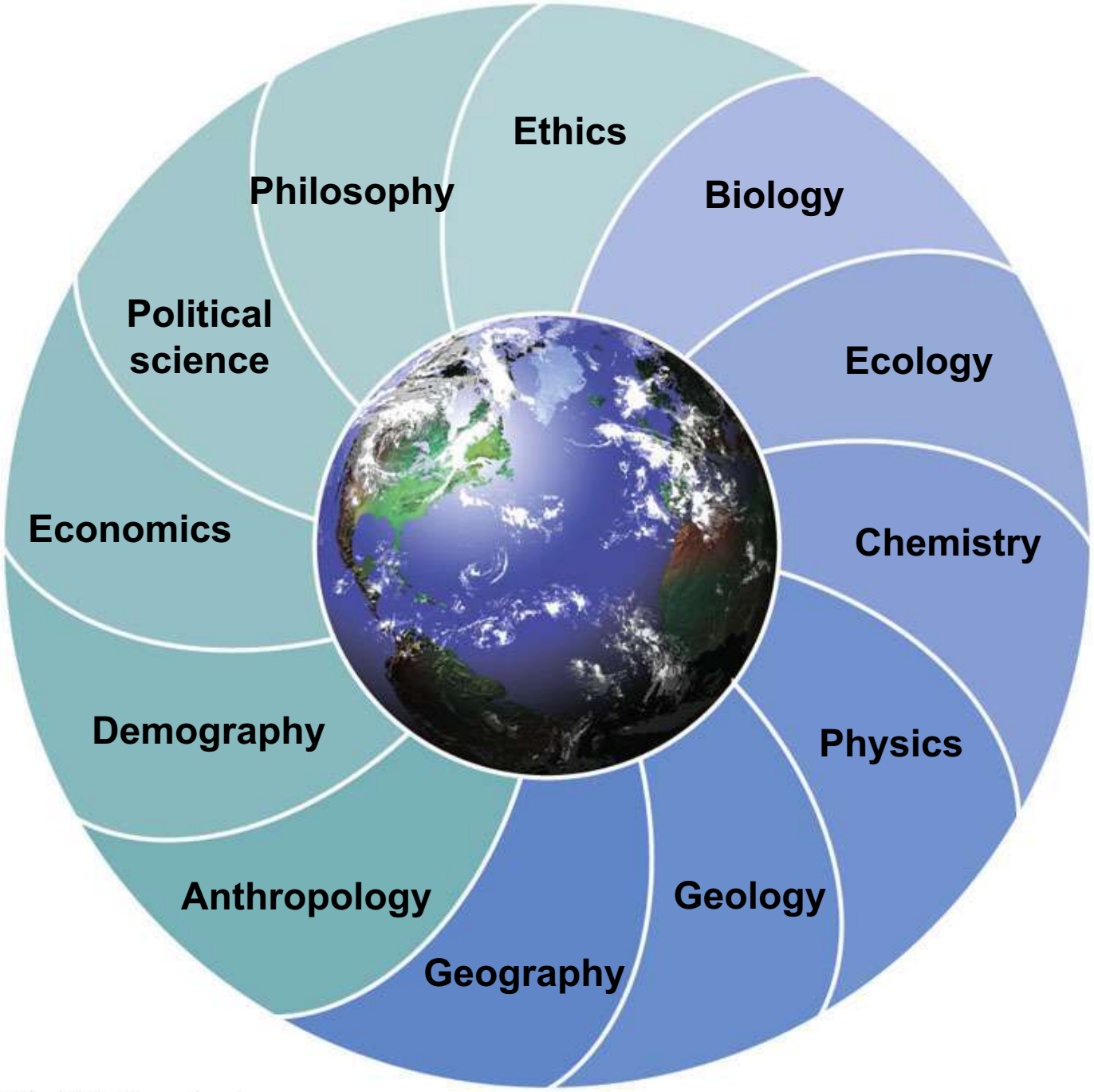
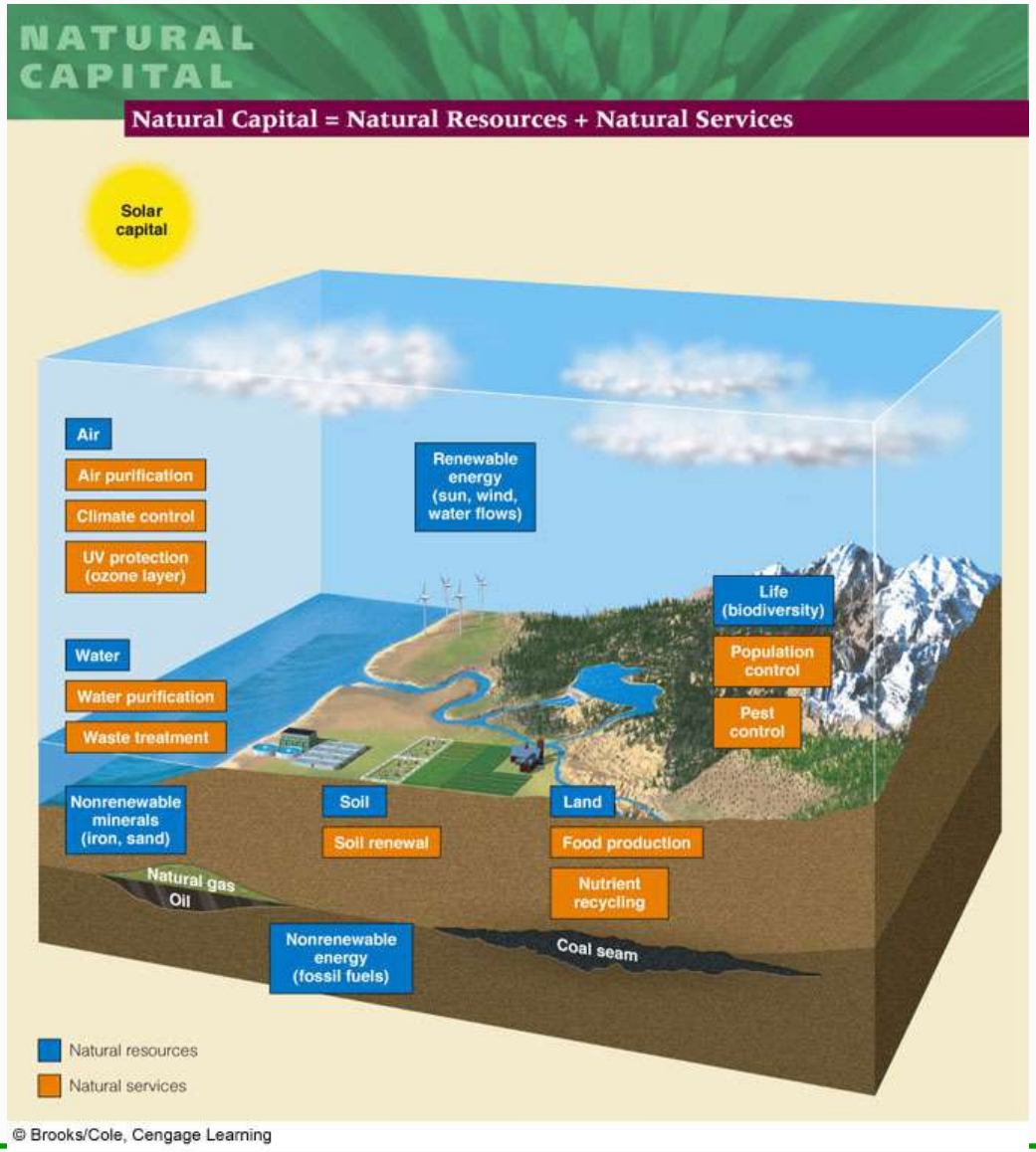


Fig. 1-2, p. 7

Sustainability Is the Central Theme of This Book

- Natural capital: supported by solar capital
  - Natural resources
  - Natural services
    - E.g., nutrient cycling
- Degradation of natural capital through human activities
- Scientific solutions

Natural Capital = Natural Resources + Natural Services



NATURAL CAPITAL

Natural Capital = Natural Resources + Natural Services

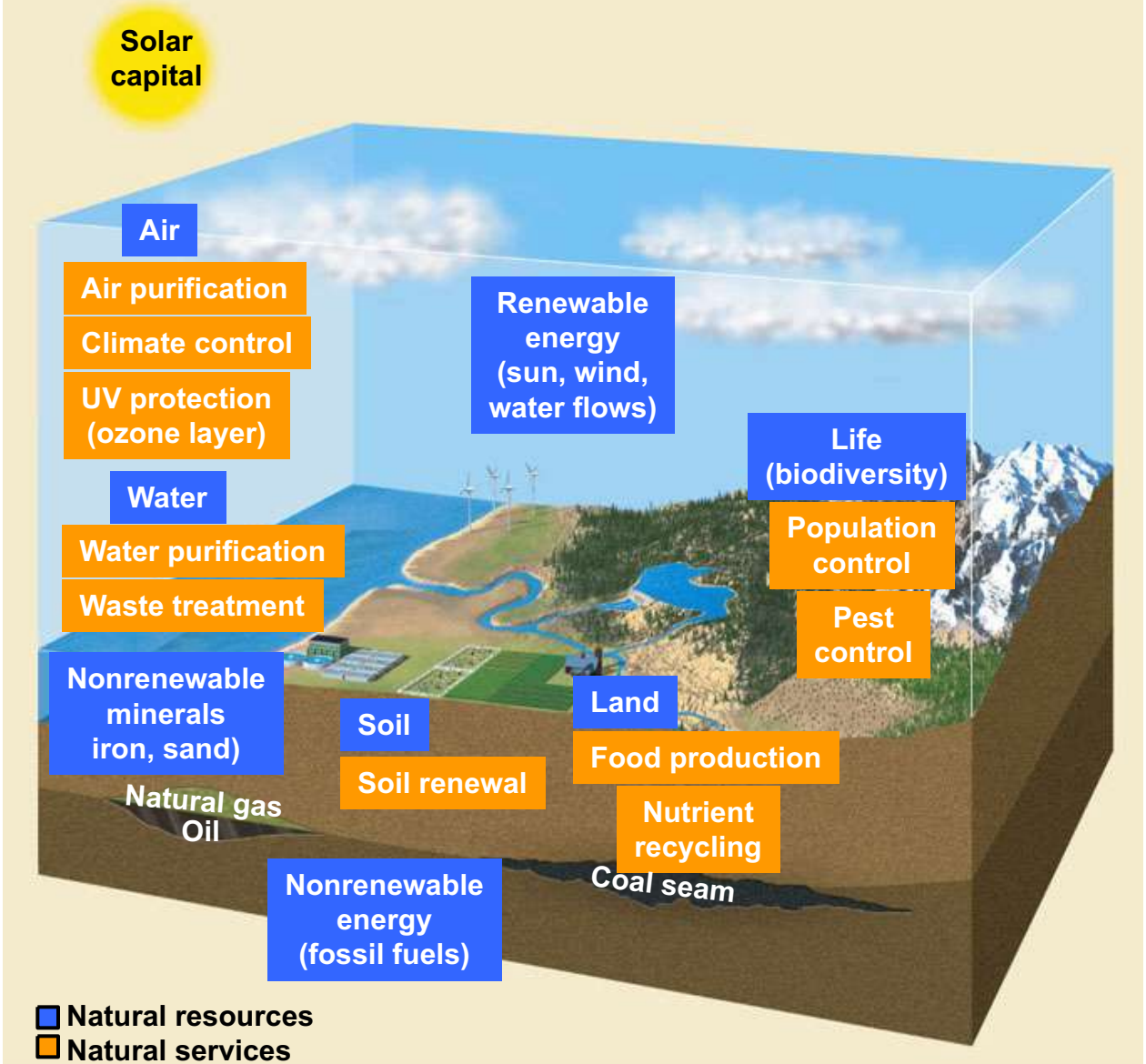
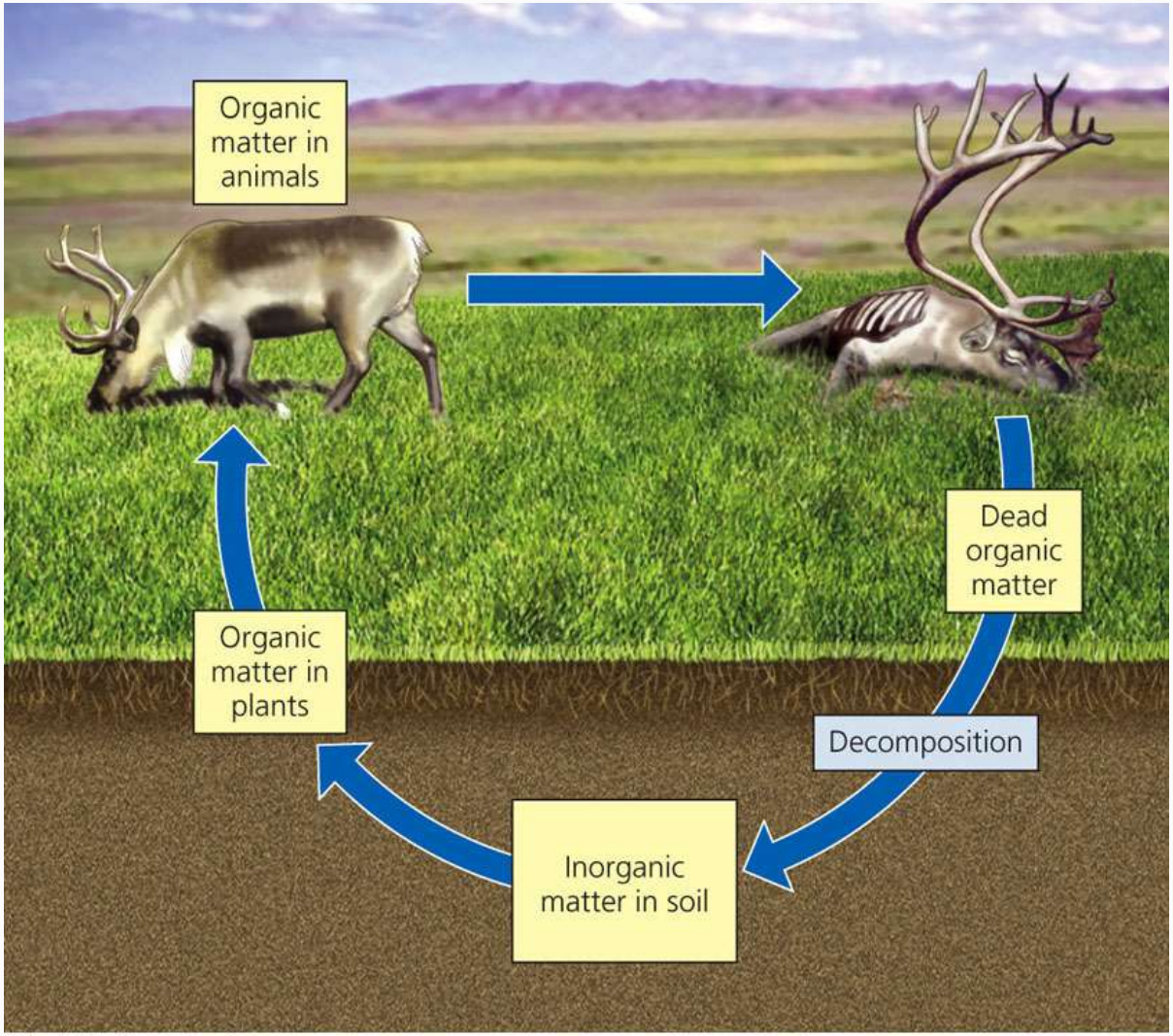


Fig. 1-3, p. 8

Nutrient Cycling



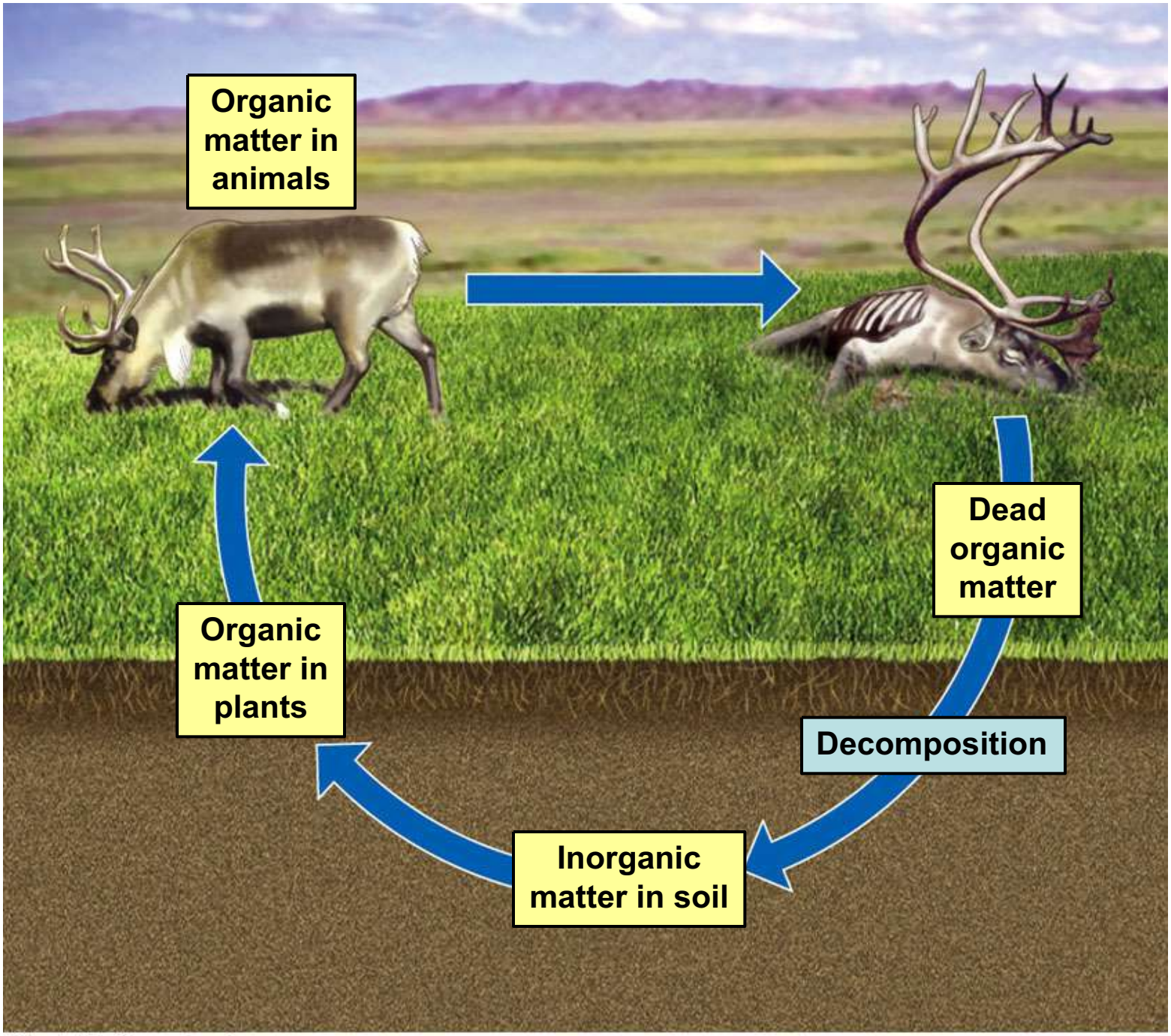


Fig. 1-4, p. 9

Environmentally Sustainable Societies Protect Natural Capital and Live off Its Income

- Live off natural income
- Human activity and its affect on the earth's natural capital

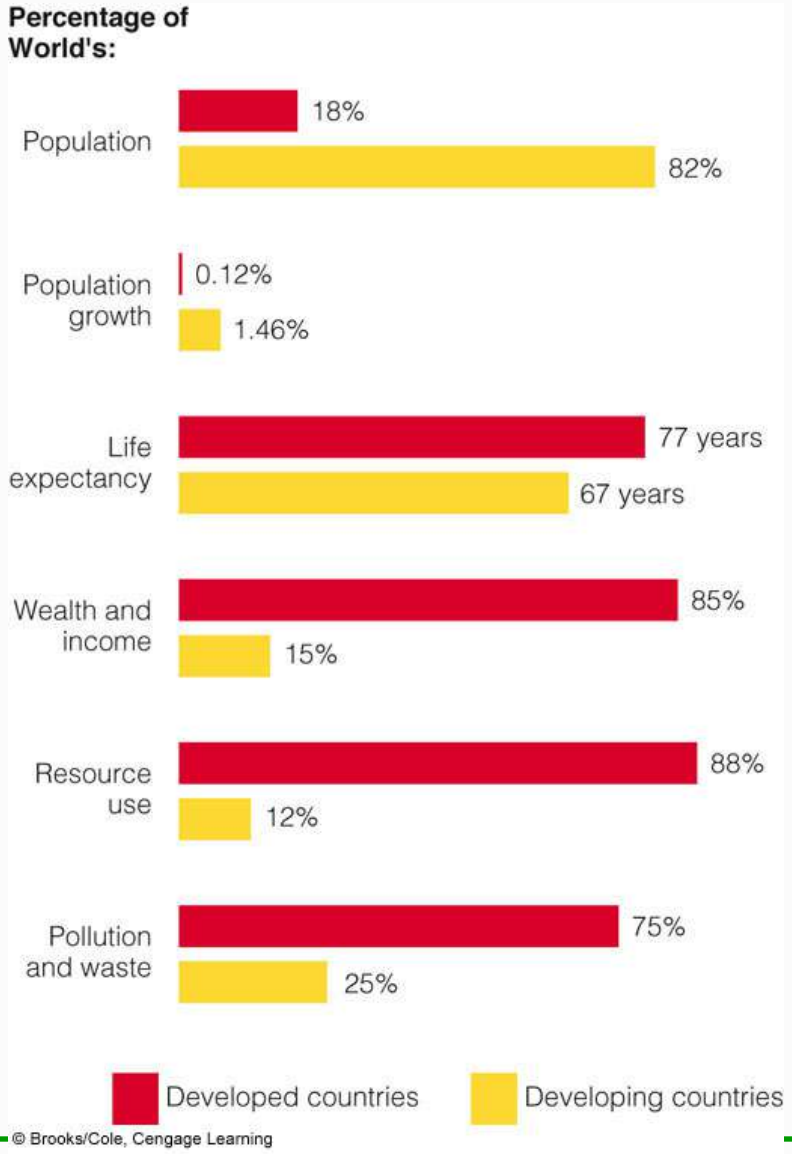
1-2 How Can Environmentally Sustainable Societies Grow Economically?

- ***Concept 1-2*** *Societies can become more environmentally sustainable through economic development dedicated to improving the quality of life for everyone without degrading the earth's life support systems.*

There Is a Wide Economic Gap between Rich and Poor Countries

- Country's economic growth: measured by **gross domestic product (GDP)**
- Changes in economic growth: measured by **per capita GDP**
- Purchasing power parity (PPP) plus GDP are combined for **per capita GDP PPP**
- Compare developed with developing countries

Comparison of Developed and Developing Countries, 2008



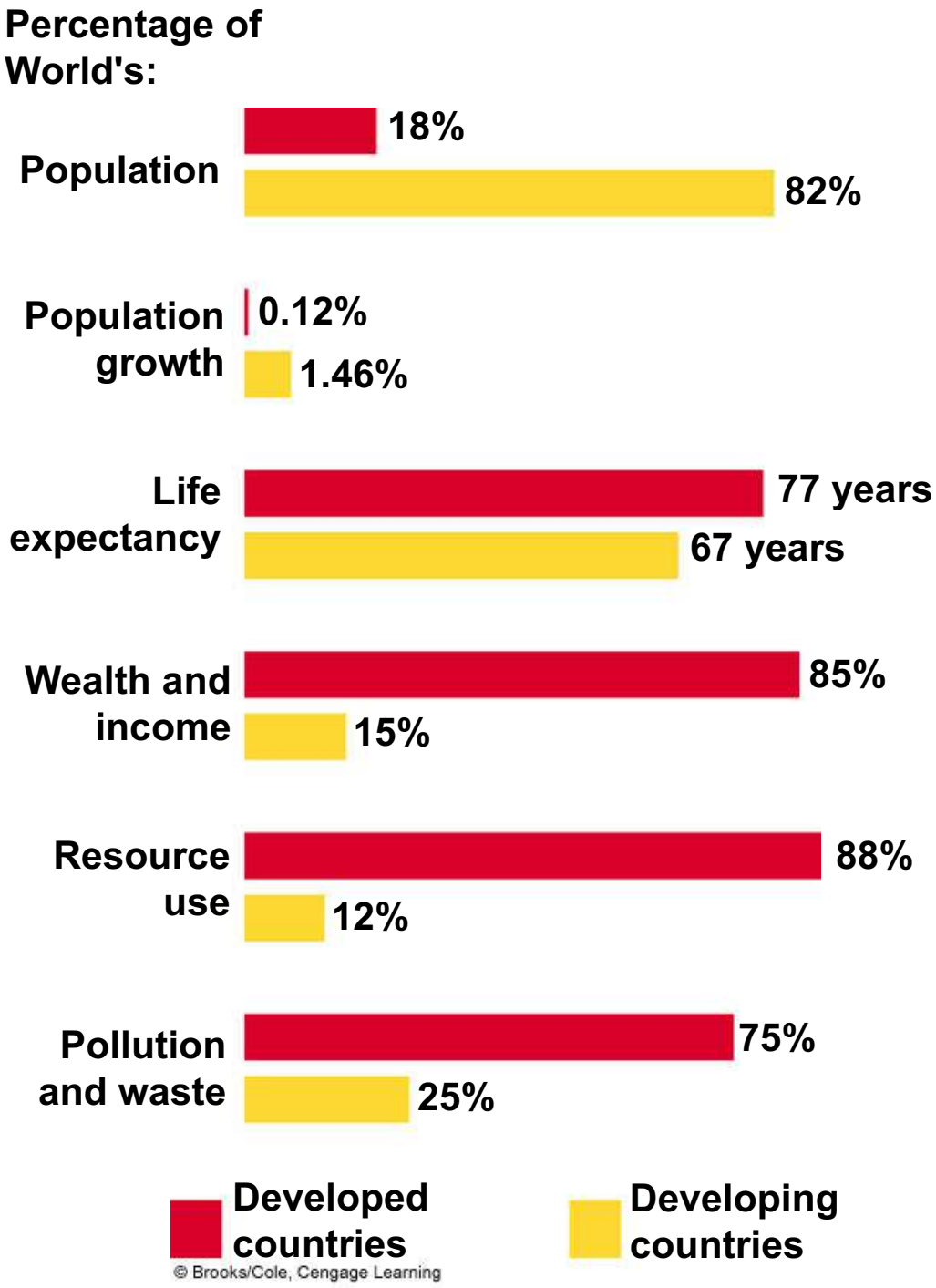

Percentage of World's:
Population
18%
82%
Population growth
0.12%
1.46%
Life expectancy
77 years
67 years
Wealth and income
85%
15%
Resource use
88%
12%
Pollution and waste
75%
25%
Developed countries
Developing countries
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Fig. 1-5, p. 11

Extreme Poverty in a Developing Country

1-3 *How Are Our Ecological Footprints Affecting the Earth?*

- ***Concept 1-3*** *As our ecological footprints grow, we are depleting and degrading more of the earth's natural capital.*

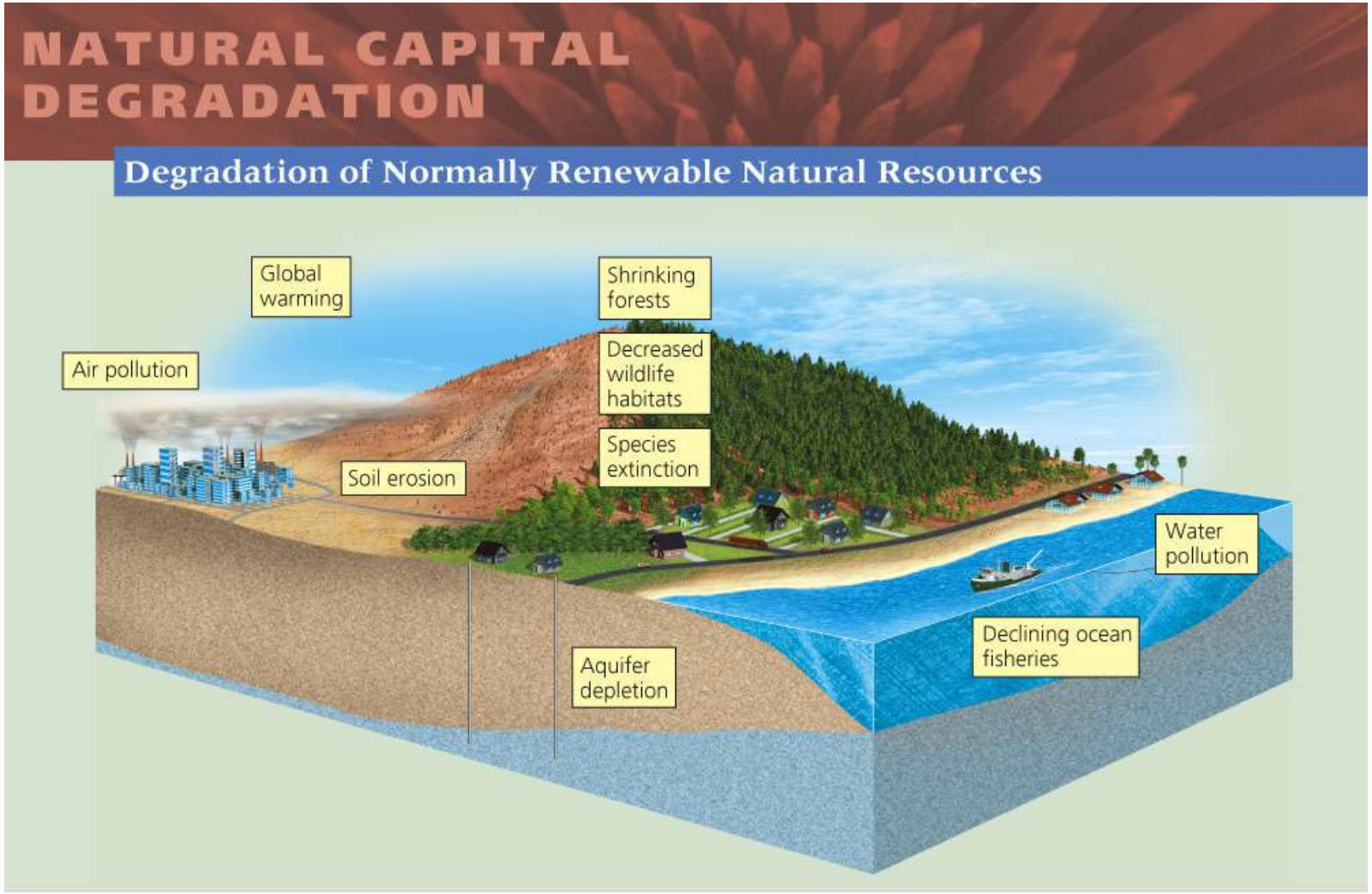
Some Sources Are Renewable (1)

- **Resource**
  - Directly available for use
  - Not directly available for use
- **Perpetual resource**
  - Solar energy

Some Sources Are Renewable (2)

- **Renewable resource**
  - E.g., forests, grasslands, fresh air, fertile soil
- **Sustainable yield**
- **Environmental degradation**

Degradation of Normally Renewable Natural Resources and Services



Overexploiting Shared Renewable Resources: Tragedy of the Commons

- Three types of property or resource rights
  - **Private property**
  - **Common property**
  - **Open access renewable resources**

- Tragedy of the commons
  - Solutions

Some Resources Are Not Renewable

- **Nonrenewable resources**
  - Energy resources
  - Metallic mineral resources
  - Nonmetallic mineral resources
- **Reuse**
- **Recycle**

Reuse

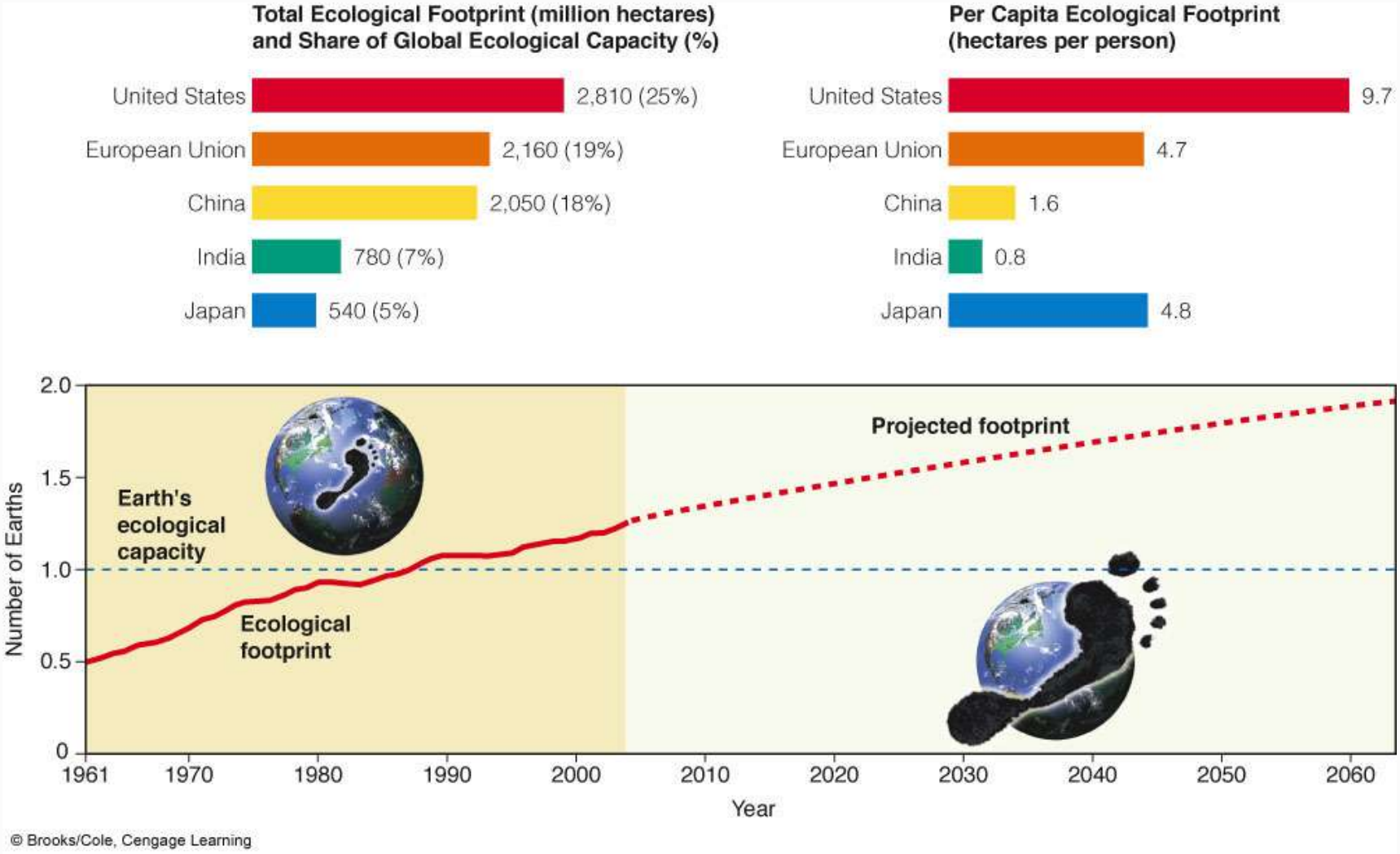
Consumption of Natural Resources

Consumption of Natural Resources

Our Ecological Footprints Are Growing

- **Ecological footprint** concept
  - Biological capacity
  - Ecological footprint

Natural Capital Use and Degradation



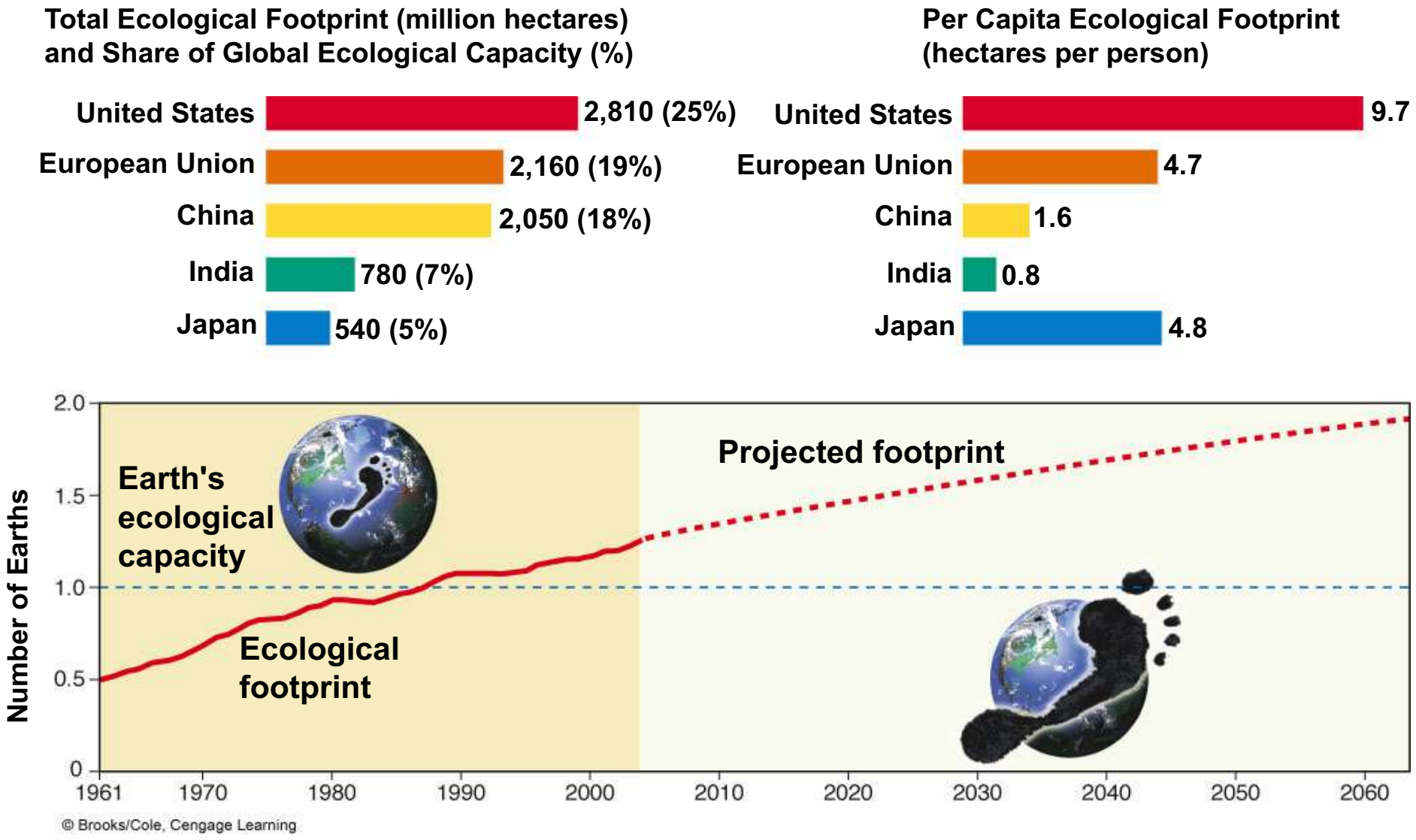

Total Ecological Footprint (million hectares) and Share of Global Ecological Capacity (%)
United States
2,810 (25%)
European Union
2,160 (19%)
China
2,050 (18%)
India
780 (7%)
Japan
540 (5%)
Per Capita Ecological Footprint (hectares per person)
United States
9.7
European Union
4.7
China
1.6
India
0.8
Japan
4.8
Number of Earths
2.0
1.5
1.0
0.5
0
Earth's ecological capacity
Projected footprint
Ecological footprint
1961
1970
1980
1990
2000
2010
2020
2030
2040
2050
2060
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Fig. 1-10, p. 15

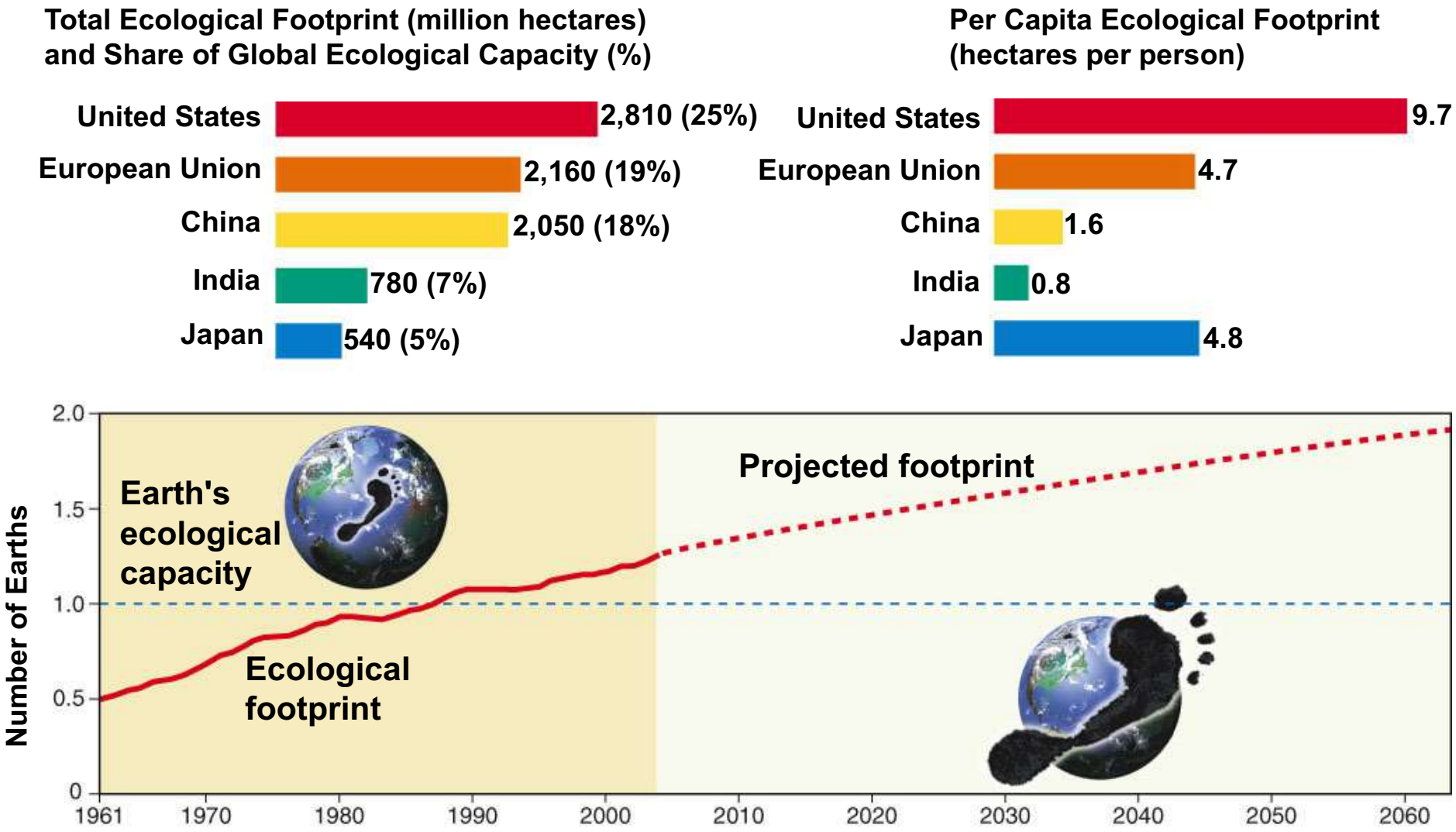

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Fig. 1-10, p. 15

Case Study: China's New Affluent Consumers (1)

- Leading consumer of various foods and goods
  - Wheat, rice, and meat
  - Coal, fertilizers, steel, and cement
- Second largest consumer of oil

Case Study: China's New Affluent Consumers (2)

- Two-thirds of the most polluted cities are in China

- Projections, by 2020
  - Largest consumer and producer of cars
  - World's leading economy in terms of GDP PPP

Cultural Changes Have Increased Our Ecological Footprints

- 12,000 years ago: hunters and gatherers

- Three major cultural events
  - Agricultural revolution
  - Industrial-medical revolution
  - Information-globalization revolution

1-4 What Is Pollution and What Can We Do about It?

- ***Concept 1-4*** *Preventing pollution is more effective and less costly than cleaning up pollution.*

Pollution Comes from a Number of Sources

- Sources of pollution
  - **Point**
    - E.g., smokestack
  - **Nonpoint**
    - E.g., pesticides blown into the air
- Main type of pollutants
  - **Biodegradable**
  - **Nondegradable**
- Unwanted effects of pollution

Point-Source Air Pollution

We Can Clean Up Pollution or Prevent It

- Pollution cleanup (**output pollution control**)
- Pollution prevention (**input pollution control**)

1-5 Why Do We Have Environmental Problems? (1)

- ***Concept 1-5A*** *Major causes of environmental problems are population growth, wasteful and unsustainable resource use, poverty, exclusion of environmental costs of resource use from the market prices of goods and services, and attempts to manage nature with insufficient knowledge.*

1-5 Why Do We Have Environmental Problems? (2)

- ***Concept 1-5B*** *People with different environmental worldviews often disagree about the seriousness of environmental problems and what we should do about them.*

Experts Have Identified Five Basic Causes of Environmental Problems

- Population growth
- Wasteful and unsustainable resource use
- Poverty
- Failure to include the harmful environmental costs of goods and services in their market prices
- Insufficient knowledge of how nature works

Causes of Environmental Problems

Causes of Environmental Problems

Population growth

Unsustainable resource use

Poverty

Excluding environmental costs from market prices

Trying to manage nature without knowing enough about it

Causes of Environmental Problems

Population growth

Unsustainable resource use

Poverty

Excluding environmental costs from market prices

Trying to manage nature without knowing enough about it

Fig. 1-12, p. 18

Causes of Environmental Problems

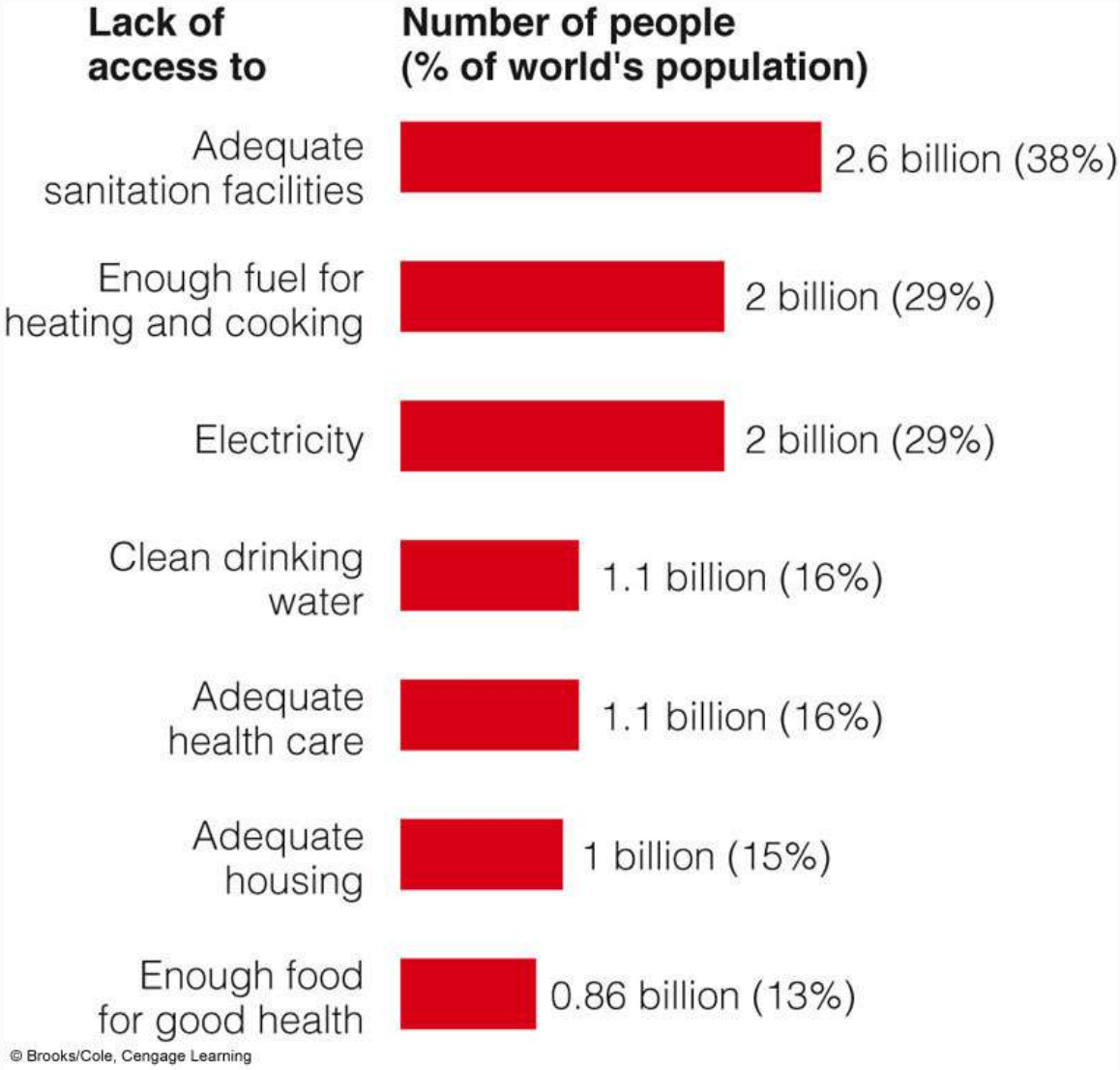
Stepped Art

Fig. 1-12, p. 18

Poverty Has Harmful Environmental and Health Effects

- Population growth affected
- Malnutrition
- Premature death
- Limited access to adequate sanitation facilities and clean water

Some Harmful Results of Poverty



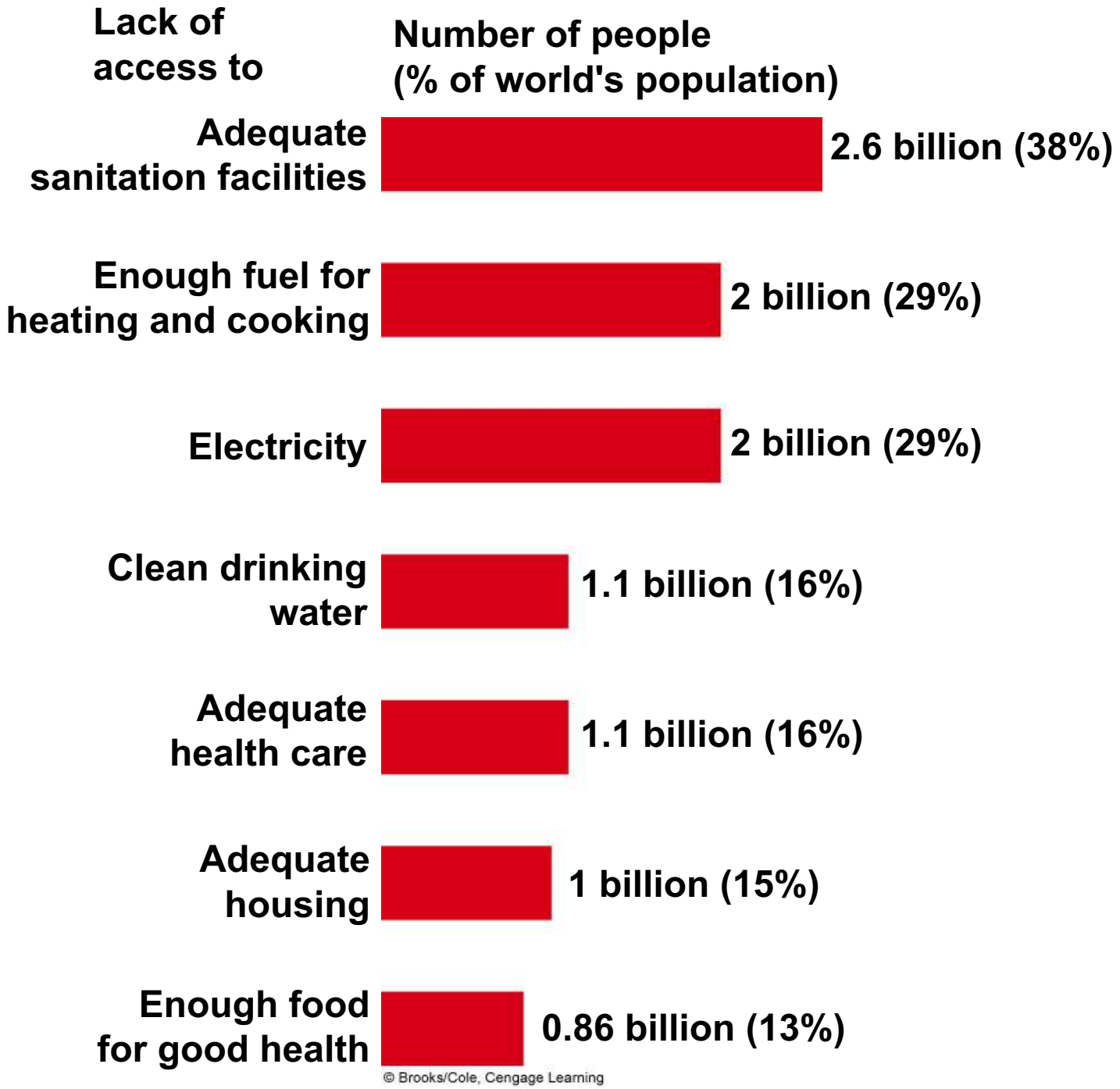

Lack of access to
Number of people (% of world's population)
Adequate sanitation facilities
2.6 billion (38%)
Enough fuel for heating and cooking
2 billion (29%)
Electricity
2 billion (29%)
Clean drinking water
1.1 billion (16%)
Adequate health care
1.1 billion (16%)
Adequate housing
1 billion (15%)
Enough food for good health
0.86 billion (13%)
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Fig. 1-13, p. 18

Global Outlook on Malnutrition

Affluence Has Harmful and Beneficial Environmental Effects

- Harmful environmental impact due to
  - High levels of consumption
  - Unnecessary waste of resources

- Affluence can provide funding for
  - Developing technologies to reduce
    - Pollution
    - Environmental degradation
    - Resource waste

Prices Do Not Include the Value of Natural Capital

- Companies do not pay the environmental cost of resource use
- Goods and services do not include the harmful environmental costs
- Companies receive tax breaks and subsidies
- Economy may be stimulated but there may be a degradation of natural capital

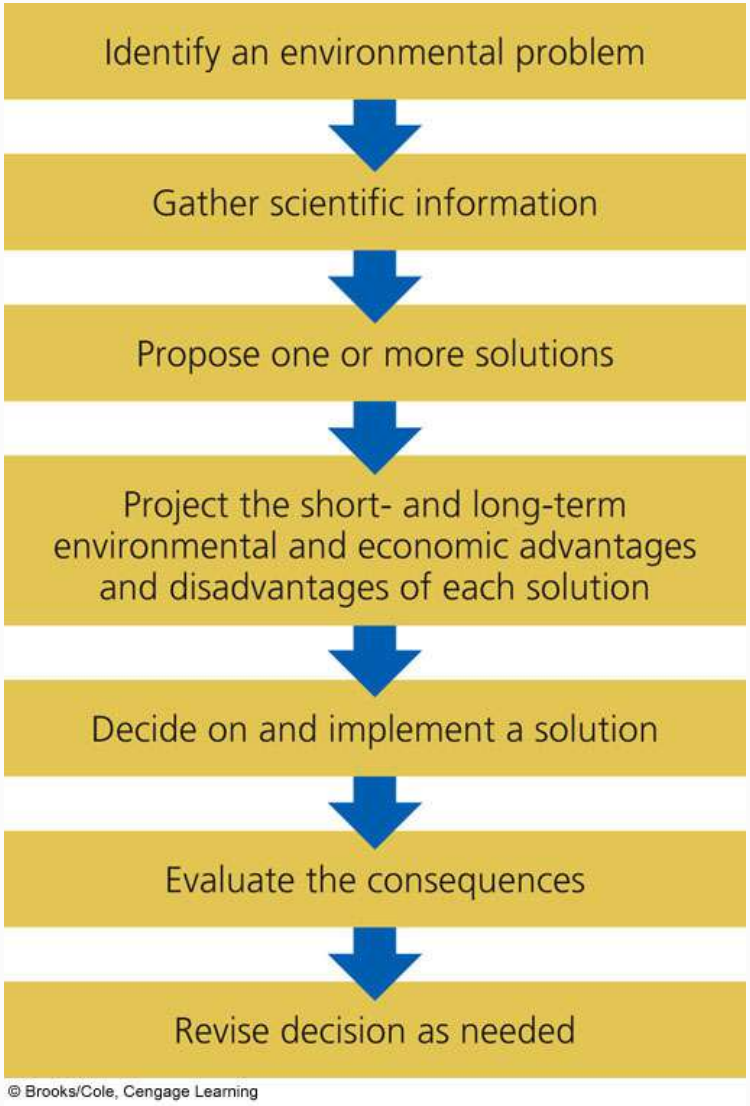
Different Views about Environmental Problems and Their Solutions

- Environmental Worldview including environmental ethics
  - **Planetary management worldview**
  - **Stewardship worldview**
  - **Environmental wisdom worldview**

We Can Learn to Make Informed Environmental Decisions

- Scientific research
- Identify problem and multiple solutions
- Consider human values

Steps Involved in Making an Environmental Decision



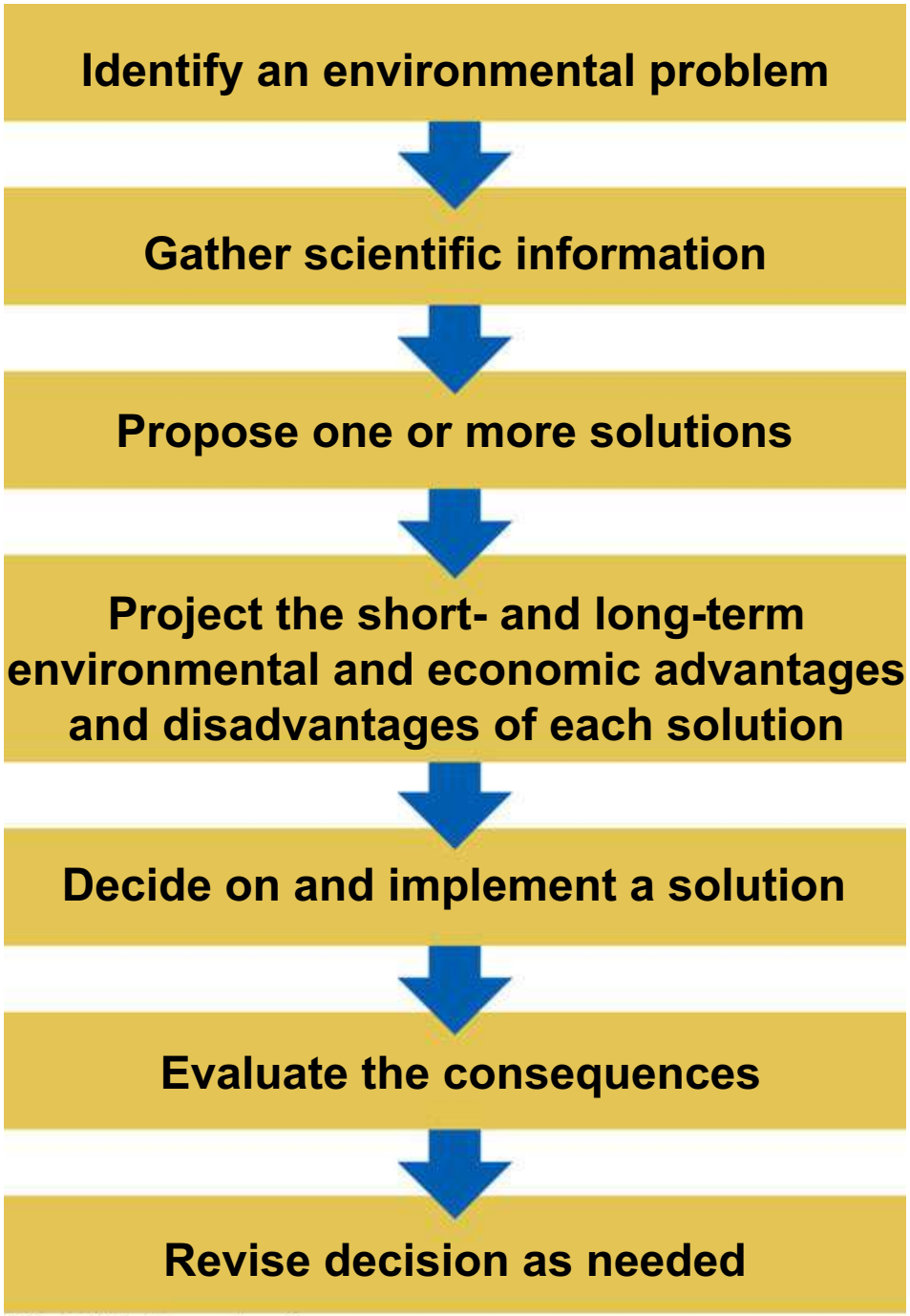


Fig. 1-15, p. 21

We Can Work Together to Solve Environmental Problems

- **Social capital**
  - Encourages
    - Openness and communication
    - Cooperation
    - Hope
  - Discourages
    - Close-mindedness
    - Polarization
    - Confrontation and fear

Case Study: The Environmental Transformation of Chattanooga, TN

- Environmental success story: example of building their social capital
- 1960: most polluted city in the U.S.
- 1984: *Vision 2000*
- 1995: most goals met
- 1993: *Revision 2000*

Chattanooga, Tennessee

Individuals Matter: Aldo Leopold

- 5–10% of the population can bring about major social change
- Anthropologist Margaret Mead
- Aldo Leopold: environmental ethics
  - A leader of the *conservation and environmental movements* of the 20th century
    - Land ethic
  - Wrote: *A Sand County Almanac*

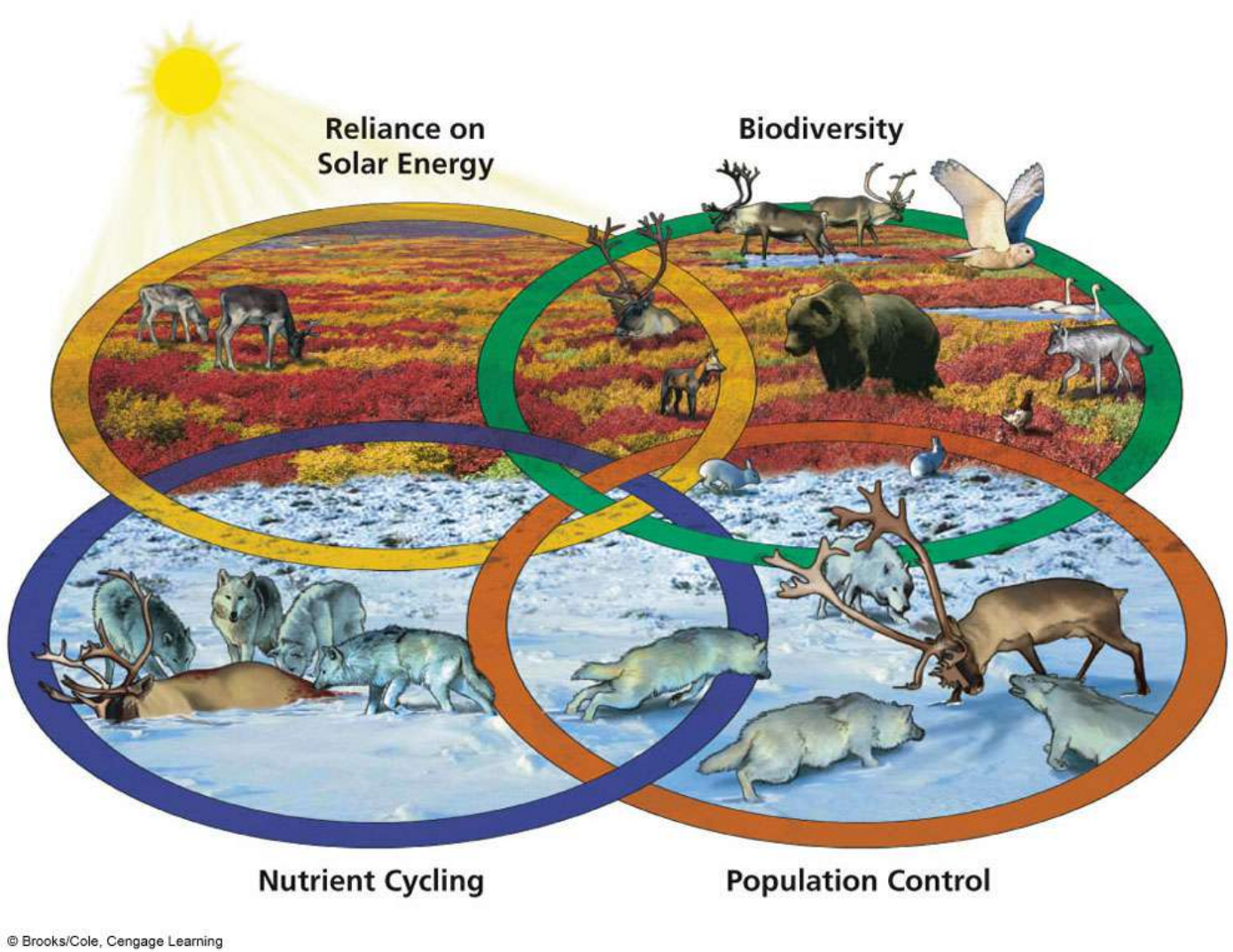
1-6 What Are Four Scientific Principles of Sustainability?

- ***Concept 1- 6*** *Nature has sustained itself for billions of years by using solar energy, biodiversity, population control, and nutrient cycling—lessons from nature that we can apply to our lifestyles and economies.*

Studying Nature Reveals Four Scientific Principles of Sustainability

- Reliance on solar energy
- Biodiversity
- Population control
- Nutrient cycling

Four Scientific Principles of Sustainability



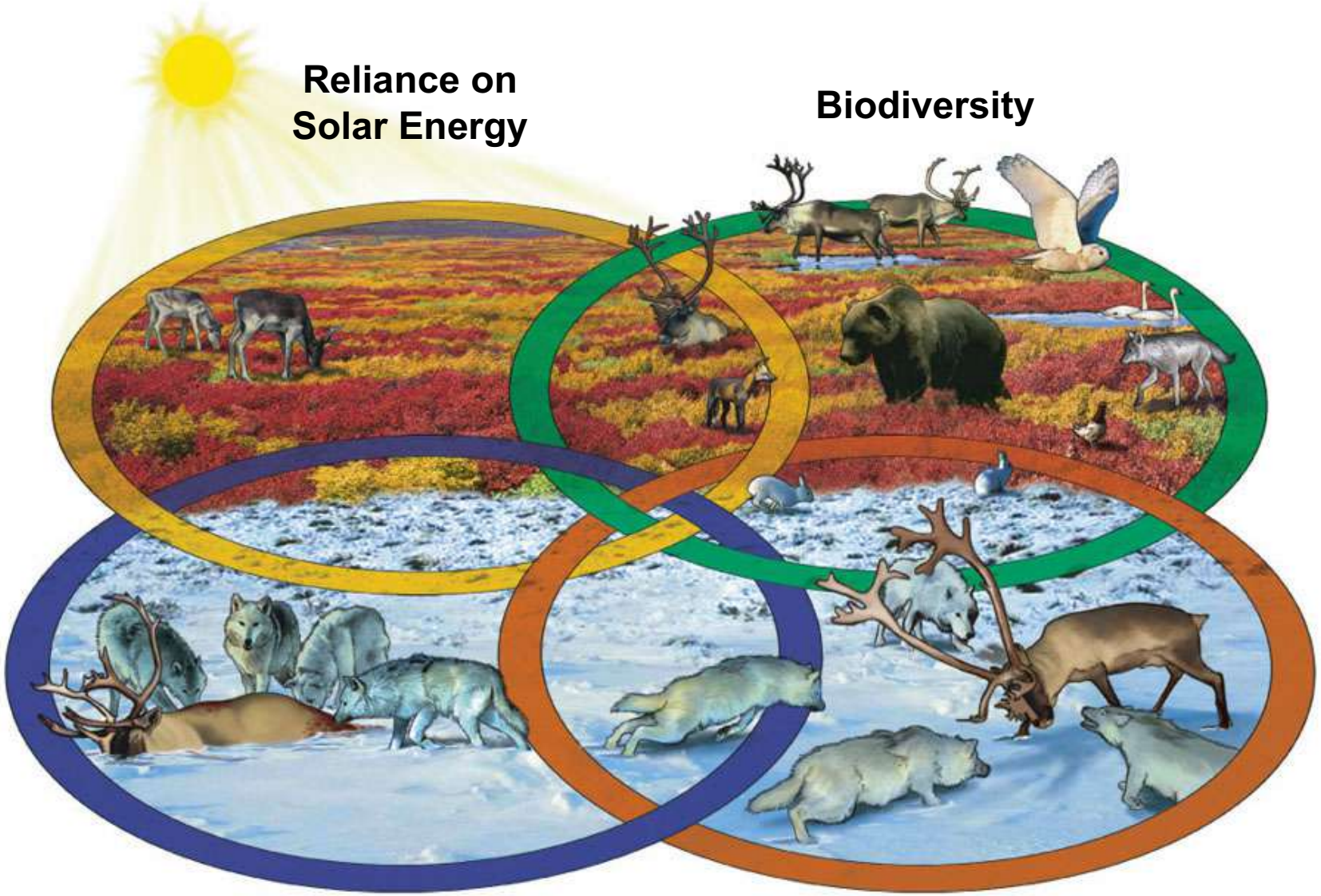


Fig. 1-17, p. 23

Solutions For Environmental or Sustainability Revolution


Current Emphasis
Sustainability Emphasis
Pollution cleanup
Pollution prevention
Waste disposal (bury or burn)
Waste prevention
Protecting species
Protecting habitat
Environmental degradation
Environmental restoration
Increasing resource use
Less resource waste
Population growth
Population stabilization
Depleting and degrading natural capital
Protecting natural capital
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Fig. 1-18, p. 24