CHAPTER 1

## ENVIRONMENTAL PROBLEMS,

## THEIR CAUSES, AND SUSTAINABILITY

**Outline**

* 1. **What are some principles of sustainability?**

A. Environmental science is a study of connections in nature.

1. Environment includes all living and nonliving things with which an organism interacts.
2. Environmental science studies how the earth works, our interaction with the earth, and ways to deal with environment problems and live more sustainably.
3. Ecology studies relationships between living organisms, and their interaction with the environment.
4. Environmentalism is a social movement dedicated to protecting life support systems for all species.

B. Nature’s survival strategies follow three principles of sustainability.

1. Life depends on solar energy.
2. Biodiversity provides natural services.
3. Chemical/nutrient cycling means that there is little waste in nature.

C. Sustainability has certain key components.

1. Life depends on natural capital, natural resources and natural services.
2. Many human activities can degrade natural capital.
3. Solutions are being found and implemented.
4. Sustainability begins at personal and local levels.

D. Some resources are renewable and some are not.

1. Humans depend upon resources to meet our needs.
2. A perpetual resource is continuously renewed and expected to last (e.g. solar energy).
3. A renewable resource is replenished in days to several hundred years through natural processes (forests, grasslands, fish populations, freshwater, fresh air, and fertile soil).
4. Sustainable yield is the highest rate at which a renewable and non-renewable resource can be used indefinitely without reducing its available supply.
5. Some resources are not renewable.
   1. Nonrenewable resources exist in fixed quantities.

a. Exhaustible energy (coal and oil).

b. Metallic minerals (copper and aluminum).

c. Nonmetallic minerals (salt and sand).

6. Sustainable solutions: Reduce, reuse, and recycle.

E. Rich and poor countries have different environmental impacts.

* 1. Developed countries include the high income ones, such as the U.S. and Canada.
  2. Developing countries include the low income ones, such as China and India.

**1-2 How are our ecological footprints affecting the earth?**

1. We are living unsustainably.
   1. Environmental, or natural capital, degradation is occurring.
   2. We have solutions to these problems that can be implemented.
2. Pollution comes from a number of sources.
   1. Point sources are single, identifiable sources (e.g., smokestack).
   2. Nonpoint sources are dispersed and often difficult to identify (e.g., lawn runoff).
   3. We can clean up pollution or prevent it.
   4. Pollution cleanup is usually more expensive and less effective.
   5. Pollution prevention reduces or eliminates the production of pollutants.
3. The tragedy of the commons: overexploiting shared renewable resources.
   1. In 1968, the biologist Garrett Hardin called the degradation of openly shared resources the *tragedy of the commons*.
   2. Reducing degradation.
      1. Reduce use by government regulations.
      2. Shift to private ownership.
4. Ecological footprints: our environmental impacts.
   1. Ecological footprint is the amount of biologically productive land and water needed to supply a person or country with renewable resources and to recycle the waste and pollution produced by such resource use.
   2. Per capita ecological footprint is the average ecological footprint of an individual in a given country or area.
   3. Ecological deficit means the ecological footprint is larger than the biological capacity to replenish resources and absorb wastes and pollution.
   4. Humanity is living unsustainably.
   5. Footprints can also be expressed as number of Earths it would take to support consumption.
   6. Case study: A vision of a more sustainable world in 2060.
5. IPAT is another environmental impact model
   1. In the early 1970s, scientists Paul Ehrlich and John Holdren developed the IPAT model.
   2. I (environmental impact) = P (population size) x A (affluence/person) x T (technology’s beneficial and harmful effects).
6. Case Study: China’s new affluent consumers.

**1-3 Why do we have environmental problems?**

1. Experts have identified four basic causes of environmental problems:
   1. Population growth.
   2. Unsustainable resource use.
   3. Poverty.
   4. Excluding environmental costs from market prices.
2. The human population is growing exponentially at a rapid rate.
   1. Human population is increasing at a fixed percentage so that we are experiencing doubling of larger and larger populations.
   2. Human population in 2009 was about 6.8 billion.
   3. Based on the current increase rate there will be 9.6 billion people by 2050.
   4. We can slow population growth; see Core Case Study.
3. Affluence has harmful and beneficial environmental effects.
   1. Wealth results in high levels of consumption and waste of resources.
   2. Average American consumes 30 times as much as the average consumer in India.
   3. “Shop-until-you-drop” affluent consumers are afflicted with a disorder called affluenza.
   4. Affluence has provided better education, scientific research, and technological solutions, which result in improvements in environmental quality (e.g., safe drinking water).
4. Poverty has harmful environmental and health effects.
   1. Poverty occurs when the basic needs for adequate food, water, shelter, health, and education are not met.
   2. One in every five people live in extreme poverty (<$1.25/day), and more are susceptible.
   3. Poverty causes harmful environmental and health effects.
      1. Environmental degradation caused by need for short-term survival.
      2. Malnutrition.
      3. Inadequate sanitation and lack of clean drinking water.
      4. Severe respiratory disease (inadequate ventilation of heat sources).
      5. High rates of premature death for children under the age of 5 years.
5. Prices of goods and services due not include harmful environmental and health costs.
   1. A company’s goal is often to maximize the profit.
   2. Often consumers do not know the damage caused by their consumption.
   3. Government subsidies may increase environmental degradation.
   4. There are ways to include harmful costs of goods and services.
      1. Shift from environmentally harmful to beneficial government subsidies.
      2. Tax pollution and waste heavily while reducing taxes on income and wealth.
6. People have different views about environmental problems and their solutions.
   1. Each individual has their own environmental worldview—a set of assumptions and values reflecting how you think the world works and what your role should be.
   2. Environmental ethics are beliefs about what is right and wrong with how we treat the environment.
   3. Planetary management worldview holds that we are separate from and in charge of nature.
   4. Stewardship worldview holds that we can and should manage the earth for our benefit, but that we have an ethical responsibility to be caring and responsible managers.
   5. Environmental wisdom worldview holds that we are part of, and dependent on, nature and that nature exists for all species, not just for us.

**1-4 What is an environmentally sustainable society?**

1. Environmentally sustainable societies protect natural capital and live off its income.
   1. Increase reliance on renewable resources.
   2. Protect earth’s natural capital.
2. We can work together to solve environmental problems.
   1. Trade-off solutions provide a balance between the benefits and the costs.
   2. Individuals matter especially in success of bottom-up grassroots action.

**Objectives**

**1-1 What are some principles of sustainability?**

**CONCEPT 1-1A** Life on the earth has been sustained for billions of years by solar energy, biodiversity, and chemical cycling.

**CONCEPT 1-1B** Our lives and economies depend on energy from the sun and on natural resources and ecosystem services *(natural capital)* provided by the earth.

1. Define **natural capital**. Make a list of several local examples of depleting or degrading behaviors that impact our environment. Analyze which of these behaviors humans are currently shifting away from. Define **sustainable society**.

2. Describe how **natural services** work to recycle materials. Draw the relationship between solar energy, **nutrient cycling**, and **biodiversity**. Provide a specific **nutrient cycling** example.

3. Distinguish between the following terms: **inexhaustible**, **renewable,** and **nonrenewable resources** and specify the importance of **reduce, reuse,** and **recycle** for the **nonrenewable resources**.

**CONCEPT 1.1C** We could shift toward living more sustainably by applying full-cost pricing, searching for win-win solutions, and committing to preserving the earth’s life-support system for future generations.

**1-2 How are our ecological footprints affecting the earth?**

**CONCEPT 1-2** As our ecological footprints grow, we are depleting and degrading more of the earth’s natural capital.

1. Distinguish between **point** and **nonpoint sources** of pollution. Describe two local examples of each type and suggest recommend solutions to reduce or eliminate these problems.

2. Distinguish between **pollution** **prevention** and **pollution** **cleanup**. Evaluate the effectiveness of these two approaches in decreasing **pollution**. List four causes of environmental problems.

3. Give 3 examples of resources that have been degrade due to the tragedy of the commons.

4. Calculate your **ecological footprint** at www.myfootprint.org and evaluate the long-term consequences of continuing to live in your current style.

**1-3 Why do we have environmental problems?**

**CONCEPT 1-3A** Major causes of environmental problems are population growth, unsustainable resource use, poverty, avoidance of full-cost pricing, and not including the harmful environmental costs of resource use in the market prices of goods and services.

**CONCEPT 1-3B** Our environmental worldviews play a key role in determining whether we live unsustainably or more sustainably.

1. What is affluenza? List several behaviors that you have observed that are signs of affluenza. What are the long-term consequences of continued high levels of consumption?

2. Describe several environmental problems associated with poverty. Distinguish between **developed countries** and **developing countries**.

**1-4 What is an environmentally sustainable society?**

**CONCEPT 1-4** Livingsustainably means living off the earth’s natural income without depleting or degrading the natural capital that supplies it.

1. Define **sustainable yield**. Describe the relationship between **sustainable yield** and environmental **degradation**. Describe the “tragedy of the commons.”

2. Define **biodiversity**. Briefly describe your community’s **biodiversity**. Analyze the relationship between **biodiversity** and human life.

**Key Terms**

biodiversity

chemical cycling

earth-centered worldview

ecological footprint

ecology

ecosystem

ecosystem services

environment

environmental   
degradation

environmental ethics

environmental science

environmental

worldview

environmentalism

environmentally sustainable society

exponential growth

exhaustible resource

full-cost pricing

human-centered worldview

inexhaustable resource

less-developed countries

life-centered worldview

more-developed

countries

natural capital

natural capital degradation

natural income

natural resources

nonpoint sources

nonrenewable

resource

nutrient cycling

nutrients

organism

per capita ecological   
footprint

point sources

pollution pollution cleanup

pollution prevention

poverty

principles of sustainability renewable resource

resource

scientific principles of sustainability

social science principles of sustainability

solar energy

species

sustainability

sustainable yield

**Teaching Tips**

Ask students to look up their hometown’s 1990 and 2000 census population at [www.census.gov](http://www.census.gov); or let the students know that around 1900 the world population was approximately 2 billion and around 1975 approximately 4 billion, then ask them what our current population is. Ask them how these numbers have influenced their quality of life. Use this dramatic change in population to introduce the core case study.

* Using the notion of exponential population growth, move on to ask them how long this unchecked population growth can go on.
* Discuss the impacts population growth will have on the sustainability of Earth’s resources (e.g., food, space, and non-renewable resources). With a bit of coaxing, this should lead to a discussion of environmental problems and solutions. Discuss the concept of the tragedy of the commons.
* Discuss how different cultures distribute resources, then ask the students (1) how their parents distributed the family resources, such as groceries, tuition money and entertainment expenses and (2) how the students handle their own resources.
* Stress the idea of a sustainable society, how this type of society can grow, and humans’ effect on Earth.
* In addition, introduce and develop the topic of pollution, its sources, and solutions to pollution. Lastly, emphasize the principles of sustainability.

**Discussion Topics**

1. What are the UN population projections and how might these population changes influence sustainability?
2. Define poverty and specify several geographic areas struggling with poverty. Discuss several causes of poverty. Suggest possible strategies to address the current situation.
3. Discuss the current research, development, and distribution of new technologies in the United States that can contribute to living more sustainably (e.g., alternate fuel sources).
4. State of the world: Use the annotated bibliography of current resources to summarize the state of the world and the most important areas of environmental concern.
5. What is one form of pollution or environmental degradation, and describe its existence in different countries, choosing one incident as a case study.
6. How have cultural views of the human-environment relationship influenced a sustainable-Earth worldview? What about indigenous cultures? Discuss attitudes toward nature; distribution of labor, power, and wealth; relationships between the sexes; social structure; and political style.
7. How has energy consumption and use of materials throughout history changed in relation to increases in population size?
8. What variables influence a person’s quality of life? What are the minimum requirements for each person to have a “good” quality of life? What is a “good life”? Does increased resource consumption improve quality of life?
9. What is the history of conflict among pollution control, environmental degradation, and employment in the United States? List possible cases of interest such as the automobile industry and fuel efficiency standards, the spotted owl and the logging industry, and offshore drilling and the oil industry.
10. Is the United States overpopulated? What is the difference between people overpopulation and consumption overpopulation?
11. Do you feel a part of or apart from nature?
12. Do you think technology can solve our environmental problems?
13. Do you think human ingenuity, technology and substitutes for materials that are being used up quickly can create a good life for Earth’s people?
14. When poor economic growth accompanies population growth, poverty increases. How does the use or misuse of natural/renewable resources affect poverty? How does this poverty affect the environment? How can the use of common property affect resources?
15. Why is a U.S. citizen’s “ecological footprint” so much larger than that of someone in a less developed country?
16. What are some technological resources that compromise the environment, and some that are environmentally beneficial?

**Activities and Projects**

1. Create an environmental movie list: each student submits a movie title, description, and how it is related to environmental science. Students can give a brief presentation about the movie and show a one-minute, or less, scene from the movie to the class.

1. Compare your family size and resource consumption to that of your parents or grandparents. Make a table of the class data and generate some statistics (e.g., average family size, average water usage, and average number of household cars).
2. As a class project, “adopt” a country. Assign teams of students to investigate various aspects of the nation’s physical, population, economic, social, political, and other characteristics as well as lifestyle and life quality. Allocate class time for periodic, brief reports and discussions of research results.
3. Find and share with the class songs, essays, poems, paintings, and literary passages that are strongly pro- or anti-technology/environment.
4. As a class exercise, make lists of the beneficial and harmful consequences that have resulted from America’s adoption of automobile technology. Survey the class to see how often students travel by walking, bicycle, public transit or by car. Collect data on the mpg of students’ cars and average number of miles driven/year. Discuss any changes in driving habits caused by the increase in gas prices.
5. As a class project or extra-credit exercise, contact the local Department of Transportation (DOT) and find out if they offer an *Adopt-A-Highway* program. Adopt a stretch of highway and have the students pick up litter. Students can keep tallies of the different types of litter collected (e.g., metal cans, snack food wrappers) and prepare a pie chart and report to submit to the DOT. Alternatively, students can do a similar project on your campus.
6. Find and share with the class songs, folklore, literary passages, and artwork that reflect U.S. land-use values and ethics as they have evolved from the frontier era to the present. Be sure to include Native American works. What can be discerned about the relationship of humans to nature in different cultures through their expressions of art?
7. Have your students devise a way to diagnose affluenza and recommend cures for the problem.
8. Have your students survey four of their friends or family members to determine their worldview. Pool the class data and create a bar chart. Discuss factors that might affect a person’s worldview, such as age, profession, level of education or cultural or ethnic background.

**Attitudes and Value Assessment**

1. Are we living on our planet in a sustainable manner?
2. Is the world overpopulated? Have you experienced countries that you felt to be overpopulated? Have you seen videos of countries that you felt to be overpopulated?
3. Is your local community overpopulated? What do you feel are the costs and benefits of the population size of your community?
4. Do you feel that the size of the human population is one of the top environmental issues?
5. Should something be done to reduce poverty? Will a reduction in poverty help our planet be more sustainable?
6. Do you think the rate of resource consumption is too high?
7. Do you consume too many resources? Should your ecological footprint be regulated?
8. Do you think it’s important to change your consumption patterns?
9. What kinds of changes do you think would improve the quality of life on Earth?
10. What kinds of changes are you willing to make to decrease your resource consumption?
11. Would decreasing your resource consumption improve your own quality of life?
12. What kinds of changes do you think industrialized countries might make to improve the quality of life?
13. What is your environmental worldview?

**Laboratory Skills**

Wells, Edward*. Lab Manual for Environmental Science.* 2009. Lab #2: The Tragedy of the Commons—A Classroom Simulation Exercise.

Wells, Edward*. Lab Manual for Environmental Science.* 2009. Lab #21: Why is Your Footprint So Big?

### **News Videos**

***Sacrificing the environment for energy?***; Brooks/Cole Environmental Science Video Library 2010 with Workbook, ©2012, DVD ISBN-13: 978-0-538-73495-0

**Additional Videos**

**Planet Earth: *The Future:* *Living Together***(Documentary, 2007).Companion to the BBC nature documentary Planet Earth. Three episodes: ["Saving Species,"](http://en.wikipedia.org/wiki/Planet_Earth:_The_Future#1._.22Saving_Species.22) ["Into the Wilderness,"](http://en.wikipedia.org/wiki/Planet_Earth:_The_Future#2._.22Into_the_Wilderness.22) and “Living Together.”

**Reinventing the World** (Documentary, 2000). Explores some of the biggest challenges facing us today, including urban sustainability.

<http://www.bullfrogfilms.com/catalog/rtw.html>

**Human Footprint** (National Geographic Documentary, 2008). This video looks at the total impact one human can have on the planet in their life.

<http://channel.nationalgeographic.com/channel/human-footprint/>

**Kilowatt Ours: A Plan to Re-Energize America** (Documentary, 2008). Examines the source of our electricity, problems caused by energy production and ways to conserve energy.

<http://www.kilowattours.org/>

### **Web Resources**

**Center for Sustainable Economy**

Ecological footprint quiz.

<http://www.myfootprint.org/>

**Earth 911.org**

Environmental and sustainability resources.

<http://earth911.org/>

**Online Community for the Environment**

Many resources.

<http://www.envirolink.org/>

**Center for Ecoliteracy**

Educational sources on Sustainable living

<http://www.ecoliteracy.org/>

**Eartheasy**

Many resources.

<http://www.eartheasy.com/>

**Digital Integration**

**Correlation to Global Environment Watch**

Consumption Overpopulation

Ecological Footprint Poverty

Environmental Philosophy Sustainability

**Correlation to Explore More**

Sustainability

### **Suggested Answers to End of Chapter Questions**

Answers will vary, but these represent phrases from this chapter. The following are examples of the material that should be contained in possible student answers to the end of chapter questions. They represent only a summary overview and serve to highlight the core concepts that are addressed in the text. It should be anticipated that the students will provide more in-depth and detailed responses to the questions depending on an individual instructor’s stated expectations.

**Review**

**Core Case Study**

1. Define sustainability, and summarize the story of how many college campuses are working to become more environmentally sustainable.

* Sustainability is the capacity of the earth’s natural systems and human cultural systems to survive, flourish, and adapt to changing environmental conditions into the very long-term future. Since the 1980s, college campuses have begun to use more environmentally sustainable sources of energy, such as solar panels, geothermal heating and cooling, natural waste water purification, and collection of rainwater for irrigation. Most notable are the over-arching recycling programs that have become very prevalent. In addition to innovative design, most colleges have begun to offer curriculum, even programs, on environmental sustainability.

**Section 1-1**

2. What are the three key concepts for this section? Define environment. Distinguish among environmental science, ecology, and environmentalism. Distinguish between an organism and a species. What is an ecosystem? What are three scientific principles of sustainability derived from how the natural world works? What is solar energy and why is it important to life on the earth? What is biodiversity and why is it important to life on the earth? Define nutrients. Define chemical cycling (or nutrient cycling) and explain why it is important to life on the earth.

The key concepts for this section are:

* + Nature has sustained itself for billions of years by relying on solar energy, biodiversity, and nutrient cycling.
  + Our lives and economies depend on energy from the sun (*solar capital*) and natural resources and natural services (*natural capital*) provided by the earth.
  + We could shift toward living more sustainably by applying full-cost pricing, searching for win-win solutions, and committing to preserving the earth’s life-support system for future generations.
* The environment is everything around us.
* Environmental science is an interdisciplinary study of how humans interact with living and nonliving parts of their environment.
* Ecology is the biological science that studies how organisms, or living things, interact with one another and with their environment.
* Environmentalism is a social movement dedicated to protecting the earth’s life-support systems for all forms of life.
* Every organism is a member of a certain species: a group of organisms that have distinctive traits and, for sexually reproducing organisms, can mate and produce fertile offspring.
* An ecosystem is a set of organisms within a defined area or volume interacting with one another and with their environment of nonliving matter and energy.
* Nature has sustained itself with solar energy, biodiversity, and chemical cycling.
* Solar energy warms the earth and provides energy for plants to produce nutrients. All life on earth depends upon solar energy.
* Biodiversity is the variety of organisms, the natural systems in which they live and the natural services that they provide.
* Nutrient cycling is the circulation of nutrients, or chemicals necessary for life, from the environment (mostly from soil and water) through organisms and back to the environment

3. Define natural capital. Define natural resources and ecosystem services, and give two examples of each. Give three examples of how we are degrading natural capital. Explain how finding solutions to environmental problems involves making trade-offs. Explain why individuals matter in dealing with the environmental problems we face. What are three social science principles of sustainability? What is full-cost pricing and why is it important?

* Natural capital—the natural resources and natural services that keep us and other forms of life alive and support our economies.
* Natural resources are materials and energy in nature that are essential or useful to humans. These resources are often classified as renewable (such as air, water, soil, plants, and wind) or nonrenewable (such as copper, oil, and coal).
* Natural services are processes in nature such as purification of air and water, which support life and human economies.
* Natural capital degradation occurs when the natural resources and services are hurt.
* Solutions to natural degradation, such as reducing energy consumption, reducing resource use and advocating a reduction in population growth, may require economic changes and life-style modifications.
* Individuals matter because data suggests that it takes only 5–10% of the population of a community, country, or the world to bring about major social change, and significant social change can occur in a much shorter time than most people think.
* Three social science principles of sustainability are full-cost pricing, win-win solutions, and responsibility to future generations.
* Full-cost pricing includes the harmful environmental and health costs of producing and using goods and services in the market prices

4. What is a resource? Distinguish between a resource and a renewable resource and give an example of each. What is the sustainable yield of a renewable resource? Define and give two examples of a nonrenewable resource. Distinguish between recycling and reuse and give an example of each. What percentage of the non-renewable metals and plastics that we use could be recycled or reused? Distinguish between more-developed countries and less-developed countries and give an example of a high-income, middle-income and low-income country.

* A resource is anything obtained from the environment to meet our needs and wants such as solar energy, fresh air, fertile soil, wild edible plants, petroleum, iron, underground water, and cultivated crops.
* Solar energy is called a perpetual resource because it is renewed continuously and is expected to last at least 6 billion years as the sun completes its life cycle.
* A renewable resource can be replenished in days to several hundred years through natural processes as long as it is not used up faster than it is renewed. Examples include forests, grasslands, fish populations, freshwater, fresh air, and fertile soil.
* Sustainable yield of a renewable resource is the highest rate at which it can be used indefinitely without reducing its available supply.
* Nonrenewable resources, such as coal and oil, exist in a fixed quantity, or stock, in the earth’s crust and take millions to billions of years to renew.
* Recycling involves collecting waste materials and processing them into new materials, for example cans that are collected and reprocessed. Reuse means using a resource over and over in the same form, for example glass bottles that are collected, washed, and refilled many times.
* Eighty to 90% of the non-renewable metals and plastics that we use could be recycled or reused.
* The United Nations classifies the world’s countries as economically more developed or less developed based primarily on their average income per person. High-income countries include the United States, Canada, Japan, Australia, New Zealand, and most countries of Europe. Middle-income countries include China, India, Brazil, Thailand, and Mexico. Low-income countries include Congo, Haiti, Nigeria, and Nicaragua.

**Section 1-2**

5.What is the key concept for this section? Define and give three examples of environmental degradation (natural capital degradation). About what percentage of the earth’s natural or ecosystem services have been degraded by human activities? Define pollution. Distinguish between point sources and nonpoint sources of pollution and give an example of each. Distinguish between pollution cleanup and pollution prevention. Describe three drawbacks to solutions that rely mostly on pollution cleanup. What is the *tragedy of the commons* and what are two ways to deal with it?

* The key concept for this section is:
  + As our ecological footprints grow, we are depleting and degrading more of the earth’s natural capital.
* Environmental degradation is when the use of a renewable resource exceeds its natural replacement rate, causing the available supply to shrink. Examples include climate change, soil erosion, aquifer depletion, decreased wildlife habitats, species extinction, and declining ocean fisheries.
* According to the 2005 UN *Millenium Ecosystem Assessment*, about 60% of the earth’s natural or ecosystem services have been degraded.
* Pollution is contamination of the environment by a chemical or other agent, such as noise or heat that is harmful to health, survival, or activities of humans or other organisms.
* Point sources are single, identifiable sources, such as the smokestack of a coal-burning power or industrial plant, a factory drainpipe, or the exhaust pipe of an automobile. Nonpoint sources are dispersed and often difficult to identify. Examples include pesticides blown from the land into the air and the runoff of fertilizers, pesticides, and trash from the land into streams and lakes.
* Pollution cleanup involves cleaning up or diluting pollutants after they have been produced, for example water filters used to clean contaminated groundwater. Pollution prevention reduces or eliminates the production of pollutants, for example air purifying technologies used on smoke stacks for cleaner exhaust.
* Drawbacks to solutions that rely on pollution cleanup include:
  + It is only a temporary bandage as long as population and consumption levels grow without corresponding improvements in pollution control technology.
  + Cleanup often removes a pollutant from one part of the environment only to cause pollution in another. For example, we can collect garbage.
  + Once pollutants become dispersed into the environment at harmful levels, it usually costs too much to reduce them to acceptable levels.
* The tragedy of the commons is the environmental degradation of openly shared renewable resources. One solution is using a shared renewable resource at a rate well below its estimated sustainable yield by using less of the resource, regulating access to the resource, or both. Another possible solution is to convert open-access renewable resources to private ownership; this is not practical for global resources such as the atmosphere and the oceans.

6. What is an ecological footprint? What is a per capita ecological footprint? Use the ecological footprint concept to explain how we are living unsustainably. What is meant by upcycling? What is the IPAT model for estimating our environmental impact?

* An ecological footprint is the amount of biologically productive land and water needed to indefinitely supply the people in a particular country or area with renewable and non-renewable resources and to absorb and recycle the wastes and pollution produced by such resource use.
* A per capita ecological footprint is the average ecological footprint of an individual in a given country or area.
* If the total ecological footprint for a city, a country, or the world is larger than its biological capacity to replenish its renewable resources and absorb the resulting wastes and pollution, it is said to have an ecological deficit. In other words, its people are living unsustainably by depleting natural capital instead of living off the renewable supply of resources and ecosystem services provided by such capital.
* Upcycling acknowledges our growing ecological footprints and the need to reduce them, but it stresses that in pursuing our activities and in creating products and services, we need to consider how we can improve some aspect of the environment while we serve our needs and wants.
* The IPAT model shows how population size (P), affluence (A), or wealth, as measured by rates of resource consumption per person, and the beneficial and harmful environmental effects of technologies (T) help to determine the environmental impact (I) of human activities.
* To indefinitely sustain the resource use of the current human population, we would need the equivalent of 1.3 planet earths. If we continue on our current path, by around 2035 we will need 2 planet earths.

**Section 1-3**

7. What are the two key concepts for this section? Identify five basic causes of the environmental problems that we face. What is exponential growth? What is the rule of 70? What is the current size of the human population? About how many people are added each year? How big is the population projected to be in 2050? How do Americans, Indians, and the average people in the poorest countries compare in terms of average resource consumption per person? What are two types of environmental damage resulting from growing affluence? How can affluence help us to solve environmental problems?

* The two key concepts for this section are:
  + Major causes of environmental problems are population growth, unsustainable resource use, poverty, avoidance of full-cost pricing, and increasing isolation from nature. Our environmental worldview plays a key role in determining whether we live unsustainably or more sustainably**.**
* Five basic causes of environmental problems are:
  + population growth
  + wasteful and unsustainable resource use
  + poverty
  + failure to include the harmful environmental and health costs of goods and services in their market prices
  + increasing isolation from nature
* Exponential growth occurs when a quantity such as the human population or pollution increases at a fixed percentage per unit of time, for example 2% per year. Exponential growth starts off slowly. But after only a few doublings, it grows to enormous numbers because each doubling is twice the total of all earlier growth.
* The rule of 70 is that the doubling time of the human population or of any growing quantity can be calculated by using the rule of 70: doubling time (years) = 70/annual growth rate (%).
* There are currently about 7 billion people with about 83 million being added each year. By 2050 there may be 9.6 billion people.
* The average American consumes about 30 times the amount of resources that the average Indian consumes and 100 times the amount consumed by the average person in the world’s poorest countries.
* Affluence can support high levels of consumption which can waste and degrade resources.
* Affluence can allow for better education, which can lead people to become more concerned about environmental quality. It also provides money for developing technologies to reduce pollution, environmental degradation, and resource waste.

8. What is poverty and what are three of its harmful environmental and health effects? About what percentage of the world’s people struggle to live on the equivalent of $1.25 a day? About what percentage struggle to live on $2.25 a day? Explain the connection between poverty and population growth. Describe three major health problems suffered by many of the world’s poor.

* Poverty is a condition in which people are unable to fulfill their basic needs for adequate food, water, shelter, health care, and education.
* According to the World Bank, about 900 million people—almost three times the U.S. population—live in extreme poverty, struggling to live on the equivalent of less than $1.25 a day
* About one of every three, or 2.6 billion, of the world’s people struggles to live on less than $2.25 a day.
* To many poor people, having more children is a matter of survival. Their children help them gather firewood, haul water, and tend crops and livestock. The children also help to care for their aging parents, most of whom do not have social security, health care, and retirement funds. This daily struggle for survival is largely why populations in some of the poorest countries continue to grow at high rates.
* Three health problems suffered by the poor include malnutrition, illness from lack of access to clean water, and health issues from outdoor air pollution.
  + Excluding the harmful environmental costs in the prices of goods and services can hurt the environment because the consumer does not realize the value being lost.
  + Government subsidies can cause the consumer not to realize the value of the product or service, causing the resource to be depleted or degrade.
  + Two ways to include the full cost of goods are to shift from environmentally harmful to beneficial government subsidies and to tax pollution and waste heavily while reducing taxes on income and wealth.

9. Explain how exclusion of the harmful environmental and health costs of production from the prices of goods and services is related to the environmental problems we face. What is the connection between government subsidies, resource use, and environmental degradation? What are two ways to include the harmful environmental and health costs of the goods and services in their market prices? Explain how a lack of knowledge about nature and the importance of natural capital, along with our increasing isolation from nature, can intensify the environmental problems we face. Describe how Juan Martinez is working to reconnect people with nature. What is an environmental worldview? What is environmental ethics? Distinguish among the human-centered, life-centered, and earth-centered worldviews. Describe the rise of environmental conservation and protection in the United States.

* Because the prices of goods and services do not include most of their harmful environmental and health costs, consumers and decision makers have no effective way to evaluate these harmful effects.
* Although subsidies help to create jobs, and stimulate economies, environmentally harmful subsidies encourage the depletion and degradation of natural capital.
* Two ways to include the harmful environmental and health costs of the goods and services in their market prices over the next two decades would be to shift from environmentally harmful government subsidies to environmentally beneficial subsidies, and to tax pollution and waste heavily while reducing taxes on income and wealth.
* Because people live isolated from nature, they are unaware of the amounts of wastes and pollutants they produce, where these wastes and pollutants go, and how they affect the environment.
* Juan Martinez created the Natural Leaders Network of the Children & Nature Network, an organization creating links between environmental organizations, corporations, government, education, and individuals to reconnect children with nature.
* An environmental worldview is your set of assumptions and values reflecting how you think the world works and what you think your role in the world should be.
* Environmental ethics, the study of varying beliefs about what is right and wrong with how we treat the environment, provides useful tools for examining worldviews.
* There are three major categories of environmental worldviews: human-centered, life-centered, and earth-centered.
* An environmental worldview is a set of assumptions and values reflecting how you think the world works and what you think your role in the world should be.
* A human-centered environmental worldview sees the natural world primarily as a support system for human life
* According to the life-centered environmental worldview, all species have value as participating members of the biosphere, regardless of their potential or actual use to humans.
* The earth-centered environmental worldview holds that we are part of, and dependent on, nature and that the earth’s life-support system exists for all species, not just for us.
* Early conservationists such as Teddy Roosevelt, John Muir, Aldo Leopold and Rachel Carson paved the way for the environmental legislation of the late 1960s and 1970s and the eventual creation of the Environmental Protection Agency

**Section 1-4**

10. What is the key principle for this section? What is an environmentally sustainable society? What is natural income and what does it mean to live off of natural income? What are two pieces of good news about making the transition to a more sustainable society? Based on the three scientific principles of sustainability, and the three social science principles of sustainability, what are the three important ways to make a transition to sustainability as summarized in this chapter’s *three big ideas*? Explain how we can use these six principles of sustainability to move us toward a more sustainable future.

* Livingsustainably means living off the earth’s natural income without depleting or degrading the natural capital that supplies it.
* An environmentally sustainable society meets the current and future basic resource needs of its people in a just and equitable manner without compromising the ability of future generations to meet their basic needs.
* Natural income means the renewable resources such as plants, animals, and soil provided by the earth’s natural capital. Living off of natural income means not depleting or degrading natural capital.
* Two pieces of good news are that we have the ability to create a sustainable future by making good environmental choices now, and that people alive today are part of the 21st century’s transition generation who have the ability to create a sustainable future.
* Three best ways to make a transition:
  + Rely more on renewable energy from the sun, including indirect forms of solar energy such as wind and flowing water, to meet most of our heating and electricity needs.
  + Protect biodiversity by preventing the degradation of the earth’s species, ecosystems, and natural processes.
  + Do not disrupt the earth’s natural chemical cycles by overloading them with harmful chemicals or by removing natural chemicals faster than the cycles can replace them.
* Answers may vary but some examples are reducing energy consumption and relying more heavily on solar energy, reducing resource use and recycling when possible, and advocating a reduction in population growth.

**Critical Thinking**

1. Do you think you are living unsustainably? Explain. If so, what are the three most environmentally unsustainable components of your lifestyle? List two ways in which you could apply each of the three principles of sustainability and each of the three social science principles of sustainability to making your lifestyle more environmentally sustainable*.*

Answers may vary and can be used as a class discussion on how best to evaluate sustainability, compare ecological footprints... Some examples of answers include reducing energy consumption and relying more heavily on solar energy, reducing resource use and recycling when possible, and advocating a reduction in population growth.

1. What are three ways in which college campuses (**Core Case Study**) are employing upcycling by expanding their beneficial environmental impacts? What are three ways in which you could do this in your daily life?

Student answers will vary depending on their viewpoint.

3. For each of the following actions, state one or more of the three scientific principles of sustainability that are involved: (a) recycling aluminum cans; (b) using a rake instead of a leaf blower; (c) walking or bicycling to class instead of driving; (d) taking your ownreusable bags to the grocery store *to carry your purchases home*; (e) volunteering to help restore a prairie; and (f) lobbying elected officials to require that 20% of your country’s electricity be produced by renewable wind power by 2030.

The three key factors are *solar energy*, *biodiversity*, and *chemical cycling*. All the examples could be connected to all three key factors.

(a) Nutrient Recycling/Reliance on Solar Energy: In nature there is no waste, so recycling the aluminum soda can mimics nutrient recycling. Since less energy is used in the aluminum recycling process than starting from raw materials such as bauxite, recycling makes us less dependent on nonrenewable energy sources.

(b) Reliance on Solar Energy: As no electrical or gasoline energy is expended by using the rake, we are less dependent on nonrenewable energy sources such as coal to generate the electricity to power the leaf blower.

(c) Reliance on Solar Energy/Biodiversity: By not using gasoline to drive the car, you are relying more on renewable rather than nonrenewable energy and positively impacting biodiversity in areas where oil drilling is having harmful ecological effects.

(d) Nutrient Recycling/Biodiversity/Reliance on Solar Energy: If you use a reusable grocery bag made from organically grown hemp, bamboo or cotton, you will be relying on solar energy rather than nonrenewable energy sources that may have been used to make a plastic bag, which may or may not be recyclable; while paper is recyclable, using paper bags can have an effect on the biodiversity of forest lands.

(e) Biodiversity/Nutrient Recycling: By restoring habitat, you will be enhancing biodiversity and also helping the future recycling of nutrients from the plantings.

(f) Reliance on Solar Energy/Biodiversity: Promoting the use of renewable energy sources complies with the principle of relying on solar energy, and less reliance on nonrenewable sources such as coal and oil that adversely affect biodiversity in their extraction.

4. Explain why you agree or disagree with the following propositions:

a. Stabilizing population is not desirable because, without more consumers, economic growth would stop.

b. The world will never run out of resources because we can use technology to find substitutes and to help us reduce resource waste.

c. We can shrink our ecological footprints while creating beneficial environmental impacts.

Student answers will vary depending on their viewpoint but could include:

Disagree: The earth has a finite amount of resources. With ever-increasing numbers of consumers the economy may eventually reach a maximum as these resources are diminished and the cost of goods skyrockets. This would cause a greater disparity between rich and poor people and end up promoting increased poverty rather than increased wealth.

Agree: Companies like 3M have reduced their waste by selling their generated waste products to other companies that can use the materials for their own manufacturing processes. With an increase in such technology in the future, more materials have the potential to be reused and recycled indefinitely.

5. What do you think when you read that the average American consumes 30 times more resources than the average citizen of India? Are you skeptical, indifferent, sad, helpless, guilty, concerned, or angry about this fact? Can you think of something that you and others could do to address this problem? What might that be?

Again student answers will vary, but the benefit of such questions is that the instructor can facilitate a discussion that could help the students come to terms with the feelings they have on the issue and take the necessary steps to minimize their own ecological footprint. The instructor can help the students see how answers such as being indifferent to the issue lead to a perpetuation of the problem, and answers may bring about a change in their own lifestyle.

6. When you read that at least 19,000 children age 5 and younger die each day (13 per minute) from preventable malnutrition and infectious disease, how does it make you feel? Can you think of something that you and others could do to address this problem? What might that be?

Student answers will vary. The instructor could lead a discussion in which each student is asked to explain their answer. Through this discussion more students may see a possible answer and be spurred into action.

7. Explain why you agree or disagree with each of the following statements: (a) humans are superior to other forms of life; (b) humans are in charge of the earth; (c) the value of other forms of life depends only on whether they are useful to humans; (d) based on past extinctions and the history of life on the earth over the last 3.8 billion years, biologists hypothesize that all forms of life eventually become extinct, and we should not worry about whether our activities cause their premature extinction; (e) all forms of life have an inherent right to exist; (f) all economic growth is good; (g) nature has an almost unlimited storehouse of resources for human use; (h) technology can solve our environmental problems; (i) I do not believe I have any obligation to future generations; and (j) I do not believe I have any obligation to other forms of life.

Student answers will vary and the instructor has the opportunity to lead a discussion where each student can elaborate on their own particular viewpoint. Some comments may include:

1. Humans *are* superior to other life forms as we have the capability to modify our environments to suit our own needs and desires, setting us apart from the rest of the animal world. Humans *are not* superior to other life forms as we are the only species capable of causing wide-spread environmental disasters.
2. Humans *are* in charge of the earth. No other species can manipulate the environment and exploit nature for food and energy sources to the same extent. .
3. Some species need to exist because they may be beneficial to other species in their ecosystem. Just because they may not benefit humans directly, they do so indirectly by helping to maintain the biodiversity and stability of ecosystems. In addition, some people believe that other species may have aesthetic, moral and ethical value.
4. We should worry about the extinction of species because although extinction does occur in nature it does so over long time periods; humans are speeding up this process and rapidly exceeding natural extinction rates.
5. Some species have a right to exist, especially if they benefit us; but what about those species that cause disease and death? We should wipe out all the bacteria and viruses that kill us, as they should not exist, and only leave the “good” organisms around.
6. Economic growth is good for everyone. For example, the people of the U.S. and Europe benefit from being able to buy cheap goods that are manufactured in China; the Chinese people have jobs, so everyone wins. Some students may believe that economic growth is bad because it can hurt the environment; building housing developments means cutting down trees and destroying homes of many animals.
7. This is true only if we use the resources in a sustainable way. If *everyone* on the planet used and consumed resources at the same rate as the people of the United States, we would run out very quickly and need more than one Earth to provide the resources for all of us. So, the resources we have are not unlimited.
8. Technology may be able to solve some of our environmental problems such as reducing the emissions from smokestacks. The impact technology will have on the future is speculative. Breakthroughs in hydrogen fuel cell technology may greatly reduce the world’s dependence on oil and may lead to increased sustainability in terms of energy use.
9. The concept of sustainability depends upon having an obligation to future generations. If we do not take the future into account by looking at our actions of today, we will not be leaving a healthy planet for our children and our children’s children.
10. We need to consider the needs of humans who, after all, are the most important species on the planet, and we need to do whatever we can to make sure we survive even if it does mean a few other species go extinct.

8. What are the basic beliefs within your environmental worldview? Record your answer. Then, at the end of this course, return to your answer to see if your environmental worldview has changed. Are the beliefs included in your environmental worldview consistent with the answers you gave to Question 7 above? Are your actions that affect the environment consistent with your environmental worldview? Explain.

Student answers will vary. This question provides the instructor with the basis for a discussion on individual worldviews and allows for each student to consider their own current beliefs. It is hoped that by the end of the course everyone in the class will have gained a greater understanding of the environment and increased their environmental literacy. The question also gives the instructor the chance to discuss specific *actions* individual members of the class can take to make sure that if they “talk the talk” they also “walk the walk” from an environmental perspective. This will help students individually, as well as the class as a whole, to live consciously and possibly to minimize their ecological footprint.

**Global Environment Watch Exercise**

Use the world maps in Figure 1, p. S00, in Supplement 4 and Figure 1.10 to choose one more-developed country and one less-developed country to compare their ecological footprints (found under Quick Facts on the country portal). Click on the ecological footprint number to view a graph of both the ecological footprint and biocapacity of each country. Using those graphs, determine whether these countries are living sustainably or not. What would be some reasons for these trends?

Answers will vary but more-developed countries will have larger ecological footprints than less-developed countries. Factors that determine whether a country is living sustainably or not include the size of the per capita ecological footprint and the size of the ecological biocapacity.

**Ecological Footprint Exercise**

1. If the ecological footprint per person of a country or the world is larger than its biological capacity per person to replenish its renewable resources and absorb the resulting waste products and pollution, the country or the world is said to have an ecological deficit. If the reverse is true, the country or the world has an ecological credit or reserve. Use the data below to calculate the ecological deficit or credit for the countries listed. (As an example, this value has been calculated and filled in for World.)  
     
   The two countries with the largest ecological deficits are the United States (-5.1 hectares per person) and the United Kingdom (-4.0 hectares per person). The United States has a large ecological deficit because it has the largest per capita ecological footprint of any country in the world. The United Kingdom has a large ecological deficit because it has a high per capita ecological footprint, but also because it has a low ecological biocapacity to replenish its renewable resources and absorb the resulting waste products and pollution due to its small land area compared to its population.

2. Rank the four countries with ecological credits in order from the highest to the lowest credit. For each of these countries, why do you think it has an ecological credit??

The four countries that have ecological credits are Russia (2.2 hectares per person), Brazil (6.7 hectares per person), Australia (7.9 hectares per person) and Canada (8.5 hectares per person), ranked in that order. Answers may vary, but one consistency in the four countries is a low population.

1. Rank the countries in order from the largest to the smallest per capita ecological footprint.  
     
   Countries listed in order of largest to smallest per capita ecological footprint:

|  |  |  |  |
| --- | --- | --- | --- |
| Saudi Arabia | 4 | 0.07 | -3.93 |
| Israel | 4 | 0.3 | -3.7 |
| Japan | 4.2 | 0.6 | -3.6 |
| UK | 4.7 | 1.3 | -3.4 |
| United States | 7.2 | 3.9 | -3.3 |
| Germany | 4.6 | 2 | -2.6 |
| Mexico | 3.3 | 1.4 | -1.9 |
| South Africa | 2.6 | 1.2 | -1.4 |
| China | 2.1 | 0.9 | -1.2 |
| Guatemala | 1.8 | 1.1 | -0.7 |
| India | 0.9 | 0.5 | -0.4 |
| Nigeria | 1.4 | 1.2 | -0.2 |
| Russia | 4.4 | 6.6 | 2.2 |
| Brazil | 2.9 | 9.6 | 6.7 |
| Australia | 6.7 | 14.6 | 7.9 |
| Canada | 6.4 | 14.9 | 8.5 |