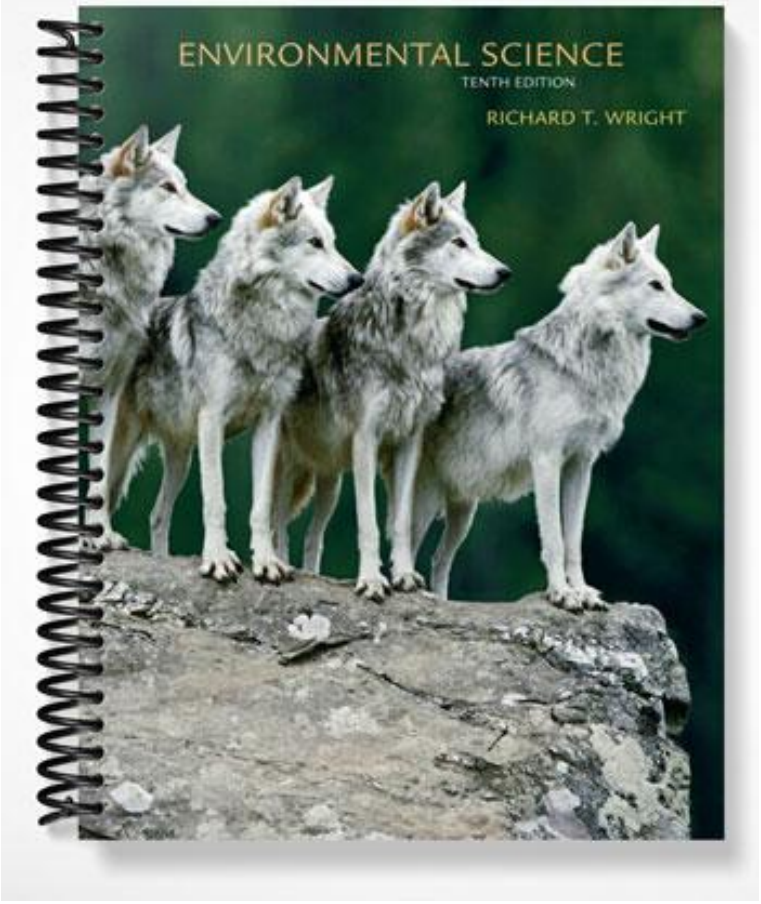
SOLUTIONS MANUAL



CHAPTER 2
Ecosystems: What They Are

Chapter Outline:

I. Ecosystems: A Description
   - A. Biotic Communities
   - B. Species
   - C. Populations
   - D. Associations
   - E. Ecosystems
   - F. Landscapes and Biomes
   - G. Biosphere

II. The Structure of Ecosystems
   - A. Trophic Categories
     1. Producers
        - a. Organic versus Inorganic
        - b. Autotrophs versus Heterotrophs
     2. Consumers
        - a. Predators, Parasites, and Pathogens
     3. Detritus Feeders and Decomposers
   - B. Trophic Relationships: Food Chains, Food Webs, and Trophic Levels
   - C. Nonfeeding Relationships
     1. Mutually Supportive Relationships
     2. Competitive Relationships
   - D. Abiotic Factors
     1. Optimum, Zones of Stress, and Limits of Tolerance
     2. Law of Limiting Factors

III. From Ecosystems to Global Biomes
   - A. The Role of Climate
   - B. Microclimate and Other Abiotic Factors
   - C. Biotic Factors
   - D. Physical Barriers
   - E. Summary

IV. The Human Presence
   - A. Three Revolutions
     1. Neolithic Revolution
     2. Industrial Revolution
     3. Environmental Revolution

Key Topics:

1. Ecosystems: A Description
2. The Structure of Ecosystems
3. From Ecosystems to Global Biomes
4. The Human Factor

Instructional Goals:

1. Humans are dependent on the natural world for survival. Basic needs such as clean air and water are obtained from the natural world. All resources and energy are obtained from the natural world.

2. Natural ecosystems are sustainable systems. We can learn a great deal about how to create a sustainable society by learning about how ecosystems are organized and function.

3. Limiting factors determine what can live where, and climate is the major abiotic cause of differences between ecosystems.

4. The amazing species diversity among and within natural ecosystems can leads a person to a greater appreciation of the beauty of our planet.

Concepts and Connections:

Ecosystems are organizations of the natural world. Cities, agriculture, and industries are human constructs that organize society. Connections can be made between ecosystems and human organizations. Cities have abiotic (buildings, roads, sewers) and biotic (humans, pets, pests) components. Cities release waste heat, as does any ecosystem. Agricultural systems are another example of a simplified ecosystem with biotic (plants, animals, soils) and abiotic (fertilizers, pesticides, water, sunlight) portions. Providing examples of the similarity between human systems and undisturbed ecosystems will help to explain ecosystem structure and the problem with nonsustainable human activities.

Detritus feeders and decomposers are an integral part of any ecosystem. Without these organisms, the nutrients locked within an organism are never released back to the soil for uptake by plants. Linking the soil to detritus feeders and decomposers and the rest of an ecosystem provides the students with a more complete understanding.

Niches and habitats help create diversity within an ecosystem. Human society, as it has become more complex, has created more niches and habitats for employment. Discussing the diversity of jobs available to humans prior to and during the Neolithic Revolution, the Industrial Revolution, and today will help students understand how complexity creates diversity and how the removal of a small piece of diversity could result in ecological disaster. (How long would most of our cars run if we did not have mechanics? Most of us do not know how to maintain our cars.)

Limiting factors can be difficult to explain to students because humans have worked so hard to not be governed by them. The inherent non-sustainability of our drive to not be constrained by limiting factors can be shown by the multitude of environmental problems. In the last 20 years the number of American moving to the Southwest, in defiance of the limiting factor of the region (water), has created an environmental nightmare. We not only have large quantities of water being extracted from ground and surface sources but the air pollution resulting from air conditioners is tremendous. Water and temperature, both limiting factors in a desert, are being ignored and the result is pollution.

The biomass pyramid can be used to explain why the number of people who can be supported is influenced by how we use resources. The lower we eat on the food chain the more people can be supported using the same level of resources. An analogy can be made between the biomass pyramid and consumer products. The manufactured products consume different amounts of energy and resources during production, use, and disposal. Those consumer goods using the fewest resources and the least amount of energy have the greatest availability and would be analogous to producers.

Concepts in Context:

Ecosystems cannot exist without energy provided by the sun. Energy flows and follows the Laws of Thermodynamics (Chapter 3). The organisms, at their various trophic levels, move nutrients through ecosystems (Chapter 3). The various trophic levels where humans feed can be related to other organisms, (e.g. pets, houseplants, insect pests). The environmental impact of humans consuming at the higher trophic levels can be discussed (Chapter 9).

A number of current environmental problems can be used to put limiting factors into a context. Eutrophication and sewage treatment (Chapter 17) are examples of excessive quantities of limiting factors causing adverse environmental effects. Global warming (Chapter 20) is another example of a limiting factor influencing

organism survival. While the current data indicate the temperature of the planet is warming, we have also had ice ages that limited the growth of organisms.

Habitats and niches can be discussed within the context of succession (Chapter 4). An ecosystem with a variety of successional stages, a mosaic, provides the greatest number of niches and habitats. The large number of habitats and niches in a mosaic ecosystem creates the conditions for maximum diversity (Chapter 10).

Key Terms and Vocabulary:

Biota, biotic community, abiotic, species, population, association, ecosystem, ecology, ecotone, landscape, biomes, biosphere, biotic structure, trophic structure, photosynthesis, chlorophyll, organic, inorganic, chemosynthesis, autotrophs, heterotrophs, consumers, detritus feeders, decomposers, primary consumers, herbivores, secondary consumers, carnivores, omnivores, predator, prey, parasites, host, pathogens, detritus, food chain, food web, trophic levels, biomass, biomass pyramid, mutualism, symbiosis, habitat, ecological niche, abiotic factors, resources, optimum, range of tolerance, limits of tolerance, zones of stress, limiting factor, law of limiting factors, climate, deciduous forest biome, grassland and prairie biomes, desert biome, tropical rain forest, coniferous forest biome, permafrost, tundra biome, microclimate, Paleolithic, Neolithic Revolution, Industrial Revolution, human system, Environmental Revolution

Encouraging students to learn vocabulary:

Generally, a limited vocabulary hinders learning. A limited scientific vocabulary limits a person's ability to understand science. All students are capable of learning vocabulary but typically only are motivated to learn specialized vocabulary in their major. Motivation is the key. The following are some suggestions to motivate students to learn words they believe to be too arcane or too specialized.

1. Write a short play or story in which the characters are the key terms or vocabulary from the chapter and the characters are true to their definitions.

2. Write a short play or story in which the key terms and vocabulary are integral to the plot.

3. Write a poem using the vocabulary words. The words must be used properly.

4. Produce a video in which the key terms and vocabulary from the chapter are used in an accurate and entertaining manner.

5. Produce an interactive computer game using the key terms and vocabulary from the chapter properly and in context.

6. Create a hands-on game for primary school children using the key terms and vocabulary from the chapter. The terms and vocabulary must be used properly and in context.

Discussion, Activities, and Labs:

In-class discussion:

1. After discussing detritus feeders and decomposers, ask the students to discuss what would happen if all detritus feeders and decomposers disappeared tomorrow. Include in the discussion the practice by modern humans to isolate our remains from the environment. How does this influence the flow of nutrients? Are we delaying the movement of nutrients, or are we removing the nutrients from the nutrient cycle?

2. Figure 2-5 describes (1) the flow of carbon dioxide and water into and oxygen out of plants, (2) the capture of the energy in sunlight and storage of that energy as glucose, (3) the release of oxygen into the atmosphere and (4) the metabolism of the glucose for plant growth. Students know that plant undergo photosynthesis and

animals respire but it is not usual for them to not realize that plants respire. To help break their incorrect linking of plants and photosynthesis but not respiration and of linking only animals to respiration, ask the students to describe what happens during photosynthesis and respiration. Once the description of photosynthesis includes the capture of energy from sunlight into glucose, ask what happens to the glucose. Suggest that the glucose has to be consumed by the plant in some way or all plants would be sweet. Lead them through the process of figuring out that the energy and carbon in glucose is used, along with the inorganic minerals obtained from soil, to create the molecules that are contained in a plant.

3. Divide the class into small groups to discuss the environmental impacts caused by the Neolithic and Industrial Revolutions. Have students list at least 10 environmental problems caused by each of these two revolutions. Have students list at least five environmental problems created during the Neolithic Revolution that were solved or reduced by the Industrial Revolution. Have students list at least five environmental problems created during the Industrial Revolution that they believe could be solved or reduced by the Environmental Revolution.

4. Because we ignore the situations where humans are consumed by other organisms, (i.e., bacteria, parasites, viruses, detritus feeders, and decomposers), we think of ourselves as at the end of every food chain. Divide the class into small groups. Have the students list all the organisms that feed on humans. Beside each organism listed, have the students indicate if the organism is a consumer, a detritus feeder, or decomposer.

In-class activities:

1. Divide the class into groups of two–three students and provide them with a container of soil. (Compost, with various soil organisms, is good for this exercise.) Have the students look at the various kinds of living organisms and create a classification system for them. (Have them define and justify the classification system.) If you have dissecting microscopes, have the students look at the smaller soil organisms. After organizing the visible living portion of the soil, have the students divide and classify the nonliving portion. Discuss, as a class, the various observations and the classification systems developed by the groups. Discuss how organisms could be grouped by habitat/niche, species (explain how this is done), or trophic level. The purpose of the activity is to expose students to the myriad of ways we can group what we see. (Which students like to lump organisms into large groups because they are similar and which students like to splitter organisms into small groups because they are different?)

2. Before class begins, put warm water (115^0F) baths containing test tube holders near each student. Give each student a closed vial containing a silverfish and a firebrat. Have the students put their two vials into the water bath. About half way through the class, after you have introduced the concept of limiting factors, ask the students to remove both vials from the water bath. Ask the students to see if both insects are alive. Record on the chalkboard the number of each insect that has died. (About one-half of the silverfish should have died and none of the firebrats.) At the end of the lecture ask the students to again tell you which insects are alive and which insects are dead. Ask the students what these observations tell them about heat as a limiting factor in the survival of firebrats and silverfish.

Think about it (labs to be done outside of class):

Have each student list everything consumed during one day—breakfast, lunch, dinner, snacks, and beverages. After creating a list of food consumed, label each item as from a producer, a primary consumer (e.g., cow), or secondary or higher consumer (e.g., fish). If the food item contains both producers and consumers, note both and guess approximately how much of each it contains. From the list, determine the approximate percentage of food obtained from producers and the approximate percentage of food obtained from consumers. Determine from which trophic level you eat. (The lowest trophic level will be secondary.) How much support do you receive from the first trophic level? How much support from the second trophic level? How much support from each remaining trophic level? If you ate more producers, how would this change the percentage of the biomass pyramid necessary to support your survival? If you ate more food from secondary consumers (fish), how would this change the percentage of the biomass pyramid necessary to support your survival?

EXAMPLE: A sample daily diet is given below based upon my (usual) ovo-lacto vegetarian diet. I eat from the first and second trophic levels. Using only the item source frequency, not the quantity of food consumed, 67% (8/12) of my diet comes directly from producers and 33% (4/12) comes from primary consumers. I eat mainly

from the first trophic level. If I ate more food from producers, the percentage of the biomass pyramid necessary to support my survival would decrease. If I ate more food from secondary consumers, the percentage of the biomass pyramid necessary to support me would increase.

	ITEM	SOURCE	PREDOMINATE TROPHIC LEVEL
Breakfast			
	Cereal	producer	2
	Milk	primary consumer	3
	Orange juice	producer	2
	Coffee (black)	producer	2
Lunch			
	Yogurt	primary consumer	3
	Fruit	producer	2
Dinner			
	Couscous and vegetarian stew	producer	2
	Mozzarella cheese	primary consumer	3
	Tomatoes	producer	2
	Bread	producer	2
Snack			
	Milk	primary consumer	3
	Pumpkin bread	producer	2

Suggested Lecture Format

I. Ecosystems: A Description?
   A. Ecosystems are the biotic and abiotic factors in a specified area that interact with each other.
      1. Understanding the interaction of the biotic and the abiotic factors in an ecosystem can help us to see why particular human activities may be a problem for human survival.
      2. Example: The loss of ozone in the stratosphere increases the quantity of UV radiation on the surface of the planet. In the same way humans experience sunburn from too much sun exposure, so do plants. Excessive UV may damage or destroy plant protein and DNA, killing the plant.
   B. Plants and animals interact with their abiotic environment. Attempts are made by the plant or animal to reduce or increase the quantity of an abiotic factor.
      1. Aspens have a waxy coating on their bark to reduce the quantity of sunlight absorbed.
      2. Desert plants have hairlike structures to reduce the quantity of sunlight reaching the surface of the leaves.
      3. Pine trees have needlelike leaves that reduce the quantity of heat lost during the winter.

II. The Structure of Ecosystems
   A. Feeding Relationships
      1. Trophic categories
         a. Producers create organic molecules—protein, lipids, and carbohydrates—by capturing light energy and combining the captured energy with inorganic molecules.
            i. Differentiate between organic and inorganic
            ii. Differentiate between natural and synthetic
         b. Consumers feed on producers and without producers would not exist.
            i. Primary consumers (herbivores)
            ii. Secondary consumers (carnivores)
            iii. Omnivores, which are both herbivorous and carnivorous
         c. Detritus feeders and decomposers
            i. A detritus feeder can be primary (feeds directly on detritus) or secondary (feeds on those who eat detritus). Generally detritus feeders can be described as those who consume dead plants and animals, feces, and so forth.
            ii. Decomposers are primary detritus feeders.
      2. Trophic relationships
         a. Food chains: feeding pathway

i. Food chains are a description of who eats whom.
ii. Predator-prey and host-parasite describe specific feeding relationships.
b. Food webs: a complex of feeding relationships
c. Trophic levels or feeding levels
i. All producers belong to the first trophic level.
ii. All herbivores (primary consumers) are on the second trophic level.
iii. All primary carnivores (secondary consumers) are on the third trophic level.

3. Biomass and the biomass pyramid
a. All organic matter can be defined as biomass.
b. All biomass can be arranged into a feeding relationship with the producers on the first trophic level.
c. On average 10% of the energy from one trophic level moves to the next trophic level. (Partly this is due to the first and second laws of thermodynamics.) At each trophic level most of the organisms are not consumed, portions of organisms consumed pass through the consumer undigested, and energy is released to the environment as high potential energy is converted to low potential energy.
d. Because so little energy can be transferred between trophic levels, the first trophic level necessarily contains the greatest number of organisms and the subsequent trophic levels contain fewer and fewer organisms. Limitations on the transfer of energy between trophic levels create the biomass pyramid.
e. If organisms (humans) eat high on the biomass pyramid (trophic levels 3, 4, 5, etc.), then fewer organisms can be supported than if organisms eat lower on the biomass pyramid.

B. Nonfeeding Relationships
1. Mutually supportive relationships: mutualism
2. Competitive relationships
a. How are competitive relationships reduced?
i. Habitat
ii. Niche: resource partitioning
b. What happens when competition is not reduced?
i. Competitive exclusion principle

C. Abiotic Factors
1. Limiting factors: A myriad of limiting factors defines the viability of life. Basic items include temperature, light, oxygen, carbon dioxide, and precipitation. Only one limiting factor need be out of its optimum range to cause stress for an organism.
a. Optimum levels
i. Each factor necessary for survival has an ideal range.
b. Zones of stress
i. Each factor has a range of values that are above or below the idea but not outside the range allowing survival.
c. Limits of tolerance
i. Each factor has an upper and lower limit beyond which the organism cannot survive.
d. Range of tolerance
i. Each factor has a range of values inclusive of the zones of stress and the optimum levels. These values do not include the upper and lower limits beyond which the organism cannot survive.

2. Law of limiting factors: Quantities of any single factor above or below optimum levels necessary for organism growth, reproduction, or survival will limit growth, reproduction, or survival.
a. Synergistic effects: Two or more factors interact to cause an effect greater than anticipated from the effects of the factors acting alone.

III. From Ecosystems to Global Biomes

A. The Role of Climate
1. Climate versus weather
a. Climate: the average temperature over time
b. Weather: the daily variations in temperature and precipitation
2. Temperature and precipitation combine to create the world's biomes.
3. Describe how ecosystems change as temperature and precipitation change.

a. Vary temperature while precipitation is held constant (moderate rainfall: cold = cool desert, warmer = grassland).
b. Vary precipitation while temperature is held constant (cold temperature: little rain = tundra, more rain = cool desert, even more rain = spruce/fir forest).

B. Microclimate and Other Abiotic Factors
1. Light intensity—south- versus north-facing hillside
2. Soil type
a. pH
b. Salinity
c. Sand, clay, silt
3. Topography

C. Biotic Factors
1. Shading of one plant by another
2. Chemical produced by a plant limiting the growth of other plants
3. Presence of herbivores—tasty plants consumed first

D. Physical Barriers

IV. Implications for Humans

A. Three Revolutions
1. Neolithic Revolution
a. Development of agriculture
b. Required permanent or long-term settlements and specialized skills
c. Allowed for the initial increase in human population—reliable food
2. Industrial Revolution
a. Created the modern world
b. Energized by fossil fuels (initially timber)
c. Resulted in the concentration of waste products
d. Even greater increase in human population size possible because of the specialization of the workforce and the replacement of animal/human power with fossil fuels
3. Environmental Revolution
a. Need to create sustainable human systems
b. Need to create systems in which waste products are not concentrated (pollution) and wastes are resources

Review Questions: Possible Answers

1. *Distinguish between the biotic community and the abiotic environmental factors of an ecosystem.*

The biotic community is the living portion of the ecosystem—plants, animals and microbes—while the abiotic community is the nonliving portion—chemical and physical factors. The abiotic factors support and limit that biotic community. The biotic community members influence each other and will contribute to the abiotic community (minerals, etc.) during decomposition.

2. *Define and compare the terms species, population, association, and ecosystem.*

"Species are the different kinds of plants, animals, and microbes in the community. A given species includes all those individuals that are like one another and that are distinct from other such groups (robins vs. redwing blackbirds, for example.) Similarity in appearance suggests a close genetic relationship." "(T)he biological definition of a species is the entirety of a population that can interbreed." A population is the "individuals that make up the interbreeding reproducing group" within a species. "The distinction between population and species is that population refers only to those individuals of a certain species that live within a given area, such as all the wolves in Yellowstone National Park, whereas species is all inclusive, such as all of the wolves of North America." An association is the "plant community with a definite composition, uniform habitat characteristics, and uniform plant growth." An ecosystem is "a dynamic complex of plants, animals, and microorganism communities and the nonliving environmental interactions as a functional unit within an explicit space." Individuals within a species make up a population; there can be more than one population of a species. An association is the plants found within an ecosystem. There can be more than one plant association within an ecosystem.

3. *Compared with an ecosystem, what are an ecotone, landscape, biome, and biosphere?*

An ecotone is area between two (or more ecosystems) where many of the species and characteristics of the adjacent ecosystems are found plus some "unique conditions that support distinctive plant and animals species." A landscape is a group of interacting ecosystems. Landscapes acknowledge that ecosystems impact each other. Biomes are "similar or related ecosystems or landscapes . . . often grouped together to form major kinds of ecosystems." The biosphere is all the ecosystems of the Earth combined.

4. *Identify and describe the biotic and the abiotic components of the biome of the region in which you live.*

The answers to this question will vary. The description should include the ecosystem type (e.g., desert, prairie grassland, temperate deciduous forest, coniferous forest, etc.) and a description of the kinds of plants and animals found, the climatic conditions and seasons (e.g. semi-arid, rainy/dry seasons, four seasons, etc.), the predominant soil or geologic conditions (e.g., acid, salt marshes, granite, limestone), and a description of the food web.

5. *Name and describe the roles of the three main trophic categories that make up the biotic structure of every ecosystem. Give examples of organisms from each category.*

The three major trophic categories are producers, consumers, and detritus feeders and decomposers. Producers capture energy from the sun; consumers eat producers or other consumers, and detritus feeders and decomposers consume detritus. A corn plant is a producer, a cow is a consumer, and mushrooms are decomposers.

6. *How do the terms* organic *and* inorganic *relate to the biotic and abiotic components of an ecosystem?*

Organic refers to those materials that make up the bodies of living organisms, including detritus material; this is the biotic portion of an ecosystem. Inorganic refers to the nonliving or abiotic portion of the ecosystem; but the abiotic portion of the ecosystem is larger, in that it also includes climate, pH, and so forth.

7. *Name and describe the attributes of the two categories into which all organisms can be divided.*

All organisms can be divided into "autotrophs, or producers, which produce organic matter that becomes the source of energy and nutrients for" the second group, "heterotrophs, which are various categories of consumers, detritus feeders, and decomposers."

8. *Give four categories of consumers in an ecosystem and the role that each plays.*

The four categories are primary consumers, carnivores, omnivores, and parasites. A primary consumer eats plants. A carnivore eats herbivores and/or other carnivores. An omnivore eats plants and other animals. A parasite obtains its resources from a plant or animal, typically without killing it, and is intimately associated with its host.

9. *State the similarities and differences between detritus feeders and decomposers, based on what they do, how they do it, and the kinds of organisms that occupy each category.*

Detritus feeders consume detritus or detritus feeders. Decomposers are also detritus feeders; but instead of eating and then digesting the eaten material, decomposers "secrete digestive enzymes that break down wood, for example, into simple sugars that (they) then absorb for their nourishment." Decomposers tend to be fungi and bacteria, while detritivores include organisms such as earthworms, millipedes, fiddler crabs, termites, ants, wood beetles, and blowflies.

10. *Differentiate between the concepts of* food chain, food web, *and* trophic level.

A food chain describes who eats whom but only shows one species at each trophic level, while a food web tries to describe more completely who eats whom at each trophic level. A food web shows the complexity of feeding relationships and shows that each organism eats more than one thing and/or is eaten by more than one type of organism. A trophic level is the feeding level, with producers occupying the first trophic level.

11. *Relate the concept of the biomass pyramid to the fact that all heterotrophs depend upon autotrophic production.*

The biomass pyramid consists of autotrophic production by plants and bacteria that do chemosynthesis in the first trophic level and consumers (heterotroph) in the second and higher trophic level. No heterotroph can survive without autotrophs because the autotrophs capture the energy and nutrients.

12. *Describe three nonfeeding relationships that exist between organisms.*

Mutualism is a nonfeeding relationship between species where both benefit. Mutualistic relationships result in survival advantages for the species involved and may result in a species to being able to survive in an environment that is otherwise inhospitable, (e.g., alga in association with fungus to form lichen). Commensalism is a relationship between two species where one benefits and the other is not harmed. Symbiosis is a relationship between two organisms but it doesn't specify benefit or harm. There are also competitive relationships that are limited by habitats and niches. These are nonfeeding relationships that include competition for space, nest locations, and so on.

13. *How is competition among different species of an ecosystem reduced?*

Competition between species is reduced by habitats and niches. Habitat is the kind of place a species lives. You may live in the soil, on the surface of the forest floor, in the brush, in the understory trees, or in the canopy. There can be similar resource use, but different habitats will reduce competition. Niches describe "what an animal feeds on, where it feeds, when it feeds, where it finds shelter, how it responds to abiotic factors, and where it nests." If two species have different niches, they can coexist in the same habitat. For example, swallows and bats feed on insects but the swallows feed during the day and the bats feed at night. Therefore, they do not have the same niche.

14. *Differentiate between the two types of abiotic factors. What is the effect on a population when any abiotic factor shifts from the optimum to the limit of tolerance and beyond? What things in addition to abiotic factors may act as limiting factors?*

"Abiotic factors can be categorized as conditions or resources. Conditions are abiotic factors that vary in space and time, but are not used up or made unavailable to other species." "Resources are any factors—biotic or abiotic—that are consumed by organisms." "(T)here is an optimum, a certain level at which the organisms do best. At higher or lower levels the organisms do less well, and at further extremes they may not be able to survive at all."

Non-abiotic factors which may act as limiting factors include "competition or predation from another species."

15. *Describe how differences in climate cause the Earth to be partitioned into six major biomes.*

"Climates in different parts of the world vary widely." "Different temperature and rainfall conditions may occur in almost any combination, yielding a wide variety of climates. In turn, a given climate will support only those species that find the temperature and precipitation levels optimal or at least within their ranges of tolerance." Rainfall determines if you have a forest biome, **grassland/prairie biome**, or a **desert biome**. Temperature will then alter the type of forest. If it is warm the forest will be a **tropical forest**; if cooler it will be a **deciduous forest**; and the coldest forest is the **coniferous forest**. If the temperature gets even colder the forest gives way to **tundra** (because the extreme cold limits the amount of water available for tree growth in addition to the ground being frozen—permafrost).

16. *What are three situations that might cause microclimates to develop within an ecosystem?*

South-facing slopes, "which receive more direct sunlight in the Northern Hemisphere will be relatively warmer and hence also drier than north-facing slopes. Similarly, the temperature range in a sheltered ravine will be narrower than that in a more exposed location." "Soil type and topography may also contribute to the diversity found in a biome, because these two factors affect the availability of moisture." "Salt spray from the ocean will also create specific conditions for plants and animals as will pH."

17. *What is significant about each of the following revolutions: Neolithic, Industrial, and Environmental?*

The development of agriculture, resulting in a more abundant and reliable food supply, is called the Neolithic Revolution. A more reliable and abundant food supply resulted in the growth of the human population. Greater incentives and more potential for the development of technology were a result of the Neolithic Revolution. Resource use increased.

The primary differences between the Industrial Age and the Neolithic Age are the energy sources used and the scale of resources used. The Neolithic Age relied on animal and renewable energy sources (trees, dung, etc.), while the Industrial Age was energized by fossil fuels. The Neolithic Age used fewer resources than the Industrial Age.

The Environmental Revolution is a paradigm shift that the authors believe is necessary for the survival of the planet as we know it. The Environmental Revolution would be ". . . characterized by stewardship as its leading ethic and sustainability as its goal."

Thinking Environmentally: Possible Answers

1. *From local, national, and international news, compile a list of the many ways humans are altering abiotic and biotic factors on a local, regional, and global scale. Analyze ways that local changes may affect ecosystems on larger scales and ways that global changes may affect ecosystems locally.*

Look for articles on waste disposal, hazardous waste and materials, energy consumption and production, pesticide use, land use (building homes, business, parks, etc.), road construction, air pollution, water pollution, consumer buying, and so forth. It is possible to find information about how we are altering abiotic and biotic factors on a local, regional, and global scale in a substantial portion of news articles. Any article on cars can be evaluated for energy efficiency, air pollution, resource extraction (petroleum, minerals, etc.), waste

disposal, urban sprawl, road construction impacts, water pollution from road and parking lot runoff, and energy consumption due to road building and maintenance, traffic and street lights, and law enforcement.

Local changes may impact ecosystems on a larger scale in a variety of ways. The release of mercury from coal-fired power plants impacts local ecosystems, and the mercury moves from local ecosystems all over the world. Local loss of species impacts on a larger scale because of the loss of biodiversity.

Global changes may impact local ecosystems when overall climate shifts or if the quantity of UV reaching the surface of the planet changes.

2. *Write a scenario of what would happen to an ecosystem or to the human system in the event of one of the following: (a) all producers are killed through a loss of fertility of the soil or through toxic contamination; (b) all parasites are eliminated, (c) decomposers and detritus feeders are eliminated. Support all of your statements with reasons drawn from your understanding of the way ecosystems function.*
   a) If all producers were killed through a loss of fertility of the soil or through toxic contamination, no consumer would be able to survive. The plants that are alive will eventually die and the herbivores will run out of food. Once the herbivores no longer have plants to consume, the carnivore population will be decline. Eventually all organisms will die from lack of food.
   b) If all parasites are eliminated, then one group of consumers has been eliminated. If the parasite is a factor in controlling the population size of the host, then the number of host organisms will increase. If the parasite weakens the host, then the organisms that depend upon the host for food (e.g., a predator that kills weak or sick prey) will be less able to find food. The elimination of parasites will influence the food web.
   c) If decomposers and detritus feeders are eliminated, the first thing that will be observed is that nothing that has died will disappear. Also, the feces from various organisms will not be consumed by other organisms. All the detritus will pile up. Eventually, the fertility of soil will decline because detritus feeders are responsible for breaking down organisms such that the plants have nutrients for growth, and so forth.

5. *Consider the various kinds of relationships humans have with other species, both natural and domestic. Give examples of relationships that (a) benefit humans, but harm other species; (b) benefit both humans and other species; and (c) benefit other species but harm humans. Give examples in which the relationship may be changing—for instance, from exploitation to protection. Discuss the ethical issues involved in changing relationships.*
   a) Examples of relationships where humans benefit but other species are harmed are as follows: cows and humans (we eat them); wheat, barley, etc. and humans (we eat the plants); pine trees and humans (we obtain lumber from pine trees); cotton plants and humans (we obtain cotton and the plant dies—the cotton comes from the flower).
   b) Examples of relationships where both humans and the other species benefit are as follows: the organisms that consume dead skin on humans; the organisms that live in the human gut and help in digestion; and the organisms that assist in the decomposition of human feces, thus reducing pollution and diseases.
   c) Examples of relationships where another organism benefits and humans are harmed are as follows: head lice, cold virus, cholera, West Nile virus, mosquitoes, ticks, plague, smallpox, and malaria.

   Changing the relationships can involve ethical issues. There has been a great deal of discussion of the ethical dilemma concerning the elimination of smallpox. It is no longer a disease that exists in the wild, but do we have the "right" to kill the remaining smallpox viruses that exists in Russia and the United States? Do we have the right to knowingly eliminate a species? If we are harming another species but obtain a benefit, we could also encounter an ethical dilemma. How much harm can we cause and how little of a benefit can we obtain? How much is justified? If other organisms benefit when we also benefit, do we have the right to reduce the amount of benefit obtained by the other organisms? Washing our hands constantly changes the relative quantity of the microbes on our skin. Is this ethical?

6. *Explore how the human system can be modified into a sustainable ecosystem in balance with (i.e., preserving) other natural ecosystems without losing the benefits of modern civilization.*

   We have to make choices about what we need versus what we want. Consumption to satisfy a psychological need, if the consumption causes ecological harm, needs to be reduced. We need to evaluate what constitutes a high standard of living. Is it being able to buy things, have large houses, or drive large cars when and wherever we wish? Or does a high standard of living mean that we have leisure time, our possessions don't own us, and we spend time with our families and friends? Does it mean that we read, take walks, and go to concerts and plays? Does a high standard of living put more emphasis on education than acquisition? Does a high standard of living mean that my way of living today does not interfere with another person's ability to live in the future? We need to decide what we think is valuable about our modern civilization and determine if it is compatible with sustainability.