SECTION 1

Everything Is Connected

An alligator drifts in a weedy Florida river, watching a long, thin fish called a gar. *The gar swims too close to the alligator. Then, in a rush of murky water, the alligator swallows the gar whole and slowly swims away.*

It is clear that two organisms have interacted when one eats the other. But organisms have many interactions other than simply "who eats whom." For example, alligators dig underwater holes to escape from the heat. After the alligators abandon these holes, fish and other aquatic organisms live in the holes during the winter dry period.

READING WARM-UP

Objectives

- Distinguish between the biotic and abiotic parts of the environment.
- Explain how populations and communities are related.
- Describe how the abiotic parts of the environment affect ecosystems.

Terms to Learn

ecology	community
biotic	ecosystem
abiotic	biosphere
population	

READING STRATEGY

Reading Organizer As you read this section, create an outline of the section. Use the headings from the section in your outline.

Studying the Web of Life

All living things are connected in a web of life. Scientists who study the web of life specialize in the science of ecology. **Ecology** is the study of the interactions of organisms with one another and with their environment.

The Two Parts of an Environment

An organism's environment consists of all the things that affect the organism. These things can be divided into two groups. All of the organisms that live together and interact with one another make up the **biotic** part of the environment. The **abiotic** part of the environment consists of the nonliving factors, such as water, soil, light, and temperature. How many biotic parts and abiotic parts do you see in **Figure 1?**

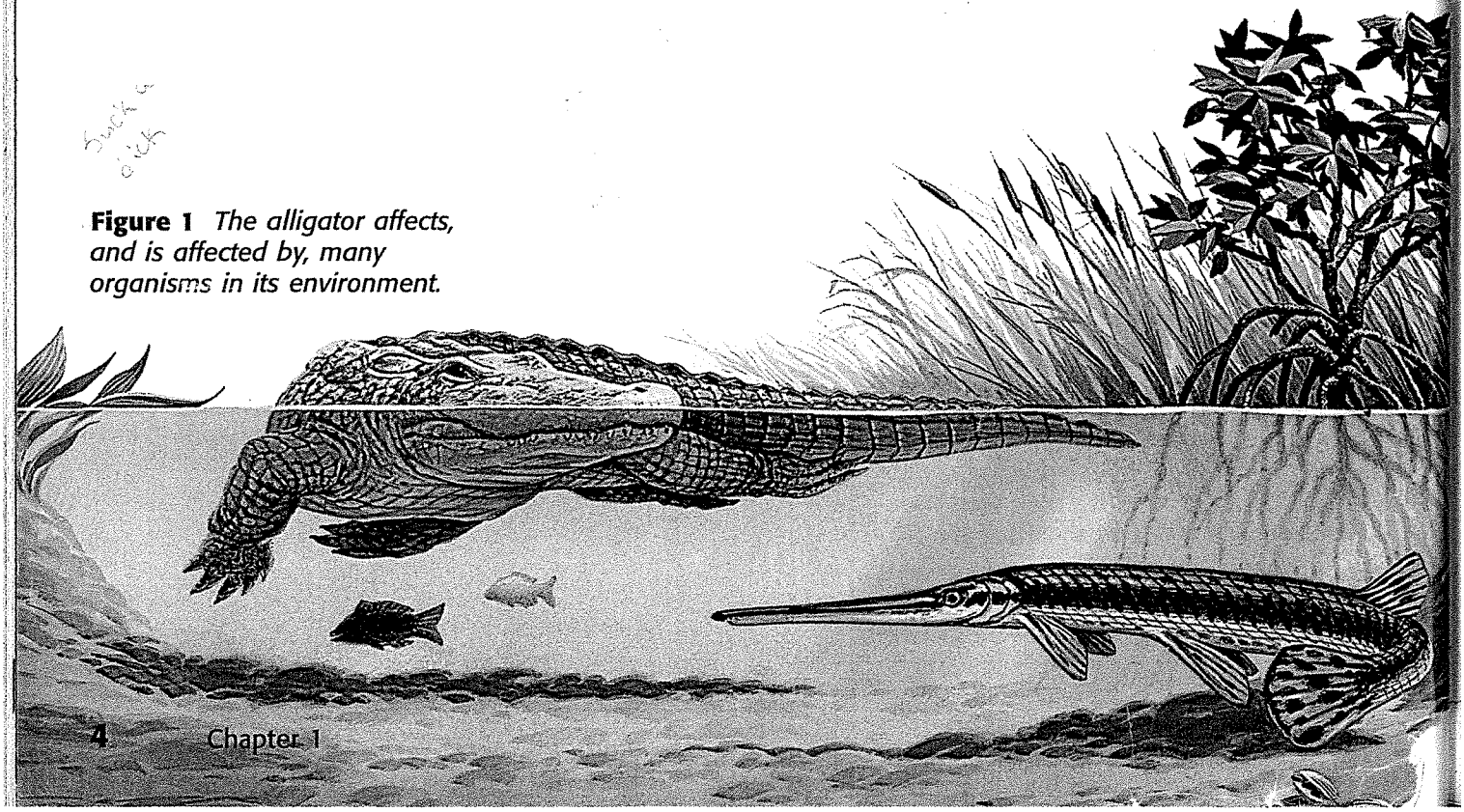


Figure 1 *The alligator affects, and is affected by, many organisms in its environment.*

Organization in the Environment

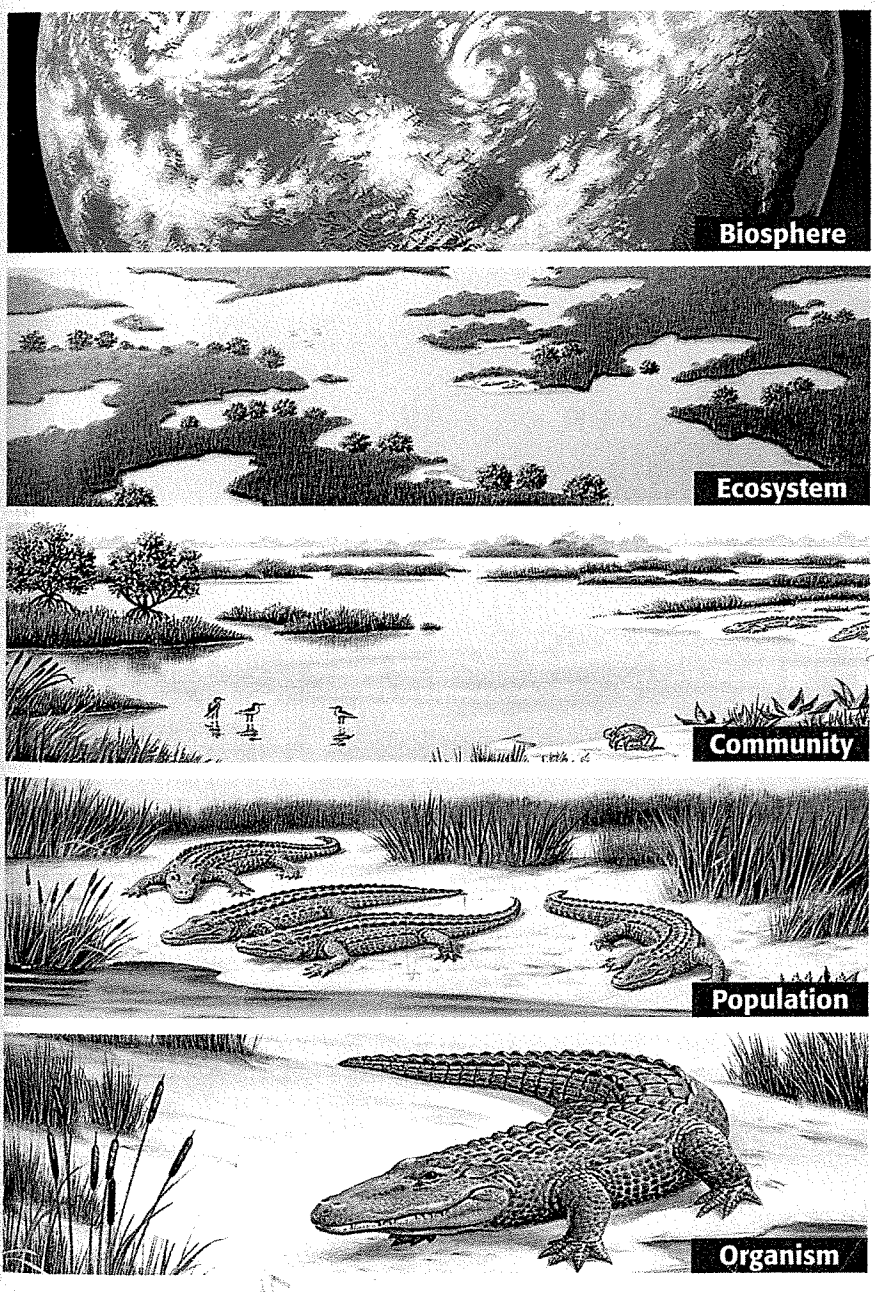
At first glance, the environment may seem disorganized. However, the environment can be arranged into different levels, as shown in **Figure 2.** The first level is made of an individual organism. The second level is larger and is made of similar organisms, which form a population. The third level is made of different populations, which form a community. The fourth level is made of a community and its abiotic environment, which form an ecosystem. The fifth and final level contains all ecosystems, which form the biosphere.

ecology the study of the interactions of living organisms with one another and with their environment

biotic describes living factors in the environment

abiotic describes the nonliving part of the environment, including water, rocks, light, and temperature

Figure 2 The Five Levels of Environmental Organization



QUICK LAB

Meeting the Neighbors

1. Explore two or three blocks of your neighborhood.
2. Draw a map of the area's biotic and abiotic features. For example, map the location of sidewalks, large rocks, trees, water features, and any animals you see. Remember to approach all plants and animals with caution. Use your map to answer the following questions.
3. How are the biotic factors affected by the abiotic factors?
4. How are the abiotic factors affected by the biotic factors?

Populations

population a group of organisms of the same species that live in a specific geographical area

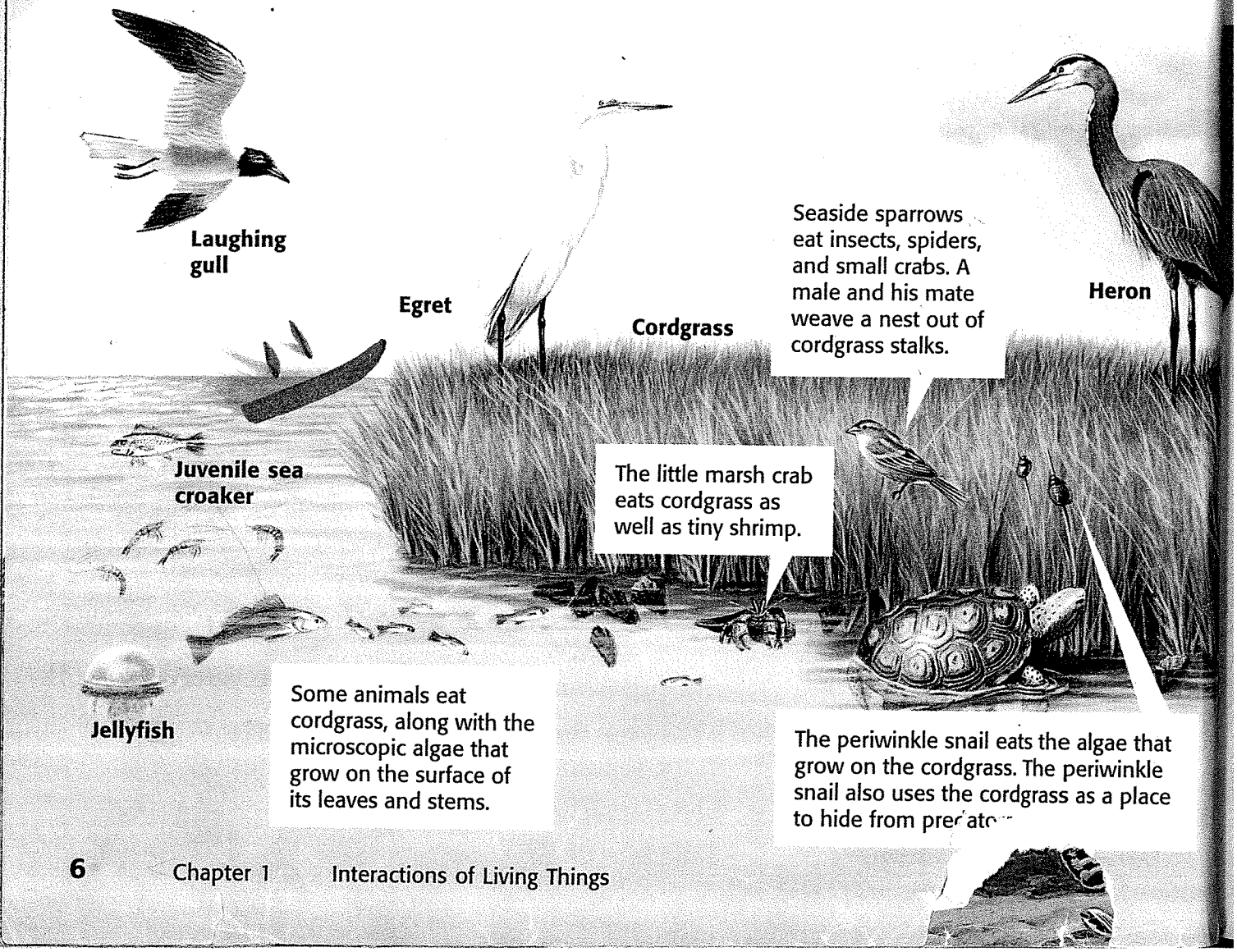
community all the populations of species that live in the same habitat and interact with each other

A salt marsh, such as the one shown in **Figure 3,** is a coastal area where grasslike plants grow. Within the salt marsh are animals. Each animal is a part of a **population,** or a group of individuals of the same species that live together. For example, all of the seaside sparrows that live in the same salt marsh are members of a population. The individuals in the population often compete with one another for food, nesting space, and mates.

Communities

A **community** consists of all of the populations of species that live and interact in an area. The animals and plants you see in **Figure 3** form a salt-marsh community. The populations in a community depend on each other for food, shelter, and many other things.

Figure 3 *Examine the picture of a salt marsh. Try to find examples of each level of organization in this environment.*



Ecosystems

An **ecosystem** is made up of a community of organisms and the abiotic environment of the community. An ecologist studying the ecosystem could examine how organisms interact as well as how temperature, precipitation, and soil characteristics affect the organisms. For example, the rivers that empty into the salt marsh carry nutrients, such as nitrogen, from the land. These nutrients affect the growth of the cordgrass and algae.

ecosystem a community of organisms and their abiotic environment

biosphere the part of Earth where life exists

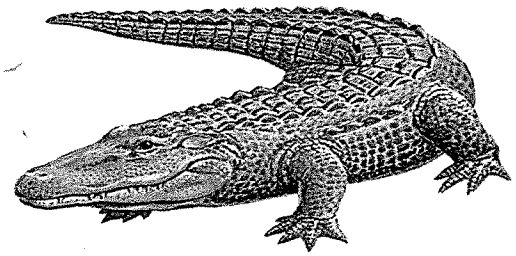
The Biosphere

The **biosphere** is the part of Earth where life exists. It extends from the deepest parts of the ocean to high in the air where plant spores drift. Ecologists study the biosphere to learn how organisms interact with the abiotic environment—Earth's atmosphere, water, soil, and rock. The water in the abiotic environment includes fresh water and salt water as well as water that is frozen in polar icecaps and glaciers.

Reading Check **What is the biosphere?** (*See the Appendix for answers to Reading Checks.*)

INTERNET ACTIVITY

For another activity related to this chapter, go to **go.hrw.com** and type in the keyword **HL5INTW.**



SECTION Review

Summary

- All living things are connected in a web of life.
- The biotic part of an environment is made up of all of the living things found within it.
- The abiotic part of an environment is made up of all of the nonliving things found within it, such as water and light.
- An ecosystem is made up of a community of organisms and its abiotic environment.

Using Key Terms

1. In your own words, write a definition for the term *ecology.*
2. Use the following terms in the same sentence: *biotic* and *abiotic.*

Understanding Key Ideas

3. Which one of the following is the highest level of environmental organization?
   a. ecosystem **c.** population
   b. community **d.** organism
4. What makes up a community?
5. Give two examples of how abiotic factors can affect an ecosystem.

Math Skills

6. From sea level, the biosphere goes up about 9 km and down about 19 km. What is the thickness of the biosphere in meters?

Critical Thinking

7. **Analyzing Relationships** What would happen to the other organisms in the salt-marsh ecosystem if the cordgrass suddenly died?
8. **Identifying Relationships** Explain in your own words what people mean when they say that everything is connected.
9. **Analyzing Ideas** Do ecosystems have borders? Explain your answer.

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For a variety of links related to this chapter, go to www.scilinks.org
Topic: Biotic and Abiotic Factors; Organization in the Environment
SciLinks code: HSM0164; HSM1079

SECTION 2

Living Things Need Energy

Do you think you could survive on only water and vitamins? Eating food satisfies your hunger because it provides something you cannot live without—energy.

Living things need energy to survive. For example, black-tailed prairie dogs, which live in the grasslands of North America, eat grass and seeds to get the energy they need. Everything a prairie dog does requires energy. The same is true for the plants that grow in the grasslands where the prairie dogs live.

READING WARM-UP

Objectives

- Describe the functions of producers, consumers, and decomposers in an ecosystem.
- Distinguish between a food chain and a food web.
- Explain how energy flows through a food web.
- Describe how the removal of one species affects the entire food web.

Terms to Learn

herbivore	food chain
carnivore	food web
omnivore	energy pyramid

READING STRATEGY

Reading Organizer As you read this section, make a table comparing producers, consumers, and decomposers.

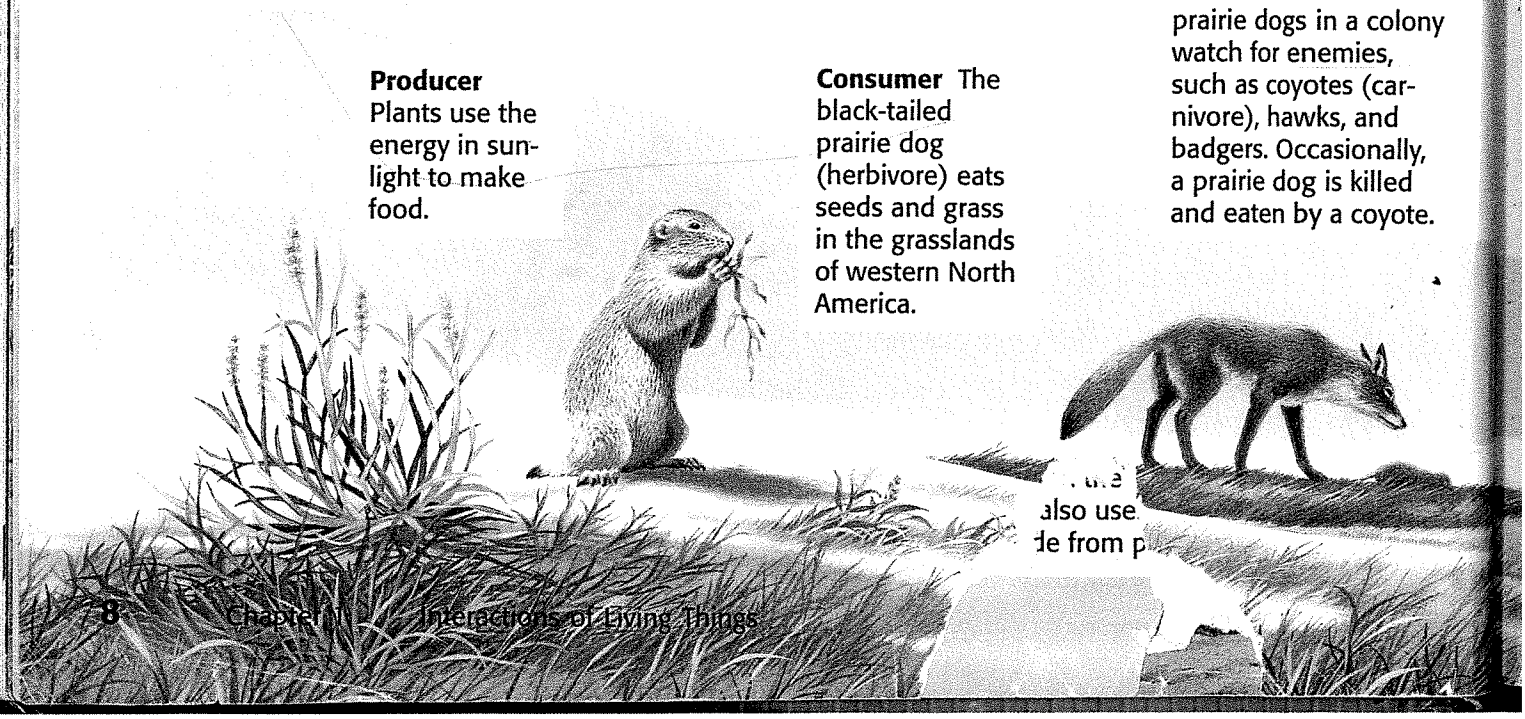
The Energy Connection

Organisms, in a prairie or any community, can be divided into three groups based on how they get energy. These groups are producers, consumers, and decomposers. Examine **Figure 1** to see how energy passes through an ecosystem.

Producers

Organisms that use sunlight directly to make food are called *producers*. They do this by using a process called *photosynthesis*. Most producers are plants, but algae and some bacteria are also producers. Grasses are the main producers in a prairie ecosystem. Examples of producers in other ecosystems include cordgrass and algae in a salt marsh and trees in a forest. Algae are the main producers in the ocean.

Figure 1 *Living things get their energy either from the sun or from eating other organisms.*



Consumers

Organisms that eat other organisms are called *consumers*. They cannot use the sun's energy to make food like producers can. Instead, consumers eat producers or other animals to obtain energy. There are several kinds of consumers. A consumer that eats only plants is called a **herbivore.** Herbivores found in the prairie include grasshoppers, prairie dogs, and bison. A **carnivore** is a consumer that eats animals. Carnivores in the prairie include coyotes, hawks, badgers, and owls. Consumers known as **omnivores** eat both plants and animals. The grasshopper mouse is an example of an omnivore. It eats insects, lizards, and grass seeds.

Scavengers are omnivores that eat dead plants and animals. The turkey vulture is a scavenger in the prairie. A vulture will eat what is left after a coyote has killed and eaten an animal. Scavengers also eat animals and plants that have died from natural causes.

herbivore an organism that eats only plants

carnivore an organism that eats animals

omnivore an organism that eats both plants and animals

Reading Check **What are organisms that eat other organisms called?** (*See the Appendix for answers to Reading Checks.*)

Decomposers

Organisms that get energy by breaking down dead organisms are called *decomposers*. Bacteria and fungi are decomposers. These organisms remove stored energy from dead organisms. They produce simple materials, such as water and carbon dioxide, which can be used by other living things. Decomposers are important because they are nature's recyclers.

SCHOOL to HOME

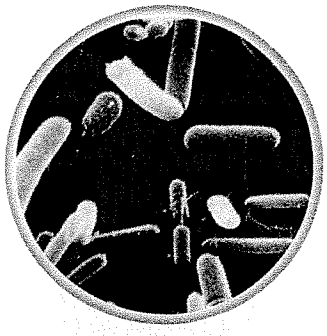
A Chain Game

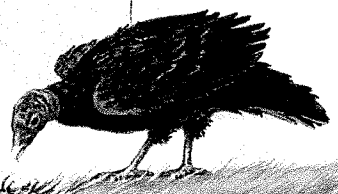
With the help of your parent, make a list of the foods you ate at your most recent meal. Trace the energy of each food back to the sun. Which foods on your list were consumers? How many were producers?

ACTIVITY

Consumer A turkey vulture (scavenger) may eat some of the coyote's leftovers. A scavenger can pick bones completely clean.

Decomposer Any prairie dog remains not eaten by the coyote or the turkey vulture are broken down by bacteria (decomposer) and fungi that live in the soil.





Food Chains and Food Webs

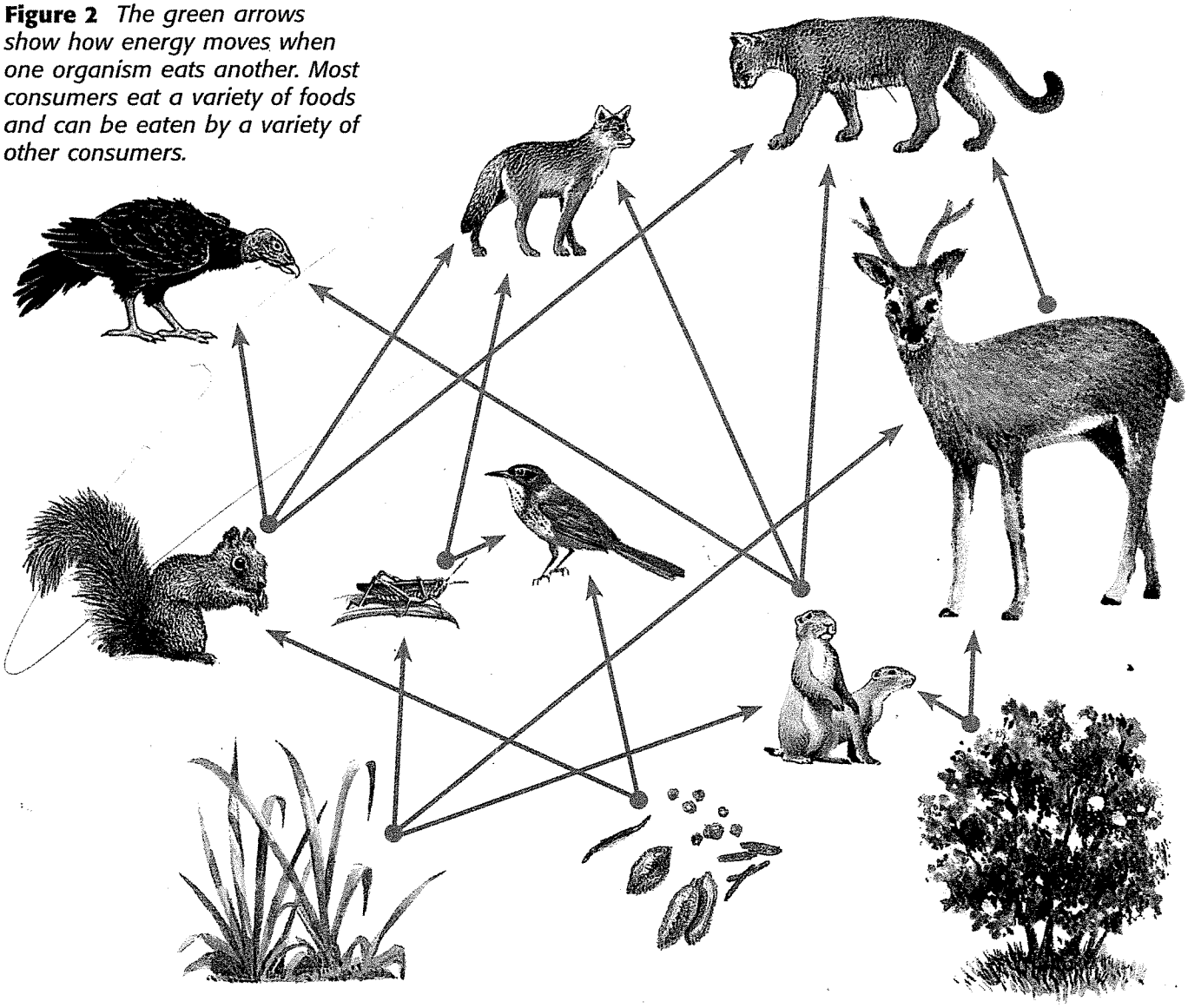
food chain the pathway of energy transfer through various stages as a result of the feeding patterns of a series of organisms

food web a diagram that shows the feeding relationships between organisms in an ecosystem

Figure 1 on the previous page, shows a food chain. A **food chain** is a diagram that shows how energy in food flows from one organism to another. Because few organisms eat just one kind of food, simple food chains are rare.

The energy connections in nature are more accurately shown by a food web than by a food chain. A **food web** is a diagram that shows the feeding relationships between organisms in an ecosystem. **Figure 2** shows a simple food web. Notice that an arrow goes from the prairie dog to the coyote, showing that the prairie dog is food for the coyote. The prairie dog is also food for the mountain lion. Energy moves from one organism to the next in a one-way direction, even in a food web. Any energy not immediately used by an organism is stored in its tissues. Only the energy stored in an organism's tissues can be used by the next consumer. There are two main food webs on Earth: a land food web and an aquatic food web.

Figure 2 *The green arrows show how energy moves when one organism eats another. Most consumers eat a variety of foods and can be eaten by a variety of other consumers.*



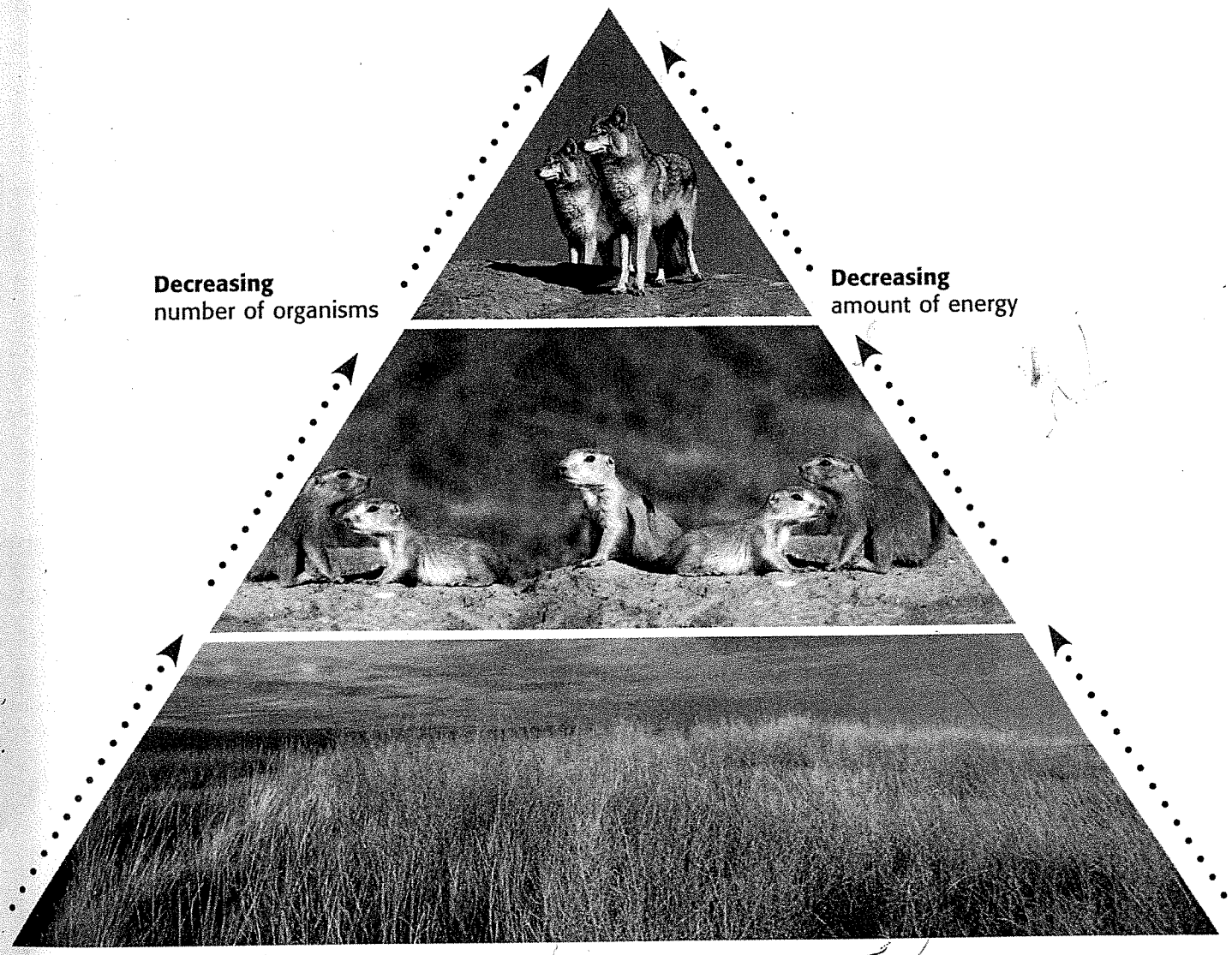


Figure 3 *The pyramid represents energy. As you can see, more energy is available at the base of the pyramid than at its top.*

Energy Pyramids

Grass uses most of the energy it gets from sunlight for its own life processes. But some of the energy is stored in the grass' tissues. This energy is used by the prairie dogs and other animals that eat the grass. Prairie dogs use most of the energy they get from eating grass and store only a little in their tissues. Therefore, a population of prairie dogs can support only a few coyotes. In the community, there must be more grass than prairie dogs and more prairie dogs than coyotes.

The energy at each level of the food chain can be seen in an energy pyramid. An **energy pyramid** is a diagram that shows an ecosystem's loss of energy. An example of an energy pyramid is shown in **Figure 3.** You can see that the energy pyramid has a large base and a small top. Less energy is available at higher levels because only energy stored in the tissues of an organism can be transferred to the next level.

energy pyramid a triangular diagram that shows an ecosystem's loss of energy, which results as energy passes through the ecosystem's food chain

Reading Check **What is an energy pyramid?**

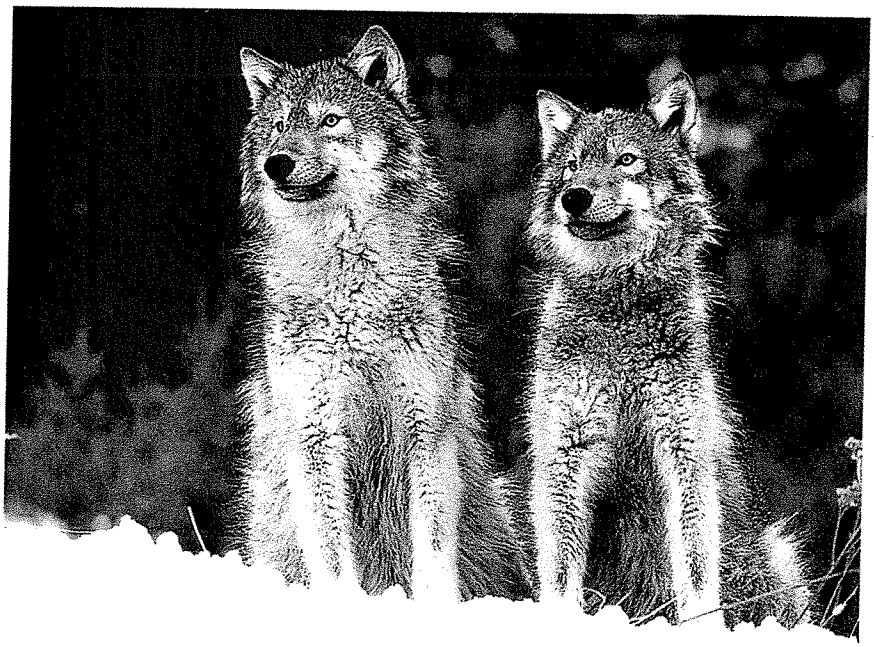


Figure 4 *As the wilderness was settled, the gray wolf population in the United States declined.*

Wolves and the Energy Pyramid

One species can be very important to the flow of energy in an environment. Gray wolves, which are shown in **Figure 4,** are consumers that control the populations of many other animals. The diet of gray wolves can include anything from a lizard to an elk. Because gray wolves are predators that prey on large animals, their place is at the top of the food pyramid.

Once common throughout much of the United States, gray wolves were almost wiped out as the wilderness was settled. Without wolves, some species, such as elk, were no longer controlled. The overpopulation of elk in some areas led to overgrazing. The overgrazing left too little grass to support the elk and other populations who depended on the grass for food. Soon, almost all of the populations in the area were affected by the loss of the gray wolves.

Reading Check **How were other animals affected by the disappearance of the gray wolf?**

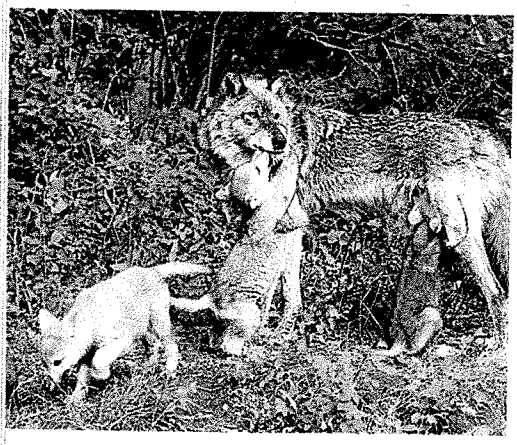


Figure 5 *In small wolf packs, only one female has pups. They are cared for by all of the males and females in the pack.*

Gray Wolves and the Food Web

Gray wolves were brought back to Yellowstone National Park in 1995. The reintroduced wolves soon began to breed. **Figure 5** shows a wolf caring for pups. The U.S. Fish and Wildlife Service thinks the return of the wolves will restore the natural energy flow in the area, bring populations back into balance, and help restore the park's natural integrity.

Not everyone approves, however. Ranchers near Yellowstone are concerned about the safety of their livestock. Cows and sheep are not the natural prey of wolves. However, the wolves will eat cows and sheep if they are given the chance.

Balance in Ecosystems

As wolves become reestablished in Yellowstone National Park, they kill the old, injured, and diseased elk. This process is reducing the number of elk. The smaller elk population is letting more plants grow. So, the numbers of animals that eat the plants, such as snowshoe hares, and the animals that eat the hares, such as foxes, are increasing.

All organisms in a food web are important for the health and balance of all other organisms in the food web. But the debate over the introduction of wolves to Yellowstone National Park will most likely continue for years to come.

MATH PRACTICE

Energy Pyramids

Draw an energy pyramid for a river ecosystem that contains four levels—aquatic plants, insect larvae, bluegill fish, and a largemouth bass. The plants obtain 10,000 units of energy from sunlight. If each level uses 90% of the energy it receives from the previous level, how many units of energy are available to the bass?

SECTION Review

Summary

- Producers use the energy in sunlight to make their own food.
- Consumers eat producers and other organisms to gain energy.
- Food chains represent how energy flows from one organism to another.
- All organisms are important to maintain the balance of energy in the food web.
- Energy pyramids show how energy is lost at each food chain level.

Using Key Terms

1. Use each of the following terms in a separate sentence: *herbivores, carnivores,* and *omnivores.*
2. In your own words, write a definition for each of the following terms: *food chain, food web,* and *energy pyramid.*

Understanding Key Ideas

3. Herbivores, carnivores, and scavengers are all examples of
   a. producers. **c.** consumers.
   b. decomposers. **d.** omnivores.
4. Explain the importance of decomposers in an ecosystem.
5. Describe how producers, consumers, and decomposers are linked in a food chain.
6. Describe how energy flows through a food web.

Math Skills

7. The plants in each square meter of an ecosystem obtained 20,810 Calories of energy from sunlight per year. The herbivores in that ecosystem ate all the plants but obtained only 3,370 Calories of energy. How much energy did the plants use?

Critical Thinking

8. **Identifying Relationships** Draw two food chains, and depict how they link together to form a food web.
9. **Applying Concepts** Are consumers found at the top or bottom of an energy pyramid? Explain your answer.
10. **Predicting Consequences** What would happen if a species disappeared from an ecosystem?

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Topic: Food Chains and Food Webs
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