

MODULE 1.1

Guiding Question 1

What is the purpose and scope of environmental science?

Multiple Choice

1. Environmental science does NOT rely or draw on:
 - A. natural sciences such as ecology.
 - B. applied sciences such as engineering.
 - C. social sciences such as anthropology.
 - D. humanities such as literature.
 - E. All of these choices are related to environmental science.

Answer: E

Section: Environmental Science

Level: 1

Bloom's Level: Remembering

2. Which example does NOT describe an environment?

- A. fish living in a stream
- B. bacteria living in a human's intestinal tract
- C. mold growing on a wood stump in a forest
- D. a cat living in a house
- E. All of these choices describe an environment.

Answer: E

Section: Environmental Science

Level: 1

Bloom's Level: Understanding

3. Which phrase BEST describes the term *environment*?

- A. the climate where an organism lives
- B. the living surroundings in which an organism exists
- C. the living and nonliving surroundings in which an organism exists
- D. the nonliving surroundings where an organism lives
- E. the domination of nonliving systems by living systems

Answer: C

Section: Environmental Science

Level: 1

Bloom's Level: Remembering

4. Which statement is TRUE of environmental science?

- A. It relies only on natural sciences such as ecology and geology.
- B. It examines only the workings of the natural world.
- C. It examines the natural world and our relationship to it.
- D. It is focused on areas without human impact.
- E. It focuses on the future of the Earth.

Answer: C

Section: Environmental Science
Level: 1
Bloom's Level: Understanding

Essay

5. What does an environment include?

Section: Environmental Science

Level: 1

Bloom's Level: Remembering

Feedback: An environment includes the biological (living) and physical (nonliving) surroundings in which any given living organism exists.

6. What is environmental science, and what fields of study does it rely on?

Section: Environmental Science

Level: 1

Bloom's Level: Remembering

Feedback: Environmental science is an interdisciplinary field of research that draws on the natural (for example, ecology) and social sciences (for example, anthropology) as well as the humanities (for example, literature) in order to understand the natural world and our relationship to it.

7. Why are nonliving things included in the definition of an environment?

Section: Environmental Science

Level: 3

Bloom's Level: Analyzing

Feedback: Nonliving things—such as rocks, water, and oxygen—are included in the definition of an environment because although they are not living, they still have a tremendous impact on the organic beings that do live in that environment. Imagine an environment that contains several species of fish, some of which suddenly start to die off. Now let's say this die-off is caused by the temperature of the water rising in this environment. If we didn't consider water to be part of an environment, we would not know to test the water for the possible cause of the fish dying.

Guiding Question 2

Why are both empirical and applied approaches useful in environmental science?

Multiple Choice

8. An example of applied science is:

- A. designing a solar panel for increased efficiency.
- B. observing chimpanzee behavior in a rainforest.
- C. collecting ice core samples to determine carbon dioxide levels 100,000 years ago.
- D. determining the diet of Greenland Vikings based on analysis of their garbage.
- E. counting the number of geese on a pond.

Answer: A

Section: Empirical and Applied Science

Level: 1

Bloom's Level: Understanding

9. Which example illustrates an empirical study?

- A. developing more efficient photovoltaic cells for electricity production
- B. producing models of the impact of various greenhouse gas concentrations on global temperature
- C. developing ultrafast passenger trains
- D. improving the efficiency of electricity transmission
- E. developing pest control methods that do not include pesticides

Answer: B

Section: Empirical and Applied Science

Level: 1

Bloom's Level: Understanding

10. What is empirical science?

- A. a scientific approach using observation and experimentation
- B. research findings that help solve practical problems
- C. a scientific approach to predict climate problems in the future
- D. a method to examine the nonliving components of the world
- E. a field of research including humanities and social sciences

Answer: A

Section: Empirical and Applied Science

Level: 1

Bloom's Level: Remembering

11. What did mud cores from lake beds around Viking settlements tell scientists?

- A. The temperature was unusually higher than average over the past 1,000 years.
- B. The Vikings vanished during the Little Ice Age.
- C. There were not enough people in the Viking settlements.
- D. Soil erosion was a significant problem for the Vikings.
- E. Vikings ate sheep, seal, and walrus.

Answer: D

Section: Empirical and Applied Science

Level: 1

Bloom's Level: Remembering

12. Which statement is NOT an example of self-inflicted environmental damage done by the Greenland Vikings?

- A. They overgrazed.
- B. They used grassland to insulate their houses.
- C. They chopped down forests for fuel and home construction.
- D. They grew to a few thousand individuals.
- E. The climate cooled.

Answer: E

Section: Empirical and Applied Science

Level: 1

Bloom's Level: Remembering

13. What evidence did scientists use in Greenland to study atmospheric conditions at the time of the Viking settlements?

- A. air bubbles trapped in ice cores
- B. mud core samples
- C. animal bones collected from *middens*
- D. insect fossils
- E. the law of superposition

Answer: A

Section: Empirical and Applied Science

Level: 1

Bloom's Level: Remembering

Essay

14. Which would likely come first when studying an environmental issue: an applied science study or an empirical science study? Why?

Section: Empirical and Applied Science

Level: 2

Bloom's Level: Applying

Feedback: It is likely that an empirical science study would occur first. These studies investigate the environmental issue through rigorous scientific testing to determine the impact and extent of the issue. An applied science study may take the findings of the empirical study to design and test a potential solution to the problems uncovered.

Guiding Question 1-3

What characteristics make an environmental dilemma a “wicked problem”?

Multiple Choice

15. Due to their complexity, any given response to an environmental problem involves significant _____, and no one response is likely to present the ultimate solution.

- A. sliding reinforcers
- B. trade-offs
- C. wicked problems
- D. anthropogenics
- E. tragedies

Answer: B

Section: Environmental Issues as “Wicked Problems”

Level: 1

Bloom's Level: Understanding

16. Which factors make up the triple bottom line?

- A. human, natural, and solar
- B. international, national, and local
- C. social, economic, and environmental

- D. agricultural, financial, and environmental
- E. solar energy, water, and air

Answer: C

Section: Environmental Issues as “Wicked Problems”

Level: 1

Bloom’s Level: Remembering

17. What does it mean when an environmental issue is a “wicked problem”?

- A. It is created by people who care only about themselves.
- B. It is global in nature.
- C. It involves trade-offs that not everyone will be happy with.
- D. It is a problem that cannot be solved.
- E. It involves the destruction of a specific habitat.

Answer: C

Section: Environmental Issues as “Wicked Problems”

Level: 1

Bloom’s Level: Remembering

18. Potential trade-offs to reforestation efforts do NOT include:

- A. high cost.
- B. water shortages.
- C. fragmentation of habitats.
- D. less land for agriculture.
- E. All of these answers are potential trade-offs to reforestation efforts.

Answer: E

Section: Environmental Issues as “Wicked Problems”

Level: 2

Bloom’s Level: Applying/Analyzing

19. Which example illustrates a consequence of climate change?

- A. deforestation
- B. sea level rise
- C. overconsumption
- D. irrigation
- E. burning fossil fuels

Answer: B

Section: Environmental Issues as “Wicked Problems”

Level: 2

Bloom’s Level: Understanding

Essay

20. What is environmental literacy? Why is it important for individuals to have a strong understanding of environmental literacy when discussing environmental problems caused by humans?

Section: Environmental Issues as “Wicked Problems”

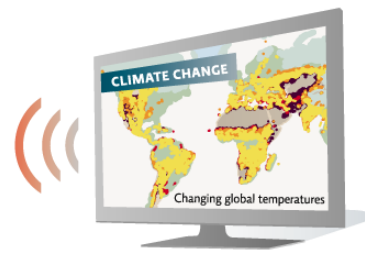
Level: 2

Bloom's Level: Understanding/Applying

Feedback: Environmental literacy is a basic understanding of how ecosystems function and of the impact of our choices on the environment. Most environmental problems can be traced to three causes: human population growth, overuse of resources, and pollution. It is important that people understand the impact that a growing human population has on Earth and how our increasing numbers are consuming resources at unsustainable rates. Additionally, it is important that individuals understand how our activities generate pollution and how this pollution affects our health and the environment.





21. Refer to Infographic 3. The Green Revolution brought modern industrialized agricultural techniques to developing countries so that they could better feed their growing populations. The idea is to achieve higher yields by taking advantage of better seed types, irrigation, chemical fertilizers, and pesticides. By doing this, less land, such as rainforest, would need to be converted to agriculture. Use the infographic to describe the pros and cons of the Green Revolution on the environment, thus illustrating why climate change is a wicked problem.

Wicked problems are difficult to address because they have many causes, many consequences, and, in many cases, each stakeholder hopes for a different solution. Solutions that address wicked problems usually involve trade-offs, so there is no clear "winner." One example of a wicked problem is climate change. Many causes exist for the current climate change we are experiencing, some of which are shown below. There are multiple consequences of climate change; these effects will be varied for different species and people, depending on where they live and their ability to adapt to the changes. While there are many solutions that can help address climate change, each brings new problems that must also be addressed.







CLIMATE CHANGE





MULTIPLE CAUSES:

-  Burning fossil fuels
-  Deforestation
-  Methane from agriculture
-  Overconsumption by modern society

MULTIPLE CONSEQUENCES:

-  Sea level rise
-  Habitat loss and species endangerment
-  Spread of tropical disease
-  Agriculture: worse in some areas, better in others

SOLUTIONS COME WITH TRADE-OFFS:

-  Alternative energy sources (less pollution but can be costly)
-  Irrigation (increases crop yields but can cause water shortages and soil problems)
-  Reforestation projects (lessen CO₂ in atmosphere and increase habitats but may take land needed for agriculture or other uses)
-  Protecting flood-prone areas with levees or sea walls (may protect cities and farms but may fragment aquatic habitats and isolate species' populations)

Infographic 1.1-3

Karr, et al., *Environmental Science for a Changing World*, 3e, © 2018 W. H. Freeman and Company

Section: Environmental Issues as "Wicked Problems"

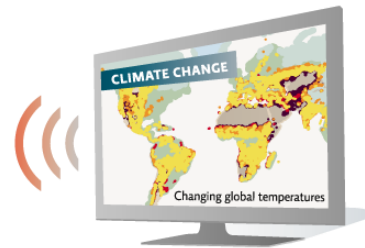
Level: 2

Bloom's Level: Applying

Feedback: When deforestation is prevented, more carbon dioxide is taken out of the atmosphere, which helps to prevent global warming. Also, when habitats are kept intact, biodiversity is better protected in those areas not converted into agriculture. However, by adding use of tractors, fossil fuels need to be combusted, and this contributes to global warming. Chemicals added to crops will run off into water and soil. Added irrigation can cause water shortages and soil problems.





22. Refer to Infographic 3. What is the triple bottom line of climate change?

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Infographic 1.1-3

Karr, et al., *Environmental Science for a Changing World*, 3e, © 2018 W. H. Freeman and Company

Section: Environmental Issues as “Wicked Problems”

Level: 3

Bloom’s Level: Analyzing

Feedback: The triple bottom line includes the environmental, social, and economic impacts of our choices. In the instance of climate change, our choices, such as burning fossil fuels, deforestation, and overconsumption, have led to global warming. Some of the environmental impacts of these choices include increased average atmospheric temperature, sea level rise due to melting of polar ice caps, and habitat and species endangerment and loss. Some of the social impacts of our choices that have led to climate change are the suffering of agriculture in certain regions, the spread of tropical disease (which impacts socioeconomic factors when people are too sick to work or contribute to their societies or when the cost of treating the disease increases), human habitat

destruction (such as mining, conversion of forest to farmland, and so on), and the development of political issues surrounding the causes of and potential solutions to climate change. Some of the economic impacts of climate change are decreased food production due to poor climate conditions and lack of water for farming; financial crisis in some industries such as commercial fishing, since some species of fish can no longer survive in the warmer waters; and increased costs in food production and energy production.

Guiding Question 4

What does it mean to be sustainable?

Multiple Choice

23. What food source was absent from the animal bones found in the Greenland *middens*?

- A. seal
- B. caribou
- C. walrus
- D. cattle
- E. fish

Answer: E

Section: Sustainable Development

Level: 1

Bloom's Level: Remembering

24. Some of the most revealing clues to the demise of the Greenland Vikings come from:

- A. ice cores.
- B. mud samples.
- C. animal bones.
- D. the Inuit.
- E. the climate.

Answer: D

Section: Sustainable Development

Level: 1

Bloom's Level: Remembering

25. Which statement is NOT a goal of the UN 2030 Sustainable Development Agenda?

- A. Develop more uses for fossil fuels.
- B. End hunger and all forms of malnutrition.
- C. Increase efficient use of water to reduce waste.
- D. Prevent or significantly reduce ocean pollution.
- E. Eliminate poverty.

Answer: A

Section: Sustainable Development

Level: 1

Bloom's Level: Understanding

Essay

26. Unlike the Icelandic Vikings or Inuit, the Greenland Viking society was not sustainable. Describe what we know about their collapse.

Section: Sustainable Development

Level: 1

Bloom's Level: Understanding

Feedback: From ice cores, we know the climate cooled due to natural causes, and this made life difficult for the population in terms of growing food and raising livestock. In terms of self-inflicted environmental damage, evidence from mud cores indicates that soil erosion was a significant problem. This was due to overgrazing livestock (cows); using grassland to insulate Viking homes; and cutting down forests for fuel, homes, and other wooden products. These impacts on the environment were particularly severe because the environment was sensitive to begin with. As the population swelled to several thousand, the environment could no longer support the population and it crashed.

Guiding Question 5

Why do scientists think we are living in a new geologic epoch, the Anthropocene?

Multiple Choice

27. Why do scientists suggest that we have entered the Anthropocene, a new geologic time interval?

A. We have been in the Holocene so long, it is time for a new interval on the Geological Time Scale.

B. The human population will be 11 billion in 2100.

C. Geologic evidence from humans is accumulating and will be found after we are gone.

D. Climate change from greenhouse gas-emitting fossil fuels is melting too much polar ice.

E. The previous natural climate cycle is ending.

Answer: C

Section: Human Impact and the Anthropocene

Level: 2

Bloom's Level: Understanding

28. How is anthropogenic climate change different from the climate change experienced by the Greenland Vikings?

A. It involves new chemical compounds.

B. It is caused by human actions.

C. It is a natural cycle Earth goes through.

D. It causes average atmospheric temperature to decrease.

E. It is caused by increased tectonic activity.

Answer: B

Section: Human Impact and the Anthropocene

Level: 2

Bloom's Level: Understanding/Applying

29. What was the conclusion of the UN Millennium Ecosystem Assessment?

- A. Human actions have no impact on the planet's ecosystems.
- B. Human actions will impact the planet's ecosystems only in the far future.
- C. Human actions are straining the ability of the planet's ecosystems to sustain the current generation.
- D. The damage of human actions on the planet's ecosystems cannot be reversed.
- E. Human actions are straining the ability of the planet's ecosystems to sustain future generations.

Answer: E

Section: Human Impact and the Anthropocene

Level: 2

Bloom's Level: Understanding

30. Which example illustrates a disconnect between our actions and their environmental consequences?

- A. buying sustainably raised fish
- B. leaving lights on and the air conditioning running when no one is home
- C. driving an electric car
- D. using sustainable farming practices
- E. learning seasonal cycles of the area to respond accordingly

Answer: B

Section: Human Impact and the Anthropocene

Level: 2

Bloom's Level: Applying

Guiding Question 6

What are the characteristics of a sustainable ecosystem?

31. Which statement is NOT characteristic of a sustainable ecosystem?

- A. It makes the most of renewable energy.
- B. It uses matter conservatively. (It recycles or reuses so nothing is wasted.)
- C. It keeps populations in check.
- D. It depends on local biodiversity.
- E. It is able to support an ever-increasing number of species.

Answer: E

Section: The Characteristics of a Sustainable Ecosystem

Level: 1

Bloom's Level: Remembering

32. Which statement is NOT characteristic of a sustainable ecosystem?

- A. It uses renewable energy.
- B. It eliminates waste by reusing matter.
- C. It contains species that all depend on the same limited resource.
- D. It recycles matter.
- E. Local biodiversity is present to perform essential ecosystem processes.

Answer: C

Section: The Characteristics of a Sustainable Ecosystem

Level: 1

Bloom's Level: Understanding

33. What does it mean for sustainable ecosystems to rely on renewable energy?

- A. Population size is kept in check.
- B. Energy is replenished daily by new inputs.
- C. Energy can be recycled.
- D. No new energy arrives on Earth.
- E. Waste from one organism can be used by another.

Answer: B

Section: The Characteristics of a Sustainable Ecosystem

Level: 1

Bloom's Level: Understanding

34. Which factor does NOT provide population control in sustainable ecosystems?

- A. disease
- B. predators
- C. competition
- D. abundant food and water

Answer: D

Section: The Characteristics of a Sustainable Ecosystem

Level: 1

Bloom's Level: Remembering

Essay

35. What does it mean to be sustainable, and what are four characteristics of a sustainable ecosystem?

Section: The Characteristics of a Sustainable Ecosystem





Level: 1

Bloom's Level: Understanding

Feedback: Sustainable methods use resources in such a way that we can continue to use them indefinitely. A sustainable ecosystem (1) makes the most of renewable energy, (2) wastes nothing by recycling and reusing resources, (3) keeps populations in check so that resources are not overused, and (4) depends on local biodiversity to perform many of these tasks.

36. Is our modern society acting sustainably? What are some areas of concern? Refer Infographic 6 and compare and contrast a sustainable ecosystem to our current human ecosystem.

Ecosystems found on Earth today have the capacity to be naturally sustainable—those that were not died out long ago. They all share characteristics that allow the capture of energy and use of matter in a way that allows them to persist over time, all without degrading the environment itself.

| SUSTAINABLE ECOSYSTEMS | |
|---|--|
|  RELY ON RENEWABLE ENERGY |  RECYCLE MATTER |
| Ecosystems must rely on sources of energy that are replenished daily because energy that is used by one organism is "used up" and cannot be used by another; energy is NOT recycled. This means new inputs are constantly needed. | No new matter arrives on Earth, so ecosystems must make do with what they have. Fortunately, matter can be recycled, and organisms in ecosystems use matter resources over and over again; the waste of one becomes resource for the next. |
|  HAVE POPULATION CONTROL |  DEPEND ON LOCAL BIODIVERSITY |
| The sizes of the various populations in an ecosystem are kept in check by disease, predators, and competitors. This prevents a population from getting too large and damaging the ecosystem it, and others, depends on. | Ecosystems access energy, recycle matter, and control population sizes largely through the actions of their resident species. Higher biodiversity (greater number of species and more variation of individuals within a species) generally means more energy can be captured, more matter can be recycled and at a faster pace, and population sizes can be better controlled. |

Infographic 1.1-6
Karr, et al., *Environmental Science for a Changing World*, 3e, © 2018 W. H. Freeman and Company

Section: The Characteristics of a Sustainable Ecosystem

Level: 2/3

Bloom's Level: Analyzing/Evaluating

Feedback: Experts claim that humans are already living beyond the means our planet has to support us, and if we continue along this path, a population crash could occur, similar to the collapse of the Greenland Vikings.

In our society, we do not use matter sustainably. We use farming practices that erode topsoil faster than it can form. We have overharvested forests at the expense of habitat and biodiversity loss, soil erosion, and water pollution. In a sustainable ecosystem, systems would be in place to prevent topsoil erosion and curb the overharvesting of forests. We would find ways to make our waste usable by other organisms in the environment, thus keeping with the idea that to use matter sustainably, it must be recycled.

We also do not depend on local biodiversity and have actually driven ecosystem biodiversity in some places to an alarmingly low level. We have overfished and overhunted and allowed invasive species to further degrade natural ecosystems, thus reducing biodiversity. In a sustainable ecosystem, the value of having a high biodiversity is seen, as it better prepares the ecosystem to weather disturbances. Biodiversity should be protected through regulations of hunting, fishing, and the introduction of invasive species.

Our human ecosystem certainly does not have population control, at least for humans. The population continues to grow exponentially, and our consumption of resources and generation of waste continue unabated. Although fraught with ethical issues, the population of humans currently living on Earth is not sustainable and is damaging almost every ecosystem. In a sustainable ecosystem, every population is kept in check so that resources are evenly distributed and shared.

We also do not rely on renewable energy. We depend largely on nonrenewable resources for energy, which have all sorts of implications for ecosystem health. Since energy is nonrenewable, if we continue to use only nonrenewable sources, we will eventually run

out. In this process, we also damage ecosystems through pollution, habitat destruction, and many other negative actions. In a sustainable ecosystem, organisms must rely on new inputs of energy that are renewable and sensitive to environmental effects.

Guiding Question 7

What can human societies and individuals do to pursue sustainability?

Multiple Choice

37. In biomimicry, scientists use nature as a model, _____, and measure.

- A. map
- B. method
- C. control
- D. mentor
- E. mean

Answer: D

Section: Nature as a Model for Sustainable Actions

Level: 1

Bloom's Level: Remembering

38. Coal, natural gas, and oil are examples of:

- A. renewable resources.
- B. nonrenewable resources.
- C. alternative forms of energy.
- D. infinite resources.
- E. unlimited resources.

Answer: B

Section: Nature as a Model for Sustainable Actions

Level: 1

Bloom's Level: Remembering

39. Solar, wind, geothermal, and biomass energy sources are examples of:

- A. nonrenewable energy.
- B. finite energy.
- C. renewable energy.
- D. fossil fuels.
- E. nonsustainable energy.

Answer: C

Section: Nature as a Model for Sustainable Actions

Level: 1

Bloom's Level: Remembering

40. What is biomimicry?

- A. cloning technologies and equipment that allow scientists to re-create photosynthetic bacteria in laboratory settings
- B. re-creating natural ecosystems in areas where severe deforestation has occurred

- C. turning natural ecosystems into scientific experiment sites to help scientists better understand their functioning
- D. the process of collecting data from various ecosystems
- E. the use of nature as a model for our own systems

Answer: E

Section: Nature as a Model for Sustainable Actions

Level: 1

Bloom's Level: Remembering

41. A good example of sustainability is:

- A. limiting commercial fishing to amounts that allow the fish population to repopulate.
- B. using solar panels to generate electricity.
- C. riding a bicycle to work.
- D. purchasing products in packaging that can be recycled.
- E. All of the above choices are good examples of sustainability.

Answer: E

Section: Nature as a Model for Sustainable Actions

Level: 2

Bloom's Level: Understanding/Applying

42. Which personal attitude will lead to the GREATEST long-term sustainability?

- A. The forest is there for us to use.
- B. The lake will be able to handle the raw sewage because it always has.
- C. It doesn't matter what we do because we don't have the power to change anything.
- D. I wonder how using this product will affect the environment; maybe there's a better choice available.
- E. Scientists will figure out a way to reduce the effects of pollution.

Answer: D








Section: Nature as a Model for Sustainable Actions

Level: 1

Bloom's Level: Understanding

Essay

43. Refer to Infographic 7 and describe ways that you could live more sustainably.

| SUSTAINABLE ECOSYSTEMS: | WE CAN MIMIC THIS IN OUR OWN SOCIETIES BY: |
|--|---|
| <p>RELY ON RENEWABLE ENERGY</p>  | <p>USING SUSTAINABLE ENERGY SOURCES</p> <p>We can move away from nonrenewable fuels such as fossil fuels by turning to sustainable energy sources such as solar, wind, geothermal, and biomass (harvested at sustainable rates).</p>  |
| <p>RECYCLE MATTER</p>  | <p>USING MATTER CONSERVATIVELY AND SUSTAINABLY</p> <p>We can reduce our waste by reducing our use of resources and by recovering, reusing, and recycling matter that we do use; we would also benefit from minimizing the toxins we create or release into the environment that degrade our natural resources.</p>  |
| <p>HAVE POPULATION CONTROL</p>  | <p>GETTING HUMAN POPULATION GROWTH UNDER CONTROL</p> <p>While predation controls many natural populations, there are many ways to reduce human birth rates without increasing the death rate through war or disease.</p>  |
| <p>DEPEND ON LOCAL BIODIVERSITY</p>  | <p>DEPENDING ON LOCAL HUMAN CONTRIBUTIONS AND BIODIVERSITY</p> <p>Protecting biodiversity will help us achieve the three above goals; we can also regard the use of diversity as a metaphor and emulate nature by using a variety of local energy sources, building materials, and crops and by exploring the many ideas and innovations that come from a diverse human community.</p>  |

Infographic 1.1-7

Karr, et al., *Environmental Science for a Changing World*, 3e, © 2018 W. H. Freeman and Company

Section: Nature as a Model for Sustainable Actions

Level: 2

Bloom's Level: Applying

Feedback: One of the first things a person can do is become environmentally literate.

This includes becoming informed about the issues but also learning to appreciate the natural areas near where you live. Small behavioral changes are important. Can you walk, bicycle, or take public transportation at least one day per week to go to school, work, or shopping? Shopping behavior can be changed—bring your own shopping bags and question what you buy. Do an inventory of your trash. How many items were not necessary or could have been reused, recycled, or composted? Buy locally produced goods and foods. Do an inventory of your possessions. Donate or recycle unwanted items. Join a group by asking others: Are you interested in increasing the sustainability of your town? Do you like to go hiking? Are you interested in wildlife? Many small steps add up. Begin today and continue to add sustainable behaviors to your lifestyle.

44. How would you go about convincing a company to switch to renewable sources of energy?

Section: Nature as a Model for Sustainable Actions

Level: 2

Bloom's Level: Applying

Feedback: There are a growing number of companies that are obtaining more of their energy from renewable sources of energy. You would need to explain how switching to renewable sources of energy will save money over the long term and also how the switch will result in less pollution and improved health for workers and the environment.

Guiding Question 8

What challenges does humanity face in dealing with environmental issues?

Multiple Choice

45. Which situation BEST describes the tragedy of the commons?

- A. A fisherman uses his net to catch a large quantity of fish.
- B. Increasing amounts of pesticides need to be used over time to maintain the same effect on pests.
- C. An oil pipeline leaks.
- D. Sustainable forestry practices are applied to a plot of land in the rainforest.
- E. Herders put too many sheep in a public field because they think, “If I don’t use this available resource, someone else will.”

Answer: E

Section: Challenges to Solving Environmental Problems

Level: 1

Bloom’s Level: Understanding

46. Modern fishing techniques use giant nets to harvest large numbers of fish in the short term. This may result in severely reduced populations of fish in the future. Which term BEST describes this scenario?

- A. time delay
- B. tragedy of the commons
- C. sliding reinforcer
- D. extinction

Answer: A

Section: Challenges to Solving Environmental Problems

Level: 1

Bloom’s Level: Understanding

47. If antibiotics are used frequently over a short period of time, bacteria can become resistant to those antibiotics and harder to treat. This scenario is an example of:

- A. tragedy of the commons.
- B. time delay.
- C. sliding reinforcer.
- D. extinction.

Answer: A

Section: Challenges to Solving Environmental Problems

Level: 1

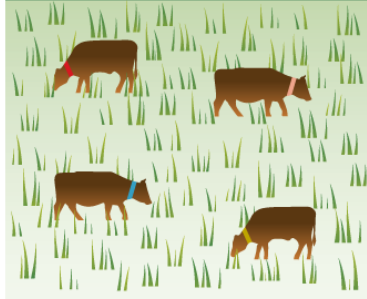
Bloom’s Level: Understanding

Essay

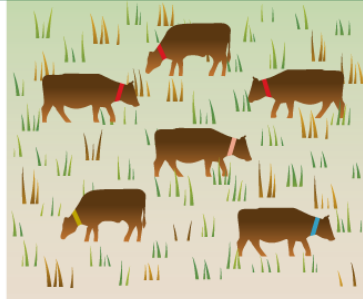
48. Refer to Infographic 8. Ethanol is often produced in locations where farmers also grow corn. Underground water reservoirs are used to grow the corn and process the ethanol. These reservoirs are being depleted in some areas of the Midwest. Which social traps apply to the water depletion?

Social traps are decisions that seem good at the time and produce a short-term benefit but that hurt society (usually in the long run).

TRAGEDY OF THE COMMONS When resources aren't "owned" by anyone (they are commonly held), individuals who try to maximize their own benefit end up harming the resource itself.



This common resource (pasture) can support four animals sustainably. Each of the four farmers benefits equally.

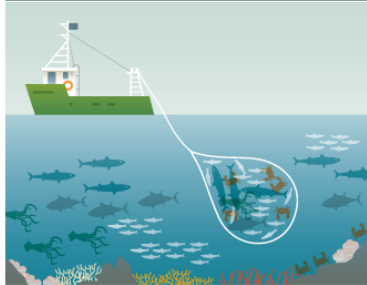


If one farmer adds two more cows, the commons becomes degraded. All four farmers share in the degradation (less milk produced per cow), but the farmer with three cows gets all the benefit from adding the extra cows.

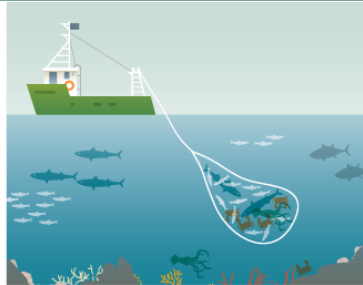


The other farmers also must add cows to return to the same level of production as before. **Over time, the commons degrades even more, and at some point, it will no longer support any animals.**

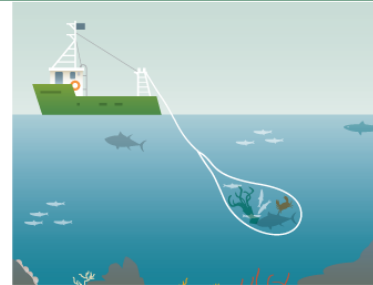
TIME DELAY Actions that produce a benefit today set into motion events that build over time and cause problems later on.



Modern fishing techniques that use giant nets can harvest large numbers of fish. Fishers try to get the most fish possible in the short term.

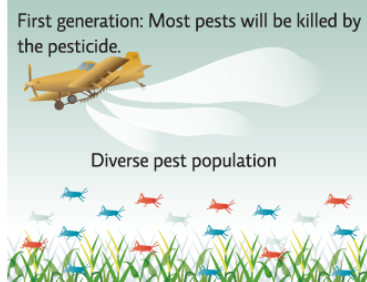


If more fish are taken over a number of years than are replaced naturally through fish reproduction, the population decreases. Other populations also decline as the fish they depend on are depleted.



After a decade or so, overfishing may so deplete the population that fishers cannot catch enough to meet needs. **The effects of decisions about how many fish to harvest are not felt until later.**

SLIDING REINFORCER Actions that are beneficial at first may change conditions such that their benefit declines over time.



First generation: Most pests will be killed by the pesticide.

Diverse pest population

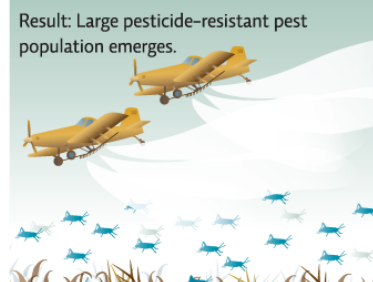
Pesticide application can reduce pest numbers on a crop, but a few pests might survive.



Next generation: Most pests are resistant.

Naturally resistant to the pesticide

The surviving pests reproduce. The pesticide is only helpful if more is applied or a more toxic pesticide is used. This can be harmful to other organisms and to humans.



Result: Large pesticide-resistant pest population emerges.

In addition to becoming resistant to the pesticide, the pest population may even become bigger if the pest's predators are also killed. **The helpful action changes how the system operates; the action loses its benefit or may even be harmful at a later time.**

Infographic 1.1-8

Karr, et al., *Environmental Science for a Changing World*, 3e, © 2018 W. H. Freeman and Company

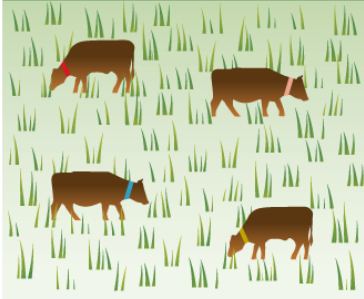
Bloom's Level: Applying

Feedback: The tragedy of the commons (no entity "owns" the groundwater, so each party draws as much as it can to meet its needs, until the unregulated resource is depleted) and time delay (a benefit of growing corn and producing ethanol is seen today, but depleted ground water decades into the future would mean an inability to produce either) apply.

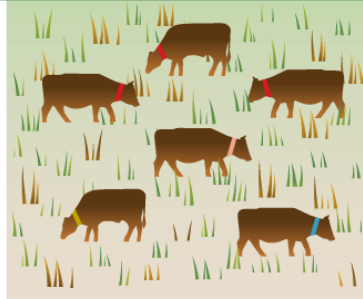
49. Refer to Infographic 8. Antibiotics are routinely given to animals in confinement facilities to avoid the spread of disease through dense populations. The antibiotics get into the surrounding environment (water and soil) and allow antibiotic-resistant strains of bacteria to flourish and become the majority strain in the population. When infected by such a strain, an animal or human will not respond to treatment with the antibiotic. Which social trap is in effect here? What should be done about this?

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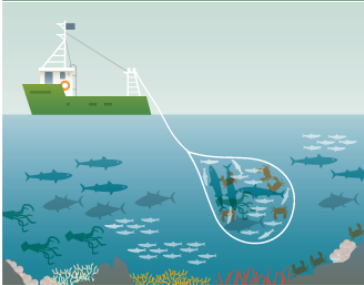


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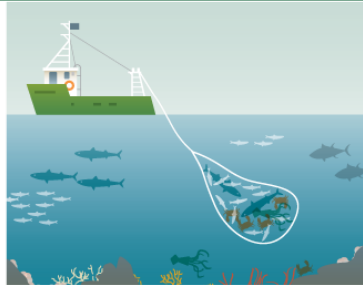


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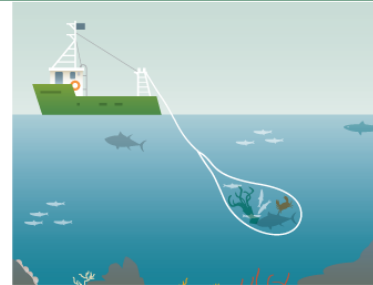
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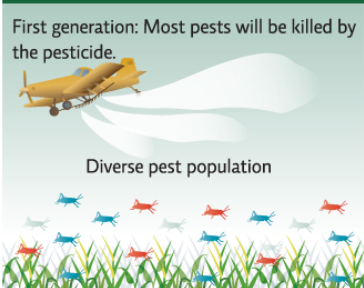


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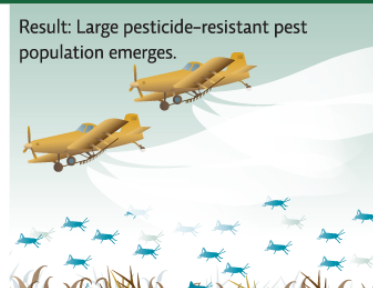
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Infographic 1.1-8

Karr, et al., *Environmental Science for a Changing World*, 3e, © 2018 W. H. Freeman and Company

Bloom's Level: Applying

Feedback: The sliding reinforcer is in effect here. We must be more careful in the application of antibiotics to humans and livestock; what is helpful at first becomes no longer helpful and then deadly over time. Many strains of bacteria exist that are resistant to all of our available antibiotic treatments.

50. How can the tragedy of the commons be applied to anthropogenic climate change?

Section: Challenges to Solving Environmental Problems

Level: 3

Bloom's Level: Analyzing

Feedback: No one entity owns the atmosphere. It is common to all countries. We combust fossil fuels and then greenhouse gases enter the atmosphere, where they trap heat and enhance the greenhouse effect. Unless regulations are enacted, each industry/nation will benefit from burning fossil fuels because it is in their own best interest. However, if everyone does this, the entire planet will suffer. This type of problem is difficult to solve because it is global and thus requires all nations to agree to reforms, without causing undue suffering to any particular participant.

51. You have been given the task of making the fishing industry more sustainable. How will you accomplish this task?

Section: Challenges to Solving Environmental Problems

Level: 2

Bloom's Level: Applying

Feedback: You will have to educate fishermen that the oceans can support only a certain catch size and that overfishing will make the industry unsustainable. By restricting catch size and the fishing season, you can make the industry sustainable and ensure abundant catches in future seasons. You will also need to address the international fishing industry and try to get governments to realize that the fishing industry is a global concern. All countries will need to protect the oceans to ensure the future of the fishing industry.

Guiding Question 9

Distinguish between an anthropocentric, a biocentric, and an ecocentric worldview

Multiple Choice

52. Which statement about environmental ethics is TRUE?

- A. All people with environmental ethics recycle.
- B. Environmental ethics have no control over how people resolve problems in the environment.
- C. People with environmental ethics tend to have an anthropogenic worldview rather than a biocentric worldview.
- D. Each person has a philosophy surrounding environmental ethics that influences his or her interactions with the natural environment.
- E. Worldviews do not tend to influence people's environmental ethics.

Answer: D

Section: Worldviews and Environmental Ethics

Level: 1

Bloom's Level: Understanding

53. Which statement is FALSE?

- A. In a biocentric worldview, all life is valued.
- B. An ecocentric worldview values the ecosystem as an intact whole.
- C. An ecocentric worldview includes all of the organisms and nonliving processes that occur in an ecosystem.
- D. In an anthropogenic worldview, human beings have an instrumental value.
- E. An anthropogenic worldview places human lives and interests as the most important.

Answer: D

Section: Worldviews and Environmental Ethics

Level: 1

Bloom's Level: Remembering

54. Which of the following choices is NOT an example of an anthropocentric worldview?

- A. clear-cutting a forest to sell timber
- B. testing a nuclear bomb
- C. large commercial fishing ships processing tons of fish per day
- D. purchasing a rice product stored in a recycled cardboard container instead of one stored in a plastic container
- E. clearing land to build shopping malls

Answer: D

Section: Worldviews and Environmental Ethics

Level: 1

Bloom's Level: Understanding

55. Which of the following is an example of a biocentric worldview?

- A. catching a spider in your house and releasing it outside
- B. exterminating all insects
- C. viewing nature as existing only for us to use its resources
- D. thinking the nitrogen and water cycles are as important as humans
- E. believing animals exist to provide food for humans

Answer: A

Section: Worldviews and Environmental Ethics

Level: 2

Bloom's Level: Applying

56. What type of worldview did the Vikings have?

- A. anthropocentric
- B. biocentric
- C. ecocentric
- D. intrinsic
- E. geologic

Answer: A

Section: Worldviews and Environmental Ethics

Level: 1

Bloom's Level: Remembering

57. The window through which we view our world and existence is called our:

- A. ethic.
- B. value.
- C. worldview.
- D. ecoview.

Answer: C

Section: Worldviews and Environmental Ethics

Level: 1

Bloom's Level: Remembering

58. If the Vikings had a _____ worldview, they would protect the forests and grasslands not just for the resources provided but also for the natural processes in those areas.

- A. anthropocentric
- B. biocentric
- C. ecocentric
- D. intrinsic

Answer: C

Section: Worldviews and Environmental Ethics

Level: 1

Bloom's Level: Understanding

59. The worldview that considers interactions between organisms and between living and nonliving components of a system is called:

- A. ecocentric.
- B. anthropocentric.
- C. biocentric.
- D. geocentric.

Answer: A

Section: Worldviews and Environmental Ethics

Level: 1

Bloom's Level: Understanding

Essay

60. What is the difference between an anthropocentric worldview, a biocentric worldview, and an ecocentric worldview?

Section: Worldviews and Environmental Ethics

Level: 2

Bloom's Level: Understanding

Feedback: An anthropocentric worldview considers human life and interests as the most important. Environmental resources such as forests and other species are valued only for what they provide for humans. A biocentric worldview considers all organisms as having the right to exist, regardless of the benefit or harm to humans. A biocentric worldview

values a mosquito as much as a dolphin. An ecocentric worldview values the living and nonliving components of an ecosystem as being equally important.

Matching Questions

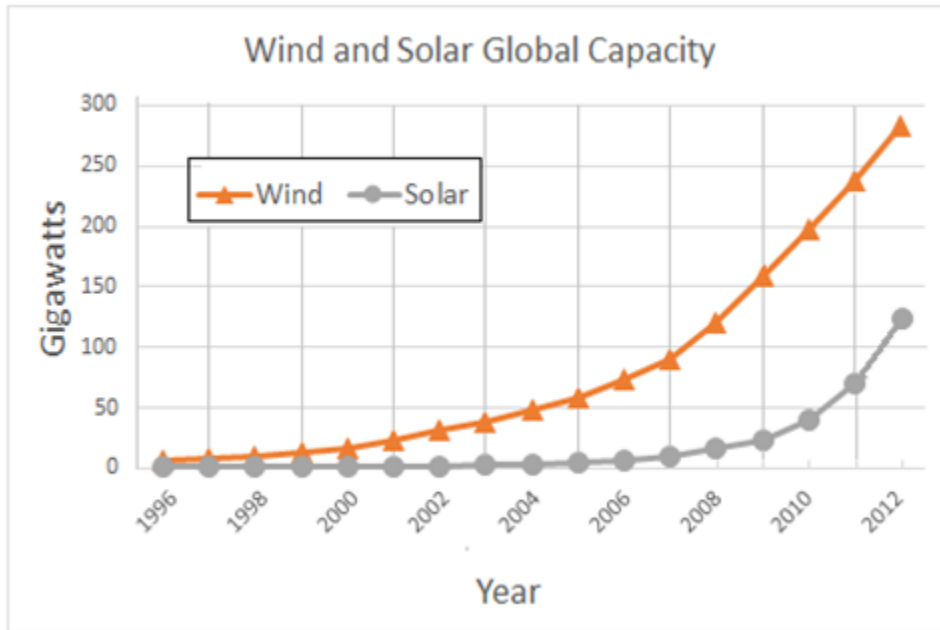
Match each term in the left-hand column to the statement that it best exemplifies.

| | |
|-------------------------------|--|
| 1. environment | resources whose supply is finite or not replenished in a timely fashion (*10) |
| 2. environmental science | the personal philosophy that influences how a person interacts with his or her natural environment and thus affects how that person responds to environmental problems (*19) |
| 3. applied science | decisions by individuals or groups that seem good at the time and produce a short-term benefit but that hurt society in the long run (*4) |
| 4. trade-offs | a scientific approach that investigates the natural world through systematic observation and experimentation (*16) |
| 5. triple bottom line | research findings that are used to help solve practical problems (*3) |
| 6. sustainable development | energy that comes from an infinitely available or easily replenished source (*8) |
| 7. sustainable | actions that are beneficial at first but then change conditions such that their benefit declines over time (*20) |
| 8. renewable energy | a method of using resources in such a way that we can continue to use them indefinitely (*7) |
| 9. biodiversity | the combination of the environmental, social, and economic impacts of our choices (*5) |
| 10. nonrenewable resources | the biological and physical surroundings in which any given living organism exists (*1) |
| 11. time delay | a basic understanding of how ecosystems function and of the impact of our choices on the environment (*21) |
| 12. worldview | an interdisciplinary field of research that draws on the natural and social sciences and the humanities in order to understand the natural world and our relationship to it (*2) |
| 13. anthropocentric worldview | the variety of species on Earth (*9) |
| 14. empirical science | a scientific approach that investigates the natural world through systematic observation and experimentation. (*14) |
| 15. anthropogenic | the window through which one views one's world and existence (*12) |

| | |
|----------------------------|--|
| 16. social traps | actions that produce a benefit today and set into motion events that cause problems later on (*11) |
| 17. Anthropocene | a human-centered view that assigns intrinsic value only to humans (*13) |
| 18. tragedy of the commons | development that meets present needs without compromising the ability of future generations to do the same (*6) |
| 19. environmental ethic | a proposed new geologic epoch that is marked by modern human impact (*17) |
| 20. sliding reinforcer | caused by or related to human action (*15) |
| 21. environmental literacy | the tendency of an individual to abuse commonly held resources in order to maximize his or her own personal interest (*18) |

Linked Questions

Data were collected on the power generated by wind and solar installations worldwide since 1996. Look at the following graph of these data and answer the three questions that follow.



Graph created by Susan Karr based on data from <http://cleantechnica.com/2013/11/07/renewable-energy-charts-renewable-energy-facts/>

1. What type of scientific study do the data in this graph represent?

- A. applied science
- B. empirical study

Answer: A

Section: Science Literacy

Level: 2

Bloom's Level: Applying

2. How much wind capacity did the world have in 2012?

- A. 280 GW
- B. 380 GW
- C. 100 GW
- D. 250 GW

Answer: A

Section: Science Literacy

Level: 1

Bloom's Level: Analyzing

3. Based on this graph and what you know about how best to pursue sustainability, which of these two renewable energy sources should we pursue most vigorously in the future?

- A. Wind: It is more popular than solar, so it is probably more useful or profitable.
- B. Solar: It appears to be increasing at a faster rate in recent years.
- C. Wind: It has shown the steadiest rise since 2002.
- D. Both should be pursued to diversify our energy options.

Answer: D

Section: Science Literacy

Level: 2

Bloom's Level: Evaluating

The following 4 questions are based on this scenario:

You attend a community meeting at which people are discussing the possibility of approving a large-scale wind power project that would allow developers to install six large wind turbines on the crest of a hill in a rural, wooded part of the county, and this installation would be enough to supply the nearby community with electricity. Answer the following questions based on this scenario.

1. One developer who recently bought land in the area near the proposed site and who has plans to develop a new subdivision complains that the wind turbines will be a noisy eyesore, and he does not want the project approved. He worries that the installation will drive down property values and make prospective buyers wary about buying his subdivision lots. What worldview do his comments suggest he has?

- A. anthropocentric
- B. biocentric
- C. ecocentric

Answer: A

Section: Making Connections

Level: 2

Bloom's Level: Understanding/Applying

2. The wind project developer replies that similar projects in other areas have actually increased property values because they attract residents who have a strong desire to protect the environment. She explains that the closest home to the proposed wind turbines would be more than 5 miles away, far enough so that they would not be heard by residents. Thus, the subdivision developer could make a larger profit than he had anticipated. With these comments, the wind developer is pointing out:

- A. the intrinsic value of wind turbines.
- B. the trade-offs of environmental projects.
- C. the instrumental value of the project.
- D. that environmental ethics don't need to be considered here.

Answer: C

Section: Making Connections

Level: 2

Bloom's Level: Understanding /Applying

3 Another resident argues strongly against the wind project, citing the number of birds and bats that are killed annually by wind turbines. "If even one bat or bird dies, that is unacceptable," he argues. "Every living thing has a right to life." His worldview is:

- A. anthropocentric.
- B. biocentric.
- C. ecocentric.

Answer: B

Section: Making Connections

Level: 2

Bloom's Level: Understanding /Applying

4. A final speaker acknowledges that wind turbines have problems but suggests that the advantages outweigh the disadvantages. The area suffers from acid rain and particulate air pollution that is linked to a nearby coal-fired power plant. These wind turbines will decrease the amount of coal that must be burned, and this will reduce air pollution. Though some animals may unfortunately be killed, the wind instillation will help the ecosystem as a whole, he argues, making it healthier for the plants and animals that live there. His argument addresses concerns of those with _____ point of view.

- A. an anthropocentric
- B. an ecocentric
- C. a biocentric
- D. both an anthropocentric and ecocentric
- E. both an anthropocentric and biocentric

Answer: D

Section: Making Connections

Level: 2

Bloom's Level: Analyzing