Chapter 13

Interactions of Life

THE BIG IDEA

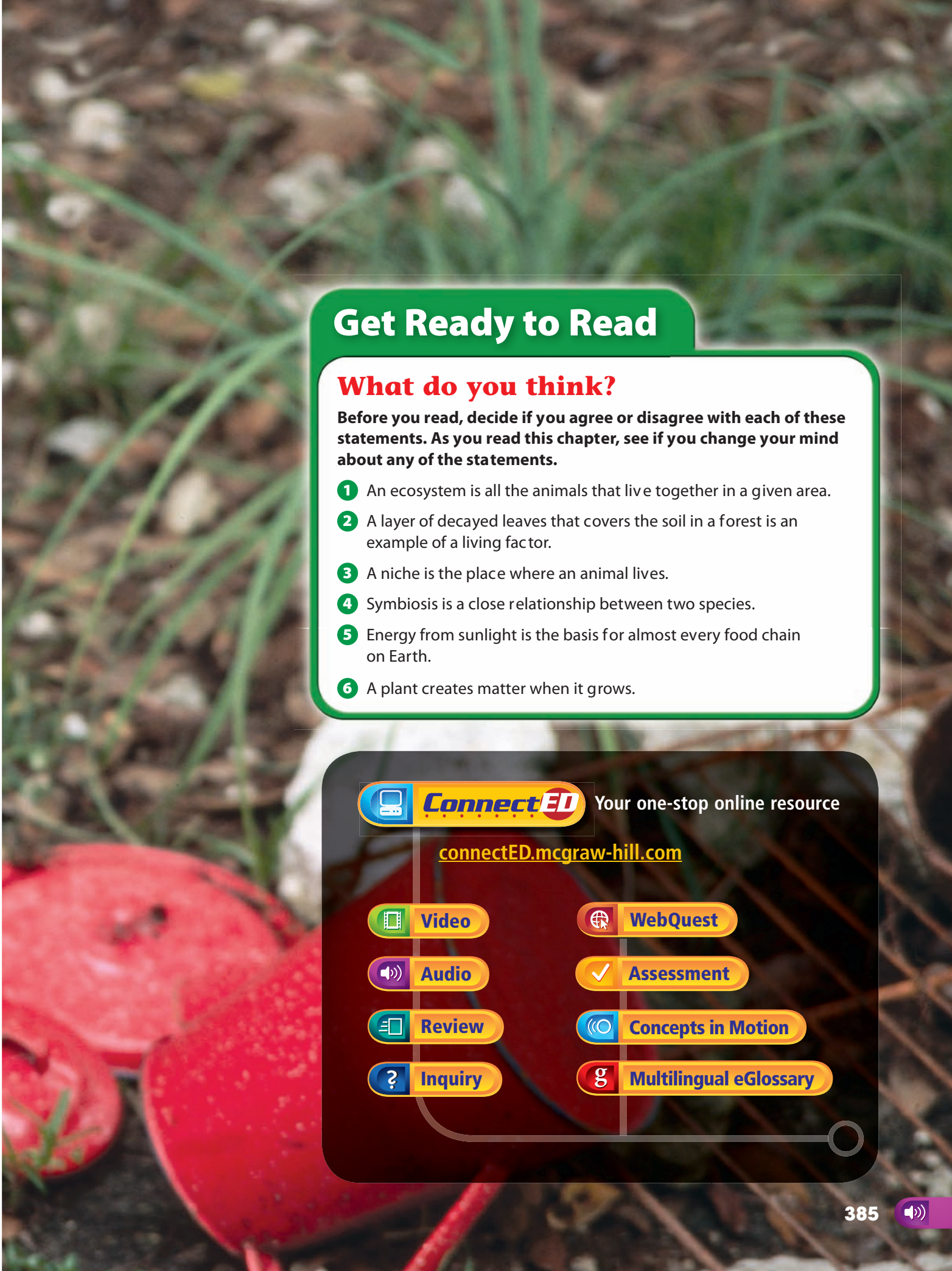
How do living things interact with each other and the environment?

Inquiry

What is it doing?

This raccoon has found its way into a campsite. While there, it might interact with humans in several ways, including taking food from the campsite or moving items, such as the cookware shown here.

- In what other ways might living things interact with humans?
- How do living things, such as this raccoon, interact with other living things and the environment?



Get Ready to Read

What do you think?

Before you read, decide if you agree or disagree with each of these statements. As you read this chapter, see if you change your mind about any of the statements.

1. An ecosystem is all the animals that live together in a given area.
2. A layer of decayed leaves that covers the soil in a forest is an example of a living factor.
3. A niche is the place where an animal lives.
4. Symbiosis is a close relationship between two species.
5. Energy from sunlight is the basis for almost every food chain on Earth.
6. A plant creates matter when it grows.

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Lesson 1

Ecosystems

Reading Guide

Key Concepts
ESSENTIAL QUESTIONS

- How can you describe an ecosystem?
- What are the similarities and differences between the abiotic and biotic parts of an ecosystem?
- In what ways can populations change?

Vocabulary

ecosystem p. 387
abiotic factor p. 388
biotic factor p. 389
habitat p. 390
population p. 391
community p. 391
population density p. 392

Multilingual eGlossary

Video BrainPOP®

Inquiry What lives here?

Look at all the organisms in this picture. This coastal reef provides a place for many organisms to live. How do you think each of these organisms survives? How do you think they interact with each other and the environment?

Launch Lab

10 minutes

What is an environment?

Earth contains many different environments. What makes these environments different?

1. Select a **postcard** from the ones provided. Look at the picture of the location on it.
2. Plan a vacation to the location on your postcard. In your Science Journal, describe the type of transportation you will need to use to get there, the clothing and other accessories you will need to pack, and the types of activities you will participate in at the location.
3. Write a note to a friend describing the environment that you might visit on your vacation. Describe the living and nonliving things you might find.

Think About This

1. How is your vacation environment different from the one where you live?
2. What types of living organisms will you see in your vacation environment? How are these organisms suited to this environment? What organisms are not suited to your vacation environment? Explain.
3. **Key Concept** What are the different ways you can describe the environment of your vacation spot?

What is an ecosystem?

Imagine that you are visiting a park. You sit on the grass in the warm sunshine. You watch a squirrel run down a tree trunk and chew an acorn. A robin pulls an earthworm from the soil. Traveling in a line, ants carry bits of dead insects to their underground nest. A breeze blows dandelion seeds through the air. These interactions are just a few of the many that can happen in an ecosystem, such as the park shown in **Figure 1.** *An* **ecosystem** *is all the living things and nonliving things in a given area.*

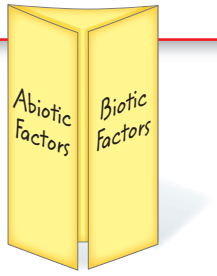
There are many kinds of ecosystems on Earth, including forests, deserts, grasslands, rivers, beaches, and coral reefs. Ecosystems that have similar climates and contain similar types of plants are grouped together into biomes. For example, the tropical rain forest biome includes ecosystems full of lush plant growth located near the equator in places where rainfall averages 200 cm per year and the temperature averages 25°C.

Key Concept Check How can you describe an ecosystem?

Figure 1 Ecosystems include the interactions among organisms and their environment.

FOLDABLES®

Make a vertical shutter-fold book. Label it as shown. Use it to organize your notes about abiotic and biotic factors.



REVIEW VOCABULARY

atmosphere
the whole mass of air surrounding Earth

Abiotic Factors

The nonliving parts of an ecosystem are called **abiotic factors.** They include sunlight, temperature, air, water, and soil. Abiotic factors provide many of the resources organisms need for survival and reproduction.

Sunlight and Temperature Sunlight is essential for almost all life on Earth. It supplies the energy for photosynthesis—the chemical reactions that produce sugars and occur in most plants and some bacteria and protists.

Sunlight also provides warmth. An ecosystem's temperature depends in part on the amount of sunlight it receives. In some ecosystems, such as the hot, dry desert shown in **Figure 2,** temperatures can be around 49°C during the day and below freezing at night.

Atmosphere The gases in Earth's **atmosphere** include nitrogen, oxygen, and carbon dioxide. Nitrogen is needed for plant growth. Some bacteria in the soil take nitrogen from the air and convert it to a form that plants can use. Oxygen is needed by most organisms for cellular respiration—the process that releases energy in cells. Air also contains carbon dioxide that is needed for photosynthesis.

Figure 2 Abiotic factors in an ecosystem determine what kinds of organisms can live there.

Desert life is limited to organisms that can survive with little water. Shade from plant life provides shelter from the heat of the Sun.

Stream life depends on a constant supply of water. Plants along stream banks provide shelter and food for hundreds of species.

Water Without water, life would not be possible. Water is required for all the life processes that take place inside cells, including cellular respiration, digestion, and photosynthesis. The stream ecosystem shown in **Figure 2** can support many forms of life because water is plentiful. Areas with very little water support fewer organisms.

Soil If you ever have planted a garden, you might know about the importance of soil for healthy plants. Soil contains a mixture of living and nonliving things. The biotic part of soil is humus (HEW mus)—the decayed remains of plants, animals, bacteria, and other organisms. Deserts have thin soil with little humus. Forest soils usually are thick and fertile, with a higher humus content. Abiotic factors include minerals and particles of rock, sand, and clay. Many animals, including gophers, insects, and earthworms, such as those shown in **Figure 3,** make their homes in soil. Their tunnels help move water and air through the soil.

Biotic Factors

Living or once-living things in an ecosystem are called **biotic factors.** They include all living organisms—from the smallest bacterium (plural, bacteria) to the largest redwood tree. Biotic factors also include the remains of dead organisms, such as fallen leaves or decayed plant matter in soil.

Species are adapted to the abiotic and biotic factors of the ecosystems in which they live. Algae, fungi, and mosses live in moist ecosystems such as forests, ponds, and oceans. Many cactus species can survive in a desert because they have thick stems that can hold stored water. Gophers live in burrows underground. They have large front claws for digging and strong teeth for loosening soil and chewing plant roots.

Key Concept Check What are the similarities and differences between abiotic and biotic factors?

Figure 3 Plant roots and soil-dwelling organisms need oxygen and water. Gophers, earthworms, and insects loosen the soil. This helps move air and water through soil.

WORD ORIGIN

biotic
from Greek *bios,* means "life"

Inquiry MiniLab — 20 minutes

How do you describe an ecosystem?

An ecosystem can be a small area or a very large environment. What makes up the ecosystem around your school yard?

1. Read and complete a lab safety form.
2. Walk around the outside of your school. Note the general appearance of your ecosystem.

3. In your Science Journal, list the abiotic factors you find around your ecosystem. Describe as many of the abiotic factors, in as much detail, as you can.
4. List and describe the biotic factors in your ecosystem. Examine the soil and the ground area closely for smaller organisms.
5. In your Science Journal, illustrate your ecosystem.

Analyze and Conclude

1. **Summarize** the interactions that occur between biotic and abiotic factors within your ecosystem.
2. **Define** the populations within your ecosystem.
3. **Describe** the community that inhabits your ecosystem.
4. **Key Concept** Diagram your ecosystem in terms of populations, community, and abiotic factors.

Habitats

Every organism in an ecosystem has its own place to live. *A* **habitat** *is the place within an ecosystem that provides food, water, shelter, and other biotic and abiotic factors an organism needs to survive and reproduce.*

Organisms have a variety of habitats. For example, house martins such as the ones shown in **Figure 4** sometimes live in meadows or grasslands, but these birds have found a habitat under the eaves of a building. Crickets live in damp, dark places with plenty of plant material and fungi to eat. Skunks live in areas where they can find food such as mice, insects, eggs, and fruit. During the day, skunks take shelter near their food supply—in hollow logs, under brush piles, and underneath buildings.

Plants have their own habitats, too. You have read that cacti live in desert habitats. The wood sorrel is a plant species that grows in deep shade beneath redwood trees.

When biotic or abiotic factors in an ecosystem change, habitats can change or disappear. A wildfire quickly can destroy the habitats of thousands of animals that live in forests or grasslands. Erosion or flooding can wash away soil, destroying plant habitats.

Reading Check What is a habitat?

Figure 4 An organism's habitat provides shelter, food, and all the other resources it needs for survival.

Populations

Every ecosystem includes many individuals of many species. *A* **population** *is all the organisms of the same species that live in the same area at the same time.* For example, all the dandelions growing in a vacant lot form a population. All the ants in the vacant lot make up another population. *All the populations living in the same area at the same time form a* **community.** As shown in **Figure 5,** a vacant-lot community might include populations of grasses, dandelions, spiders, ants, and pigeons. A community combined with all the abiotic factors in the same area forms an ecosystem. The populations that make up the community interact in the ecosystem.

Figure 5 The community living in this vacant lot includes populations of dandelions, grasses, ants, spiders, and pigeons.

Visual Check What abiotic factors are included in this ecosystem?

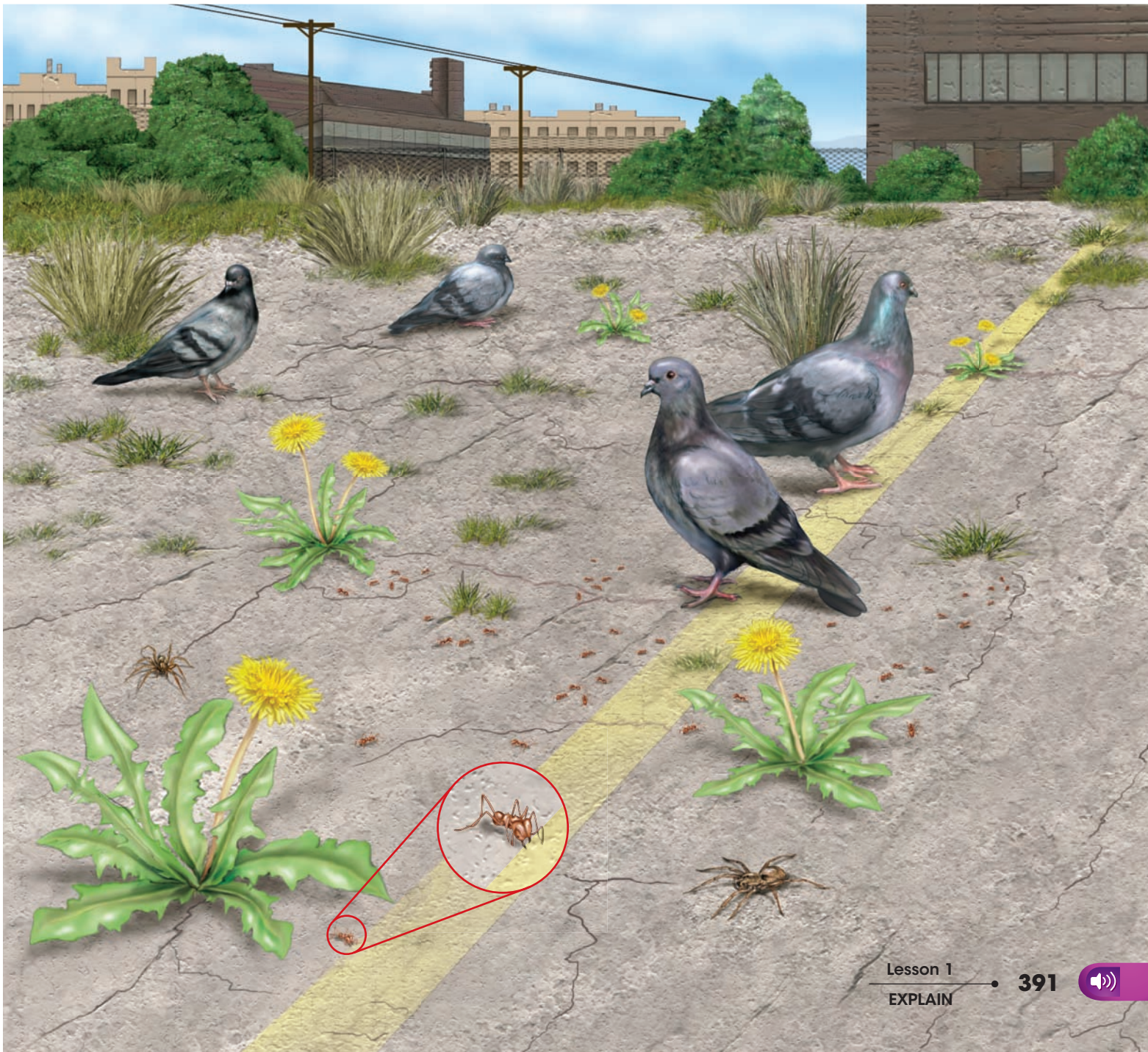


Figure 6 Guppies are easy to care for, but overcrowding can lead to disease.

Math Skills

Use a Formula

A formula shows the relationship among several factors. The formula for population density determines the number of individuals in a unit area or a volume of space. Population density = **number of individuals** / **unit area or volume of space**. For example, what is the population density of insects if **140 insects** are found in a patch of ground measuring **3.0 m^2**?

1. Replace the terms in the equation with the given values.

   $$\text{Population density} = \frac{\text{140 insects}}{\text{3.0 } m^2}$$

2. Solve the problem.

   $$\frac{\text{140 insects}}{\text{3.0 } m^2} = \frac{\text{46.6 insects}}{m^2}$$

3. Round the answer to significant figures.

   $$\frac{\text{46.6 insects}}{m^2} = \frac{\text{47 insects}}{m^2}$$

Practice

There are 20 small tropical fish swimming in a 55-gallon aquarium. What is the population density?

Review

- Math Practice
- Personal Tutor

Population Density

Suppose your classroom has an aquarium like the one shown in **Figure 6.** It contains guppies, water ferns, and a few algae-eating snails. Keeping your aquarium community healthy includes cleaning the tank and feeding the fish. However, it also means making sure the fish don't get overcrowded. Overcrowding can lead to stress and disease.

How can you determine if the aquarium contains too many fish? You could calculate the population density. **Population density** *is the size of a population compared to the amount of space available.* It can be calculated using the following formula:

$$\text{Population density} = \frac{\text{number of individuals}}{\text{unit area or volume of space}}$$

An aquarium expert has recommended that you keep no more than 10 guppies in your 20-gallon aquarium. Using the formula, you can calculate the population density:

$$\text{0.5 fish per gallon} = \frac{\text{10 fish}}{\text{20 gallons}}$$

When population density is high, organisms live closer together and might not be able to obtain all the resources needed for life. Diseases also spread more easily when organisms are forced to live too close together.

Reading Check How does population density affect organisms?

Population Change

On a hike one summer, you notice a few wild sunflowers growing among grasses in an abandoned field. Two years later you return and find the field completely covered with sunflowers. What caused the population to increase? Each sunflower plant produces hundreds of seeds. Even if only a few of the seeds from each plant sprout and grow, the number of sunflowers will increase. If a drought prevents seeds from sprouting or if a farmer plants the field with corn, soybeans, or another crop, the sunflower population will decrease.

Most populations change over time. Production of offspring increases the size of a population. The death of individuals reduces population size. If births outnumber deaths, the population grows.

Changes in the abiotic or biotic factors in an ecosystem can cause organisms to move away or die out. For example, if there is a forest fire, birds, deer, and other fast-moving animals can escape to another area. Others, such as the mountain beaver in **Figure 7,** could die out.

Key Concept Check In what ways can populations change?

Mountain beaver

Figure 7 Before fire swept through this forest ecosystem, it provided a habitat for about 5,000 mountain beavers. Fewer than 100 beavers survived the fire, but their habitat slowly grew back and the mountain beaver population increased again.

Lesson 1 Review

Assessment Online Quiz

Visual Summary

Abiotic factors include sunlight, temperature, air, water, and soil.

Many organisms often share the same habitat.

Population density can affect the health of a population.

FOLDABLES®

Use your lesson Foldable to review the lesson. Save your Foldable for the project at the end of the chapter.

What do you think NOW?

You first read the statements below at the beginning of the chapter.

1. An ecosystem is all the animals that live together in a given area.
2. A layer of decayed leaves that covers the soil in a forest is an example of a living factor.

Did you change your mind about whether you agree or disagree with the statements? Rewrite any false statements to make them true.

Use Vocabulary

1. **Define** *ecosystem* in your own words.
2. **Distinguish** between a population and a community.
3. An organism lives in a(n) _____.

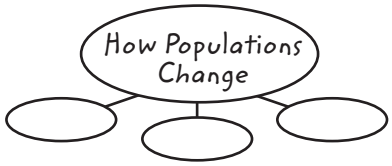
Understand Key Concepts

4. Air is an example of a(n)
   - **A.** community.
   - **B.** habitat.
   - **C.** abiotic factor.
   - **D.** biotic factor.
5. **Explain** why soil is considered both an abiotic and a biotic factor.

Interpret Graphics

6. **Classify** factors in the desert ecosystem shown at right as abiotic or biotic.

7. **Summarize Information** Copy the graphic organizer below and fill in the ways in which populations can change.



Critical Thinking

8. **Analyze** All organisms need living space to survive. Would you consider living space to be a biotic factor, an abiotic factor, or both? Explain your answer.

Math Skills

Review Math Practice

9. There are four foxes in 10 km^2 of a forest.
   - **a.** What is the population density?
   - **b.** How many foxes would you expect to find in 50 km^2?

What can analyzing data reveal about predator-prey populations?

Predators are organisms that hunt and kill other organisms, their prey, for food. You might think this means that predators control population size in an ecosystem. In reality, predators and their prey affect each other. You can observe this relationship by analyzing population data.

Learn It

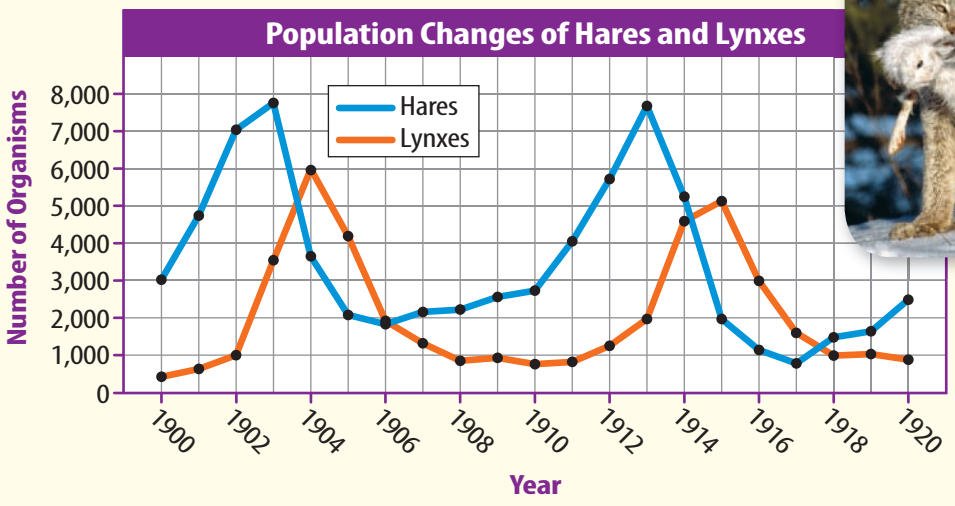
Scientists make observations to learn about the world. However, scientists rely on data as a means to present explanations and prove hypotheses. They can **analyze data** from the results and form conclusions. Unlike general observations, collecting data is effective because data are less likely to be distorted by chance or misinterpretation.

Try It

1. Observe the data table showing the populations of hares and lynxes in an ecosystem. Note that the data show the changes that occur in the numbers of both populations over time.
2. Examine the blue line that represents the population levels of hares in the ecosystem. Note any patterns in the graph.
3. Examine the orange line that represents the population levels of lynxes in the ecosystem. Note any patterns in the graph.
4. Describe the patterns of the two population lines in relation to each other.

Apply It

5. **Explain** which population is the predator and which is the prey.
6. **Describe** the patterns you note in the individual population levels of the hares and the lynxes.
7. **Describe** the patterns you notice in the relationship between both populations. What might have caused these patterns?
8. **Infer** why there is a time lag between similar patterns in both populations.
9. **Key Concept** Use the information from this graph and infer what causes the changes in both populations. Use this information to describe the relationship that each population has with the other.



Lesson 2

Relationships Within Ecosystems

Reading Guide

Key Concepts
ESSENTIAL QUESTIONS

- How does a niche differ from a habitat?
- In what ways can organisms interact in an ecosystem?

Vocabulary

niche p. 397
competition p. 398
overpopulation p. 399
predation p. 400
symbiosis p. 401
mutualism p. 401
commensalism p. 401
parasitism p. 401

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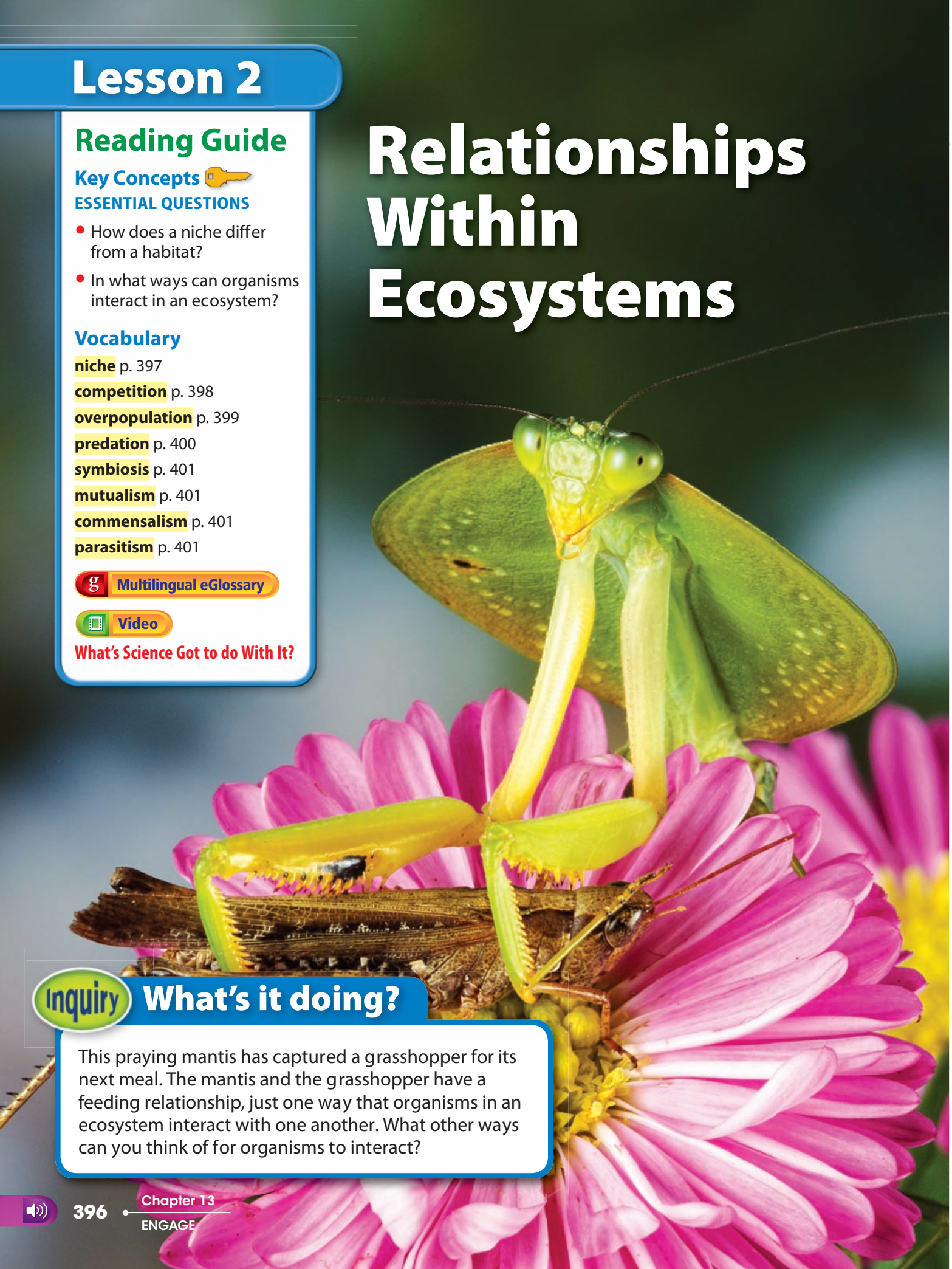
Video

What's Science Got to do With It?



Inquiry What's it doing?

This praying mantis has captured a grasshopper for its next meal. The mantis and the grasshopper have a feeding relationship, just one way that organisms in an ecosystem interact with one another. What other ways can you think of for organisms to interact?

Launch Lab

10 minutes

How do organisms help plants grow?

Different organisms often rely on other organisms to survive. One such relationship exists between types of fungi and plants. The fungi live on the roots of plants and help them obtain water and minerals. In return, the plants supply the fungi with nutrients.

1. Examine the photograph of plant roots. The roots on the right have had a beneficial fungus added to them. The roots on the left were grown in sterilized soil. Record your observations in your Science Journal.

Think About This

1. What difference do you note in the plant roots grown with a fungus added to the soil compared to the plant roots grown in sterile soil?
2. Which plants do you think might grow larger or faster?
3. **Key Concept** How do you think the relationship between these organisms helps them use the resources in their environment?

Niches

Recall that a habitat is the area within an ecosystem that provides an organism with the resources it needs for life. Most organisms don't have a habitat all to themselves. A habitat usually is shared by many species.

Hundreds of species share the coral reef habitat shown in **Figure 8.** Spiny lobsters hide under the coral. They come out at night and feed on worms, shrimp, clams, and dead fish. Angelfish have rough teeth for scraping sponges and sea squirts from the surface of the coral. Filefish scrape algae from the coral to eat.

Each species that shares a habitat has a separate niche. *A* **niche** (NICH) *is the way a species interacts with abiotic and biotic factors to obtain food, find shelter, and fulfill other needs.* Species share habitats, but no two species share the same niche. For example, two species of crabs on a reef might share a habitat, but one might eat algae and the other might eat snails.

Key Concept Check How does a niche differ from a habitat?

Figure 8 Many organisms, such as the ones that live in this coral reef, share the same habitat.

Figure 9 Organisms in the same area sometimes compete for the same resources.

Competition

In springtime, robins find mates, build nests, and raise their young. A male robin chooses a safe nesting site with plenty of food and water nearby. It sings to attract a female and to keep other males away. If another male comes too close to its territory, it chases its competitor away.

Competition *describes the demand for resources, such as food, water, and shelter, in short supply in a community.* Competition can take place among the members of a population or between populations of different species. The plants shown in **Figure 9** are competing for nutrients and living space.

Competition helps limit population size. If a community has too many robins and too few nesting sites, competition for these sites increases, and some robins will leave the area. The availability of nesting sites limits the size of the robin population.

Reading Check What is competition?

Inquiry **MiniLab** 10 minutes

How does competition affect the growth of radish plants?

All living things must obtain resources in order to survive. In any environment, there is a limited amount of resources available. How does the number of organisms in an environment affect the ability of a specific organism, such as a plant, to obtain the resources it needs?

1. Read and complete a lab safety form.
2. Fill one **small planting pot** with **potting soil.** Place five **radish seeds** on the surface, and cover the seeds with a thin layer of potting soil. Water the soil so that it is damp.
3. Fill a second small planting pot with potting soil. Add a small patch of **sod** to the surface of the soil. Place five radish seeds along the surface of the sod and cover the seeds with a thin layer of potting soil. Water the soil so that it is damp.
4. Continue to water and observe the two pots for several days. Note any observations in your Science Journal.

Analyze and Conclude

1. **Compare and contrast** the number and size of radish seedlings in both pots after several days.
2. **Key Concept** Infer how competition between plant species affects the growth of all plants in an environment.

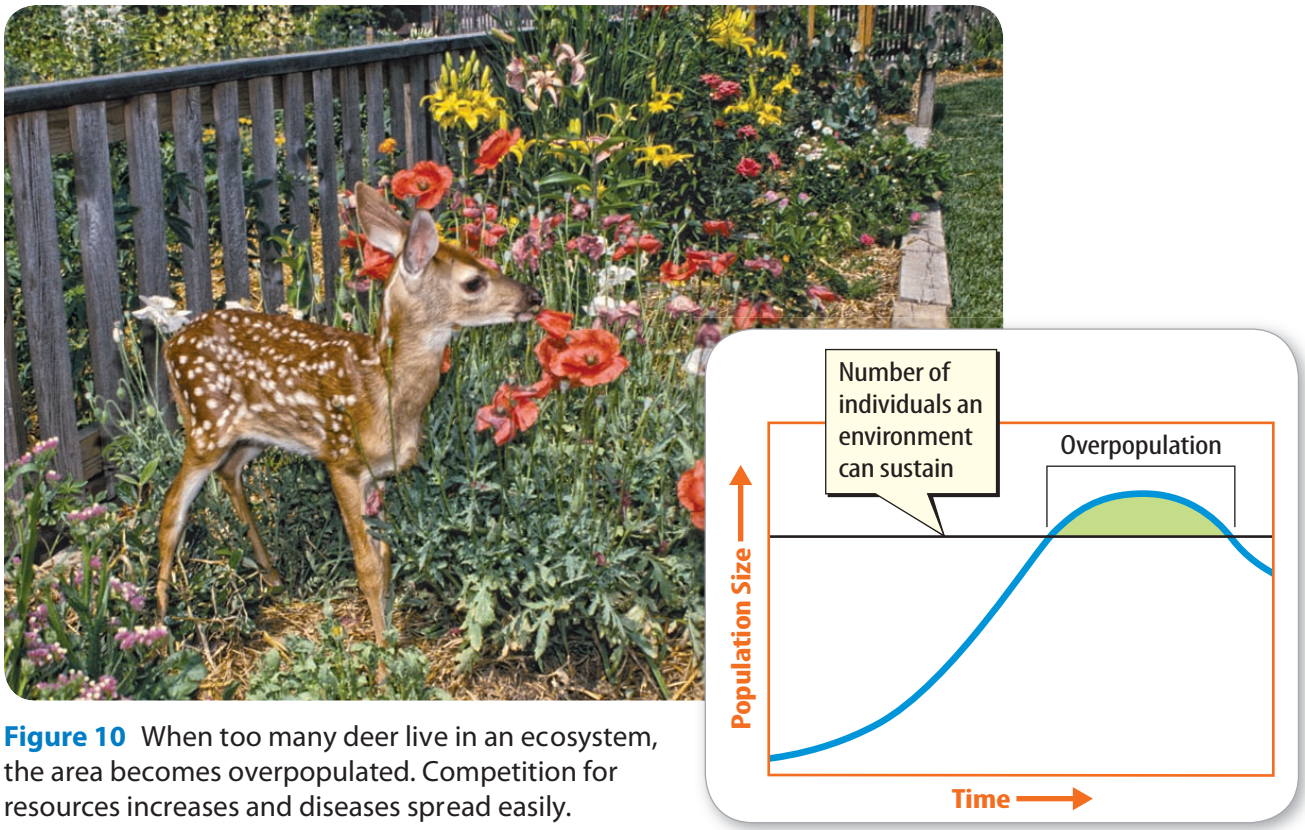


Figure 10 When too many deer live in an ecosystem, the area becomes overpopulated. Competition for resources increases and diseases spread easily.

Visual Check How might this deer affect this garden?

Overpopulation

White-tailed deer live near the edges of forests and meadows. They eat leaves, twigs, acorns, and fruit. Deer populations in some areas have become so large that they harm forest habitats, destroy crops, and even invade home gardens. **Overpopulation** *occurs when a population becomes so large that it causes damage to the environment.*

When too many deer live in an ecosystem, they eat plants at a faster rate than the plants can grow back. This reduces the available habitat for the deer and other species. The deer, as well as other organisms in the area, must compete for a limited amount of resources. Sometimes the deer move into areas where they are not normally found, such as the deer pictured in a home garden in **Figure 10.** If there is nowhere for deer to move, they are forced to live too close together. Disease can spread easily within populations when this happens.

Overpopulation is temporary. When food and other resources eventually run out, some animals will move elsewhere, starve, or die from disease. Then the population quickly shrinks, as shown in the graph in **Figure 10.** This allows the resources in the environment to slowly return to normal.

Reading Check Why is overpopulation temporary?

▲ **Figure 11** When humans build roads through an ecosystem, animals face new dangers.

Competing with Humans

Humans need some of the same biotic and abiotic factors as other organisms, including food, living space, and water. To meet these needs, people take certain actions. They plow grasslands to plant food crops. People clear forests and fill in wetlands to make room for roads and buildings. They divert water from lakes and streams to supply irrigation for crops and drinking water for cities and towns. Actions such as these put humans in competition with other species for the same resources.

You might have heard news reports about raccoons raiding garbage cans, snakes living under houses, or squirrels moving into attics. Natural habitats for these and other organisms are disrupted when humans replace natural environments with homes and other structures. As shown in **Figure 11,** roads can make it dangerous for animals to move safely from one part of their habitat to another.

Sometimes humans compete with other organisms in less-obvious ways. The North American population of monarch butterflies spends the winter in small forested areas in Mexico. Logging by humans endangers the monarch population. Without enough trees to live in, many monarchs do not survive for the return trip north in spring.

Predation

A predator is an organism that hunts and kills other organisms for food. Prey are the organisms hunted or eaten by a predator. **Predation** *is the act of one organism, a predator, feeding on another organism, its prey,* as shown in **Figure 12.** Predator and prey populations influence each other, as you learned in the Skill Practice lab. Predators help control the size of prey populations. When prey populations decrease, the number of predators usually decreases because less food is available.

Figure 12 In the relationship pictured here, the dragonfly is the predator and the fly is the prey. ▶

Symbiosis

Competition and predation are two types of interactions that take place between organisms in an ecosystem. Another type of interaction that occurs is called symbiosis (sim bee OH sus). **Symbiosis** *is a close, long-term relationship between two species that usually involves an exchange of food or energy.* Examples of the three types of symbiosis are shown in **Figure 13.**

A symbiotic relationship in which both organisms benefit is **mutualism.** For example, fish benefit by having tiny organisms removed from their bodies by cleaner shrimp, and cleaner shrimp benefit by getting food. *A symbiotic relationship in which one organism benefits but the other neither benefits nor is harmed is* **commensalism.** Clumps of moss growing on the bark of a tree is an example of a commensal relationship. The moss benefits by having somewhere to grow, and the tree is neither benefited nor harmed. *A symbiotic relationship in which one organism benefits while the other is harmed is* **parasitism.** The organism that benefits is a parasite. For example, a parasitic wasp lays its eggs in a caterpillar's body. When the eggs hatch, the larvae develop and eventually chew their way out of the caterpillar and kill it. The organism that is harmed is the host, in this case the caterpillar that was attacked by the wasp.

Key Concept Check In what ways can organisms interact in an ecosystem?

WORD ORIGIN

symbiosis
from Greek *symbios,* means "living together"

FOLDABLES®

Make a horizontal three-tab concept map book. Label it as shown. Use it to organize your notes on symbiotic relationships.

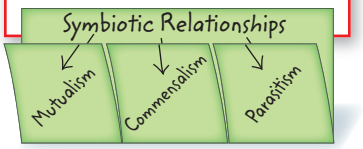
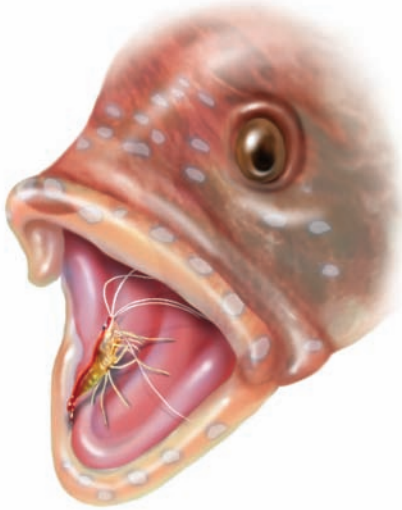


Figure 13 The three types of symbiosis are mutualism, commensalism, and parasitism.

Mutualism



Commensalism

Parasitism

Lesson 2 Review

Assessment Online Quiz

Visual Summary

Each species that shares a habitat has a separate niche.

Overpopulation occurs when a population becomes so large that it causes damage to the environment.

Symbiosis usually involves obtaining energy.

FOLDABLES®

Use your lesson Foldable to review the lesson. Save your Foldable for the project at the end of the chapter.

What do you think NOW?

You first read the statements below at the beginning of the chapter.

3. A niche is the place where an animal lives.

4. Symbiosis is a close relationship between two species.

Did you change your mind about whether you agree or disagree with the statements? Rewrite any false statements to make them true.

Use Vocabulary

1. **Define** *competition* in your own words.
2. **Distinguish** between predation and symbiosis.
3. **Distinguish** between commensalism and parasitism.

Understand Key Concepts

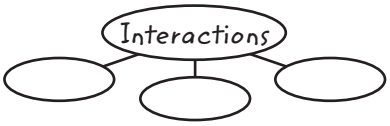
4. Which is a symbiotic relationship in which both organisms benefit?

   A. commensalism **C.** parasitism
   B. mutualism **D.** predation

5. **Compare and contrast** a habitat and a niche.
6. **List** two ways in which human populations compete with populations of other species.

Interpret Graphics

7. **Organize** Copy and fill in the graphic organizer below. In each oval, list the types of interactions that can take place among organisms in an ecosystem.



8. **Describe** the relationship that the organisms shown at right have with each other.

Critical Thinking

9. **Analyze** Some biologists consider predation to be a kind of symbiosis. Explain why you agree or disagree.
10. **Apply** A mite species lives on the bodies of bees. The mites help keep beehives clear of fungus. The bees provide the mites with a place to live. What kind of relationship is this? Explain your reasoning.

GREEN SCIENCE

Purple Loosestrife: An Invasive Plant Species

Stamping Out the Purple Plague

Wetlands, such as swamps and marshes, are important ecosystems. These soggy areas control flooding, affect the flow of rivers, and filter pollution from water. They also are home to a diversity of wildlife, such as birds, fish, mammals, and plants. But not every species in a wetland is native to the habitat. In North America, one invasive species in particular has caused trouble for many wetland ecosystems.

In the early 1800s, European ships brought a hardy plant to America's shores—purple loosestrife. Settlers used it as a medicinal herb to treat digestive problems, such as diarrhea and ulcers. Before long, the tall plant with reddish-purple flowers was growing in wetlands across the United States.

The fast-growing plant is devastating for wetlands. Its thick roots crowd out native plants that provide food, shelter, and nesting sites for many animal species. Loosestrife also can disrupt the flow of water to rivers and canals and clog irrigation systems. The effect of loosestrife on biodiversity and local communities is so harmful that the plants have become known as the purple plague.

Scientists have tried many ways of controlling purple loosestrife, including plant-eating animals, bacteria, and herbicides. Cutting down the plants doesn't work because new plants sprout from even tiny pieces of root left in the soil. The best solution to date has been the introduction of organisms that eat purple loosestrife. Scientists have identified five species of beetles that eat purple loosestrife in its native range in Europe. These beetles do not harm other North American plants, so they have been released into the wetlands. Since 1996, the insects have successfully controlled the spread of purple loosestrife in many regions.

Scientists release leaf-eating beetles such as this one into a wetland invaded by purple loosestrife. ▼

▲ A sea of purple loosestrife overruns a wetland. It spreads quickly because one plant can produce up to three million seeds a year. The hardy seeds are scattered long distances by wind, water, animals, and even people.

It's Your Turn

RESEARCH AND REPORT Choose another invasive species. Describe how it was introduced into an ecosystem, its impact on the environment, and the steps taken to control it. Present your findings to the class.

Lesson 3

Matter and Energy in Ecosystems

Reading Guide

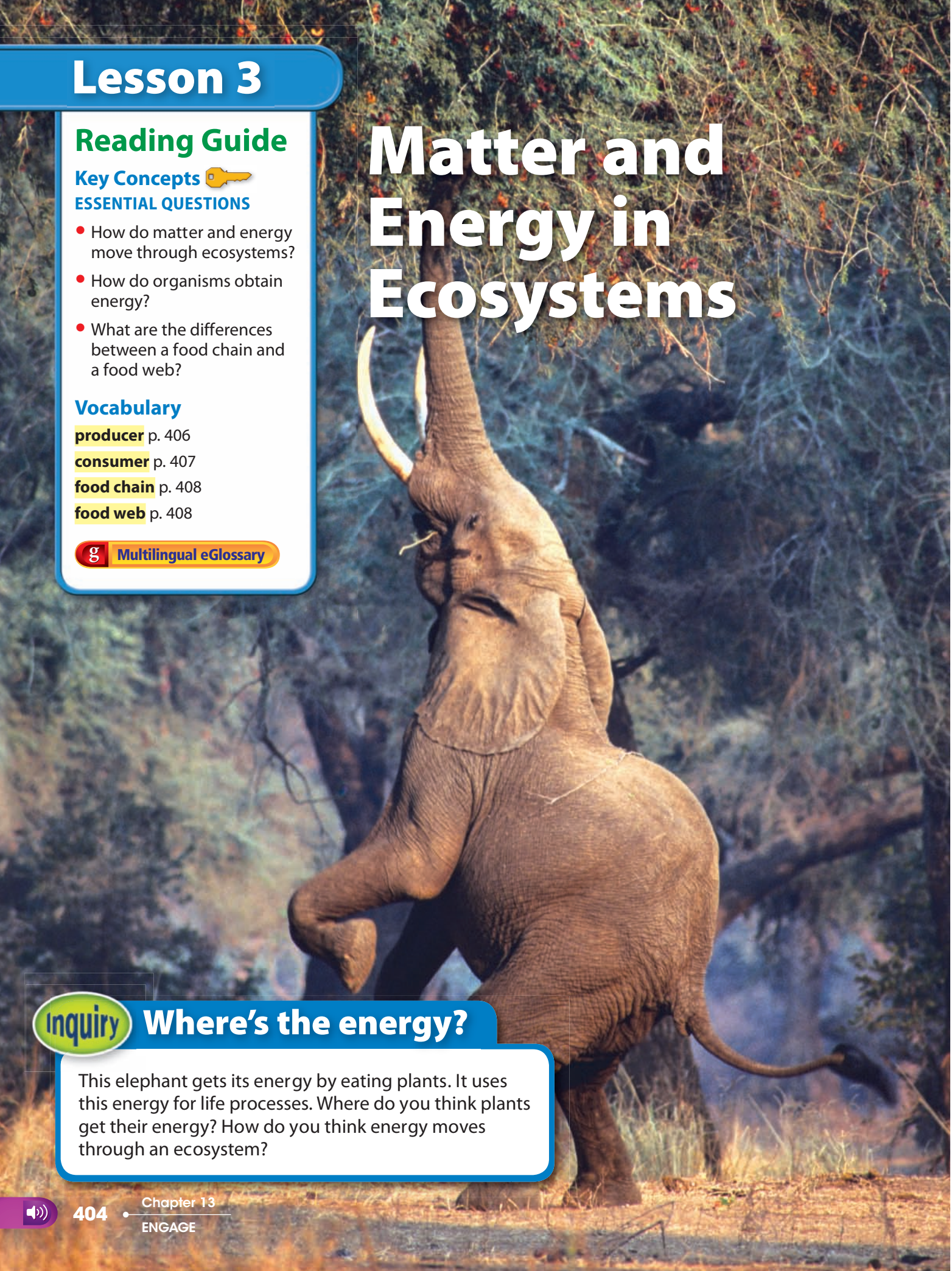
Key Concepts
ESSENTIAL QUESTIONS

- How do matter and energy move through ecosystems?
- How do organisms obtain energy?
- What are the differences between a food chain and a food web?

Vocabulary

producer p. 406
consumer p. 407
food chain p. 408
food web p. 408

Multilingual eGlossary



Inquiry Where's the energy?

This elephant gets its energy by eating plants. It uses this energy for life processes. Where do you think plants get their energy? How do you think energy moves through an ecosystem?

Launch Lab

15 minutes

Where does matter go?

Matter cannot be created or destroyed but is recycled. What happens to matter that seems to vanish?

1. Read and complete a lab safety form.
2. Half fill a small **paper cup** with water. Find the mass of the cup and water using a **balance,** and record it in your Science Journal**.**
3. Use the balance to find the mass of two **effervescent antacid tablets.** Add this mass to the mass from step 2 to find the total.
4. Add the tablets to the cup of water. After the reaction is complete, find and record the mass of the cup and its contents. Compare this to the total mass you calculated in step 3.
5. Find and record the mass of a **large self-sealing bag.** Repeat steps 2 and 3, but also add the mass of the bag to find total mass. Place the cup and tablets into the bag and seal it.
6. Holding the cup with one hand, pick up each tablet and drop it in the water.
7. After the reaction is complete, find the total mass.

Think About This

1. How did the mass compare between steps 3 and 4? Between steps 5 and 7?
2. **Key Concept** Where do you think the mass of the tablets went? What observation indicates that energy was involved?

Matter and Energy

A leaf drops to the ground. Over time, bacteria and fungi break apart the chemical bonds that hold together the atoms and the molecules of the leaf. This releases energy, water vapor, and other compounds. Carbon compounds and water molecules become part of the soil. When new seedlings grow in spring, these materials enter the seedlings.

Almost all of the matter on Earth today has been here since it formed. Matter can change form, but it cannot be created or destroyed. As shown in **Figure 14,** some matter cycles through ecosystems as organisms grow, die, and decompose.

Unlike matter, energy cannot be recycled. However, energy can be converted. The chemical energy in a log converts to thermal energy and light energy when it burns.

Key Concept Check How do matter and energy move through ecosystems?

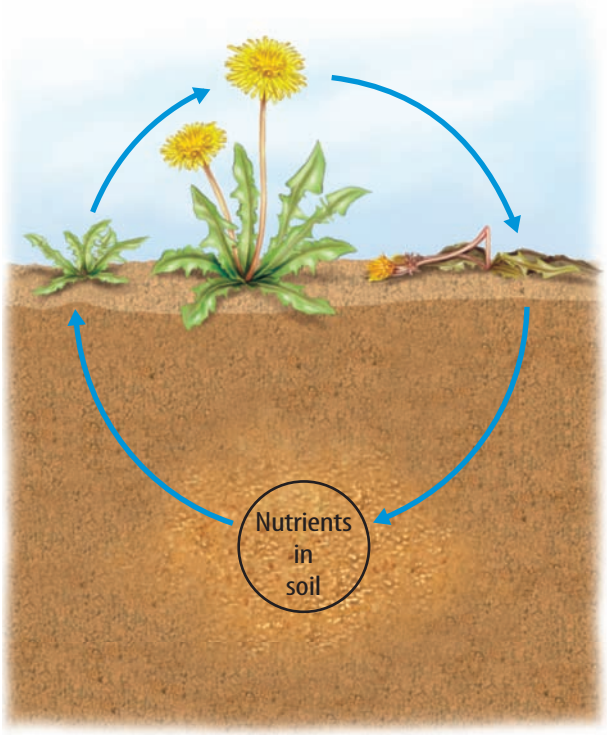


Figure 14 Matter cycles through an ecosystem as organisms grow, die, and decompose.

Obtaining Energy

When you eat a sandwich, your body gets atoms and molecules that it needs to make new cells and tissues. Your cells also get the energy they need to make proteins and carry out other life processes. All organisms need a constant supply of energy to maintain life. Where does that energy come from?

Producers

WORD ORIGIN
producer
from Latin *producere*, means "to lead or bring forth"

Most of the energy used by all organisms on Earth comes from the Sun. Photosynthesis is the process during which some organisms use carbon dioxide, water, and light energy, usually from the Sun, and make sugars. These sugars serve as food for living organisms.

Producers *are organisms that use an outside energy source, such as the Sun, and produce their own food.* The energy in food molecules is in the chemical bonds that hold the molecules together. During cellular respiration, these bonds break. This releases energy that fuels the producer's life processes. As shown in **Figure 15,** photosynthesis and cellular respiration occur throughout ecosystems.

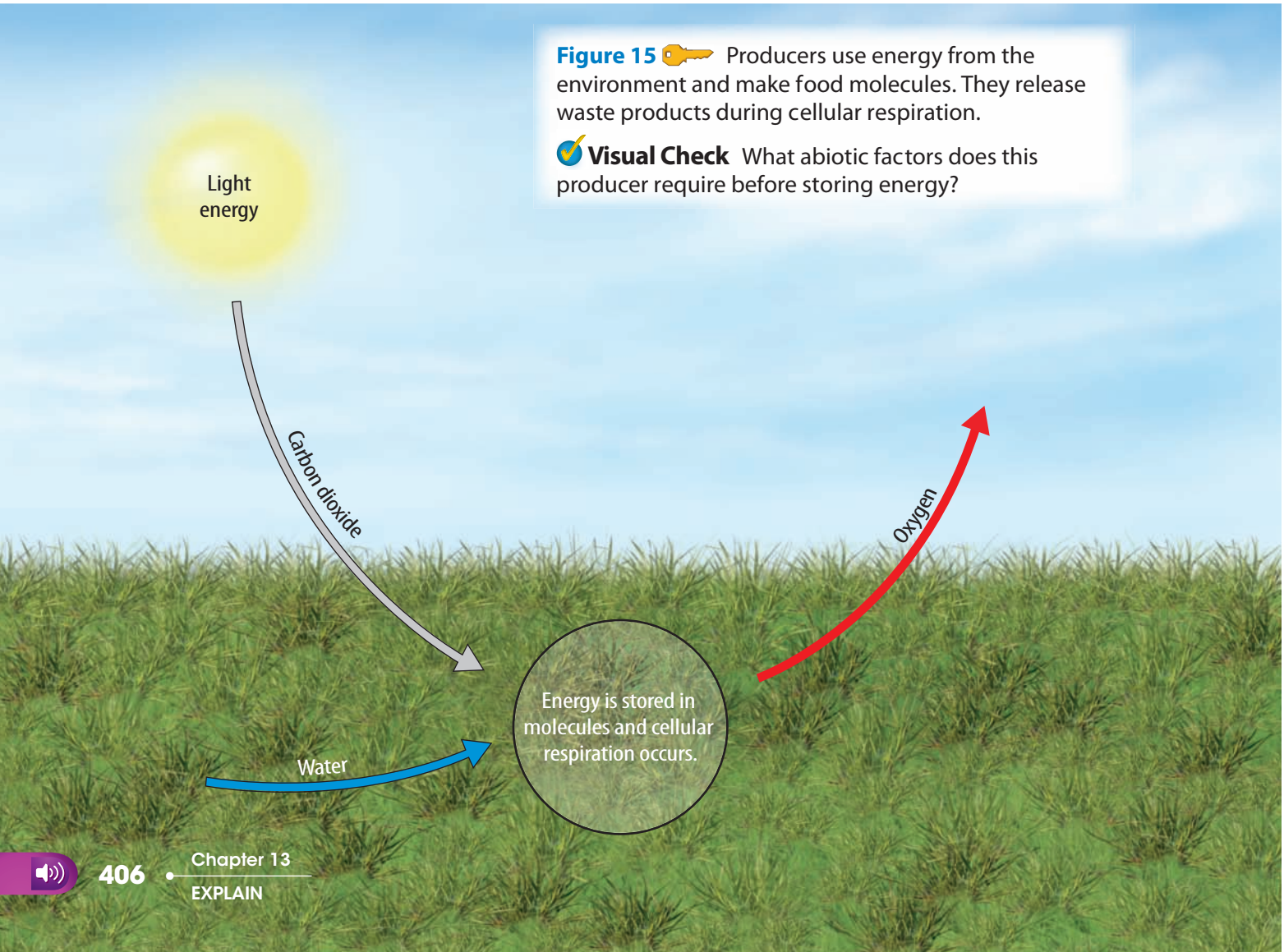


Figure 15 Producers use energy from the environment and make food molecules. They release waste products during cellular respiration.

Visual Check What abiotic factors does this producer require before storing energy?

Consumers

The energy-rich molecules formed by producers provide food for other organisms. **Consumers** *are organisms that cannot make their own food. Consumers obtain food by eating producers or other consumers.* Ecosystems include several different kinds of consumers, as shown in **Table 1.**

Table 1 Types of Consumers

	Herbivores eat only plants and other producers.
	Carnivores eat herbivores and other consumers.
	Omnivores eat producers and consumers.
	Decomposers break down dead organisms.

Herbivores eat plants and other producers. Examples of herbivores include snails, rabbits, deer, and bees. Carnivores eat herbivores and other consumers. Cats, snakes, hawks, frogs, and spiders are carnivores. Omnivores eat producers and consumers. Omnivores include bears, robins, pigs, rats, and humans. Decomposers break down the bodies of dead organisms into compounds that can be used by living organisms. Without decomposers, matter could not be recycled. Decomposers include fungi, bacteria, wood lice, termites, and earthworms.

Key Concept Check How do organisms obtain energy?

Inquiry **MiniLab** 10 minutes

How do decomposers recycle nutrients in an ecosystem?

Nutrients and other materials do not simply disappear when they are used in an ecosystem. Organisms called decomposers break down waste, and it can be used again. You can observe decomposition in action.

1. Read and complete a lab safety form.
2. Half fill a **glass jar** with **whole, steel-cut oats.**
3. Add two small wedges of **apple** to the contents of the jar.
4. Place 3–4 **mealworms** in the jar.
5. Cover the contents of the jar with **strips of paper.** ⚠ Do not put a lid on the jar or cover it with anything.

6. Observe the activity in the jar over several days.

Analyze and Conclude

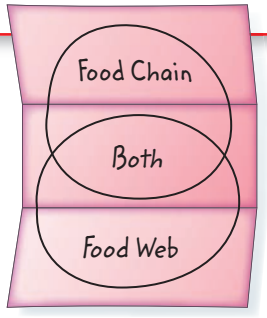
1. **Describe** what you observed in the jar over several days.
2. **Infer** what happened to the oats and the apple you placed in the jar.
3. **Key Concept** Analyze the importance of this activity to plants and other organisms present in an ecosystem. Predict what might result if this activity did not take place.

ACADEMIC VOCABULARY

transfer
(verb) to pass from one to another

FOLDABLES®

Make a vertical trifold Venn book. Label it as shown. Use it to compare and contrast the transfer of energy in a food chain and a food web.



Transferring Energy

Not only can energy be converted from one form to another, it also can be **transferred** from one organism to another. The transfer of energy takes place in an ecosystem when one organism eats another. Food chains and food webs are models used to describe these energy transfers.

Food Chains

A model that shows how energy flows in an ecosystem through feeding relationships is called a **food chain.** A food chain always begins with a producer because producers are the source of energy for the rest of the organisms in a community. Energy moves from a producer to consumers such as herbivores or omnivores, and then on to other omnivores, carnivores, or decomposers.

A simple food chain from a community of organisms living in a vacant lot might look like this:

Grass → Mouse → Cat

The arrows show the directions of the energy transfer.

Food Webs

Most ecosystems contain many food chains. *A* **food web** *is a model of energy transfer that can show how the food chains in a community are interconnected.* For example, in the food web shown in **Figure 16,** pigeons eat berries and insects. They are prey for hawks and cats.

Key Concept Check What are the differences between a food chain and a food web?

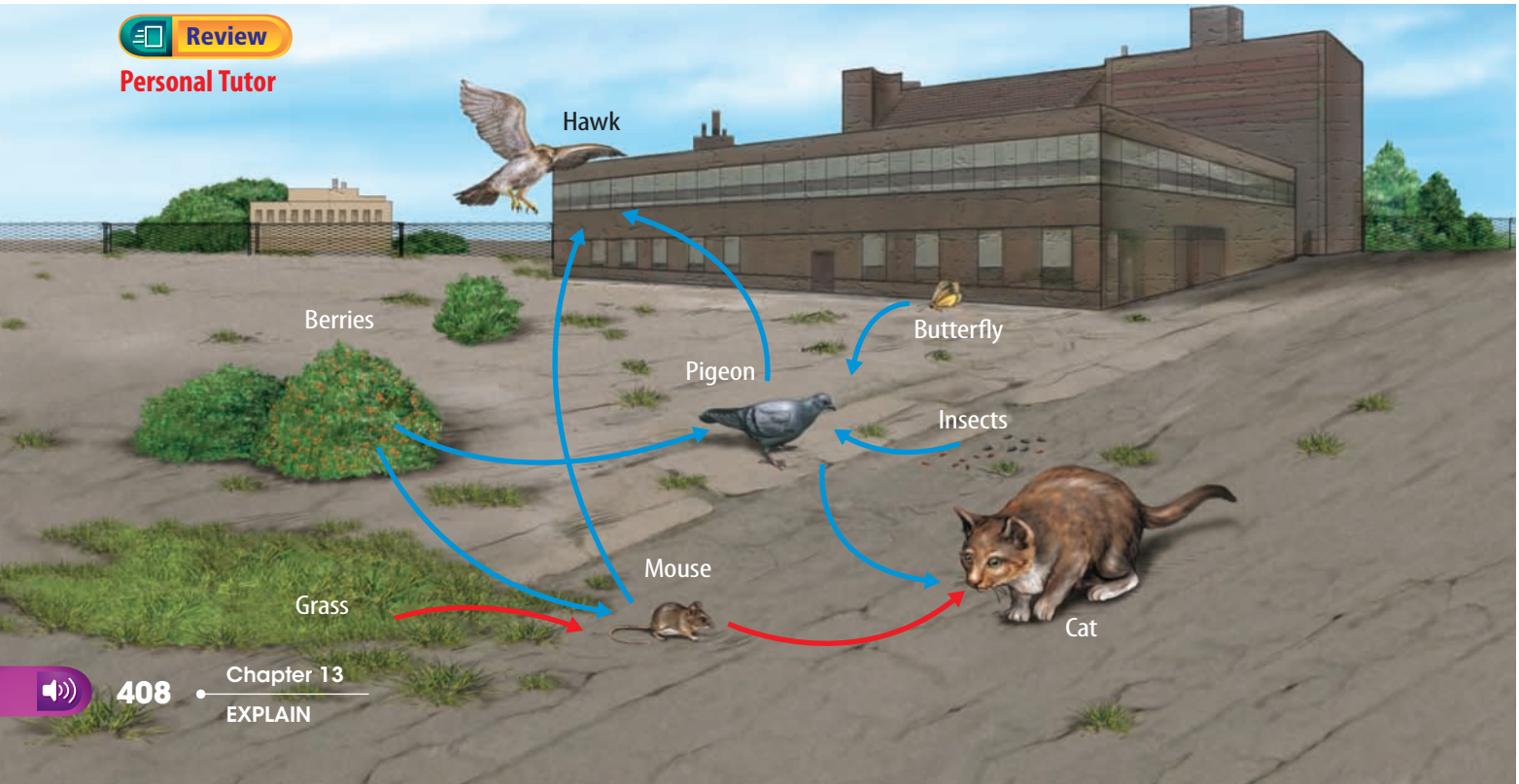


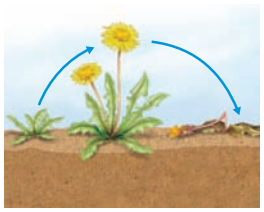
Figure 16 Avacant lot food web contains many food chains.

Lesson 3 Review

Assessment Online Quiz

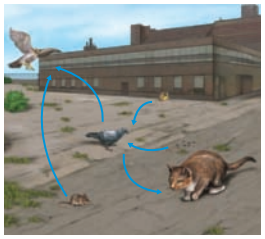
Inquiry Virtual Lab

Visual Summary



Matter cycles throughout an ecosystem.

Organisms obtain energy from the environment or by eating other organisms.



Many exchanges of energy occur among organisms in an ecosystem.

FOLDABLES®

Use your lesson Foldable to review the lesson. Save your Foldable for the project at the end of the chapter.

What do you think NOW?

You first read the statements below at the beginning of the chapter.

5. Energy from sunlight is the basis for almost every food chain on Earth.

6. Matter is created when a plant grows.

Did you change your mind about whether you agree or disagree with the statements? Rewrite any false statements to make them true.

Use Vocabulary

1. **Define** *producer* in your own words.
2. An organism that cannot make its own food is called a(n) _____.
3. **Define** *food chain* in your own words.

Understand Key Concepts

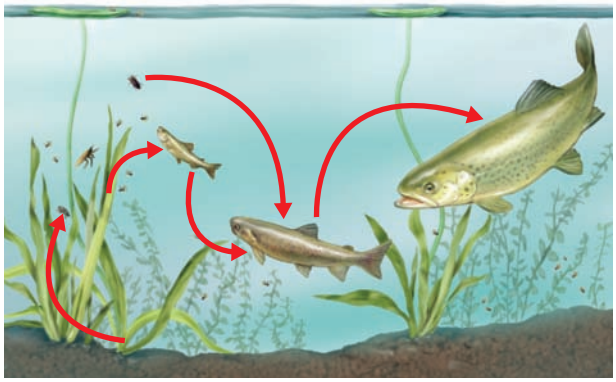
4. Which term describes a bacterium that uses light energy and makes energy-rich molecules?

   A. consumer **C.** herbivore
   B. decomposer **D.** producer

5. **Predict** why many species of orb-weaver spiders eat their old webs before spinning new ones.
6. **Distinguish** between a food chain and a food web.

Interpret Graphics

7. **List** the producers and the consumers in the food web shown below.



Critical Thinking

8. **Construct** a food chain that models energy transfer among the following organisms: an oak tree, a squirrel, and a hawk.
9. **Construct** a food web that includes bacteria, fungi, oak trees, deer, quail, crows, raccoons, foxes, hawks, and bobcats.

Inquiry **Lab**

3 class periods

Design an Ecosystem

Materials

5–10-gallon aquarium

assorted ecosystem materials

Safety

You have read about the connections between biotic and abiotic factors of an ecosystem and how they depend on each other. An ecosystem requires abiotic factors to support the organisms that inhabit it. In addition, the organisms of the ecosystem serve different roles. Some organisms are producers, some are consumers, and some are decomposers. In this lab, you will create an ecosystem with abiotic and biotic factors that function together. Then you will use your observations to analyze the role of each part of the ecosystem you assembled.

Ask a Question

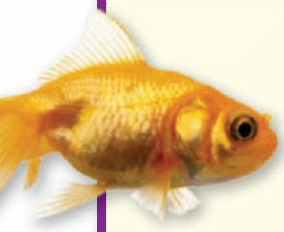
What biotic and abiotic factors can you assemble to create a functioning ecosystem?

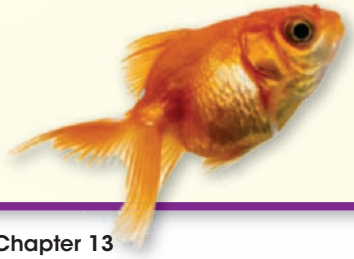
Make Observations

1. Read and complete a lab safety form.
2. In your Science Journal, make three columns with the following headings: *Organism*, *Abiotic Needs*, and *Biotic Needs*.
3. Visit a pet store or go online to research the types of organisms that can live in your glass aquarium. As you research, list the organisms in your Science Journal. Along with the types of organisms, list the specific biotic and abiotic needs of each organism.
4. Using your research, design an ecosystem that you can build in your aquarium. The ecosystem can be aquatic or terrestrial. Your plan must provide for the needs of all organisms in your ecosystem.
5. Have your teacher approve your design before you create your ecosystem.

Form a Hypothesis

6. After receiving approval for your ecosystem design, formulate a hypothesis about what your ecosystem requires to function successfully.





Test Your Hypothesis

7. With your teacher's help, obtain the resources and organisms you need to construct your ecosystem. Work with your teacher to put your ecosystem together and add the living organisms. Take care to research the needs of each organism you use. You might consult a biologist or a specialist at a pet store to make sure the needs of all your organisms will be met.
8. Observe your ecosystem over several days. Record your observations. Provide details on the ways that the parts of your ecosystem interact and connect with each other.

Analyze and Conclude

9. **Analyze** Describe the parts and interactions of your ecosystem. How well does your ecosystem sustain itself? What things, if any, must you add to the ecosystem to maintain it? How do the populations in your ecosystem change?
10. **Classify** Write a list of the organisms in your ecosystem. Classify each organism as a producer, a consumer, or a decomposer.
11. **The Big Idea** Create a food-web diagram of your ecosystem. Diagram the connections that occur between the organisms. Describe how nutrients and resources cycle through the ecosystem. Explain how matter and energy are transformed.

Communicate Your Results

Prepare a scientific report on your ecosystem. Include descriptions of the niches occupied by the organisms, explanations of relationships between organisms, and data on population changes.

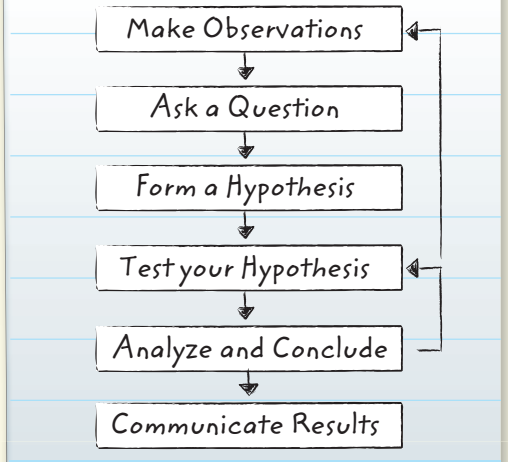
Inquiry Extension

A successful ecosystem recycles all the things needed for survival. What additions or changes could you make to your ecosystem so that nothing would need to be added or removed for it to sustain itself? Write a brief plan.

Lab Tips

- ☑ Ask for help from several different sources for obtaining and working with the organisms in your ecosystem.
- ☑ Remember that your organisms will need an appropriate environment in which to live. Find a suitable location, with proper light and temperature, in which to keep your aquarium.

Remember to use scientific methods.



Chapter 13 Study Guide

WebQuest

Organisms depend on one another and on their environment for food, shelter, living space, and other needs. The nonliving parts of the environment—including sunlight, water, air, and soil nutrients—determine what kinds of organisms can live in a given area and how many organisms can live there.

Key Concepts Summary

Lesson 1: Ecosystems

- An **ecosystem** is all the interactions among the living and nonliving parts of the environment in a given area.
- Both **abiotic factors** and **biotic factors** are parts of an ecosystem. Abiotic factors include nonliving things such as sunlight, water, and air. Biotic factors include all the living and once-living organisms in an ecosystem.

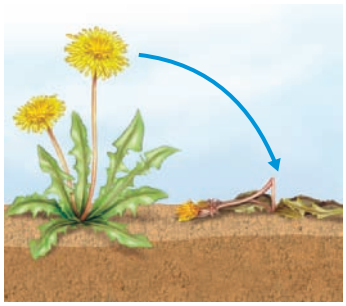
- **Populations** can increase, decrease, move, and die out.

Lesson 2: Relationships Within Ecosystems

- A habitat is the place within an ecosystem that provides the resources an organism needs. A **niche** is the way an organism interacts with the biotic and abiotic factors in its environment to meet its needs.
- Organisms rely on each other for food and other resources, compete with each other for resources, and cooperate with each other to obtain resources.

Lesson 3: Matter and Energy in Ecosystems

- Matter cycles through ecosystems. Energy transfers from one organism to another in ecosystems.
- Organisms obtain energy from sunlight or chemicals in the environment or by eating other organisms.
- A **food chain** shows a series of feeding relationships that follows the path of energy through an ecosystem. A **food web** shows the interaction among several food chains within an ecosystem.



Vocabulary

ecosystem p. 387
abiotic factor p. 388
biotic factor p. 389
habitat p. 390
population p. 391
community p. 391
population density p. 392

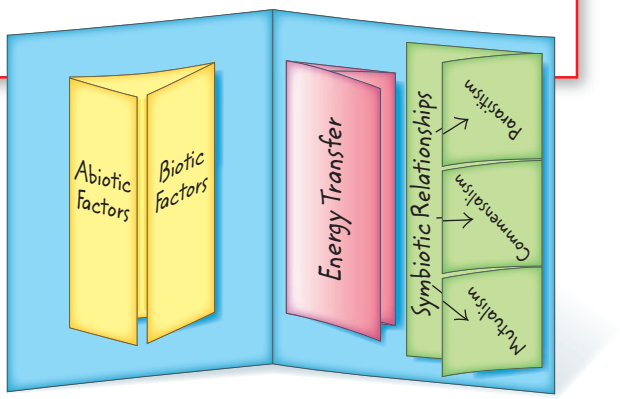
niche p. 397
competition p. 398
overpopulation p. 399
predation p. 400
symbiosis p. 401
mutualism p. 401
commensalism p. 401
parasitism p. 401

producer p. 406
consumer p. 407
food chain p. 408
food web p. 408

Review
- Personal Tutor
- Vocabulary eGames
- Vocabulary eFlashcards

FOLDABLES® Chapter Project

Assemble your lesson Foldables as shown to make a Chapter Project. Use the project to review what you have learned in this chapter.



Use Vocabulary

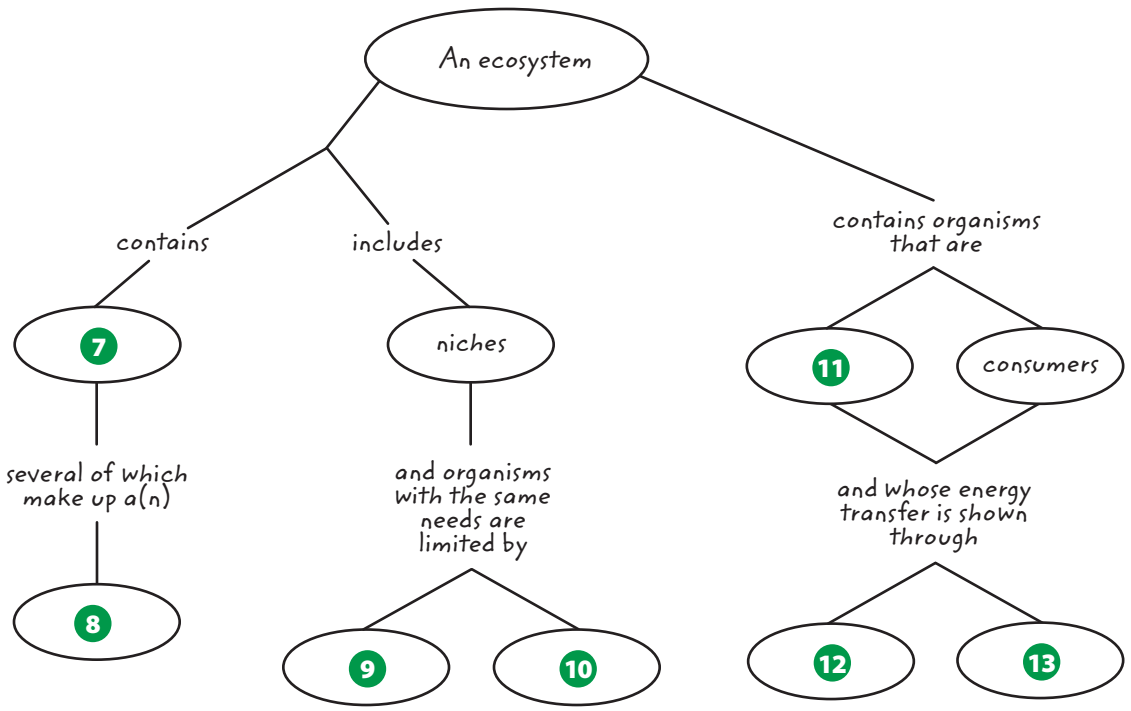
Write the vocabulary term that best matches each phrase.

1. provides an organism with the abiotic and biotic factors needed for life
2. a number of individuals of a species living in the same area at the same time
3. a relationship in which one organism hunts another for food
4. a close relationship between two organisms in which one organism benefits and the other is harmed
5. an organism that can convert energy from sunlight into chemical energy
6. an organism that cannot make its own food

Link Vocabulary and Key Concepts

Concepts in Motion Interactive Concept Map

Copy this concept map, and then use vocabulary terms from the previous page to complete the concept map.



Chapter 13 Review

Understand Key Concepts

1 Which two abiotic factors probably have the greatest effect on the organisms living in the ecosystem shown below?

A. carbon dioxide and water
B. nitrogen and soil
C. sunlight and oxygen
D. water and temperature

2 Sunlight plus what other two abiotic factors are required for photosynthesis?

A. soil and air
B. soil and water
C. carbon dioxide and oxygen
D. carbon dioxide and water

3 Which is a biotic factor in the habitat of an insect?

A. bark
B. oxygen
C. soil
D. water

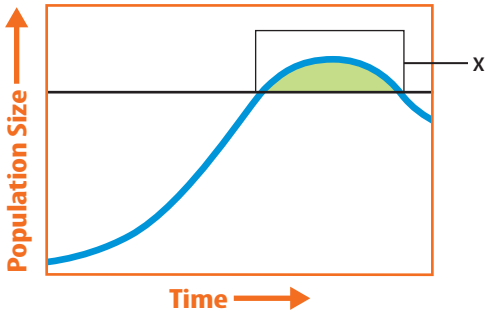
4 What do all individuals of all species living in an area form?

A. a community
B. an ecosystem
C. a habitat
D. a population

5 The way a robin builds a nest and finds food describes its

A. habitat.
B. niche.
C. population.
D. species.

6 What does X on the graph below show?



A. overpopulation
B. predation
C. ecosystem size
D. population density

7 Which term describes two organisms needing the same resources in the same place at the same time?

A. competition
B. niches
C. predation
D. symbiosis

8 Termites eat dead wood. What are they examples of?

A. carnivores
B. decomposers
C. omnivores
D. producers

9 Which is a fern an example of?

A. carnivore
B. decomposer
C. omnivore
D. producer

Assessment
Online Test Practice

Critical Thinking

10 **Describe** two ways in which loss of habitat could affect the size of a population.

11 **Predict** how a squirrel population would be affected if a pine forest that had been cut down grew again.

12 **Hypothesize** In what ways might a bird and a squirrel compete for resources?

13 **Summarize** Describe the ways in which the size of the fish population shown at right could be reduced by changes in the abiotic factors in its habitat.

14 **Compare** In what ways is predation similar to parasitism?

15 **Explain** A plant uses a carbon atom from a carbon dioxide molecule and makes a sugar molecule. How could that carbon molecule be in the body of a carnivore?

16 **Construct** a food chain that describes the feeding relationships between a bird, a wildflower, and a butterfly.

17 **Draw** a food web that describes the following relationships: A parasite sucks the blood of fish and eels. The fish feed on algae. Eels feed on the fish. Cleaner shrimp remove parasites from the fish and eat the parasites.

Writing in Science

18 **Write** a four- or five-sentence paragraph that explains the difference between the flow of matter through an ecosystem and the flow of energy through an ecosystem. Be sure to include a topic sentence and a concluding sentence in your paragraph.

REVIEW THE BIG IDEA

19 Describe five different ways in which the biotic factors in an ecosystem can interact, and give an example of each.

20 The photo below shows a raccoon that has gotten into a human's campsite. In what ways might the raccoon interact with other living things, including humans, and the environment?

Math Skills

Review
Math Practice

Use a Formula

21 Between 1991 and 2000, the moose population in Poland decreased from 5,400 animals to 1,718 animals. The area of Poland is 3,115 km^2.

a. What was the population density in 1991?

b. What was the population density in 2000?

22 A total of 1,650 earthworms were counted in a 50-m^2 area of moist forest. What is the population density?

23 The recommended density for a freshwater aquarium is 2.5 cm of fish per gallon of wat er. How many fish should you put in a 30-gallon aquarium if each fish measures 5 cm?

Standardized Test Practice

Record your answers on the answer sheet provided by your teacher or on a sheet of paper.

Multiple Choice

1 What do abiotic and biotic factors have in common?

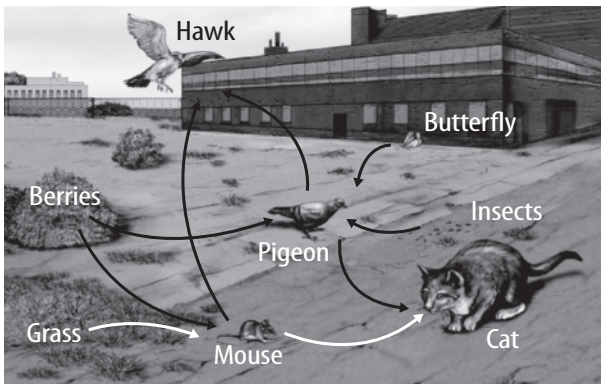
A They both contain living parts.

B They both contain nonliving parts.

C They both include water for living things.

D They both provide resources for living things.

Use the figure below to answer questions 2 and 3.



2 Which statement describes the food chain shown in the figure above?

A Cats and hawks both eat pigeons.

B Hawks eat pigeons, which eat cats.

C Mice eat grass and are eaten by hawks.

D Pigeons eat beetles and butterflies.

3 Which result is likely if the cat population moves away from the vacant lot in the figure?

A The grass population will increase.

B The hawk population will decrease.

C The mouse population will increase.

D The pigeon population will decrease.

4 Which is a biotic factor in an ecosystem?

A atmosphere

B plants

C temperature

D water

5 What do herbivores eat?

A consumers and decomposers

B only consumers

C only producers

D producers and consumers

6 Which is an example of parasitism?

A A bat pollinates a cactus.

B A bird builds a nest in a tree.

C A flea ingests the blood of a dog.

D A hawk eats a rabbit.

Use the food chain below to answer question 7.

Parsley → Rabbit → Fox → Bear

7 In the food chain shown, which organism eats a producer?

A bear

B fox

C parsley

D rabbit

8 Which relationship between organisms allows both species to benefit?

A commensalism

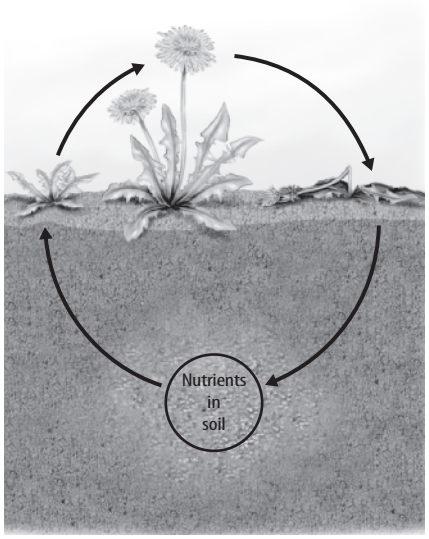
B mutualism

C parasitism

D predation

Assessment
Online Standardized Test Practice

Use the figure below to answer question 9.



9 What is shown in the diagram above?

A Energy cycles through ecosystems as one organism eats another.

B Energy moves through ecosystems as it is transferred from one organism to another.

C The matter that makes up a plant is recycled as the plant grows, dies, and decomposes.

D The matter that makes up a plant moves through the ecosystem from producer to consumer.

10 How do decomposers benefit an ecosystem?

A They carry out photosynthesis.

B They control population growth.

C They produce energy.

D They recycle nutrients.

Constructed Response

Use the figure below to answer question 11.

A B C

11 The figure above illustrates three examples of interactions between organisms in an ecosystem. Pick one diagram, and describe the type of interaction shown.

12 Explain how symbiosis differs from predation.

13 Competition between members of the same species is usually more intense than between members of different species. Explain why this is usually true based on your understanding of habitats and niches.

14 Explain how a food chain and a food web are related. Could they contain the same living things? Why or why not?

NEED EXTRA HELP?														
If You Missed Question...	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Go to Lesson...	1	3	1	1	3	2	3	2	3	3	2	2	2	3