Living Things and the Environment

Reading Preview

Key Concepts

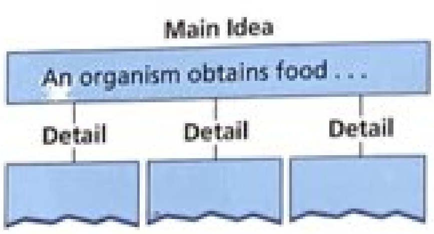
- What needs are met by an organism's environment?
- What are the two parts of an organism's habitat with which it interacts?
- What are the levels of organization within an ecosystem?

Key Terms

- organism • habitat
- biotic factor • abiotic factor
- photosynthesis • species
- population • community
- ecosystem • ecology

Target Reading Skill

Identifying Main Ideas As you read the Habitats section, write the main idea—the biggest or most important idea—in a graphic organizer like the one below. Then write three supporting details that give examples of the main idea.



Lab zone Discover Activity

What's in the Scene?

1. Choose a magazine picture of a nature scene. Paste the picture onto a sheet of paper, leaving space all around the picture.
2. Locate everything in the picture that is alive. Use a colored pencil to draw a line from each living thing. If you know its name, write it on the line.
3. Using a different colored pencil, label each nonliving thing.

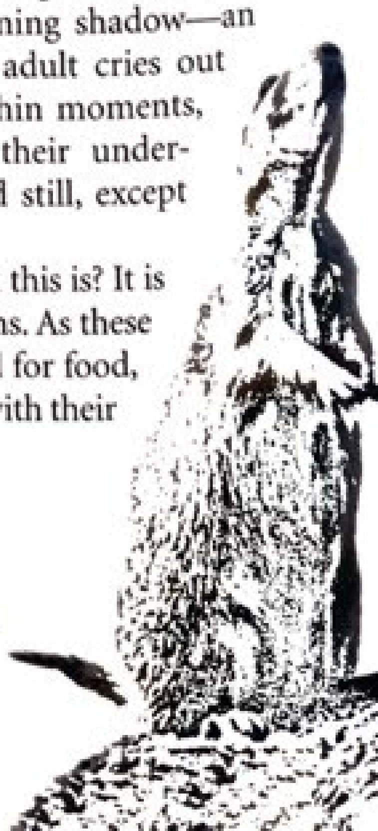
Think It Over

Inferring How do the living things in the picture depend on the nonliving things? Using a third color, draw lines connecting the living things to the nonliving things they need.

As the sun rises on a warm summer morning, the Nebraska town is already bustling with activity. Some residents are hard at work building homes for their families. They are working underground, where it is dark and cool. Other inhabitants are collecting seeds for breakfast. Some of the town's younger residents are at play, chasing each other through the grass.

Suddenly, an adult spots a threatening shadow—an enemy has appeared in the sky! The adult cries out several times, warning the others. Within moments, the town's residents disappear into their underground homes. The town is silent and still, except for a single hawk circling overhead.

Have you guessed what kind of town this is? It is a prairie dog town on the Nebraska plains. As these prairie dogs dug their burrows, searched for food, and hid from the hawk, they interacted with their environment, or surroundings.



Black-Tailed Prairie Dog ▶

FIGURE 1

An Organism in Its Habitat
Like all organisms, this red-tailed hawk obtains food, water, and shelter from its habitat. Prairie dogs are a major source of food for the red-tailed hawk.

Habitats

A prairie dog is one type of **organism,** or living thing. Different types of organisms must live in different types of environments. **An organism obtains food, water, shelter, and other things it needs to live, grow, and reproduce from its environment.** An environment that provides the things the organism needs to live, grow, and reproduce is called its **habitat.**

One area may contain many habitats. For example, in a forest, mushrooms grow in the damp soil, salamanders live on the forest floor, and woodpeckers build nests in tree trunks.

Organisms live in different habitats because they have different requirements for survival. A prairie dog obtains the food and shelter it needs from its habitat. It could not survive in a tropical rain forest or on the rocky ocean shore. Likewise, the prairie would not meet the needs of a spider monkey or hermit crab.

Reading Checkpoint **Why do different organisms live in different habitats?**

Biotic Factors

To meet its needs, a prairie dog must interact with more than just the other prairie dogs around it. **An organism interacts with both the living and nonliving parts of its habitat.** The living parts of a habitat are called **biotic factors** (by AHT ik). Biotic factors in the prairie dogs' habitat include the grass and plants that provide seeds and berries. The hawks, ferrets, badgers, and eagles that hunt the prairie dogs are also biotic factors. In addition, worms, fungi, and bacteria are biotic factors that live in the soil underneath the prairie grass.

Reading Checkpoint **Name a biotic factor in your environment.**

FIGURE 2
Abiotic Factors
The nonliving things in an organism's habitat are abiotic factors. Applying Concepts *Name three abiotic factors you interact with each day.*

▲ This orangutan is enjoying a drink of water.

▲ Sunlight enables this plant to make its own food.

▲ This banjo frog burrows in the soil to stay cool.

Abiotic Factors

Abiotic factors (ay by AHT ik) are the nonliving parts of an organism's habitat. They include water, sunlight, oxygen, temperature, and soil.

Water All living things require water to carry out their life processes. Water also makes up a large part of the bodies of most organisms. Your body, for example, is about 65 percent water. Plants and algae need water, along with sunlight and carbon dioxide, to make their own food in a process called **photosynthesis** (foh toh SIN thuh sis). Other living things depend on plants and algae for food.

Sunlight Because sunlight is needed for photosynthesis, it is an important abiotic factor for most living things. In places that do not receive sunlight, such as dark caves, plants and algae cannot grow. Because there are no plants or algae to provide food, few other organisms can live in such places.

Oxygen Most living things require oxygen to carry out their life processes. Oxygen is so important to the functioning of the human body that you can live only a few minutes without it. Organisms that live on land obtain oxygen from air, which is about 20 percent oxygen. Fish and other water organisms obtain oxygen that is dissolved in the water around them.

Temperature The temperatures that are typical of an area determine the types of organisms that can live there. For example, if you took a trip to a warm tropical island, you might see colorful orchid flowers and tiny lizards. These organisms could not survive on the frozen plains of Siberia.

Some animals alter their environments so they can survive very hot or very cold temperatures. Prairie dogs, for example, dig underground dens to find shelter from the hot summer sun and cold winter winds.

Soil Soil is a mixture of rock fragments, nutrients, air, water, and the decaying remains of living things. Soil in different areas consists of varying amounts of these materials. The type of soil in an area influences the kinds of plants that can grow there. Many animals, such as the prairie dogs, use the soil itself as a home. Billions of microscopic organisms such as bacteria also live in the soil.

Reading Checkpoint How do abiotic factors differ from biotic factors?

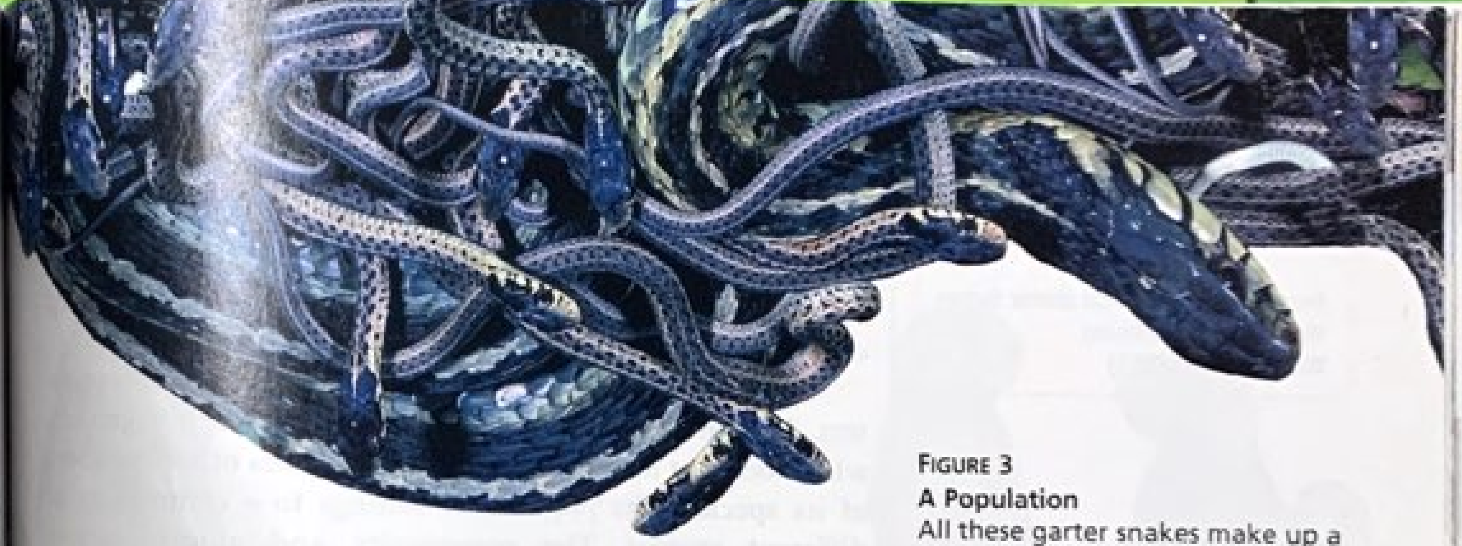


FIGURE 3
A Population
All these garter snakes make up a population.

Levels of Organization

Of course, organisms do not live all alone in their habitat. Instead, organisms live together in populations and communities, and with abiotic factors in their ecosystems.

Populations In 1900, travelers saw a prairie dog town in Texas that covered an area twice the size of the city of Dallas. The town contained more than 400 million prairie dogs! These prairie dogs were all members of one species, or single kind, of organism. A **species** (SPEE sheez) is a group of organisms that are physically similar and can mate with each other and produce offspring that can also mate and reproduce.

All the members of one species in a particular area are referred to as a **population.** The 400 million prairie dogs in the Texas town are one example of a population. All the pigeons in New York City make up a population, as do all the bees that live in a hive. In contrast, all the trees in a forest do not make up a population, because they do not all belong to the same species. There may be pines, maples, birches, and many other tree species in the forest.

Communities A particular area usually contains more than one species of organism. The prairie, for instance, includes prairie dogs, hawks, grasses, badgers, and snakes, along with many other organisms. All the different populations that live together in an area make up a **community.**

To be considered a community, the different populations must live close enough together to interact. One way the populations in a community may interact is by using the same resources, such as food and shelter. For example, the tunnels dug by prairie dogs also serve as homes for burrowing owls and black-footed ferrets. The prairie dogs share the grass with other animals. Meanwhile, prairie dogs themselves serve as food for many species.

Lab zone Try This **Activity**

With or Without Salt?

In this activity you will explore salt as an abiotic factor.

1. Label four 600-mL beakers A, B, C, and D. Fill each with 500 mL of room-temperature spring water.
2. Set beaker A aside. Add 2.5 grams of noniodized salt to beaker B, 7.5 grams of salt to beaker C, and 15 grams of salt to beaker D. Stir each beaker.
3. Add $\frac{1}{8}$ spoonful of brine shrimp eggs to each beaker.
4. Cover each beaker with a square of paper. Keep them away from direct light or heat. Wash your hands.
5. Observe the beakers daily for three days.

Drawing Conclusions In which beakers did the eggs hatch? What can you conclude about the amount of salt in the shrimps' natural habitat?

Go Online
SCI LINKS NSTA

For: Links on biotic and abiotic factors
Visit: www.SciLinks.org
Web Code: scn-0511

Ecosystems The community of organisms that live in a particular area, along with their nonliving surroundings, make up an **ecosystem.** A prairie is just one of the many different ecosystems found on Earth. Other ecosystems in which living things make their homes include mountain streams, deep oceans, and evergreen forests.

Figure 4 shows the levels of organization in a prairie ecosystem. **The smallest level of organization is a single organism, which belongs to a population that includes other members of its species. The population belongs to a community of different species. The community and abiotic factors together form an ecosystem.**

Because the populations in an ecosystem interact with one another, any change affects all the different populations that live there. The study of how living things interact with each other and with their environment is called **ecology.** Ecologists are scientists who study ecology. As part of their work, ecologists study how organisms react to changes in their environment. An ecologist, for example, may look at how a fire affects a prairie ecosystem.

Reading Checkpoint What is ecology?

Section 1 Assessment

Target Reading Skill Identifying Main Ideas
Use your graphic organizer to help you answer Question 1 below.

Reviewing Key Concepts

1. a. **Listing** What basic needs are provided by an organism's habitat?
   b. **Predicting** What might happen to an organism if its habitat could not meet one of its needs?
2. a. **Defining** Define the terms *biotic factors* and *abiotic factors.*
   b. **Interpreting Illustrations** List all the biotic and abiotic factors in Figure 4.
   c. **Making Generalizations** Explain why water and sunlight are two abiotic factors that are important to most organisms.
3. a. **Sequencing** List these terms in order from the smallest level to the largest: *population, organism, ecosystem, community.*
   b. **Classifying** Would all the different kinds of organisms in a forest be considered a population or a community? Explain.
   c. **Relating Cause and Effect** How might a change in one population affect other populations in a community?

Writing in Science

Descriptive Paragraph What habitat do you live in? Write a one-paragraph description of your habitat. Describe how you obtain the food, water, and shelter you need from your habitat. How does this habitat meet your needs in ways that another would not?

FIGURE 4
Ecological Organization
The smallest level of organization is the organism. The largest is the entire ecosystem.

Section 2

Integrating Mathematics

Studying Populations

Reading Preview

Key Concepts

- How do ecologists determine the size of a population?
- What causes populations to change in size?
- What factors limit population growth?

Key Terms

- estimate
- birth rate
- death rate
- immigration
- emigration
- population density
- limiting factor
- carrying capacity

Target Reading Skill

Asking Questions Before you read, preview the red headings. In a graphic organizer like the one below, ask a question for each heading. As you read, write the answers to your questions.

Studying Populations

Question	Answer
How do you determine population size?	Some methods of determining population size are . . .

Lab zone Discover Activity

What's the Population of Beans in a Jar?

1. Fill a plastic jar with dried beans. This is your model population.
2. Your goal is to determine the bean population size, but you will not have time to count every bean. You may use any of the following to help you: a ruler, a small beaker, another large jar. Set a timer for two minutes when you are ready to begin.
3. After two minutes, record your answer. Then count the beans. How close was your answer?

Think It Over

Forming Operational Definitions In this activity, you came up with an estimate of the size of the bean population. Write a definition of the term *estimate* based on what you did.

How would you like to be an ecologist today? Your assignment is to study the albatross population on an island. One question you might ask is how the size of the albatross population has changed over time. Is the number of albatrosses on the island more than, less than, or the same as it was 50 years ago? To answer this question, you must first determine the current size of the albatross population.

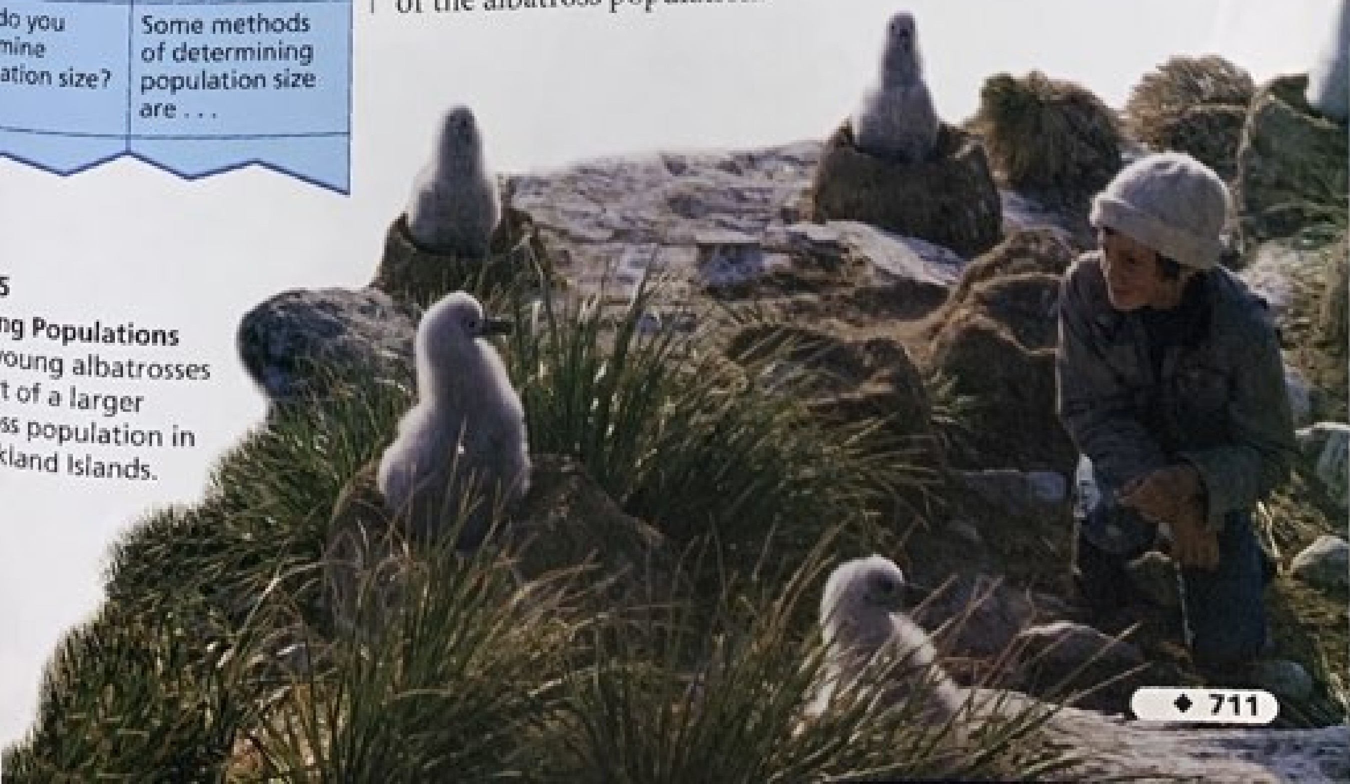


FIGURE 5
Studying Populations
These young albatrosses are part of a larger albatross population in the Falkland Islands.

Determining Population Size

Some methods of determining the size of a population are direct and indirect observations, sampling, and mark-and-recapture studies.

Direct Observation The most obvious way to determine the size of a population is to count all of its members. For example, you could try to count all the crabs in a tide pool.

Indirect Observation Sometimes it may be easier to observe signs of organisms rather than the organisms themselves. Look at the mud nests built by cliff swallows in Figure 6. Each nest has one entrance hole. By counting the entrance holes, you can determine the number of swallow nests in this area. Suppose that the average number of swallows per nest is four: two parents and two offspring. If there are 120 nests, you can multiply 120 by 4 to determine that there are 480 swallows.

Sampling In many cases, it is not even possible to count signs of every member of a population. The population may be very large or spread over a wide area. In such cases, ecologists usually make an estimate. An **estimate** is an approximation of a number, based on reasonable assumptions.

FIGURE 6
Determining Population Size
Scientists use a variety of methods to determine the size of a population.

Direct Observation
Counting these crabs one by one is an example of direct observation.

Indirect Observation
One way to determine this cliff swallow population is to count their cone-shaped nests.

One way to estimate the size of a population is to count the number of organisms in a small area (a sample), and then multiply to find the number in a larger area. To get the most accurate estimate, your sample area should be typical of the larger area. Suppose you count 8 birch trees in 100 square meters of a forest. If the entire forest were 100 times that size, you would multiply your count by 100 to estimate the total population, or 800 birch trees.

Mark-and-Recapture Studies Another estimating method is called "mark and recapture." Here's an example showing how mark and recapture works. First, turtles in a bay are caught in a way that does not harm them. Ecologists count the turtles and mark each turtle's shell with a dot of paint before releasing it. Two weeks later, the researchers return and capture turtles again. They count how many turtles have marks, showing that they have been recaptured, and how many are unmarked. Using a mathematical formula, the ecologists can estimate the total population of turtles in the bay. You can try this technique for yourself in the Skills Lab at the end of this section.

Reading Checkpoint When might an ecologist use indirect observation to estimate a population?

Lab zone Skills Activity

Calculating

An oyster bed is 100 meters long and 50 meters wide. In a 1-square-meter area you count 20 oysters. Estimate the population of oysters in the bed. (*Hint:* Drawing a diagram may help you set up your calculation.)

Sampling
To estimate the birch tree population in a forest, count the birches in a small area. Then multiply to find the number in the larger area.

Mark and Recapture
This researcher is releasing a marked turtle as part of a mark-and-recapture study.

Changes in Population Size

By returning to a location often and using one of the methods described on the previous pages, ecologists can monitor the size of a population over time. **Populations can change in size when new members join the population or when members leave the population.**

Births and Deaths The main way in which new individuals join a population is by being born into it. The **birth rate** of a population is the number of births in a population in a certain amount of time. For example, suppose that a population of 100 cottontail rabbits produces 600 young in a year. The birth rate in this population would be 600 young per year.

The main way that individuals leave a population is by dying. The **death rate** is the number of deaths in a population in a certain amount of time. If 400 rabbits die in a year in the population, the death rate would be 400 rabbits per year.

The Population Statement When the birth rate in a population is greater than the death rate, the population will generally increase. This can be written as a mathematical statement using the "is greater than" sign:

If birth rate > death rate, population size increases.

However, if the death rate in a population is greater than the birth rate, the population size will generally decrease. This can also be written as a mathematical statement:

If death rate > birth rate, population size decreases.

Immigration and Emigration The size of a population also can change when individuals move into or out of the population, just as the population of your town changes when families move into town or move away. **Immigration** (im ih GRAY shun) means moving into a population. **Emigration** (em ih GRAY shun) means leaving a population. For instance, if food is scarce, some members of an antelope herd may wander off in search of better grassland. If they become permanently separated from the original herd, they will no longer be part of that population.

Graphing Changes in Population Changes in a population's size can be displayed on a line graph. Figure 7 shows a graph of the changes in a rabbit population. The vertical axis shows the numbers of rabbits in the population, while the horizontal axis shows time. The graph shows the size of the population over a ten-year period.

Math Skills

Inequalities

The population statement is an example of an inequality. An inequality is a mathematical statement that compares two expressions. Two signs that represent inequalities are

< (is less than)

> (is greater than)

For example, an inequality comparing the fraction to the decimal 0.75 would be written

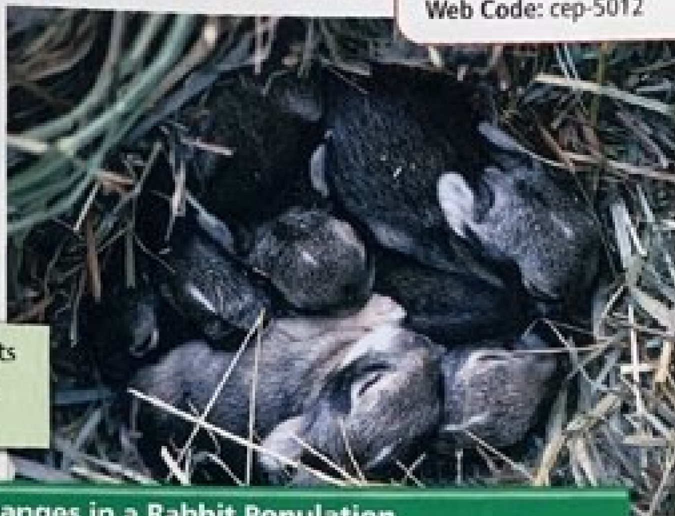
$$\frac{1}{2} < 0.75$$

Practice Problems Write an inequality comparing each pair of expressions below.

1. $5 \blacksquare -6$
2. $0.4 \blacksquare \frac{3}{5}$
3. $-2 - (-8) \blacksquare 7 - 1.5$

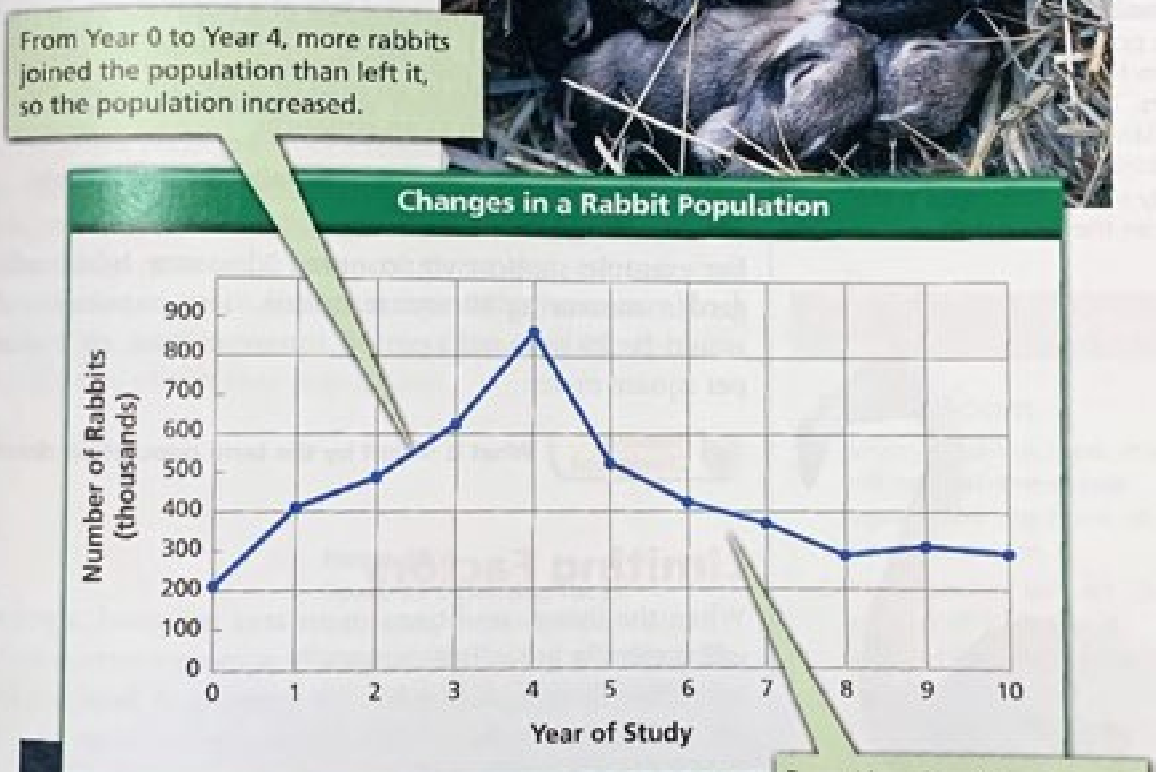
FIGURE 7
This line graph shows how the size of a rabbit population changed over a ten-year period.
Interpreting Graphs *In what year did the rabbit population reach its highest point? What was the size of the population in that year?*

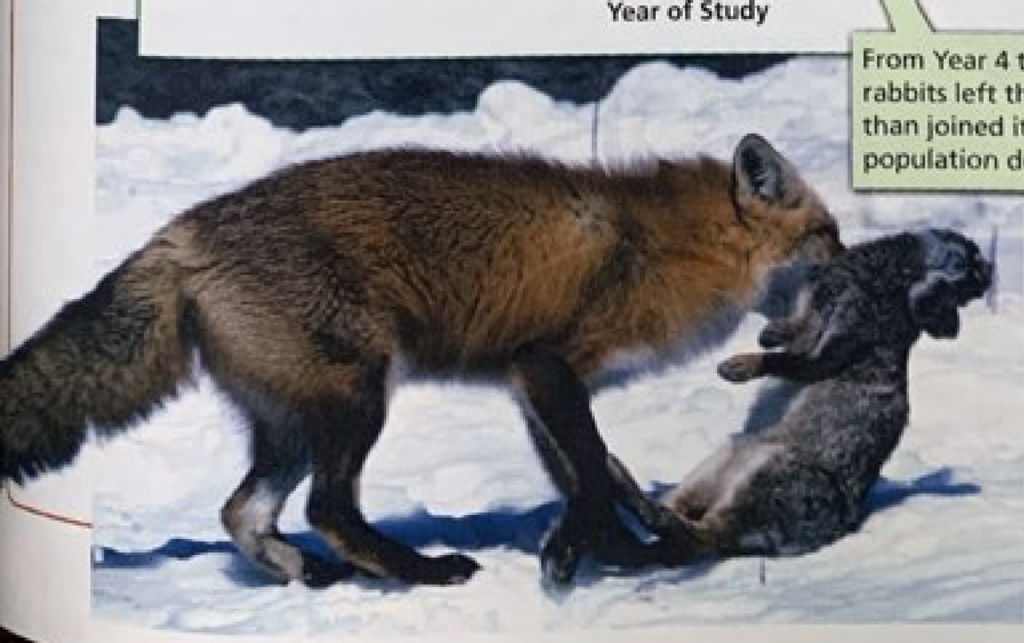
▼ Young cottontail rabbits in a nest



Go Online *active art*

For: Changes in Population activity
Visit: PHSchool.com
Web Code: cep-5012





◀ Cottontail rabbit caught by a fox

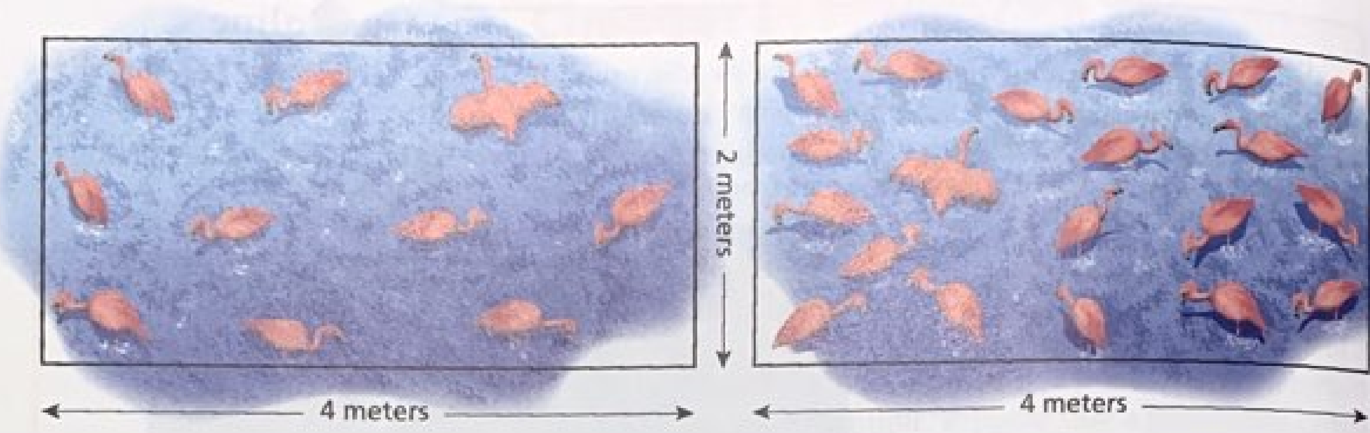


FIGURE 8
Population Density
In the pond on the top left, there are ten flamingos in 8 square meters. The population density is 1.25 flamingos per square meter.
Calculating *What is the population density of the flamingos in the pond on the top right?*

Population Density Sometimes an ecologist may need to know more than just the total size of a population. In many situations, it is helpful to know the **population density**—the number of individuals in an area of a specific size. Population density can be written as an equation:

$$\text{Population density} = \frac{\text{Number of individuals}}{\text{Unit area}}$$

For example, suppose you counted 20 monarch butterflies in a garden measuring 10 square meters. The population density would be 20 monarchs per 10 square meters, or 2 monarchs per square meter.

Reading Checkpoint What is meant by the term *population density?*

Limiting Factors

When the living conditions in an area are good, a population will generally grow. But eventually some environmental factor will cause the population to stop growing. A **limiting factor** is an environmental factor that causes a population to decrease. **Some limiting factors for populations are food and water, space, and weather conditions.**

Food and Water Organisms require food and water to survive. Since food and water are often in limited supply, they are often limiting factors. Suppose a giraffe must eat 10 kilograms of leaves each day to survive. The trees in an area can provide 100 kilograms of leaves a day while remaining healthy. Five giraffes could live easily in this area, since they would only require a total of 50 kilograms of food. But 15 giraffes could not all survive—there would not be enough food. No matter how much shelter, water, and other resources there were, the population would not grow much larger than 10 giraffes.

◄ Greater flamingo

The largest population that an area can support is called its **carrying capacity.** The carrying capacity of this giraffe habitat would be 10 giraffes. A population usually stays near its carrying capacity because of the limiting factors in its habitat.

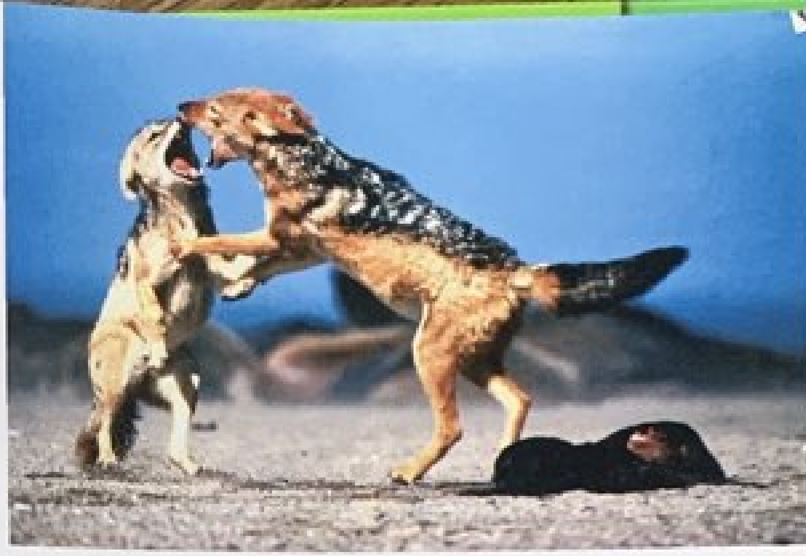


FIGURE 9
Food as a Limiting Factor
These jackals are fighting over the limited food available to them.

Space Space is another limiting factor for populations. Gannets are seabirds that are usually seen flying over the ocean. They come to land only to nest on rocky shores. But the nesting shores get very crowded. If a pair does not find room to nest, they will not be able to add any offspring to the gannet population. So nesting space on the shore is a limiting factor for gannets. If there were more nesting space, more gannets would be able to nest, and the population would increase.

Space is also a limiting factor for plants. The amount of space in which a plant grows determines whether the plant can obtain the sunlight, water, and soil nutrients it needs. For example, many pine seedlings sprout each year in a forest. But as the seedlings grow, the roots of those that are too close together run out of space. Branches from other trees may block the sunlight the seedlings need. Some of the seedlings then die, limiting the size of the pine population.

FIGURE 10
Space as a Limiting Factor
Could any more sunflower plants grow in this field? If not, the field has reached its carrying capacity for sunflowers.

Lab zone Try This **Activity**

Elbow Room

1. Using masking tape, mark off several one-meter squares on the floor of your classroom.
2. Your teacher will set up groups of 2, 4, and 6 students. Each group's task is to put together a small jigsaw puzzle in one of the squares. All the group members must keep their feet within the square.
3. Time how long it takes your group to finish the puzzle.

Making Models How long did it take each group to complete the task? How does this activity show that space can be a limiting factor? What is the carrying capacity of puzzle-solvers in a square meter?

FIGURE 11
Weather as a Limiting Factor
A snowstorm can limit the size of an orange crop.
Applying Concepts *What other weather conditions can limit population growth?*

Weather Weather conditions such as temperature and the amount of rainfall can also limit population growth. A cold snap in late spring can kill the young of many species of organisms, including birds and mammals. A hurricane or flood can wash away nests and burrows. Such unusual events can have long-lasting effects on population size.

Reading Checkpoint **What is one weather condition that can limit the growth of a population?**

Section 2 Assessment

Target Reading Skill **Asking Questions** Use the answers to the questions you wrote about the headings to help you answer the questions below.

Reviewing Key Concepts

1. a. **Listing** What are four methods of determining population size?
   b. **Applying Concepts** Which method would you use to determine the number of mushrooms growing on the floor of a large forest? Explain.
2. a. **Identifying** Name two ways organisms join a population and two ways organisms leave a population.
   b. **Calculating** Suppose a population of 100 mice has produced 600 young. If 200 mice have died, how many mice are in the population now? (Assume for this question that no mice have moved into or out of the population for other reasons.)
   c. **Drawing Conclusions** Suppose that you discovered that there were actually 750 mice in the population. How could you account for the difference?
3. a. **Reviewing** Name three limiting factors for populations.
   b. **Describing** Choose one of the limiting factors and describe how it limits population growth.
   c. **Inferring** How might the limiting factor you chose affect the pigeon population in your town?

Math Practice

4. **Inequalities** Complete the following inequality showing the relationship between carrying capacity and population size. Then explain why the inequality is true.

   If population size ■ carrying capacity, then population size will decrease.

Section 3

Interactions Among Living Things

Reading Preview

Key Concepts

- How do an organism's adaptations help it to survive?
- What are the major ways in which organisms in an ecosystem interact?
- What are the three types of symbiotic relationships?

Key Terms

- natural selection
- adaptations • niche
- competition • predation
- predator • prey • symbiosis
- mutualism • commensalism
- parasitism • parasite • host

Target Reading Skill

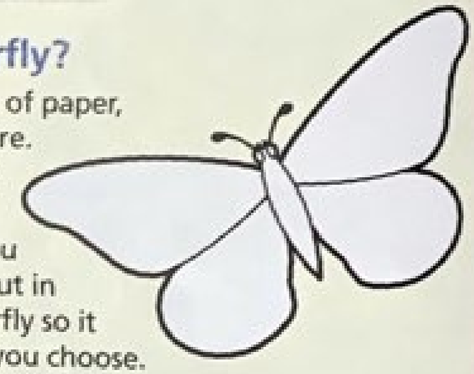
Using Prior Knowledge Before you read, look at the section headings and visuals to see what this section is about. Then write what you know about how living things interact in a graphic organizer like the one below. As you read, continue to write in what you learn.

What You Know
1. Organisms interact in different ways.
2.

What You Learned
1.
2.

Lab zone Discover Activity

Can You Hide a Butterfly?



1. Trace a butterfly on a piece of paper, using the outline shown here.
2. Look around the classroom and pick a spot where you will place your butterfly. You must place your butterfly out in the open. Color your butterfly so it will blend in with the spot you choose.
3. Tape your butterfly down. Someone will now have one minute to find the butterflies. Will your butterfly be found?

Think It Over

Predicting Over time, do you think the population size of butterflies that blend in with their surroundings would increase or decrease?

Can you imagine living in a cactus like the one in Figure 12? Ouch! You probably wouldn't want to live in a house covered with sharp spines. But many species live in, on, and around saguaro cactuses.

As day breaks, a twittering sound comes from a nest tucked in one of the saguaro's arms. Two young red-tailed hawks are preparing to fly for the first time. Farther down the stem, a tiny elf owl peeks out of its nest in a small hole. This owl is so small it could fit in your palm! A rattlesnake slithers around the base of the saguaro, looking for lunch. Spying a shrew, the snake strikes it with its needle-like fangs. The shrew dies instantly.

Activity around the saguaro continues after sunset. Long-nosed bats come out to feed on the nectar from the saguaro's blossoms. The bats stick their faces into the flowers to feed, dusting their long snouts with white pollen. As they move from plant to plant, they carry the pollen to other saguaros. This enables the cactuses to reproduce.

Adapting to the Environment

Each organism in the saguaro community has unique characteristics. These characteristics affect the individual's ability to survive in its environment.

Natural Selection A characteristic that makes an individual better suited to its environment may eventually become common in that species through a process called **natural selection.** Natural selection works like this: Individuals whose unique characteristics are best suited for their environment tend to survive and produce offspring. Offspring that inherit these characteristics also live to reproduce. In this way, natural selection results in **adaptations,** the behaviors and physical characteristics that allow organisms to live successfully in their environments.

Individuals with characteristics that are poorly suited to the environment are less likely to survive and reproduce. Over time, poorly suited characteristics may disappear from the species.

Niche **Every organism has a variety of adaptations that are suited to its specific living conditions.** The organisms in the saguaro community have adaptations that result in specific roles. The role of an organism in its habitat, or how it makes its living, is called its **niche.** A niche includes the type of food the organism eats, how it obtains this food, and which other organisms use the organism as food. A niche also includes when and how the organism reproduces and the physical conditions it requires to survive.

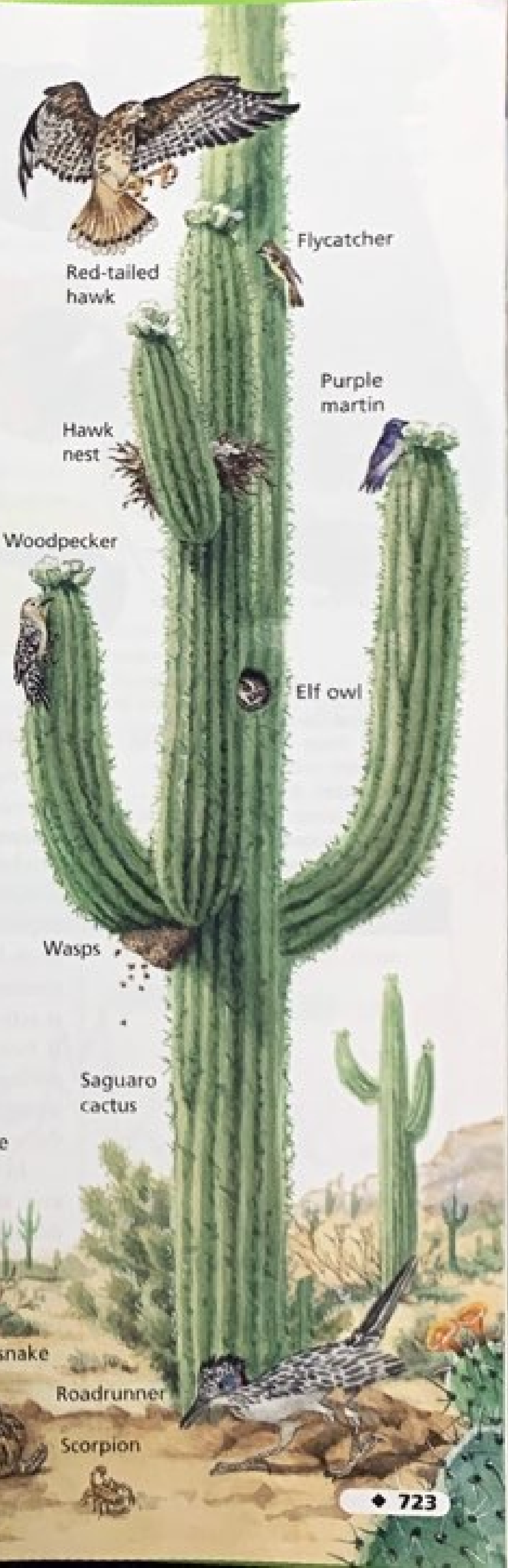


FIGURE 12
Saguaro Community
The organisms in the saguaro community are well adapted to their desert environment.
Observing *Identify two interactions taking place in this scene.*

Cape May Warbler
This species feeds at the tips of branches near the top of the tree.

Bay-Breasted Warbler
This species feeds in the middle part of the tree.

Yellow-Rumped Warbler
This species feeds in the lower part of the tree and at the bases of the middle branches.

FIGURE 13
Niche and Competition
Each of these warblers occupies a different niche in its spruce tree habitat. By feeding in different areas of the tree, the birds avoid competing for food.
Comparing and Contrasting *How do the niches of these three warblers differ?*

Competition

During a typical day in the saguaro community, a range of interactions takes place among organisms. **There are three major types of interactions among organisms: competition, predation, and symbiosis.**

Different species can share the same habitat and food requirements. For example, the roadrunner and the elf owl both live on the saguaro and eat insects. However, these two species do not occupy exactly the same niche. The roadrunner is active during the day, while the owl is active mostly at night. If two species occupy the same niche, one of the species will eventually die off. The reason for this is **competition,** the struggle between organisms to survive as they attempt to use the same limited resource.

In any ecosystem, there is a limited amount of food, water, and shelter. Organisms that survive have adaptations that enable them to reduce competition. For example, the three species of warblers in Figure 13 live in the same spruce forest habitat. They all eat insects that live in the spruce trees. How do these birds avoid competing for the limited insect supply? Each warbler "specializes" in feeding in a certain part of a spruce tree. This is how the three species coexist.

Reading Checkpoint Why can't two species occupy the same niche?

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Predation

A tiger shark lurks below the surface of the clear blue water, looking for shadows of albatross chicks floating above. The shark spots a chick and silently swims closer. Suddenly, the shark bursts through the water and seizes the albatross with one snap of its powerful jaw. This interaction between two organisms has an unfortunate ending for the albatross.

An interaction in which one organism kills another for food is called **predation.** The organism that does the killing, in this case the tiger shark, is the **predator.** The organism that is killed, in this case the albatross, is the **prey.**

The Effect of Predation on Population Size Predation can have a major effect on the size of a population. Recall from Section 2 that when the death rate exceeds the birth rate in a population, the size of that population usually decreases. So if there are many predators, the result is often a decrease in the size of the population of their prey. But a decrease in the number of prey results in less food for their predators. Without adequate food, the predator population starts to decline. So, generally, populations of predators and their prey rise and fall in related cycles.

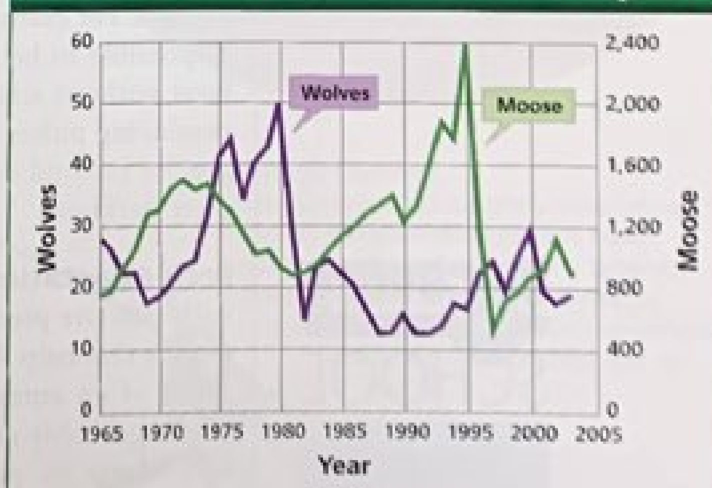
FIGURE 14
Predation
This green tree python and mouse are involved in a predator-prey interaction.

Math Analyzing Data

Predator-Prey Interactions

On Isle Royale, an island in Lake Superior, the populations of wolves (the predator) and moose (the prey) rise and fall in cycles. Use the graph to answer the questions.

Wolf and Moose Populations on Isle Royale



1. **Reading Graphs** What variable is plotted on the x-axis? What two variables are plotted on the y-axis?
2. **Interpreting Data** How did the moose population change between 1965 and 1972? What happened to the wolf population from 1973 through 1976?
3. **Inferring** How might the change in the moose population have led to the change in the wolf population?
4. **Drawing Conclusions** What is one likely cause of the dip in the moose population between 1974 and 1981?
5. **Predicting** How might a disease in the wolf population one year affect the moose population the next year?

FIGURE 15
Predator Adaptations
This greater horseshoe bat has adaptations that allow it to find prey in the dark. The bat produces pulses of sound and locates prey by interpreting the echoes.
Inferring *What other adaptations might contribute to the bat's success as a predator?*

Predator Adaptations Predators have adaptations that help them catch and kill their prey. For example, a cheetah can run very fast for a short time, enabling it to catch its prey. A jellyfish's tentacles contain a poisonous substance that paralyzes tiny water animals. Some plants, too, have adaptations for catching prey. The sundew is covered with sticky bulbs on stalks—when a fly lands on the plant, it remains snared in the sticky goo while the plant digests it.

Some predators have adaptations that enable them to hunt at night. For example, the big eyes of an owl let in as much light as possible to help it see in the dark. Insect-eating bats can hunt without seeing at all. Instead, they locate their prey by producing pulses of sound and listening for the echoes. This precise method enables a bat to catch a flying moth in complete darkness.

Prey Adaptations How do organisms avoid being killed by such effective predators? Organisms have many kinds of adaptations that help them avoid becoming prey. The alertness and speed of an antelope help protect it from its predators. And you're probably not surprised that the smelly spray of a skunk helps keep its predators at a distance. As you can see in Figure 16, other organisms also have some very effective ways to avoid becoming a predator's next meal.

Reading Checkpoint **What are two predator adaptations?**

Discovery Channel School

Populations and Communities

Video Preview
▶ Video Field Trip
Video Assessment

FIGURE 16
Defense Strategies

Organisms display a wide array of adaptations that help them avoid becoming prey.

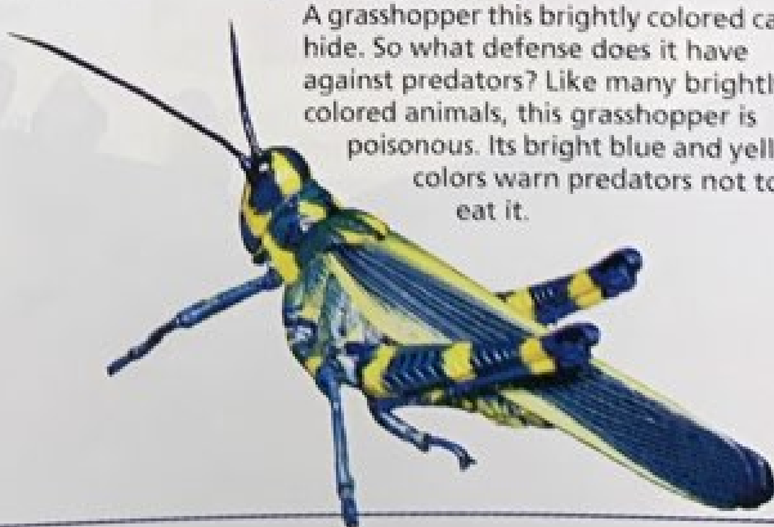
Mimicry ▶
If you're afraid of snakes, you'd probably be terrified to see this organism staring at you. But this caterpillar only looks like a snake. Its convincing resemblance to a viper tricks would-be predators into staying away.

False Coloring ▲
If you saw this moth in a dark forest, you might think you were looking into the eyes of a large mammal. The large false eyespots on the moth's wings scare potential predators away.

Protective Covering ▼
Have you ever seen a pine cone with a face? This organism is actually a pangolin, a small African mammal. When threatened, the pangolin protects itself by rolling up into a scaly ball.

Camouflage ▲
Is it a leaf? Actually, it's a walking leaf insect. But if you were a predator, you might be fooled into looking elsewhere for a meal.

▼ Warning Coloring
A grasshopper this brightly colored can't hide. So what defense does it have against predators? Like many brightly colored animals, this grasshopper is poisonous. Its bright blue and yellow colors warn predators not to eat it.



Lab zone

Classifying

Classify each interaction as an example of mutualism, commensalism, or parasitism. Explain your answers.

- A remora fish attaches itself to the underside of a shark without harming the shark, and eats left-over bits of food from the shark's meals.
- A vampire bat drinks the blood of horses.
- Bacteria living in cows' stomachs help them break down the cellulose in grass.

Symbiosis

Many of the interactions in the saguaro community you read about are examples of symbiosis. **Symbiosis** (sim bee OH sis) is a close relationship between two species that benefits at least one of the species. **The three types of symbiotic relationships are mutualism, commensalism, and parasitism.**

Mutualism A relationship in which both species benefit is called **mutualism** (MYOO choo uh liz um). The relationship between the saguaro and the long-eared bats is an example of mutualism. The bats benefit because the cactus flowers provide them with food. The saguaro benefits as its pollen is carried to another plant on the bat's nose.

In some cases of mutualism, two species are so dependent on each other that neither could live without the other. This is true for some species of acacia trees and stinging ants in Central and South America. The stinging ants nest only in the acacia tree, whose thorns discourage the ants' predators. The tree also provides the ants' only food. The ants, in turn, attack other animals that approach the tree and clear competing plants away from the base of the tree. To survive, each species needs the other.

Commensalism A relationship in which one species benefits and the other species is neither helped nor harmed is called **commensalism** (kuh MEN suh liz um). The red-tailed hawks' interaction with the saguaro is an example of commensalism. The hawks benefit by having a place to build their nest, while the cactus is not affected by the hawks.

Commensalism is not very common in nature because two species are usually either helped or harmed a little by any interaction. For example, by creating a small hole for its nest in the cactus stem, the elf owl slightly damages the cactus.

FIGURE 17
Mutualism
Three yellow-billed oxpeckers get a cruise and a snack aboard an obliging hippopotamus. The oxpeckers eat ticks living on the hippo's skin. Since both the birds and the hippo benefit from this interaction, it is an example of mutualism.

Parasitism Parasitism (PA ruh sit iz um) involves one organism living on or inside another organism and harming it. The organism that benefits is called a **parasite,** and the organism it lives on or in is called a **host.** The parasite is usually smaller than the host. In a parasitic relationship, the parasite benefits from the interaction while the host is harmed.

Some common parasites are fleas, ticks, and leeches. These parasites have adaptations that enable them to attach to their host and feed on its blood. Other parasites live inside the host's body, such as tapeworms that live inside the digestive systems of dogs, wolves, and some other mammals.

Unlike a predator, a parasite does not usually kill the organism it feeds on. If the host dies, the parasite loses its source of food. An interesting example of this rule is shown by a species of mite that lives in the ears of moths. The mites almost always live in just one of the moth's ears. If they live in both ears, the moth's hearing is so badly affected that it is likely to be quickly caught and eaten by its predator, a bat.

Reading Checkpoint **Why doesn't a parasite usually kill its host?**

FIGURE 18
Parasitism
Ticks feed on the blood of certain animals. **Classifying** *Which organism in this interaction is the parasite? Which organism is the host?*

Section 3 Assessment

Target Reading Skill **Using Prior Knowledge** Review your graphic organizer and revise it based on what you just learned in the section.

Reviewing Key Concepts

1. a. **Defining** What are adaptations?
   b. **Explaining** How are a snake's sharp fangs an adaptation that helps it survive in the saguaro community?
   c. **Developing Hypotheses** Explain how natural selection in snakes might have led to adaptations such as sharp fangs.
2. a. **Reviewing** What are three main ways in which organisms interact?
   b. **Classifying** Give one example of each type of interaction.
3. a. **Listing** List the three types of symbiotic relationships.
   b. **Comparing and Contrasting** For each type of symbiotic relationship, explain how the two organisms are affected.
   c. **Applying Concepts** Some of your classroom plants are dying. Others that you planted at the same time and cared for in the same way are growing well. When you look closely at the dying plants, you see tiny mites on them. Which symbiotic relationship is likely occurring between the plants and mites? Explain.

Lab zone At-Home Activity

Feeding Frenzy You and your family can observe interactions among organisms at a bird feeder. Fill a clean, dry, 2-liter bottle with birdseed. With paper clips, attach a plastic plate to the neck of the bottle. Then hang your feeder outside where you can see it easily. Observe the feeder at different times of the day. Keep a log of all the organisms you see near it and how they interact.

Section 4

Changes in Communities

Reading Preview

Key Concept

- How do primary and secondary succession differ?

Key Terms

- succession
- primary succession
- pioneer species
- secondary succession

Target Reading Skill

Comparing and Contrasting As you read, compare and contrast primary and secondary succession by completing a table like the one below.

Factors in Succession	Primary Succession	Secondary Succession
Possible cause	Volcanic eruption	
Type of area		
Existing ecosystem?		

Lab zone Discover Activity

What Happened Here?

1. The two photographs at the bottom of this page show the same area in Yellowstone National Park in Wyoming. The photograph on the left was taken soon after a major fire. The photograph on the right was taken a few years later. Observe the photographs carefully.
2. Make a list of all the differences you notice between the two scenes.

Think It Over

Posing Questions How would you describe what happened during the time between the two photographs? What questions do you have about this process?

In 1988, huge fires raged through the forests of Yellowstone National Park. The fires were so hot that they jumped from tree to tree without burning along the ground. Huge trees burst into flame from the intense heat. It took months for the fires to burn themselves out. All that remained were thousands of blackened tree trunks sticking out of the ground like charred toothpicks.

Could a forest community recover from such disastrous fires? It might seem unlikely. But within just a few months, signs of life had returned. First, tiny green shoots of new grass poked through the sooty ground. Then, small tree seedlings began to grow. The forest was coming back! After 15 years, young forests were flourishing in many areas.

Fires, floods, volcanoes, hurricanes, and other natural disasters can change communities very quickly. But even without disasters, communities change. The series of predictable changes that occur in a community over time is called **succession.**

Changes in a Yellowstone community ▼

FIGURE 19
Primary Succession
Primary succession occurs in an area where no soil and no organisms exist.
Applying Concepts *What determines the particular species that appear during succession?*

Primary Succession

Primary succession is the series of changes that occur in an area where no soil or organisms exist. Such an area might be a new island formed by the eruption of an undersea volcano or an area of rock uncovered by a melting sheet of ice.

Figure 19 shows the series of changes an area might undergo after a violent volcanic eruption. The first species to populate the area are called **pioneer species.** They are often carried to the area by wind or water. Typical pioneer species are mosses or lichens, which are fungi and algae growing in a symbiotic relationship. As pioneer species grow, they help break up the rocks. When the organisms die, they provide nutrients that enrich the thin layer of soil that is forming on the rocks.

Over time, plant seeds land in the new soil and begin to grow. The specific plants that grow depend on the climate of the area. For example, in a cool, northern area, early seedlings might include alder and cottonwood trees. Eventually, succession may lead to a community of organisms that does not change unless the ecosystem is disturbed. Reaching this mature community can take centuries.

Reading Checkpoint What are some pioneer species?

1 **Abandoned Field**
Grasses and wildflowers have taken over this abandoned field.

2 **Tree Growth Begins**
After a few years, pine seedlings and other plants replace some of the grasses and wildflowers.

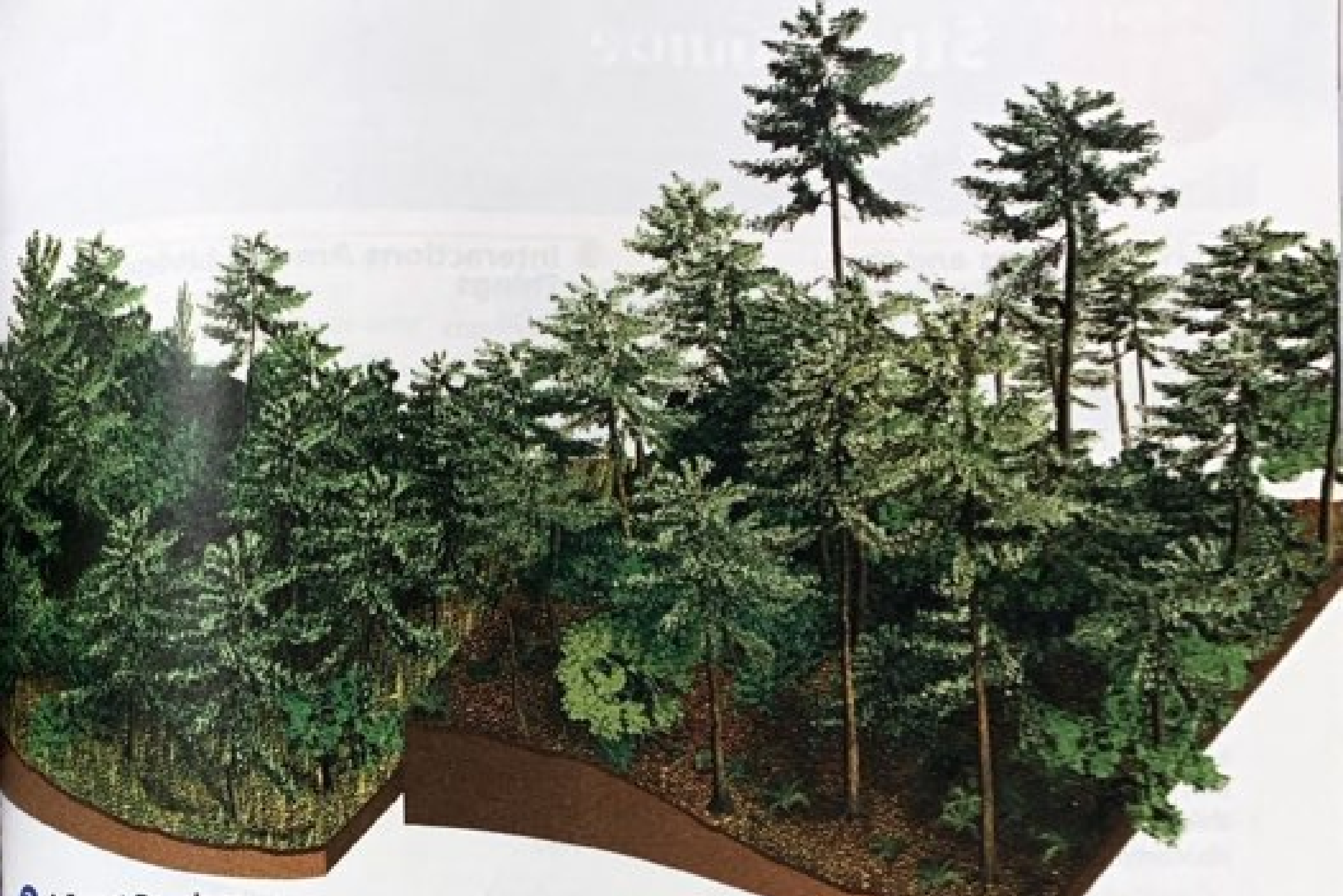
FIGURE 20
Secondary Succession
Secondary succession occurs following a disturbance to an ecosystem, such as clearing a forest for farmland.

Secondary Succession

The changes following the Yellowstone fire were an example of secondary succession. **Secondary succession** is the series of changes that occur in an area where the ecosystem has been disturbed, but where soil and organisms still exist. Natural disturbances that have this effect include fires, hurricanes, and tornadoes. Human activities, such as farming, logging, or mining, may also disturb an ecosystem. **Unlike primary succession, secondary succession occurs in a place where an ecosystem currently exists.**

Secondary succession usually occurs more rapidly than primary succession. Consider, for example, an abandoned field in the southeastern United States. You can follow the process of succession in such a field in Figure 20. After a century, a hardwood forest is developing. This forest community may remain for a long time.

Reading Checkpoint **What are two natural events that can disturb an ecosystem?**



3 **A Forest Develops**
As tree growth continues, the trees begin to crowd out the grasses and wildflowers.

4 **Mature Community**
Eventually, a mixed forest of pine, oak, and hickory dominates the landscape.

Section 4 Assessment

Target Reading Skill **Comparing and Contrasting** Use the information in your table to help you answer Question 1 below.

Reviewing Key Concepts

1. a. **Defining** What is primary succession? What is secondary succession?
   b. **Comparing and Contrasting** How do primary succession and secondary succession differ?
   c. **Classifying** Grass poking through a crack in a sidewalk is an example of succession. Is it primary succession or secondary succession? Explain.

Lab zone At-Home Activity

Community Changes Interview a family member or neighbor who has lived in your neighborhood for a long time. Ask the person to describe how the neighborhood has changed over time. Have areas that were formerly grassy been paved or developed? Have any farms, parks, or lots returned to a wild state? Write a summary of your interview. Can you classify any of the changes as examples of succession?