Chapter 1

Introducing Environmental Science and Sustainability

Lecture Outline:

I. Human Impacts on the Environment

A. Increasing human numbers

i. Although several million species inhabit Earth, the human species is the most

significant agent of environmental change on the planet ii. Over 7.5 billion people currently inhabit planet Earth

iii. Human activities, such as overpopulation, deforestation, pollution and species eradication are disrupting global systems

B. The gap between rich and poor countries

i. 81% of the world’s population live in poor countries

1. Poor countries fall into two subcategories: moderately developed countries (Mexico, South Africa, Thailand) and less developed countries (LDCs - Bangladesh, Ethiopia, Laos)

2. Nearly one in two people lives in extreme poverty which is associated with low life expectancy, illiteracy, and inadequate access to health services, safe water, and balanced nutrition

ii. Countries with complex industrialized bases, low rates of population growth, and high per capita incomes are considered highly developed countries (HDCs - Canada, Japan, the United States, and most of Europe)

iii. Some countries have a mix of HDC and LDC characteristics, with very poor rural populations contrasting with wealthy urban population and high income disparity between the two. Therefore the terms LDC and HDC is becoming more blurred.

II. Population, Resources, and the Environment

A. Types of resources

i. Nonrenewable resources are present in limited supplies and are depleted by

use (aluminum, copper, fossil fuels)

ii. Renewable resources are replaced by nature fairly rapidly and can be used

forever as long as they are not overexploited in the short term (trees, animals, soils, fresh water)

B. Resource consumption

i. Consumption is the human use of materials

ii. A single child born in a HDC causes a greater impact on the environment and on resource depletion than 12 or more children born in a developing country

C. People overpopulation and consumption overpopulation

i. A country is overpopulated if the level of demand on its resource base results in damage to the environment

ii. A country can be overpopulated in two ways: people overpopulation (LDCs)

and consumption overpopulation (HDCs)

iii. The amount of productive land, fresh water, and ocean required on a continuous basis to supply a person food, wood, energy, water, housing, clothing, transportation, and waste disposal is termed an **ecological footprint**

D. The IPAT model

i. The IPAT model shows the mathematical relationship between environmental impacts and the forces driving them: I = P x A x T

ii. The three most important factors in determining environmental impact (I) are: number of people (P), the affluence per person (A), and the environmental effects of the technologies used to obtain and consume resources (T)

III. Sustainability

A. When the environment is used sustainably, humanity’s present needs are met without endangering the welfare of future generations

B. Inadequate understanding of how the environment works and how human choices affect the environment is a major reason that problems of environmental

sustainability are difficult to resolve

C. Sustainability and the Tragedy of the Commons

i. Proposed by Garrett Hardin in 1968, he postulates that our inability to solve many environmental problems is the result of a struggle between short-term individual welfare and long-term environmental sustainability and societal welfare

ii. Effective legal and economic policies are needed to prevent the short-term degradation of our global commons

iii. The shared responsibility for the sustainable care of our planet is termed

stewardship. Stewardship works best when all levels of society (government, NGOs, local residents) work together

D. Global plans for sustainable development

i. The goals of *Agenda 21* are achieving improved living conditions for all

people while maintaining a healthy environment in which natural resources are not overused and excessive pollution is not generated

iii. Three factors interact to promote sustainable development: environmentally sound decisions, economically viable decisions, and socially equitable

decisions.

iv. A further commitment to the goals of Agenda 21 were made in In 2015, representatives from

nearly 200 countries committed to an international plan to reduce poverty and food insecurity, improve global human well-being and education, and preserve biodiversity

IV. Environmental Science

A. Environmental science encompasses the many interconnected issues involving human population, Earth’s natural resources, and environmental pollution

B. Earth systems and environmental science

i. Understanding how systems that consist of many interacting parts function as

a whole help scientists gain valuable insights that are not obvious when looking at system components

ii. Environmental scientists often use models to describe the interaction within and among environmental systems

iii. Many aspects of Earth’s systems are in a steady state of dynamic equilibrium

1. Feedback occurs when a change in one part of the system leads to a

change in another part

2. A negative feedback mechanism works to keep an undisturbed system

in dynamic equilibrium, and occurs when a change in some condition triggers a response that counteracts, or reverses, the changed condition

3. A positive feedback mechanism leads to greater change from the original condition, and occurs when a change in some condition

triggers a response that intensifies the changing condition

C. Science as a process

i. There is no absolute certainty or universal agreement about anything in science; it is self-correcting over time

ii. The established processes scientists use to answer questions or solve problems are collectively called the scientific method

1. The scientific method involves five steps: recognize a problem or unanswered question, develop a hypothesis, design and perform an

experiment to test the hypothesis, analyze and interpret the data to reach a conclusion, share new knowledge

2. Scientists collect objective data by observation and experimentation a. Inductive reasoning is the basis of modern experimental

science

b. Deductive reasoning is used to determine the type of

experiment or observations necessary to test a hypothesis

3. Controls and variables are accounted for in experimental design

4. Scientific theories are integrated explanations of numerous hypotheses, each supported by a large body of observations and experiments and evaluated by the peer review process

V. Addressing Environmental Problems

A. There are five stages in addressing an environmental problem: scientific assessment, risk analysis, public education and involvement, political action, evaluation

B. The reversal of the pollution of Lake Washington is a clear example of how environmental science identifies and addresses environmental problems (read and discuss CASE IN POINT: Lake Washington)

Additional Resources

* Ecological Footprint exercise: <http://www.footprintcalculator.org/>
* Tragedy of the Commons
  + Short explanation: <https://www.youtube.com/watch?v=jSuETYEgY68>
  + Khan Academy, 6+ minutes: <https://www.youtube.com/watch?v=0b2Tl0x-niw>
  + Garret Hardin’s explanation of the Tragedy of the Commons: <https://www.youtube.com/watch?v=L8gAMFTAt2M>
* Case in Point, Lake Washington:
  + Interesting side effect of cleaning the lake was that brown stickleback fish, which had previously hidden in the muck of the lake, were exposed when the lake was cleaned up. They quickly (re)developed a new mechanism to avoid predation, that of shark bony spikes. This was a return to previous form that they had 10,000 years ago, a resurgence of an evolutionary train in response to a changing environment. You can read about it here: <http://news.nationalgeographic.com/news/2008/05/080520-fish-evolution_2.html>

In-Class Activities:

Instructor Notes for In-Class Activity 1

Title: Student Resource Use and IPAT

Time: 10 minutes prep; 15 – 20 OR 40 – 50 minutes in class

Materials: Paper for class, or print instructions on worksheets. Post the instructions on a PowerPoint or overhead as an alternative to printing out instructions. Either provide paper for students or let them bring their own.

Handouts: Optional. See below.

Procedures: Divide class into at least five groups of two to four students. Assign each group of students to one of the five categories. Each group of students will try to estimate how much of one of five categories of resources a typical student uses in a single day. The categories are:

1. Agricultural

2. Consumer goods

3. Infrastructure

4. Water

5. Energy

Notes to instructor:

1. Give the students the next following “challenge” after they have spent some time working on their lists

2. Keep in mind that there should be overlap in these lists. For example, energy is needed to provide any of the other four

categories; agriculture is the source of multiple types of resources, and so on.

3. Use this lesson to emphasize that everything is either matter or energy

4. To shorten the exercise, omit the IPAT part, or assign as homework

Next, have them evaluate the “technology” component of each, in the context of IPAT. Does this by having them assume that world Population will stabilize at about twice the current size, and all of those people will seek Affluence like that found in highly developed countries. What types of technologies would be required to keep impacts constant? Is that even possible?

Student

Instructions:

1. Estimate how much of the resource type assigned to you (Agricultural, consumer goods, infrastructure, water and energy) a typical student uses in a day. Think broadly!

2. Next, evaluate the “technology” component of your resource, in the IPAT model. Assume that world Population will stabilize at about twice the current size, and all of those people will seek Affluence like that found in highly developed countries. What

types of Technologies would be required to keep Impacts

constant? Is that even possible?

Specific

Suggestions:

If more than 16 students are in your class, have more than one group work on each category. You may be able to skip the “thinking broadly”

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| --- | --- | --- |
| Objectives: |    | Describe the resource use by students in highly developed countries  Contrast this with resource use by people in less developed |
|  |  | countries.  Describe the three most important factors that determine human |
|  |  | impact on the environment. |

In-Class Activity 1: Handout

1. Estimate how much of the resource type assigned to you (Agricultural, consumer goods,

infrastructure, water and energy) a typical student uses in a day. Think broadly!

2. Next, evaluate the “technology” component of your resource, in the IPAT model.

Assume that world Population will stabilize at about twice the current size, and all of those people will seek Affluence like that found in highly developed countries. What types of Technologies would be required to keep Impacts constant? Is that even possible?

Instructor Notes for In-Class Activity 2

Title: Do Americans Use Too Much?

Time: 5 – 10 Minutes prep; 40 – 60 minutes in class (or can assign research between class periods)

Materials: None

Handouts: None

Procedures: For – Against – Jury standard procedure. Randomly divide class into three groups.

Assign one group each to argue FOR or AGAINST the statement, and the third group to serve as a JURY.

Each group should select a leader and a recorder.

The FOR (Americans Use Too Much) group should research (not just think up!) information that supports the statement. They should be explicit about their sources, whether those are data, ethics, theories, or political positions. They should then synthesize this into a five-minute verbal argument, to be made before the full class.

The AGAINST (American Resource Use is Reasonable) group should do the same for the opposite position. Their original argument SHOULD NOT respond to items brought up by the FOR group.

After each has made a five-minute argument, each side will have two minutes to respond to claims or statements made by the other side.

The JURY group will then deliberate openly; the FOR and AGAINST

groups will listen to the deliberations, but may not respond. The JURY may challenge either group to provide evidence for up to three pieces of information, and may ask up to three questions of each group (they may ask the same question to both groups).

The JURY should then make two judgments:

1. Which, if either, provided the most credible INFORMATION?

2. Which provided the most compelling overall argument?

Student

Instructions:

See above

Specific

Suggestions:

The instructor is likely to have to serve as a facilitator or moderator from time to time

1. Do not allow personal assaults

2. Feel free to challenge pieces of information that you find dubious

if the JURY does not.

3. Be sure students argue their points forcefully, whether or not they believe them personally.

It will probably take a couple times through this debate process before you and your class are comfortable with it.

Objectives: Describe the resource use by students in highly developed countries.

Instructor Notes for In-Class Activity 3

Title: Exploring Sustainability Efforts on Campus

Time: 10 – 30 Minutes prep; full class period (assuming 50 – 75 minute period)

Materials: None

Handouts: None

Procedures: Divide students into groups of 3 – 6. Have each assess the extent to which your campus (or other relevant location) engages in sustainability efforts.

Student

Instructions:

A campus cannot be a closed system. It requires inputs such as energy, food, and water. It must export its wastes, including garbage and sewage. Many campuses, whether for ethical, legal, financial, or other reasons, have sustainability efforts. These can range from the disjointed efforts of a few individuals and groups to centrally coordinated sustainability institutes. Use the internet to research and/or tour your campus with an eye to sustainability efforts.

Answer the following questions:

1. What types of efforts did you find?

2. Who is running them, and why?

3. Are they coordinated?

4. How effective do you think they are, and why?

5. Are there any simple, low cost things your campus could do to

decrease its footprint? Why aren’t these things being done?

Specific

Suggestions:

Instructor: you should be sure to do some prior investigation into what is being done. Note that if you are teaching a course for majors, this could be a useful thesis (or even several theses).

Objectives: Define environmental sustainability.

Instructor Notes for In-Class Activity 4

Title: Final Good bye to Natural Resources

Time: 5 – 10 Minutes prep; 40 – 60 minutes in class (or can assign research between class periods)

Materials: None

Handouts: None

Procedures: Have the students either individually or in small groups write an obituary on our natural resources. You could assign one natural resource for each group or have them write on “Natural Resources” in general and see what they come up with in their own selection for all.

Student

Instructions:

Write out a 1-page obituary for the Natural Resources.

Specific

Suggestions:

Objectives: Discuss the importance of Natural Resources and what we would be like without them.

Instructor Notes for In-Class Activity 5

Title: Exclusive Environmental Problems

Time: 10 minutes explanation time with 1 week prep time for the students

Materials: None

Handouts:

Procedures: Divide the students into groups and have them come up with an environmental problem that is exclusive to the area they live in. This could be different in the same class as some students live near railroads, some live near highways, new housing construction, old buildings etc. It would be good if the students lived close to their partners so they would have basically the same problem.

Student

Instructions:

Working in groups of 3 or 4 have the students present to the rest of the class their exclusive problem using the Figure 1.14 steps for the framework on addressing environmental problems.

Specific

Suggestions:

Objectives:  Identify and describe an environmental problem or condition that is exclusive to the living environment of the students.

 Discuss the ways the problem can be solved or changed to make the area better environmentally.

 Present ideas and solutions to the class in a systemic and scientific approach.

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Answers to Critical Thinking and Review End of Chapter Questions:

1. Explain why does a single child born in the United States have a greater effect on the environment than 12 or more children born in a developing country?

Answer: A single child born in a highly developed country such as the United States causes a greater impact on the environment and on resource depletion than do 12 or more children born in a developing country. Many natural resources are used to provide the automobiles, air

conditioners, disposable diapers, cell phones, DVD players, computers, clothes, newspapers, athletic shoes, furniture, boats, and other “comforts” of life in highly developed nations. Consumer goods, such as these, require vast materials and energy for production and distribution. Thus, the disproportionately large consumption of resources by the United States affects natural resources and the environment as much as or more than the population explosion in the developing world.

2. Do you think it is possible for the world to sustain its present population of more than7.2 billion indefinitely? Why or why not?

Ans: The current global ecological footprint of each person is about 2.7 hectares (6.7 acres), which means humans have overshot our allotment. We can see the short-term results around us—forest destruction, degradation of croplands, loss of biological diversity, declining ocean fisheries, and local water shortages. The long-term outlook, if we do not seriously address our consumption of natural resources, is potentially disastrous. Therefore, it is not likely that we can maintain 6 billion people indefinitely.

3. Is consumption driven more by population than affluence in highly developed countries? Less developed countries? Explain the difference.

Answer: Consumption is the human use of materials and energy. In general the use of resources by consumers in highly developed countries is greatly out of proportion to their numbers. A single child born in a highly developed country may have a greater impact on the environment than 12 children born in developing countries. Many natural resources are required to provide automobiles, air conditioners, disposable diapers, cell phones, DVDs, computers, clothing, etc. in highly developed countries.

4. In this chapter we said the current global ecological footprint is 2.7 hectares (6.7 acres) per person. Do you think it will be higher, lower, or the same in 15 years? Explain your answer.

Answer: Answers will vary

5. How are the concepts of ecological footprint and the IPAT model similar? Which concept do you think is easier for people to grasp?

Answer: An ecological footprint is an average amount of productive land, fresh water, and ocean required on a continuous basis to supply a person food, wood, energy, water, housing, clothing,

transportation, and waste disposal. The IPAT model, shows the mathematical relationship between environmental impacts and the forces driving them.

6. Explain the following ancient proverb as it relates to the concept of environmental sustainability: We have not inherited the world from our ancestors; we have borrowed it from our children.

Answer: Environmental sustainability is the ability to meet the current human need for natural resources without compromising the ability of future generations to meet their needs. Sustainability implies that humans can manage natural resources indefinitely without the environment going into a decline from the stresses imposed by human society on natural systems that maintain life. When the environment is used sustainably, humanity's present needs are met without endangering the welfare of future generations.

7. Name an additional example of a common-pool resource other than those mentioned in this chapter.

Answer: Answers will vary

8. Explain why economic well-being, environment, and ethics all contribute to sustainable development.

Answer: Sustainability implies that humans can have economic development and fair allocation of resources without the environment going into decline. When the environment is used sustainably, humanity’s present needs are met without endangering the welfare of future generations. The

goal of sustainable development is to ensure future economic development while protecting the

environment. To ensure sustainability environmentally sound decisions, economically viable decisions, and socially equitable decisions must be thought of as a part of a complex and interlinked system.

9. Give an example of an Earth system.

Answer: At a global level are Earth systems, which include Earth’s climate, atmosphere, land, coastal zones, and the ocean. Environmental scientists use a systems approach to try to understand how human activities are altering global environmental parameters such as temperature, carbon dioxide concentration in the atmosphere, land cover, changes in nitrogen levels in coastal waters, and declining fisheries in the ocean.

10. Thomas Henry Huxley once wrote, “The great tragedy of science—the slaying of a beautiful hypothesis by an ugly fact.” Explain what he meant, based on what you have learned about the nature of science.

Answer: A hypothesis is an educated guess, an explanation of a problem. A good hypothesis will make predictions about how the natural world works. These predictions can then be tested and possibly disproved. Sometimes a seemingly sound hypothesis is disproved by experimental data.

Some people have strong beliefs about how the world should work but the scientific facts don’t always support those beliefs.

11. In the chapter, the term *model* is defined as a formal statement that describes a situation and can be used to predict the future course of events. On the basis of this definition, is a model the same thing as a hypothesis? Explain your answer.

Answer: A model is not the same thing as a hypothesis. A hypothesis is an educated guess that tries to explain the natural world. It breaks down complex systems into testable processes in order to explain the bigger picture. Many of models are computer simulations that represent the overall effect of competing factors to describe an environmental situation in numerical terms. Models help us understand how a present situation developed from the past or how to predict the future course of events.

12. Some people want scientists to give them precise, definitive answers to environmental problems. Explain why this is not possible, and explain its implications for making decisions about climate change.

Answer: Science is a dynamic process, a systematic way to investigate the natural world. Science seeks to reduce the apparent complexity of our world to general scientific laws. Scientific laws are then used to make predictions, solve problems, or provide new insights. There is no absolute certainty or universal agreement about anything in science. Science is an ongoing enterprise, and generally accepted ideas must be reevaluated in light of newly discovered data. Scientists never claim to know the “final answer” about anything because scientific understanding changes. However, this must not prevent us from using current knowledge in environmental science to make environmental decisions. Because there are so many variables on the topic of climate change, scientists have put out causes and effects of fossil fuel, global warming, resource consumption and how these issues have had an impact on climate change. It is up to the people to take steps to reduce their footprint, and try to use resources wisely, along with paying attention to the use of fossil fuels and the amount we are putting into the air, water and land. The people all over the world, need to focus their efforts to changing reckless patterns and concentrate on sustainable living to make decisions to save our earth. It is the only one we have. .

13. Explain why it might be difficult to make a decision about whether or not to allow farmers to spray pesticides even if we all agree about negative health effects of the pesticides.

Answer: Answers will vary but should include economic impact on farmer and local community, importance of crop being grown, viability and availability of alternative crops that could be grown, availability and effectiveness of alternative pesticides or use of natural predators.

14. Place the following stages in addressing environmental problems in order and briefly explain each: long-term evaluation, public education and involvement, risk analysis, scientific assessment, political action.

Answer: 1. Scientific assessment involves identifying a potential environmental problem and collecting data to construct a model.

2. Risk analysis evaluates the potential effects of intervention.

3. Public education and involvement occur when the results of scientific assessment and risk analysis are placed in the public arena.

4. Political action is the implementation of a particular risk-management strategy by elected or appointed officials.

5. Long-term evaluation monitors.

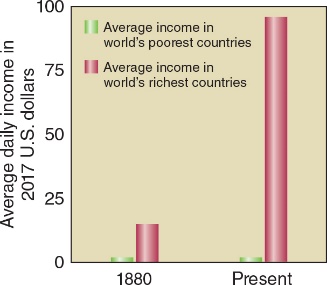
15. What does the term *system* mean in environmental science?

Answer: A system is set of components that interact and function as a whole. A natural system, consisting of a community of organisms and its physical environment, is known as an ecosystem. Ecosystems are organized into larger systems that interact with one another. Natural ecosystems are the foundation for our concept of environmental sustainability.

16. In what ways do decisions about energy use and climate change that we make today limit the possibilities available to the next generation? Explain your answer.

Answer: In order to live in a sustainable way, we must make smart choices about energy use. If we use energy in excess, the environment will be degraded for future generations. In order to not affect future generations, humans must manage natural resources without the environment going into a decline from the stresses imposed by society.

17. Examine the graph, which shows and estimate of the discrepancy between the wealth of the world’s poorest countries and that of the richest countries.



a. How has the distribution of wealth changed from the 1880’s to the present? What explains this difference?

b. Based on the trend evident in the graph, predict what the graph might look like in 100 years.

c. Some economists think that our current path of economic growth is unsustainable. Are the data consistent with this idea? Explain your answer.

Answer:

a) Wealth has increase significantly in developed countries and remained essential unchanged in developing countries. The majority of the manufacturing and industrial infrastructure is concentrated in developed countries. Developing countries normally provide the raw materials and not the final product.

b) Significant increases in wealth in developed countries and essentially no net increase in developing countries. The gap between developed and developing countries will increase substantially.

c) Yes – currently highly developed countries represent less than 20% of the world’s

population, yet they consume significantly more than half of the earth’s resources. If long-term consumption of natural resources is not decreased the outlook could be disastrous

Answers to Review Questions

Human Impacts on the Environment

1. What is one example of a global system?

Human activities are disrupting global systems of our earth. One example of how humans are impacting our planet is over population, another is consuming the natural non-renewable resources.

2. How do the total wealth of a country and income disparity relate to sustainability?

The total wealth of a country tends has an impact on how the people of that country use resources, The highly developed countries have complex industrialized bases, low rates of population growth, and high per capita incomes. Highly developed countries (i.e., the United States, Canada, and Japan) represent approximately 19% of the world’s population. Moderately developed countries are developing countries with a medium level of industrialization and average per capita incomes lower than those of highly developed countries. Examples of moderately developed countries include Mexico, Turkey, South Africa, and Thailand. Less developed countries are developing countries with high poverty rates, low levels of industrialization, high fertility rates, high infant mortality rates, and very low per capita incomes (relative to highly developed countries). Less developed countries include Bangladesh, Mali, Ethiopia, and Laos.

Population, Resources, and the Environment

1. How do renewable resources differ from nonrenewable resources?

Renewable resources are trees, fishes, fertile agriculture soil, and fresh water. Nature replaces these resources farily rapidly (on a scale of days to centuries), and they can be used for ever as long as they are not overexploited in the short term. Non-renewable resources, which include minerals such as Aluminum, copper, and uranium and fossil fuels such as coal, oil and natural gas, are present in a limited supply. Once they are used up, they can’t be replaced. Fossil fuels for example take millions of years to form.

2. How are human population growth and affluence related to natural resource depletion?

As population increases, the sheer number of people can exceed the capacity of a region to support basic needs for food, shelter, and clean water. Additionally, when greater affluence is exhibited by individuals in a given population, the resources in that region will be exceeded even more quickly. In either case, consumption that exhausts both nonrenewable and renewable resources is unsustainable.

3. What is an ecological footprint?

The concept of an ecological footprint was developed by environmental scientists Mathis Wackernagel and William Rees. It is defined as the amount of productive land, fresh water, and ocean required on a continuous basis to supply an individual with food, energy, water, housing, material goods, transportation, and waste disposal.

4. What does the IPAT model demonstrate?

The IPAT model was first proposed by biologist Paul Ehrlich and physicist John Holdren. It demonstrates the mathematical relationship between environmental impacts and the forces driving them (i.e., number of people, affluence per person, and the environmental effect of the technologies used to obtain and consume those resources). It is a valuable model because it helps identify what we do not know or understand about consumption and its environmental impact.

Sustainability

1. What is sustainability?

Sustainability is the ability to meet current human economic and social needs without compromising the ability of the environment to support future generations. The concept of environmental sustainability applies at many levels (i.e., from individual to global levels) and requires a long-term perspective to protect human welfare and natural resource assets. Efforts focused towards sustainability include stabilization of the human population, protection of natural ecosystems, education, pollution prevention, restoration of degraded environments, waste prevention and reduction, eradication of hunger and poverty, and efficient use of resources.

2. What is the tragedy of the commons?

“The Tragedy of the Commons” was an essay published in the journal Science by Garrett Hardin. In it he contended that our inability to solve many environmental problems is the result of a struggle between short-term individual welfare and long-term environmental sustainability and societal welfare.

3. What are the three foundations of sustainable development?

The three foundations of sustainable development are environmentally sound decisions, economically viable decisions, and socially equitable decisions.

Environmental Science

1. What is environmental science? Why is a systems perspective so important in environmental science?

Environmental science is the interdisciplinary study of humanity’s relationship with other organisms and the nonliving physical environment. It encompasses many interconnected issues (i.e., human population, environmental pollution, etc.), and combines information from many disciplines (i.e., biology, geology, chemistry, economics, etc.). Therefore,

due its large scope, it is important that a systems perspective is used to analyze hypotheses in environmental science. A systems perspective provides a broad look at overall processes, as opposed to the details of individual parts or steps.

2. What are the steps of the scientific method? Does the scientific process usually follow these steps? Why or why not?

The established processes scientists use to answer questions or solve problems are collectively called the scientific method. It basically involves five steps: (1) recognize a question or unexplained occurrence in the natural world; (2) develop a hypothesis to explain the problem; (3) design and perform an experiment to test the hypothesis; (4) analyze and interpret the data to reach a conclusion; (5) share the knowledge. The scientific process does not always follow these steps as science is rarely as straightforward or tidy as the scientific method implies.

Addressing Environmental Problems

1. What are the steps used to solve an environmental problem?

In general, there are five steps used in addressing environmental problems: (1) scientific assessment; (2) risk analysis; (3) public education and involvement; (4) political action; and (5) long-term evaluation.

2. What was the Lake Washington pollution problem of the 1950s? How was it addressed?

Lake Washington exemplifies a successful approach to addressing a relatively simple environmental problem. In the 1950s, suburban sewage treatment plants were releasing their effluent (treated sewage) into the lake. This, in turn, raised the lake’s level of nutrients to the point where the lake supported excessive growth of cyanobacteria. The subsequent decomposition of cyanobacteria eventually led to an inhospitable environment for the lake’s fish and small invertebrates. Scientists predicted that the lake’s decline could be reversed if the pollution was stopped. They were correct; disposal of the sewage in another way solved the lake’s pollution problem.