

Section 4–2

1 FOCUS

Objectives

- 4.2.1 Explain** how biotic and abiotic factors influence an ecosystem.
- 4.2.2 Identify** the interactions that occur within communities.
- 4.2.3 Describe** how ecosystems recover from a disturbance.

Guide for Reading

Vocabulary Preview

The text provides pronunciations for most of the new Vocabulary terms in this section. Encourage students to use a dictionary to look up the phonetic spellings of the words for which pronunciations are not given, convert those spellings to the system used in this text, and include the phonetic spellings when they list the highlighted, boldface terms.

Reading Strategy

Students often confuse the terms *symbiosis*, *mutualism*, and *commensalism*. To help them understand and remember the distinctions, have them look up the derivations of the words in a dictionary and note the derivations when they list the highlighted, boldface terms.

2 INSTRUCT

Biotic and Abiotic Factors

Build Science Skills

Applying Concepts Point out to students that in any ecosystem, removing biotic elements can dramatically affect the ecosystem's abiotic conditions. For example, the trees in a forest hold topsoil with their roots, shade the soil, contribute organic matter to the soil in the form of dead leaves, and return water to the atmosphere through evaporation and transpiration. Removing trees from the forest ecosystem reduces these benefits. Ask students to suggest other examples of removing biotic elements from an ecosystem.

L2 L3

4–2 What Shapes an Ecosystem?

Guide for Reading

Key Concepts

- How do biotic and abiotic factors influence an ecosystem?
- What interactions occur within communities?
- What is ecological succession?

Vocabulary

biotic factor
abiotic factor
habitat
niche
resource
competitive exclusion principle
predation
symbiosis
mutualism
commensalism
parasitism
ecological succession
primary succession
pioneer species
secondary succession

Reading Strategy:

Building Vocabulary Before you read, preview new vocabulary terms by skimming the section and making a list of the highlighted, boldface terms. Leave space to make notes as you read.

If you ask an ecologist where a particular organism lives, that person might say the organism lives on a Caribbean coral reef, or in an Amazon rain forest, or in a desert in the American Southwest. Those answers provide a kind of ecological address not unlike a street address in a city or town. An ecological address, however, tells you more than where an organism lives. It tells you about the climate the organism experiences and what neighbors it is likely to have. But what shapes the ecosystem in which an organism lives?

Biotic and Abiotic Factors

Ecosystems are influenced by a combination of biological and physical factors. The biological influences on organisms within an ecosystem are called **biotic factors**. These include the entire living cast of characters with which an organism might interact, including birds, trees, mushrooms, and bacteria—in other words, the ecological community. Biotic factors that influence a bullfrog, for example, might include the tiny plants and algae it eats as a tadpole, the herons that eat the adult frog, and other species that compete with the bullfrog for food or space.

Physical, or nonliving, factors that shape ecosystems are called **abiotic** (ay-by-AHT-ik) **factors**. For example, the climate of an area includes abiotic factors such as temperature, precipitation, and humidity. Other abiotic factors are wind, nutrient availability, soil type, and sunlight. For example, the bullfrog in **Figure 4–4** is affected by abiotic factors such as the availability of water and the temperature of the air. **Together, biotic and abiotic factors determine the survival and growth of an organism and the productivity of the ecosystem in which the organism lives.** The area where an organism lives is called its **habitat**. A habitat includes both biotic and abiotic factors.

Check Your Understanding Give an example of an abiotic factor.



◀ **Figure 4–4** Like all ecosystems, this pond is shaped by a combination of biotic and abiotic factors. The bullfrog, plants, and other organisms in the pond are biotic factors. The water, the air, and the rock on which the bullfrog sits are abiotic factors.



SECTION RESOURCES

Print:

- **Laboratory Manual A**, Chapter 4 Lab
- **Laboratory Manual B**, Chapter 4 Lab
- **Teaching Resources**, Section Review 4–2, Enrichment, Chapter 4 Exploration
- **Reading and Study Workbook A**, Section 4–2
- **Adapted Reading and Study Workbook B**, Section 4–2
- **Lesson Plans**, Section 4–2

Technology:

- **iText**, Section 4–2
- **Transparencies Plus**, Section 4–2

Quick Lab

How do abiotic factors affect different plant species?

Materials presoaked rye and rice seeds, sand, potting soil, 4 paper cups

Procedure   

1. Use a pencil to punch three holes in the bottom of each cup. Fill 2 cups with equal amounts of sand and 2 cups with the same amount of potting soil.
2. Plant 5 rice seeds in one sand-filled cup and 5 rice seeds in one soil-filled cup. Plant 5 rye seeds in each of the other 2 cups. Label each cup with the type of seeds and soil it contains.
3. Place all the cups in a warm, sunny location. Each day for 2 weeks, water the cups equally and record your observations of any plant growth. **CAUTION:** Wash your hands well with soap and warm water after handling plants or soil.



Analyze and Conclude

1. **Analyzing Data** In which medium did the rice grow best—sand or soil? Which was the better medium for the growth of rye?
2. **Inferring** Soil retains more water than sand, providing a moister environment. What can you infer from your observations about the kind of environment that favors the growth of rice? The growth of rye?
3. **Drawing Conclusions** Which would compete more successfully in a dry environment—rye or rice? In a moist environment?

The Niche

If an organism's habitat is its address, its niche is its occupation. A **niche** (NITCH) is the full range of physical and biological conditions in which an organism lives and the way in which the organism uses those conditions. For instance, part of the description of an organism's niche includes its place in the food web. Another part of the description might include the range of temperatures that the organism needs to survive. The combination of biotic and abiotic factors in an ecosystem often determines the number of different niches in that ecosystem.

A niche includes the type of food the organism eats, how it obtains this food, and which other species use the organism as food. For example, a mature bullfrog catches insects, worms, spiders, small fish, or even mice. Predators such as herons, raccoons, and snakes prey on bullfrogs.

The physical conditions that the bullfrog requires to survive are part of its niche. Bullfrogs spend their lives in or near the water of ponds, lakes, and slow-moving streams. A bullfrog's body temperature varies with that of the surrounding water and air. As winter approaches, bullfrogs burrow into the mud of pond or stream bottoms to hibernate.

The bullfrog's niche also includes when and how it reproduces. Female bullfrogs lay their eggs in water during the warmer months of the year. The young frogs, called tadpoles, live in the water until their legs and lungs develop.

Differentiated

Instruction Solutions for All Learners

Less Proficient Readers

Some students learn best when material is organized. Help these students better understand succession in a marine ecosystem by having them create a flowchart of the process discussed on pages 96 and 97. You could have students work in small groups to make these graphic organizers. When groups finish, display the flowcharts so that groups can compare their approaches. **L1 L2**

Advanced Learners

Encourage students who need an extra challenge to research the various types of defenses that have evolved in prey species as protection against predators. Such defenses include camouflage, mechanical defenses such as quills and thorns, chemical defenses such as toxins, warning coloration, and mimicry. Have students share their findings with the class in oral reports, posters, or displays. **L3**

Quick Lab

Objective Students will be able to describe how abiotic factors affect growth in different species of plants. **L2**

Skill Focus Drawing Conclusions

Materials rye and rice seeds, sand, potting soil, 4 paper cups

Time 15 minutes for setup; brief observation and recording each day for 2 weeks

Advance Prep Soak the rice and rye seeds in water overnight.

Strategies

- Have students place the cups in trays or other shallow containers to hold any water, sand, and soil that may leak from the holes.
- Emphasize that except for the type of soil and type of seeds in each cup, all variables must be kept the same for all four cups.

Alternative Materials If rye is not available, you may use wheat seeds instead.

Expected Outcome Rice seeds will not grow well in the sand-filled cup because the water drains out and leaves the sand too dry. Rye seeds should grow well in soil or sand.

Analyze and Conclude

1. Both types of seeds will be more successful in soil. However, the effect on rice will be more pronounced.
2. Rice requires a moister environment than rye does. Rye can tolerate dry conditions better than rice can but also benefits from an ample supply of water.
3. Rye will be more successful than rice in dry conditions. Rice will be more successful than rye in moist conditions.


The Niche

Address Misconceptions

Students sometimes misunderstand what a niche is, believing it to be a part of an ecosystem. Use simple analogies to clarify the meaning of the term. For example, each player on a baseball team has a specific niche—a different role to play.

L1 L2

Answer to . . .

 **CHECKPOINT** The example should be any nonliving factor, such as air, water, soil, or rocks.

4-2 (continued)

Community Interactions

Demonstration

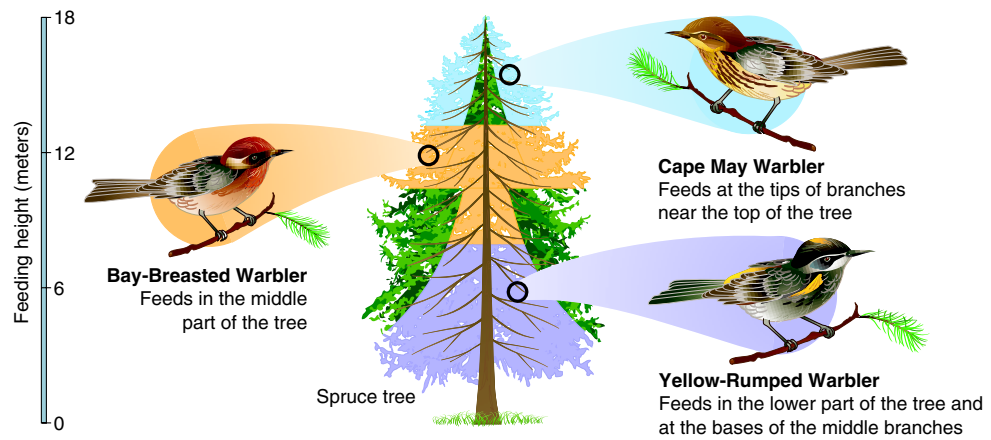
Mark off a 3-meter-square area with masking tape or string. Scatter 25 uncolored toothpicks (or other small objects) and 25 colored toothpicks over the area. Explain that the toothpicks represent two different species of insects. Choose two students to represent different species of lizards that eat both types of insects. At a signal from you, the two lizards start catching insects of both types. Signal the lizards to stop after 5–10 seconds, and ask them to count their insects. Rescatter the toothpicks and repeat the activity, but this time have one lizard eat only uncolored insects and the other lizard eat only colored insects. Compare the insect counts from the two different methods. Ask the “lizards”: **Was it easier to catch insects when you were competing with each other or when you each had a different food?** (*When each had a different food*) Also ask the other students to describe competitive behaviors they observed.

L1 L2

Build Science Skills

Problem Solving Emphasize that any given ecosystem has only a certain amount of space, food, water, and other life essentials. Ask: **If one organism is involved in direct competition for life essentials, what are the possible outcomes for that organism?** (*The organism may win the struggle and survive, or it may lose the struggle and die.*) **Is there any other alternative for organisms that are in competition with other organisms?** (*If the competition is between different yet similar species, the organisms may change in ways that will decrease competition. In this way, both species may survive.*)

L2 L3



▲ **Figure 4-5** Each of these warbler species has a different niche in its spruce tree habitat. By feeding in different areas of the tree, the birds avoid competing with one another for food. **Inferring** *What would happen if two of the warbler species attempted to occupy the same niche?*

As you will see, no two species can share the same niche in the same habitat. However, different species can occupy niches that are very similar. For instance, the three species of North American warblers shown in **Figure 4-5** live in the same spruce trees but feed at different elevations and in different parts of those trees. The species are similar, yet each warbler has a different niche within the forest.

Check Your Understanding *What is a niche?*

Community Interactions

When organisms live together in ecological communities, they interact constantly. These interactions help shape the ecosystem in which they live. **Community interactions, such as competition, predation, and various forms of symbiosis, can powerfully affect an ecosystem.**

Competition Competition occurs when organisms of the same or different species attempt to use an ecological resource in the same place at the same time. The term **resource** refers to any necessity of life, such as water, nutrients, light, food, or space. In a forest, for example, broad-leaved trees such as oak or hickory may compete for sunlight by growing tall, spreading out their leaves, and blocking the sunlight from shorter trees. Similarly, two species of lizards in a desert might compete by attempting to eat the same type of insect.

Direct competition in nature often results in a winner and a loser—with the losing organism failing to survive. A fundamental rule in ecology, the **competitive exclusion principle**, states that no two species can occupy the same niche in the same habitat at the same time. Look again at the distribution of the warblers in **Figure 4-5**. Can you see how this distribution avoids direct competition among the different warbler species?



HISTORY OF SCIENCE

The competitive exclusion principle

The competitive exclusion principle was first postulated by Russian ecologist G. F. Gause in 1934. In laboratory experiments, Gause studied the effect of interspecific competition on two closely related species of protists. When he cultured the two species separately, both populations grew rapidly and then leveled off at the culture's

carrying capacity. When he cultured the two species together, however, one species apparently had a competitive edge in obtaining food, and the other species was driven to extinction in the culture. Gause concluded that two species so similar that they compete for the same limited resources cannot coexist in the same place. His conclusion was later confirmed by further studies.

Predation An interaction in which one organism captures and feeds on another organism is called **predation** (pree-DAY-shun). The organism that does the killing and eating is called the predator (PRED-uh-tur), and the food organism is the prey. Cheetahs are active predators with claws and sharp teeth. Their powerful legs enable them to run after prey. Other predators, such as anglerfishes, are more passive. An anglerfish has a fleshy appendage that resembles a fishing lure, which it uses to draw unsuspecting prey close to its mouth.

Symbiosis Any relationship in which two species live closely together is called **symbiosis** (sim-by-OH-sis), which means “living together.” Biologists recognize three main classes of symbiotic relationships in nature: mutualism, commensalism, and parasitism. Examples of these three symbiotic relationships are shown in **Figure 4–6**.

Mutualism In **mutualism** (MYOO-choo-ul-iz-um), both species benefit from the relationship. Many flowers, for example, depend on certain species of insects to pollinate them. The flowers provide the insects with food in the form of nectar, pollen, or other substances, and the insects help the flowers reproduce.

Commensalism In **commensalism** (kuh-MEN-sul-iz-um), one member of the association benefits and the other is neither helped nor harmed. Small marine animals called barnacles, for example, often attach themselves to a whale’s skin. The barnacles perform no known service to the whale, nor do they harm it. Yet, the barnacles benefit from the constant movement of water past the swimming whale, because the water carries food particles to them.

Parasitism In **parasitism** (PAR-uh-sit-iz-um), one organism lives on or inside another organism and harms it. The parasite obtains all or part of its nutritional needs from the other organism, called the host. Generally, parasites weaken but do not kill their host, which is usually larger than the parasite. Tapeworms, for example, are parasites that live in the intestines of mammals. Fleas, ticks, and lice live on the bodies of mammals, feeding on the blood and skin of the host.

Figure 4–6 Three examples of symbiosis are shown: mutualism, commensalism, and parasitism. **Predicting** What would happen to the aphids if the ant died?



Mutualism The ant cares for the aphids and protects them from predators. The aphids produce a sweet liquid that the ant drinks.



Commensalism The orchid benefits from its perch in the tree as it absorbs water and minerals from rainwater and runoff, but the tree is not affected.



Parasitism A tick feeds on the blood of its host and may also carry disease-causing microorganisms.

Build Science Skills

Problem Solving Explain that under normal conditions, prey populations seldom become extinct as a result of predation. Tell students to imagine an ecosystem in which a predator species has killed off an entire prey species. Ask: **What would the possible consequences be for the predators?** (They would run out of food and die, they would have to change their eating habits and find other prey, or they would have to move to another area where that prey species still survives.) **L2**

Build Science Skills

Applying Concepts Have each student list examples of symbiotic relationships that he or she knows from previous learning or has researched. In a class discussion, ask volunteers to describe examples without identifying the type of symbiosis each example represents. After each description, challenge other students to identify the relationship as mutualism, commensalism, or parasitism. **L2 L3**



BACKGROUND

Predation and diversity

In nature, predator species rarely kill and eat all their prey species, which would reduce community diversity. In fact, studies have shown that predation can actually help maintain diversity. One example of this process involves the gray wolf, a top predator in its ecosystem. Where wolves were hunted to extinction, such as in many parts of North America, populations of

deer and other herbivores increased dramatically. As these populations overgrazed the vegetation, many plant species that could not tolerate such grazing pressure disappeared from the ecosystem. In turn, many insects and small animals that depended on the plants for food also disappeared. The elimination of wolves thus produced an ecosystem with considerably less species diversity.

Answers to . . .

CHECKPOINT The full range of physical and biological conditions in which an organism lives and the way in which the organism uses those conditions

Figure 4–5 Most likely, one warbler species would be more successful in that niche, and the other species would not survive.

Figure 4–6 Without the ants, the aphids could be eaten by predators.

4-2 (continued)

Ecological Succession

Demonstration

The following activity models stages of succession described on this page. Elicit student volunteers to help you create the model. Put a 2.5-cm layer of gravel in the bottom of a dishpan, and cover with a 10-cm layer of soil. Make a pond by sinking a shallow dish into the soil so its top is even with the soil surface. Put a 1-cm layer of soil in the bottom of the pond. Slowly pour water into the dishpan until the pond is completely full and the soil around it is wet. Sprinkle a handful of grass seeds over the entire dishpan. Leave the dishpan near a sunny window. Every 3 to 4 days, sprinkle grass seeds over the dishpan again. Lightly water the soil to keep it damp, but do not refill the pond or clean it out. Over time, the pond will become shallower and will eventually fill in with growing grass. When this has occurred, sprinkle a handful of mixed birdseed over the dishpan once a week for two weeks. The birdseed plants, which will be larger than the grass plants, represent the gradual invasion of shrubs and trees and the succession from a meadow to a forest. **L1 L2**

Build Science Skills

Problem Solving Ask: What types of human activities can disturb an ecosystem and cause succession? (Examples include logging, strip mining, draining a marsh, clearing woodland to grow crops or graze livestock, removing a beaver dam, and the like.) **L2**

Ecological Succession

On the time scale of a human life, some ecosystems may seem stable. The appearance of stability is often misleading, because ecosystems and communities are always changing. Sometimes, an ecosystem changes in response to an abrupt disturbance, such as a severe storm. At other times, change occurs as a more gradual response to natural fluctuations in the environment.

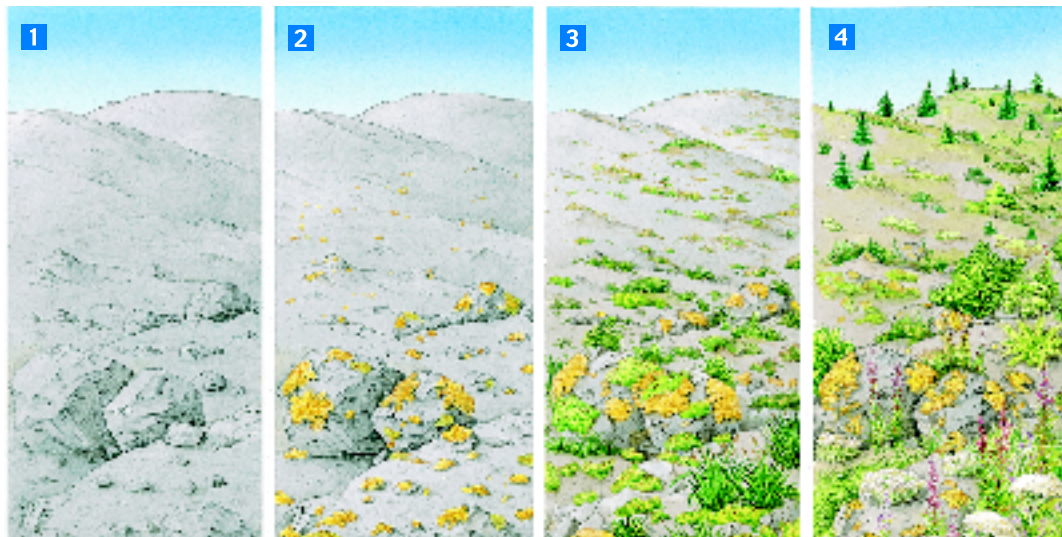
Ecosystems are constantly changing in response to natural and human disturbances. As an ecosystem changes, older inhabitants gradually die out and new organisms move in, causing further changes in the community. This series of predictable changes that occurs in a community over time is called **ecological succession**. Sometimes succession results from slow changes in the physical environment. A sudden natural disturbance from human activities, such as clearing a forest, may also be a cause of succession.

Primary Succession On land, succession that occurs on surfaces where no soil exists is called **primary succession**. For example, primary succession occurs on the surfaces formed as volcanic eruptions build new islands or cover the land with lava rock or volcanic ash. Primary succession also occurs on bare rock exposed when glaciers melt.

In **Figure 4-7**, you can follow the stages of primary succession after a volcanic eruption. When primary succession begins, there is no soil, just ash and rock. The first species to populate the area are called **pioneer species**. The pioneer species on volcanic rocks are often lichens (LY-kunz). A lichen is made up of a fungus and an alga and can grow on bare rock. As lichens grow, they help break up the rocks. When they die, the lichens add organic material to help form soil in which plants can grow.

▼ **Figure 4-7** Primary succession occurs on newly exposed surfaces, such as this newly deposited volcanic rock and ash. (1) A volcanic eruption destroys the previous ecosystem. (2) The first organisms to appear are lichens. (3) Mosses soon appear, and grasses take root in the thin layer of soil. (4) Eventually, tree seedlings and shrubs sprout among the plant community. **Predicting** What types of animals would you expect to appear at each stage, and why?

ENLIGHTEN What are pioneer species?



BIOLOGY UPDATE

Succession and chance

Many ecologists once believed that succession was an orderly and predictable process. Today, they realize that random, unpredictable events may influence which species succeed and which die off after a disturbance. For example, random variables such as the season of year the disturbance occurs, the wind direction and rainfall immediately after the disturbance, and which

organisms are in an active stage of their breeding cycle can change the succession of a community after a fire, volcanic eruption, or other major disturbance. Ecologists have also found that climax communities are often not as stable as they were once thought to be. In studying coral reefs and tropical rain forests, for example, researchers find shifting patchworks of early, middle, and late successional communities.

Secondary Succession Components of an ecosystem can be changed by natural events, such as fires, or by human activities, such as farming. These changes may affect the ecosystem in predictable or unpredictable ways. When the disturbance is over, community interactions tend to restore the ecosystem to its original condition through **secondary succession**. For example, secondary succession occurs after wildfires burn woodlands and when land cleared for farming is abandoned. **Figure 4–8** shows trees regrowing after a wildfire. In fact, fires set by lightning occur in many ecosystems, and some plants are so adapted to periodic fires that their seeds won't sprout unless exposed to fire!

Ecologists used to think that succession in a given area always proceeded through predictable stages to produce the same stable “climax community.” Old-growth forests in the Pacific Northwest, for example, were considered climax communities. But natural disasters, climate change, and human activity such as introduction of nonnative species profoundly affect these communities today. Healthy ecosystems usually recover from natural disturbances because of the way components of the system interact. Ecosystems may or may not recover from long-term, human-caused disturbances.



▲ **Figure 4–8** Ten years after wildfires burned regions of Yellowstone National Park, small evergreen trees have begun to regenerate the forest. **Predicting** How do you think this region will look 20 years after the fires?

Use Community Resources

Invite students to cite examples of natural or human disturbances they have seen in their area. Emphasize that the disturbance need not be a large-scale event, such as cutting down all the trees in an area of woodland, but could be on a small scale—for example, homeowners removing thorny bushes from a narrow strip of land between their houses. Ask students to describe any changes they observed after the disturbance or, if the disturbance is very recent, to predict changes they think will occur over time. Take the class to a disturbed site, if feasible, or ask students to visit a site on their own periodically to observe changes that occur during the school year. **L2 L3**

Careers in Biology

Encourage students to use library resources to find out how to get started in a forestry career. Suggest that they present their findings in posters that include information such as the geographic locations where forestry professionals work, specific courses that are necessary, areas of research, and issues in the industry.

L1 L2

Resources Society of American Foresters; International Union of Forestry Research Organizations; U.S. Department of Agriculture Forest Service

Go Online
PHSchool.com

You can have students write a more extensive job description as well as list the educational requirements for a career in this field.

Careers in Biology

Forestry Technician

Job Description: work outdoors to help maintain, protect, and develop forests (by planting trees, fighting insects and diseases that attack trees, and controlling soil erosion)

Education: two- or four-year college degree in forestry, wildlife, or conservation; summer work in parks, state and national forests; and private industry provides on-the-job training

Skills: knowledge of the outdoors and basic safety precautions; communication skills for working with the public; keen observational skills; physical fitness for jobs that require walking long distances through forests

Highlights: help to manage and conserve forest biomes by analyzing data, planting trees, and managing fires when necessary; contribute to people's enjoyment of outdoor recreation



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For: Career links
Visit: PHSchool.com
Web Code: cbb-2042

Answers to . . .

CHECKPOINT The first species to populate an area at the beginning of the process of primary succession

Figure 4–7 Stage 2: insects and spiders are carried in by the wind; stage 3: rodents that feed on these arthropods and new grasses; stage 4: larger mammals and birds that feed on rodents

Figure 4–8 Answers may vary. Most students will suggest that succession will have proceeded in specific and predictable stages and the community in 20 years might be mature and stable.



TEACHER TO TEACHER

To help students understand ecological succession, have them interview an older family member or neighbor who has lived in their neighborhood for a long time. Ask the person to describe how the neighborhood has changed over time. Make sure that students ask the following questions. (1) Have areas that were formerly grassy been paved or developed?

(2) Have any farms, parks, or lots returned to their wild state? Ask students to write a summary of their interview and then share it with the class.

—Deidre Galvin
Biology Teacher
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4-2 (continued)

Use Visuals

Figure 4-9 After students have studied the figure and read the caption, ask: **How is the situation shown in this illustration an example of ecological succession?** (*Ecological succession is the series of predictable changes that occurs in a community over time. In this situation, the predictable changes that occur are the different stages in the consumption of the dead whale.*) **What is the cause of succession in this situation?** (*The death and sinking of the whale causes the succession.*) **Is the succession in a marine ecosystem more like primary or secondary succession on land?** (*Students may compare it favorably to either kind of succession on land. Like primary succession, succession in a marine ecosystem begins with an event, a cause. It's also like secondary succession in that certain ocean organisms are adapted to the "disturbance" of a sinking dead whale, just as land organisms are adapted to the disturbance of fire.*) **L2**

Build Science Skills

Interpreting Graphics Collect, or ask students to find, several sets of photographs that show areas soon after a disturbance and at intervals as succession occurs. Good subjects for such photos include areas affected by a volcanic eruption or forest fire, such as the areas mentioned in the student text. Photos of succession after the eruption of Mount St. Helens are also widely available. Display each set of photos in random order, and have students identify the correct order. For each set, also ask: **How were you able to determine the correct order?** (*Sample answer: by the types and sizes of the plants growing in the area*) **L2 L3**

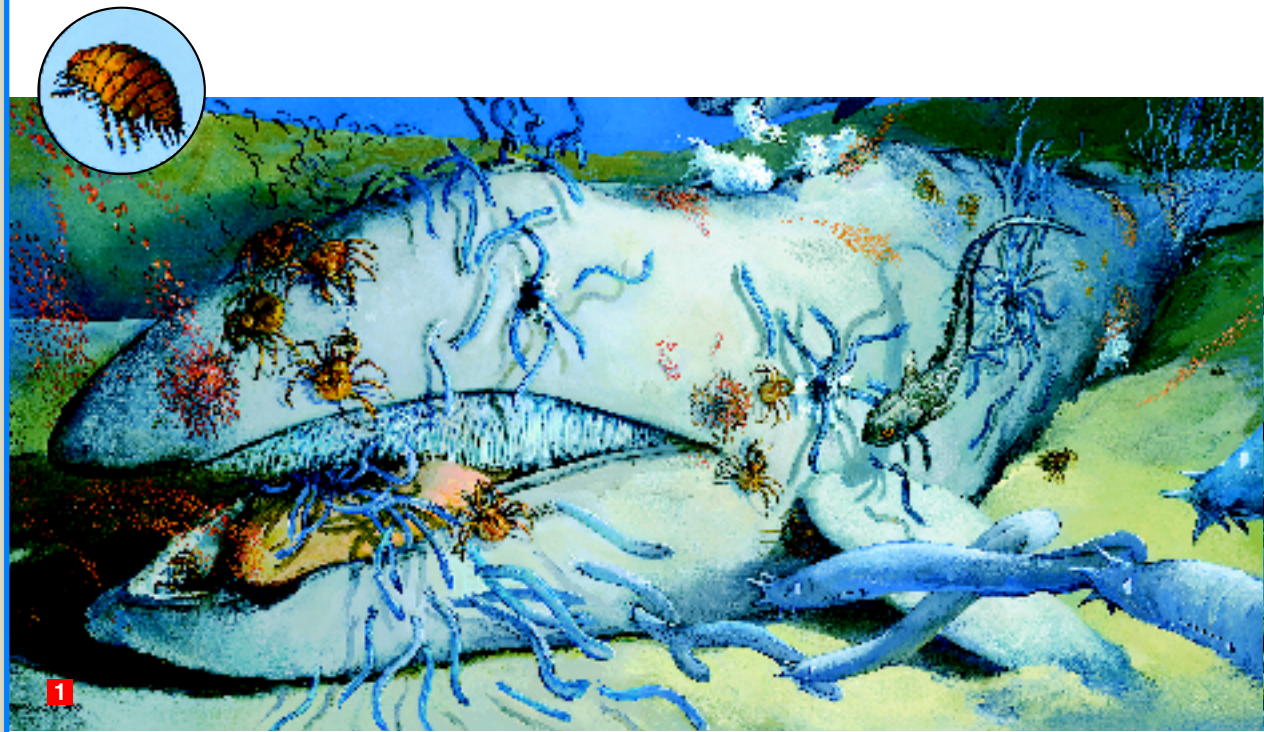
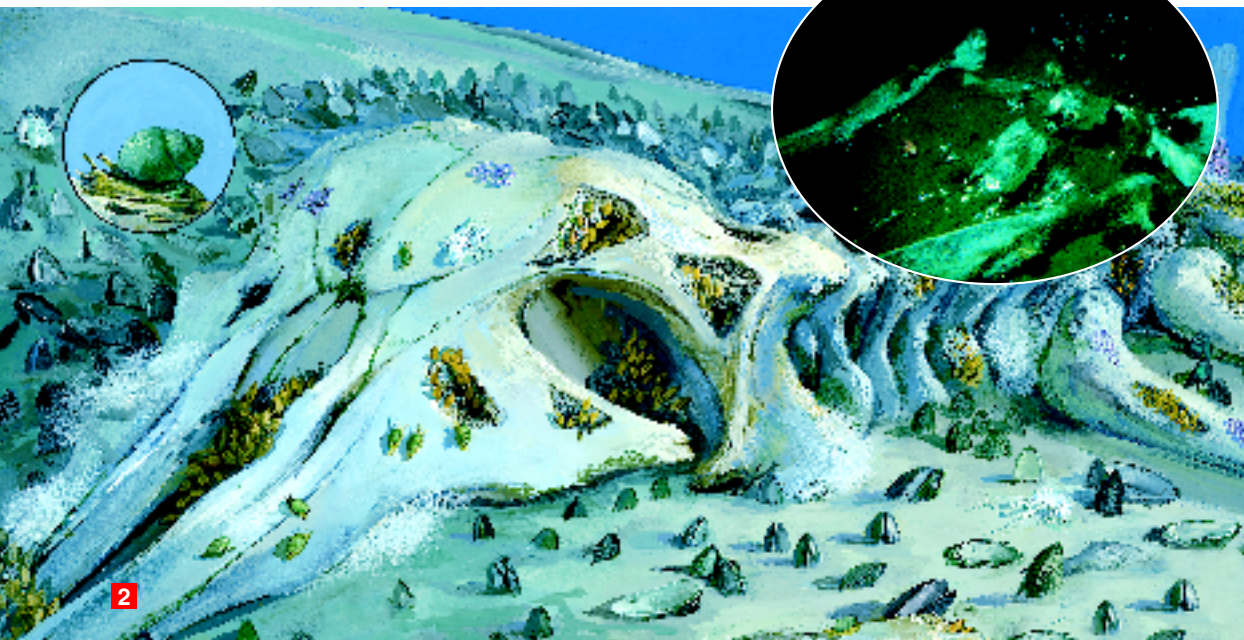


Figure 4-9 **Ecosystems are constantly changing in response to disturbances.** In natural environments, succession occurs in stages. A dead whale that falls to the ocean floor is soon covered with scavengers. After a time, only bare bones are left. The bones contain oil that supports several types of deep-sea bacteria. In the next stage of succession, the bacteria provide energy and nutrients for a different community of organisms that live on the bones and in the surrounding sediments.

Succession in a Marine Ecosystem Succession can occur in any ecosystem—even in the permanently dark, deep ocean. In 1987, scientists found an unusual community of organisms living on the remains of a dead whale in the deep waters off the coast of southern California. At first, ecologists did not know what to make of this extraordinary community. After several experiments and hours of observation, the ecologists found that the community represented a stage in succession amid an otherwise stable and well-documented deep-sea ecosystem. Since that discovery, several more whale carcasses have been found in other ocean basins with similar organisms surrounding them. **Figure 4-9** illustrates three stages in the succession of a whale-fall community.

- 1** The disturbance that causes this kind of succession begins when a large whale, such as a blue or fin whale, dies and sinks to the normally barren ocean floor. The whale carcass attracts a host of scavengers and decomposers, including amphipods (inset), hagfishes, and sharks, that feast on the decaying meat.
- 2** Within a year, most of the whale's tissues have been eaten. The carcass then supports only a much smaller number of fishes, crabs, marine snails (inset), and other marine animals. The decomposition of the whale's body, however, enriches the surrounding sediments with nutrients, forming an oasis of sediment dwellers, including many different species of marine worms.



3 ASSESS

Evaluate Understanding

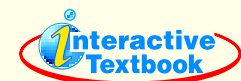
Have each student select an example of succession—either one described in the student text or one of his or her own choice—and write a brief description of the sequence of changes that the ecosystem could undergo. As an alternative, students could draw sketches to show the changes.

Reteach

Using photographs of ecosystems that you have selected from other chapters in this textbook or from other sources, have students list the biotic and abiotic factors in each ecosystem.

Writing in Science

Let students use any ecosystem and any kind of disturbance of their choice. In general, students' stories should include information about a change in the biotic or abiotic factors in a stable ecosystem, resulting in succession. Students should chronicle the gradual changes that return the ecosystem to a climax community. If students have a hard time getting started, suggest that they begin by making a flowchart of steps in succession for a particular ecosystem and then use the flowchart as an outline for the story.



If your class subscribes to the iText, use it to review the Key Concepts in Section 4–2.

3 When only the whale's skeleton remains, a third community moves in. Heterotrophic bacteria begin to decompose oils inside the whale bones. In doing so, they release chemical compounds that serve as energy sources for other bacteria that are chemosynthetic autotrophs. The chemosynthetic bacteria, in turn, support a diverse community of mussels, limpets, snails, worms, crabs, clams, and other organisms that live on the bones and within the nearby sediments.

4–2 Section Assessment

- Key Concept** What is the difference between a biotic factor and an abiotic factor?
- Key Concept** Name three types of community interactions that can affect an ecosystem.
- Key Concept** What is the difference between primary succession and secondary succession?
- How is an organism's niche determined?
- Critical Thinking Comparing and Contrasting** How are the three types of symbiotic relationships different? Similar?
- Critical Thinking Applying Concepts** Summarize the role of organisms, including microorganisms, in maintaining the equilibrium of a marine ecosystem while a dead whale decays on the ocean floor.

Writing in Science

Creative Writing

Use the information from this section to write a short story about an ecosystem that is disturbed and undergoes succession. *Hint:* Include a flowchart with your story to show the main stages of change.

4–2 Section Assessment

- A biotic factor is a living organism. An abiotic factor is nonliving.
- Competition, predation, and symbiosis
- Primary succession occurs on surfaces where no soil exists. Secondary succession occurs when a disturbance of some kind changes an existing community without removing the soil.
- An organism's niche is determined by the physical and biological conditions in its environment and how it uses those conditions.
- In mutualism, both species benefit. In commensalism, only one species benefits; the other is neither helped nor harmed. In parasitism, one species benefits; the other is harmed. In all three, two species live closely together.
- Students should describe how scavengers and decomposers eat the decaying meat, how the decomposition of the whale's body forms an oasis for sediment dwellers, and how bacteria decompose the oils inside the whale's bones.