

3

The Earth's Ecosystems

SECTION 1 Land Biomes	50
SECTION 2 Marine Ecosystems	58
SECTION 3 Freshwater Ecosystems	64
Chapter Lab	68
Chapter Review	70
Standardized Test Preparation	72
Science in Action	74

About the **PHOTO**

Is this animal a movie monster? No! The thorny devil is a lizard that lives in the desert of Australia. The thorny devil's rough skin is an adaptation that helps it survive in the hot, dry desert. Grooves in the thorny devil's skin collect water that the lizard later drinks. Water lands on its back and runs along the tiny grooves to the thorny devil's mouth.



PRE-READING **ACTIVITY**



Three-Panel Flip Chart

Before you read the chapter, create the FoldNote entitled "Three-Panel Flip Chart" described in the **Study Skills** section of the Appendix. Label the flaps of the three-panel flip chart with "Land biomes," "Marine ecosystems," and "Freshwater ecosystems." As you read the chapter, write information you learn about each category under the appropriate flap.





START-UP Activity

A Mini-Ecosystem



In this activity, you will build and observe a miniature ecosystem.

Procedure

1. Place a layer of **gravel** at the bottom of a **container**, such as a **large, wide-mouthed jar** or a **2 L soda bottle** with the top cut off. Then, add a layer of **soil**.
2. Add a variety of **plants** that need similar growing conditions. Choose small plants that will not grow too quickly.
3. Spray **water** inside the container to moisten the soil.
4. Loosely cover the container with a **lid** or **plastic wrap**. Place the container in indirect light.
5. Describe the appearance of your ecosystem.
6. Let your mini-ecosystem grow for 6 weeks. Add more water when the soil is dry.
7. Observe your mini-ecosystem every week. Record your observations.

Analysis

1. List the nonliving factors that make up the ecosystem that you built.
2. List the living factors that make up your ecosystem.
3. How is your mini-ecosystem similar to a real ecosystem? How is it different?

READING WARM-UP

Objectives

- Distinguish between abiotic factors and biotic factors in biomes.
- Identify seven land biomes on Earth.

Terms to Learn

biome	desert
savanna	tundra

READING STRATEGY

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

biome a large region characterized by a specific type of climate and certain types of plant and animal communities

Land Biomes

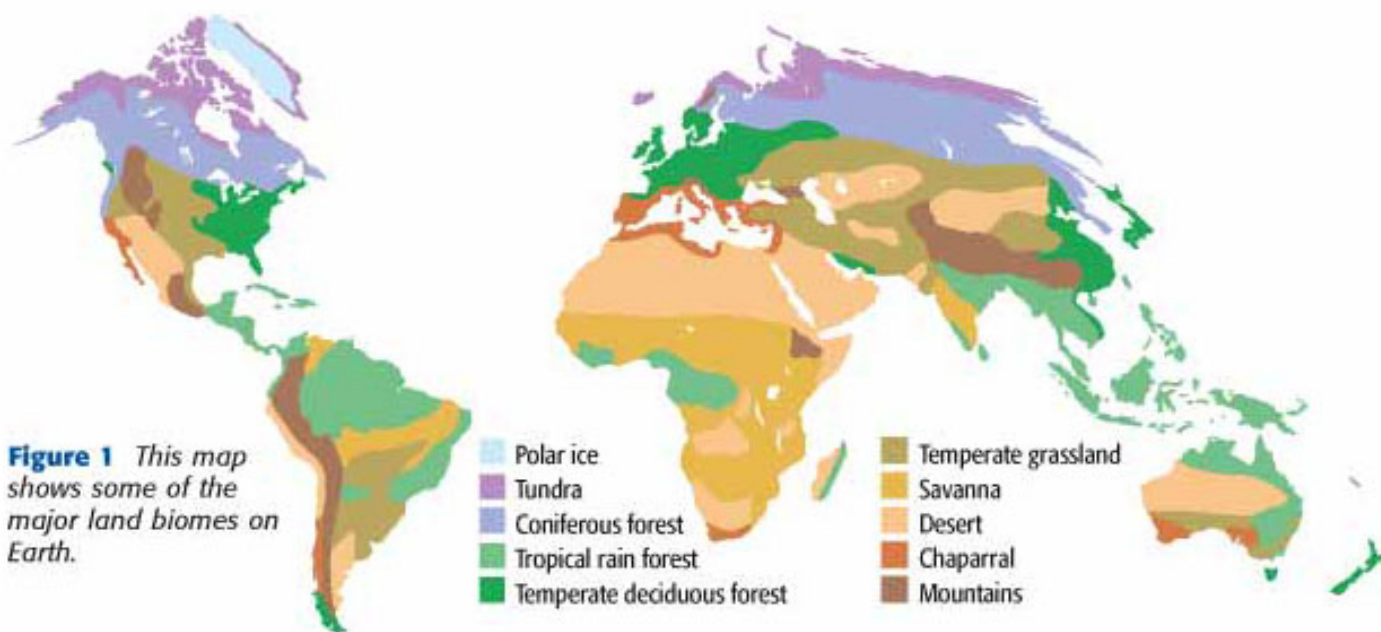
What do you think of when you think of polar bears? You probably imagine them in a snow-covered setting. Why don't polar bears live in the desert?

Different ecosystems are home to different kinds of organisms. Polar bears don't live in the desert because they are adapted to very cold environments. Polar bears have thick fur. This fur keeps polar bears warm. It also hides them in the snow.

The Earth's Land Biomes

Imagine yourself in a hot, dry, dusty place. You see a cactus on your right. A lizard sits on a rock to your left. Where are you? You may not know exactly, but you probably think you are in a desert.

A desert is different from other places because of its abiotic (AY bie AHT ik) factors and biotic (bie AHT ik) factors. *Abiotic factors* are the nonliving parts of an environment. Soil, water, and climate are abiotic factors. Climate is the average weather conditions for an area over a long period of time. *Biotic factors* are the living parts of an environment. Plants and animals are biotic factors. Areas that have similar abiotic factors usually have similar biotic factors. A **biome** (BIE OHM) is a large area characterized by its climate and the plants and animals that live in the area. A biome contains related ecosystems. For example, a tropical rain forest biome contains treetop ecosystems and forest-floor ecosystems. The major land biomes on Earth are shown in **Figure 1**.





In forests, plant growth happens in layers. The leafy tops of the trees reach high above the forest floor, where the leaves can get sunlight.

Woody shrubs catch the light that filters through the trees.

Ferns and mosses are scattered across the forest floor. Flowering plants often bloom in early spring, before the trees grow new leaves.

Temperate Deciduous Forest

- Average Yearly Rainfall
75 to 125 cm (29.5 to 49 in.)
- Average Temperatures
Summer: 28°C (82°F)
Winter: 6°C (43°F)

Forests

Forest biomes are often found in areas that have mild temperatures and plenty of rain. The kind of forest biome that develops depends on an area's temperatures and rainfall. Three forest biomes are temperate deciduous (dee SIJ oo uhs) forests, coniferous (koh NIF uhr uhs) forests, and tropical rain forests.

Temperate Deciduous Forests

Have you seen leaves change colors in the fall? Have you seen trees lose all of their leaves? If so, you have seen trees that are deciduous. The word *deciduous* comes from a Latin word that means "to fall off." Deciduous trees shed their leaves to save water during the winter or during the dry season. As shown in **Figure 2**, a variety of animals, such as bears, snakes, and woodpeckers, live in temperate deciduous forests.


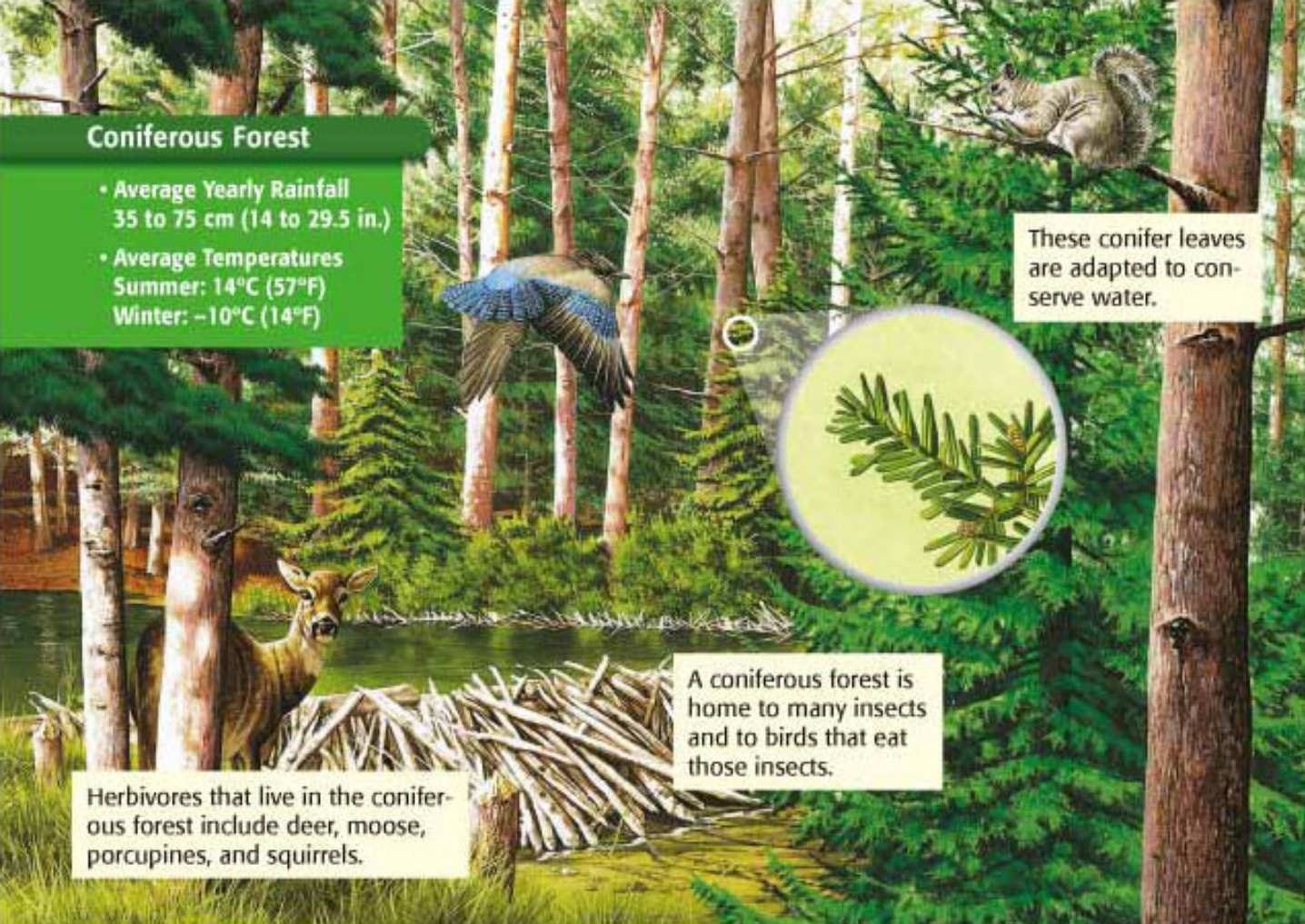
 **Reading Check** How does the word *deciduous* describe temperate deciduous forests? (See the Appendix for answers to Reading Checks.)

Figure 2 In a temperate deciduous forest, mammals, birds, and reptiles thrive on the many leaves, seeds, nuts, and insects.



Coniferous Forest

- Average Yearly Rainfall
35 to 75 cm (14 to 29.5 in.)
- Average Temperatures
Summer: 14°C (57°F)
Winter: -10°C (14°F)

These conifer leaves are adapted to conserve water.

A coniferous forest is home to many insects and to birds that eat those insects.

Herbivores that live in the coniferous forest include deer, moose, porcupines, and squirrels.

Figure 3 Many animals that live in a coniferous forest survive the harsh winters by hibernating or migrating to a warmer climate for the winter.

Coniferous Forests

Most of the trees in a coniferous forest are called *conifers*. Conifers produce seeds in cones. Conifers also have special leaves that are shaped like needles. The leaves have a thick, waxy coating. This waxy coating has three functions. First, it helps keep conifer leaves from drying out. Second, the waxy coating protects needles from being damaged by cold winter temperatures. Finally, the waxy coating allows most conifers to keep many of their leaves year-round. So, most conifers do not change very much from summer to winter. Trees that stay green all year and do not lose all of their leaves at one time are known as *evergreen trees*.

Figure 3 shows a coniferous forest and some of the animals that live there. Squirrels and insects live in coniferous forests. Birds, such as finches, chickadees, and jays, are common in these forests. Herbivores, such as porcupines, elk, and moose, also live in coniferous forests. The ground beneath large conifers is often covered by a thick layer of needles. Also, very little light reaches the ground. So, few large plants can grow beneath these trees.

✓ Reading Check What is another name for most conifers? What are some animals that live in coniferous forests?

Tropical Rain Forests

Tropical rain forests have more biological diversity than other places on Earth have. This means that rain forests have more kinds of plants and animals than any other land biome. For example, more than 100 different kinds of trees may grow in an area about one-fourth the size of a football field. Many animals live on the ground. But most animals live in the *canopy*, or the treetops. Many different animals live in the canopy. For example, nearly 1,400 species of birds live in the rain-forest canopy. **Figure 4** shows some of the diversity of the tropical rain forest.

Because of its diversity, the rain forest may seem as if it has nutrient-rich soil. But most of the nutrients in the tropical rain forest are found in the plants. The soil is actually very thin and poor in nutrients. Because the soil is so thin, many trees grow above-ground roots for extra support.

Figure 4 Tropical rain forests have a greater variety of organisms than any other biome.



Temperate Grassland

- Average Yearly Rainfall
25 to 75 cm (10 to 29.5 in.)
- Average Temperatures
Summer: 30°C (86°F)
Winter: 0°C (32°F)

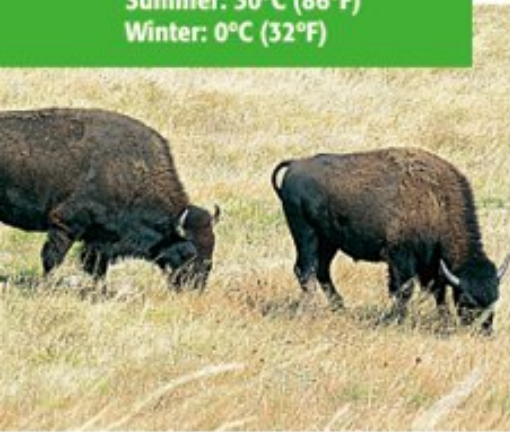


Figure 5 Bison once roamed North American temperate grasslands in great herds.

savanna a grassland that often has scattered trees and that is found in tropical and subtropical areas where seasonal rains, fires, and drought happen

CONNECTION TO Environmental Science

WRITING SKILL

Mountains and Climate

Mountains can affect the climate of the land around them. Research the ecosystems around a mountain range. In your **science journal**, write a report describing how the mountains affect the climate of the surrounding land.

Grasslands

Grasslands have many names, such as *steppes*, *prairies*, and *pampas*. Grasslands are found on every continent but Antarctica. They are often flat or have gently rolling hills.

Temperate Grasslands

Temperate grassland plants include grasses and other flowering plants. Temperate grasslands have few trees. Fires, drought, and grazing prevent the growth of trees and shrubs. Temperate grasslands support small seed-eating animals, such as prairie dogs and mice. Large grass eaters, such as the North American bison shown in **Figure 5**, also live in temperate grasslands.

Savannas

A grassland that has scattered clumps of trees and seasonal rains is called a **savanna**. Savannas are found in parts of Africa, India, and South America. During the dry season, savanna grasses dry out and turn yellow. But the grasses' deep roots survive for many months without water. The African savanna is home to many large herbivores, such as elephants, giraffes, zebras, and wildebeests. Some of these animals are shown in **Figure 6**.

Reading Check What happens to grasses on a savanna during the dry season?

Savanna

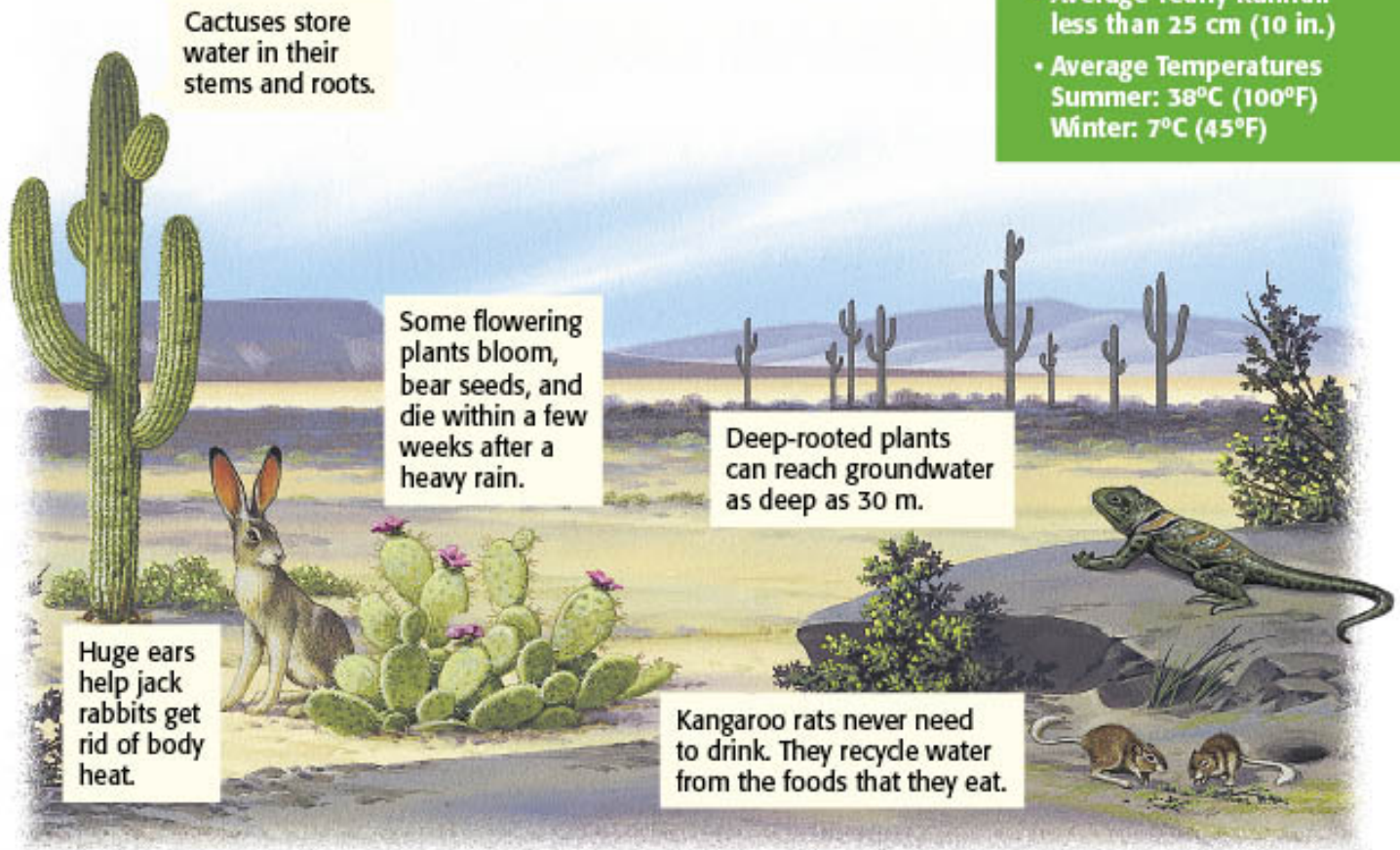
- Average Yearly Rainfall
150 cm (59 in.)
- Average Temperatures
Dry season: 34°C (93°F)
Wet season: 16°C (61°F)



Figure 6 In the African savanna, lions and leopards hunt zebras and wildebeests.

Desert

- Average Yearly Rainfall less than 25 cm (10 in.)
- Average Temperatures
Summer: 38°C (100°F)
Winter: 7°C (45°F)



Deserts

Biomes that are very dry and often very hot are called **deserts**. Many kinds of plants and animals are found only in deserts. These organisms have special adaptations to live in a hot, dry climate. For example, plants grow far apart so that the plants won't have to compete with each other for water. Some plants have shallow, widespread roots that grow just under the surface. These roots let plants take up water during a storm. Other desert plants, such as cactuses, have fleshy stems and leaves. These fleshy structures store water. The leaves of desert plants also have a waxy coating that helps prevent water loss.

Animals also have adaptations for living in the desert. Most desert animals are active only at night, when temperatures are cooler. Some animals, such as the spadefoot toad, bury themselves in the ground and are dormant during the dry season. Doing so helps these animals escape the heat of summer. Animals such as desert tortoises eat flowers or leaves and store the water under their shells. **Figure 7** shows how some desert plants and animals live in the heat with little water.


 **Reading Check** What are some adaptations of desert plants?

Figure 7 The residents of the desert biome have special adaptations to survive in a dry climate.

desert a region that has little or no plant life, long periods without rain, and extreme temperatures; usually found in hot climates

Tundra

- Average Yearly Rainfall
30 to 50 cm (12 to 20 in.)
- Average Temperatures
Summer: 12°C (54°F)
Winter: -26°C (-15°F)



Figure 8 During winters in the tundra, caribou migrate to grazing grounds that have a more-plentiful supply of food.

tundra a treeless plain found in the Arctic, in the Antarctic, or on the tops of mountains that is characterized by very low winter temperatures and short, cool summers

SCHOOL to HOME

Local Ecosystems

WRITING SKILL With a family member, explore the ecosystems around your home. What kinds of plants and animals live in your area? In your **science journal**, write a short essay describing the plants and animals in the ecosystems near your home.

ACTIVITY

Tundra

Imagine a place on Earth where it is so cold that trees do not grow. A biome that has very cold temperatures and little rainfall is called a **tundra**. Two types of tundra are polar tundra and alpine tundra.

Polar Tundra

Polar tundra is found near the North and South Poles. In polar tundra, the layer of soil beneath the surface soil stays frozen all the time. This layer is called *permafrost*. During the short, cool summers, only the surface soil thaws. The layer of thawed soil is too shallow for deep-rooted plants to live. So, shallow-rooted plants, such as grasses and small shrubs, are common. Mosses and lichens (LIE kuhnz) grow beneath these plants. The thawed soil above the permafrost becomes muddy. Insects, such as mosquitoes, lay eggs in the mud. Birds feed on these insects. Other tundra animals include musk oxen, wolves, and caribou, such as the one shown in **Figure 8**.

Alpine Tundra

Alpine tundra is similar to arctic tundra. Alpine tundra also has permafrost. But alpine tundra is found at the top of tall mountains. Above an elevation called the *tree line*, trees cannot grow on a mountain. Alpine tundra is found above the tree line. Alpine tundra gets plenty of sunlight and precipitation.

✓ Reading Check What is alpine tundra?

SECTION Review

Summary



- A biome is characterized by abiotic factors, such as climate, and biotic factors, such as plant and animal communities.
- Three forest biomes are temperate deciduous forests, coniferous forests, and tropical rain forests.
- Grasslands are areas where grasses are the main plants. Temperate grasslands have hot summers and cold winters. Savannas have wet and dry seasons.
- Deserts are very dry and often very hot. Desert plants and animals competing for the limited water supply have special adaptations for survival.
- Tundras are cold areas that have very little rainfall. Permafrost, the layer of frozen soil below the surface of arctic tundra, determines the kinds of plants and animals that live on the tundra.

Using Key Terms

1. Use each of the following terms in a separate sentence: *biome* and *tundra*.
2. In your own words, write a definition for each of the following terms: *savanna* and *desert*.

Understanding Key Ideas

3. If you visited a savanna, you would most likely see
 - a. large herds of grazing animals, such as zebras, gazelles, and wildebeests.
 - b. dense forests stretching from horizon to horizon.
 - c. snow and ice throughout most of the year.
 - d. trees that form a continuous green roof, called the *canopy*.
4. Components of a desert ecosystem include
 - a. a hot, dry climate.
 - b. plants that grow far apart.
 - c. animals that are active mostly at night.
 - d. All of the above
5. List seven land biomes that are found on Earth.
6. What are two things that characterize a biome?

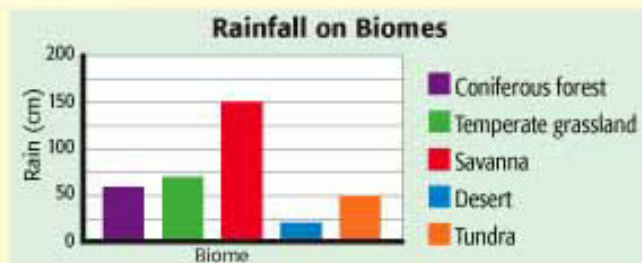
Critical Thinking

7. **Making Inferences** While excavating an area in the desert, a scientist discovers the fossils of very large trees and ferns. What might the scientist conclude about biomes in this area?

8. **Analyzing Ideas** Tundra receives very little rainfall. Could tundra accurately be called a *frozen desert*? Explain your answer.

Interpreting Graphics

Use the bar graph below to answer the questions that follow.



9. Which biomes receive 50 cm or more of rain each year?
10. Which biome receives the smallest amount of rain? the largest amount of rain?

SCILINKS

By
Nation

NSTA

For a variety of links related to this chapter, go to www.scilinks.org

Topic: Forests

SciLinks code: HSM0609

READING WARM-UP

Objectives

- List three abiotic factors that shape marine ecosystems.
- Describe four major ocean zones.
- Describe five marine ecosystems.

Terms to Learn

plankton
estuary

READING STRATEGY

Prediction Guide Before reading this section, write the title of each heading in this section. Next, under each heading, write what you think you will learn.

plankton the mass of mostly microscopic organisms that float or drift freely in freshwater and marine environments

Figure 1 Marine ecosystems support a broad diversity of life. Humpback whales rely on plankton for food.

Marine Ecosystems

What covers almost three-fourths of Earth's surface? What holds both the largest animals and some of the smallest organisms on Earth?

If your answer to both questions is *oceans*, you are correct! Earth's oceans contain many different ecosystems. Scientists call ecosystems in the ocean *marine ecosystems*.

Life in the Ocean

Marine ecosystems are shaped by abiotic factors. These factors include water temperature, water depth, and the amount of sunlight that passes into the water. The animals and plants that live in the ocean come in all shapes and sizes. The largest animals on Earth, blue whales, live in the ocean. So do trillions of tiny plankton. **Plankton** are tiny organisms that float near the surface of the water. Many plankton are producers. They use photosynthesis to make their own food. Plankton form the base of the ocean's food chains. **Figure 1** shows plankton and an animal that relies on plankton for food.

✓ Reading Check What are plankton? How are they important to marine ecosystems? (See the Appendix for answers to Reading Checks.)



Temperature

The temperature of ocean water decreases as the depth of the water increases. However, the temperature change is not gradual. **Figure 2** shows the three temperature zones of ocean water. Notice that the temperature of the water in the surface zone is much warmer than in the rest of the ocean. Temperatures in the surface zone vary with latitude. Areas of the ocean along the equator are warmer than areas closer to the poles. Surface zone temperatures also vary with the time of year. During the summer, the Northern Hemisphere is tilted toward the sun. So, the surface zone is warmer than it is during the winter.

Temperature affects the animals that live in marine ecosystems. For example, fishes that live near the poles have adaptations to live in near-freezing water. In contrast, animals that live in coral reefs need warm water to live. Some animals, such as whales, migrate from cold areas to warm areas of the ocean to reproduce. Water temperature also affects whether some animals, such as barnacles, can eat. If the water is too hot or too cold, these animals may not be able to eat. A sudden change in temperature may cause these animals to die.


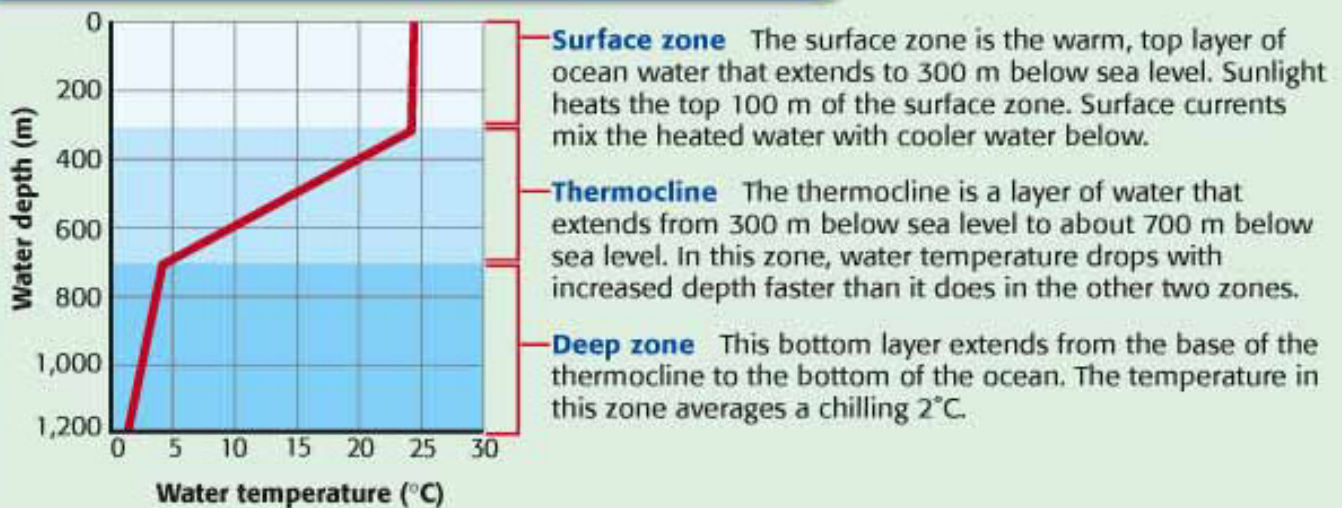
 **Reading Check** How does temperature affect marine animals?

Figure 2 Ocean Temperature Zones



Depth and Sunlight

In addition to water temperature, life in the ocean is affected by water depth and the amount of sunlight that passes into the water. The major ocean zones are shown in **Figure 3**.

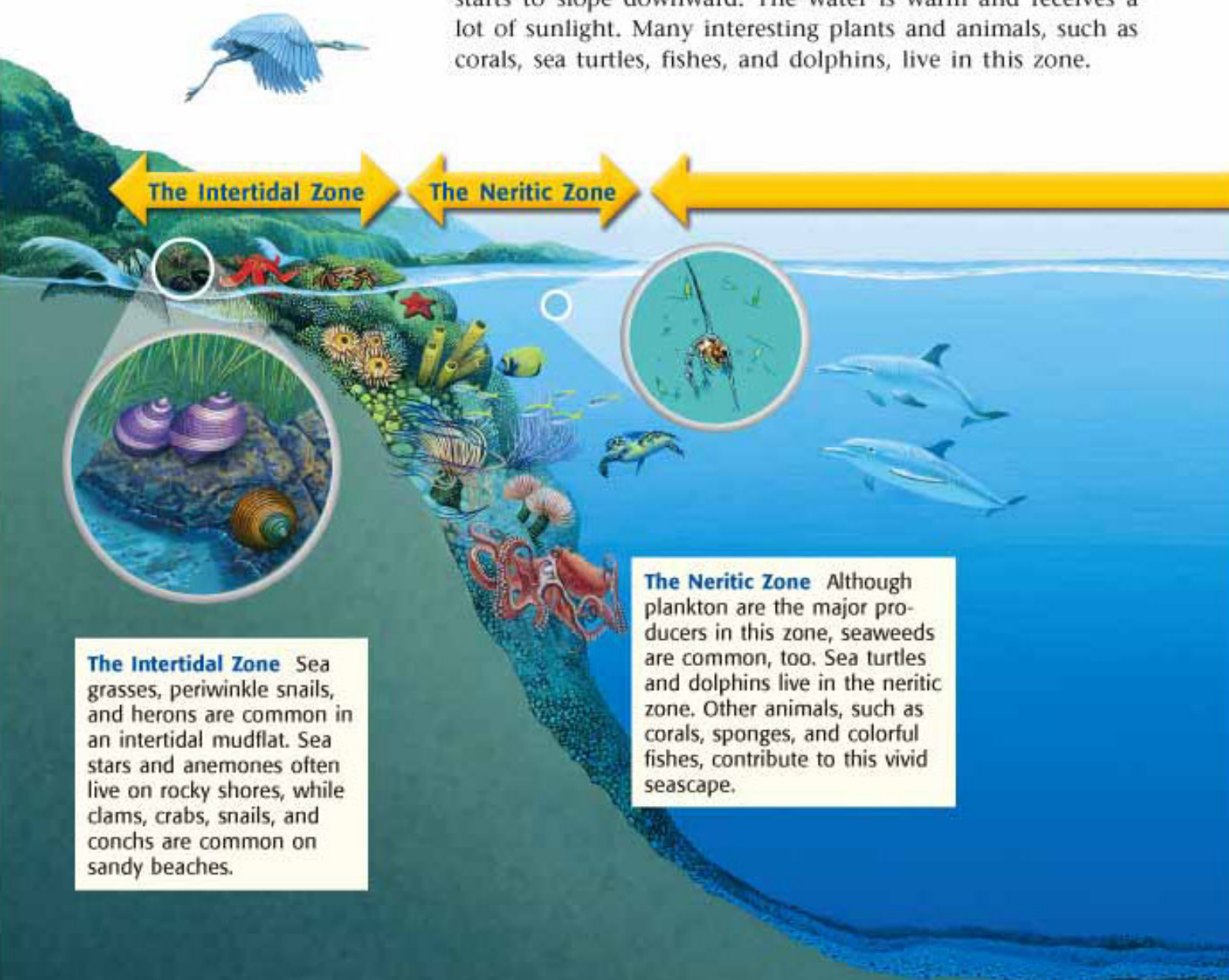
The Intertidal Zone

The intertidal zone is the place where the ocean meets the land. This area is exposed to the air for part of the day. Waves are always crashing on the rock and sand. The animals that live in the intertidal zone have adaptations to survive exposure to air and to keep from being washed away by the waves.

The Neritic Zone

As you move farther away from shore, into the neritic zone (nee RIT ik ZOHN), the water becomes deeper. The ocean floor starts to slope downward. The water is warm and receives a lot of sunlight. Many interesting plants and animals, such as corals, sea turtles, fishes, and dolphins, live in this zone.

Figure 3 The life in a marine ecosystem depends on water temperature, water depth, and the amount of sunlight the area receives.



The Intertidal Zone Sea grasses, periwinkle snails, and herons are common in an intertidal mudflat. Sea stars and anemones often live on rocky shores, while clams, crabs, snails, and conchs are common on sandy beaches.

The Neritic Zone Although plankton are the major producers in this zone, seaweeds are common, too. Sea turtles and dolphins live in the neritic zone. Other animals, such as corals, sponges, and colorful fishes, contribute to this vivid seascape.

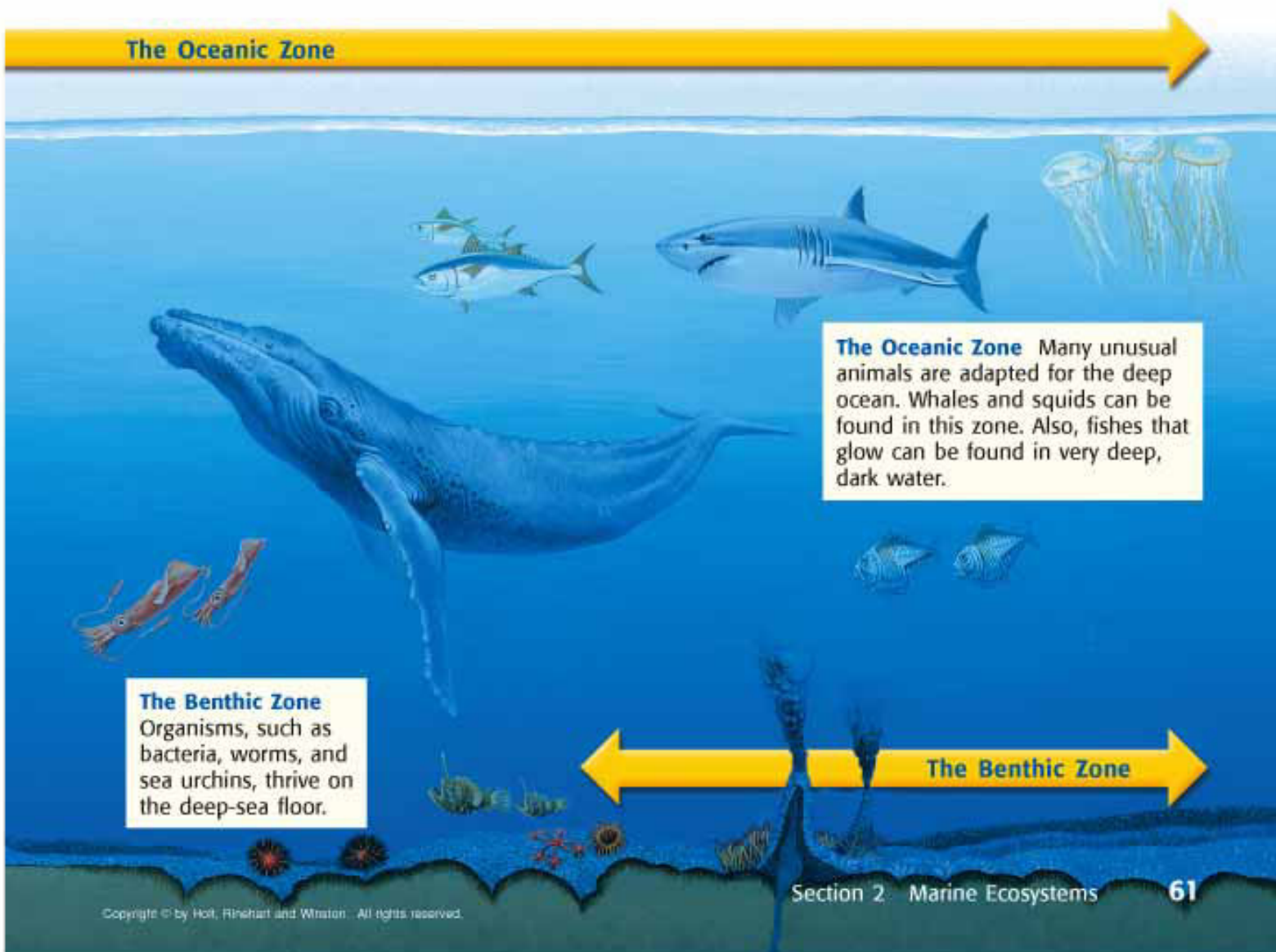
The Oceanic Zone

In the oceanic zone, the sea floor drops sharply. This zone contains the deep water of the open ocean. Plankton can be found near the water surface. Animals, such as fishes, whales, and sharks, are found in the oceanic zone. Some animals in this zone live in very deep water. These animals often get food from material that sinks down from the ocean surface.

The Benthic Zone

The benthic zone is the ocean floor. The deepest parts of the benthic zone do not get any sunlight. They are also very cold. Animals, such as fishes, worms, and crabs, have special adaptations to the deep, dark water. Many of these organisms get food by eating material that sinks from above. Some organisms, such as bacteria, get energy from chemicals that escape from thermal vents on the ocean floor. Thermal vents form at cracks in the Earth's crust.

 **Reading Check** How do animals in the benthic zone get food?



A Closer Look

Life on Earth depends on the ocean. Through evaporation, the ocean provides most of the water that makes up Earth's precipitation. Ocean temperatures and currents can affect world climates and wind patterns. Humans and many animals depend on the ocean for food.

Many ecosystems exist in the ocean. Some of these ecosystems are found on or near the shore. Other ecosystems are found in the middle of the ocean or near the poles.


Intertidal Areas

Intertidal areas are found near the shore. These areas include mudflats, sandy beaches, and rocky shores. Intertidal organisms must be able to live both underwater and out of water. The organisms that live in mudflats include worms and crabs. Shorebirds feed on these animals. Organisms that live on sandy beaches include worms, clams, crabs, and plankton. On rocky shores, organisms have adaptations to keep from being swept away by crashing waves. Some organisms use rootlike structures called *holdfasts* to attach themselves to the rocks. Other organisms attach themselves to rocks by releasing a special glue.

estuary an area where fresh water from rivers mixes with salt water from the ocean

Coral Reefs

Most coral reefs are found in warm, shallow areas of the neritic zone. The reefs are made up of small animals called *corals*. Corals live in large groups. When corals die, they leave their skeletons behind. New corals grow on these remains. Over time, layers of skeletons build up and form a reef. This reef provides a home for many marine animals and plants. These organisms include algae, brightly colored fishes, sponges, sea stars, and sea urchins. An example of a coral reef is shown in **Figure 4**.

 **Reading Check** How do coral reefs develop?

Estuaries

An area where fresh water from streams and rivers spills into the ocean is called an **estuary** (ES tyoo er ee). In estuaries, the fresh water from rivers and the salt water from the ocean are always mixing. Therefore, the amount of salt in the water is always changing. Plants and animals that live in estuaries must be able to survive the changing concentrations of salt. The fresh water that spills into an estuary is rich in nutrients. Because estuaries are so nutrient rich, they support large numbers of plankton. The plankton, in turn, provide food for many animals.



Figure 4 A coral reef is one of the most biologically diverse ecosystems on Earth.

The Sargasso Sea

An ecosystem called the *Sargasso Sea* (sahr GAS oh SEE) is found in the middle of the Atlantic Ocean. This ecosystem contains floating rafts of algae called *sargassum* (sahr GAS uhm). Many of the animals that live in the Sargasso Sea are the same color as sargassum, which helps the animals hide from predators.

Polar Ice

The Arctic Ocean and the ocean around Antarctica make up another marine ecosystem. These icy waters are rich in nutrients, which support large numbers of plankton. Many fishes, birds, and mammals rely on the plankton for food. Animals, such as polar bears and penguins, live on the polar ice.



SECTION Review

Summary

- Abiotic factors that affect marine ecosystems are water temperature, water depth, and the amount of light that passes into the water.
- Plankton form the base of the ocean's food chains.
- Four ocean zones are the intertidal zone, the neritic zone, the oceanic zone, and the benthic zone.
- The ocean contains unique ecosystems, including intertidal areas, coral reefs, estuaries, the Sargasso Sea, and polar ice.

Using Key Terms

1. Use each of the following terms in a separate sentence: *plankton* and *estuary*.

Understanding Key Ideas

2. Water temperature
 - a. has no effect on the animals in a marine ecosystem.
 - b. affects the types of organisms that can live in a marine ecosystem.
 - c. decreases gradually as water gets deeper.
 - d. increases as water gets deeper.
3. What are three abiotic factors that affect marine ecosystems?
4. Describe four major ocean zones.
5. Describe five marine ecosystems. For each ecosystem, list an organism that lives there.

Math Skills

6. The ocean covers about 71% of the Earth's surface. If the total surface area of the Earth is about 510 million square kilometers, how many square kilometers are covered by the ocean?

Critical Thinking

7. **Making Inferences** Animals in the Sargasso Sea hide from predators by blending in with the sargassum. Color is only one way to blend in. What is another way that animals can blend in with sargassum?
8. **Identifying Relationships** Many fishes and other organisms that live in the deep ocean produce light. What are two ways in which this light might be useful?
9. **Applying Concepts** Imagine that you are studying animals that live in intertidal zones. You just discovered a new animal. Describe the animal and adaptations the animal has to survive in the intertidal zone.

SCILINKS.

D
Nation

NSTA

For a variety of links related to this chapter, go to www.scilinks.org

Topic: Marine Ecosystems
SciLinks code: HSM0911

READING WARM-UP

Objectives

- Describe one abiotic factor that affects freshwater ecosystems.
- Describe the three zones of a lake.
- Describe two wetland ecosystems.
- Explain how a lake becomes a forest.

Terms to Learn

littoral zone	wetland
open-water zone	marsh
deep-water zone	swamp

READING STRATEGY

Paired Summarizing Read this section silently. In pairs, take turns summarizing the material. Stop to discuss ideas that seem confusing.

Freshwater Ecosystems

A brook bubbles over rocks. A mighty river thunders through a canyon. A calm swamp echoes with the sounds of frogs and birds. What do these places have in common?

Brooks, rivers, and swamps are examples of freshwater ecosystems. The water in brooks and rivers is often fast moving. In swamps, water moves very slowly. Also, water in swamps is often found in standing pools.

Stream and River Ecosystems

The water in brooks, streams, and rivers may flow from melting ice or snow. Or the water may come from a spring. A spring is a place where water flows from underground to the Earth's surface. Each stream of water that joins a larger stream is called a *tributary* (TRIB yoo TER ee). As more tributaries join a stream, the stream contains more water. The stream becomes stronger and wider. A very strong, wide stream is called a *river*. **Figure 1** shows how a river develops.

Like other ecosystems, freshwater ecosystems are characterized by their abiotic factors. An important abiotic factor in freshwater ecosystems is how quickly water moves.

Streams and rivers are full of life. Plants line the edges of streams and rivers. Fish live in the open waters. And clams and snails live in the mud at the bottom of a stream or river. Organisms that live in fast-moving water have adaptations to keep from being washed away. Some producers, such as algae and moss, are attached to rocks. Consumers, such as tadpoles, use suction disks to hold themselves to rocks. Other consumers, such as insects, live under rocks.

Figure 1 Rivers become larger as more tributaries flow into them.



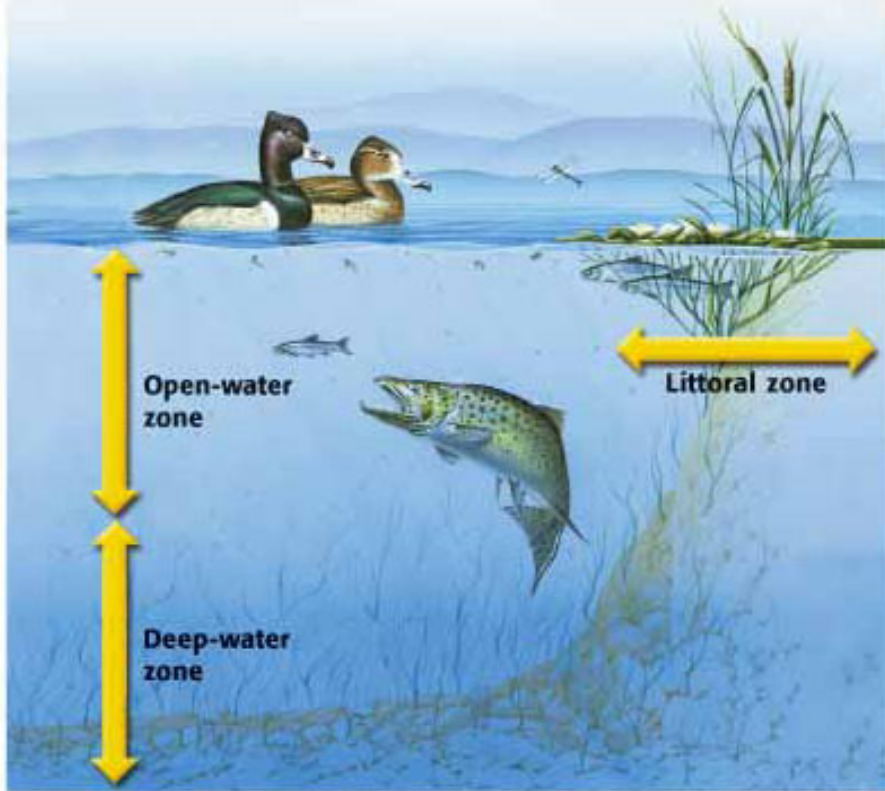


Figure 2 Ponds and lakes can be divided into three zones. Each zone has different organisms and abiotic factors.

Pond and Lake Ecosystems

Ponds and lakes have different ecosystems than streams and rivers do. **Figure 2** shows the zones of a typical lake.

Life near Shore

The area of water closest to the edge of a lake or pond is called the **littoral zone** (LIT uh ruhl ZOHN). Sunlight reaches the bottom of the littoral zone. This sunlight makes it possible for algae and plants to grow in the littoral zone. Algae grow beneath the surface of the water in the littoral zone. Plants that grow near the shore include cattails and rushes. Floating leaf plants, such as water lilies, grow farther from the shore. The plants of the littoral zone are home to small animals, such as snails and insects. Clams and worms bury themselves in the mud. Frogs, salamanders, turtles, fish, and snakes also live in this zone.

Life Away from Shore

The area of a lake or pond that extends from the littoral zone across the top of the water is called the **open-water zone**. The open-water zone goes as deep as sunlight can reach. This zone is home to bass, lake trout, and other fishes. Many photosynthetic plankton also live in this area. Beneath the open-water zone is the **deep-water zone**, where no sunlight reaches. Catfish, carp, worms, crustaceans, fungi, and bacteria live here. These organisms often feed on dead organisms that sink from above.

✓ Reading Check Describe the three zones of a lake. (See the Appendix for answers to Reading Checks.)

QUICK LAB

Pond-Food Relationships

1. On **index cards**, write the names of some of the plants and animals that live in a typical freshwater pond or small lake. Write one type of organism on each card.
2. Use **yarn or string** to connect each organism to its food sources.
3. Describe the food relationships in a pond.

littoral zone the shallow zone of a lake or pond where light reaches the bottom and nurtures plants

open-water zone the zone of a pond or lake that extends from the littoral zone and that is only as deep as light can reach

deep-water zone the zone of a lake or pond below the open-water zone, where no light reaches

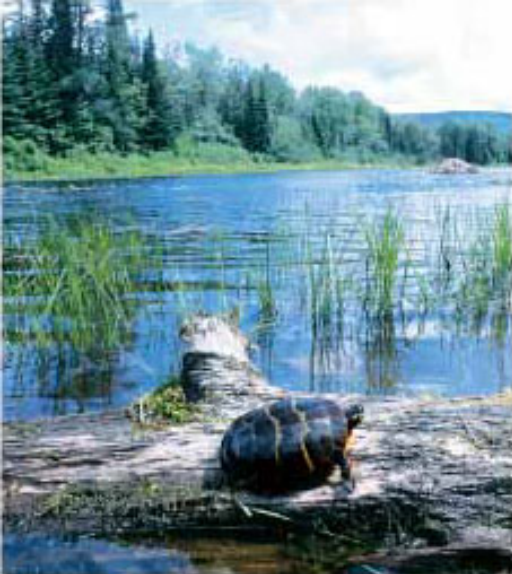


Figure 3 This painted turtle suns itself on a log in a freshwater marsh.

wetland an area of land that is periodically underwater or whose soil contains a great deal of moisture

marsh a treeless wetland ecosystem where plants such as grasses grow

swamp a wetland ecosystem in which shrubs and trees grow

Wetland Ecosystems

An area of land that is sometimes underwater or whose soil contains a great deal of moisture is called a **wetland**. Wetlands support many different plants and animals. Wetlands also play an important role in flood control. During heavy rains or spring snow melt, wetlands soak up large amounts of water. The water in wetlands also moves deeper into the ground. So, wetlands help replenish underground water supplies.

Marshes

A treeless wetland ecosystem where plants, such as grasses, grow is called a **marsh**. A freshwater marsh is shown in **Figure 3**. Freshwater marshes are often found in shallow areas along the shores of lakes, ponds, rivers, and streams. The plants in a marsh vary depending on the depth of the water and the location of the marsh. Grasses, reeds, bulrushes, and wild rice are common marsh plants. Muskrats, turtles, frogs, and birds also live in marshes.

Swamps

A wetland ecosystem in which trees and vines grow is called a **swamp**. Swamps, as shown in **Figure 4**, are found in low-lying areas and beside slow-moving rivers. Most swamps are flooded part of the year, depending on rainfall. Willows, bald cypresses, and oaks are common swamp trees. Vines, such as poison ivy, grow up tree trunks. Plants, such as orchids, may hang from tree branches. Water lilies and other plants grow in standing water. Many fishes, snakes, and birds also live in swamps.

 **Reading Check** What is a swamp?

CONNECTION TO Language Arts

Compound Words A compound word is a word made up of two or more single words. In your **science journal**, define the two words that make up the word *wetland*. Then, define three more compound words.




Figure 4 The trunks of these trees are adapted to give the trees more support in the wet, soft soil of a swamp.

From a Lake to a Forest

Did you know that a lake or pond can disappear? How can this happen? Water entering a standing body of water usually carries nutrients and sediment. These materials settle to the bottom of the pond or lake. Dead leaves from overhanging trees and decaying plant and animal life also settle to the bottom. Then, bacteria decompose this material. This process uses oxygen in the water. The loss of oxygen affects the kinds of animals that can survive in the pond or lake. For example, many fishes would not be able to survive with less oxygen in the water.

Over time, the pond or lake is filled with sediment. Plants grow in the new soil. Shallow areas fill in first. So, plants slowly grow closer and closer to the center of the pond or lake. What is left of the lake or pond becomes a wetland, such as a marsh or swamp. Eventually, the wetland can become a forest.

 **Reading Check** What happens to some of the animals in a pond as the pond becomes a forest?

INTERNET ACTIVITY

For another activity related to this chapter, go to go.hrw.com and type in the keyword **HL5ECOW**.



SECTION Review

Summary

- An important abiotic factor in freshwater ecosystems is how quickly water moves.
- The three zones of a pond or lake are the littoral zone, the open-water zone, and the deep-water zone.
- Wetlands include marshes and swamps.
- Sediments and decaying plant and animal matter build up in a pond. Over time, the pond may fill completely and become a forest.

Using Key Terms

1. Use the following terms in the same sentence: *wetland*, *marsh*, and *swamp*.

Understanding Key Ideas

2. A major abiotic factor in freshwater ecosystems is the
 - a. source of the water.
 - b. speed of the water.
 - c. width of the stream or river.
 - d. None of the above
3. Describe the three zones of a lake.
4. Explain how a lake can become a forest over time.

Math Skills

5. Sunlight can penetrate a certain lake to a depth of 15 m. The lake is five and a half times deeper than the depth to which light can penetrate. In meters, how deep is the lake?

Critical Thinking

6. **Making Inferences** When bacteria decompose material in a pond, the oxygen in the water may be used up. So, fishes in the pond die. How might the absence of fish lead to a pond filling faster?
7. **Applying Concepts** Imagine a steep, rocky stream. What kinds of adaptations might animals living in this stream have? Explain your answer.

SCILINKS.

NSTA

Developed and maintained by the
National Science Teachers Association

For a variety of links related to this chapter, go to www.scilinks.org

Topic: **Freshwater Ecosystems**
SciLinks code: **HSM0621**



OBJECTIVES

Draw common pond-water organisms.

Observe the effect of fertilizer on pond-water organisms.

Describe how fertilizer affects the number and type of pond-water organisms over time.

MATERIALS

- beaker, 500 mL
- distilled water, 2.25 L
- eyedropper
- fertilizer
- gloves, protective
- graduated cylinder, 100 mL
- jars, 1 qt or 1 L (3)
- microscope
- microscope slides with coverslips
- pencil, wax
- plastic wrap
- pond water containing living organisms, 300 mL
- stirring rod

SAFETY



Too Much of a Good Thing?

Plants need nutrients, such as phosphates and nitrates, to grow. Phosphates are often found in detergents. Nitrates are often found in animal wastes and fertilizers. When large amounts of these nutrients enter rivers and lakes, algae and plants grow rapidly and then die off. Microorganisms that decompose the dead matter use up oxygen in the water. Without oxygen, fish and other animals die. In this activity, you will observe the effect of fertilizers on organisms that live in pond water.

Procedure

- 1 Label one jar "Control," the second jar "Fertilizer," and the third jar "Excess fertilizer."
- 2 Pour 750 mL of distilled water into each jar. To the "Fertilizer" jar, add the amount of fertilizer recommended for 750 mL of water. To the "Excess fertilizer" jar, add 10 times the amount recommended for 750 mL of water. Stir the contents of each jar to dissolve the fertilizer.
- 3 Obtain a sample of pond water. Stir it gently to make sure that the organisms in it are evenly distributed. Pour 100 mL of pond water into each of the three jars.
- 4 Observe a drop of water from each jar under the microscope. Draw at least four of the organisms. Determine whether the organisms you see are producers, which are usually green, or consumers, which are usually able to move. Describe the number and type of organisms in the pond water.

Common Pond-Water Organisms



Volvox
(producer)



Spirogyra
(producer)



Daphnia
(consumer)



Vorticella
(consumer)



- 5 Cover each jar loosely with plastic wrap. Place the jars near a sunny window but not in direct sunlight.
- 6 Make a prediction about how the pond organisms will grow in each of the three jars.
- 7 Make three data tables. Title one table "Control," as shown below. Title another table "Fertilizer," and title the third table "Excess fertilizer."

Control			
Date	Color	Odor	Other observations

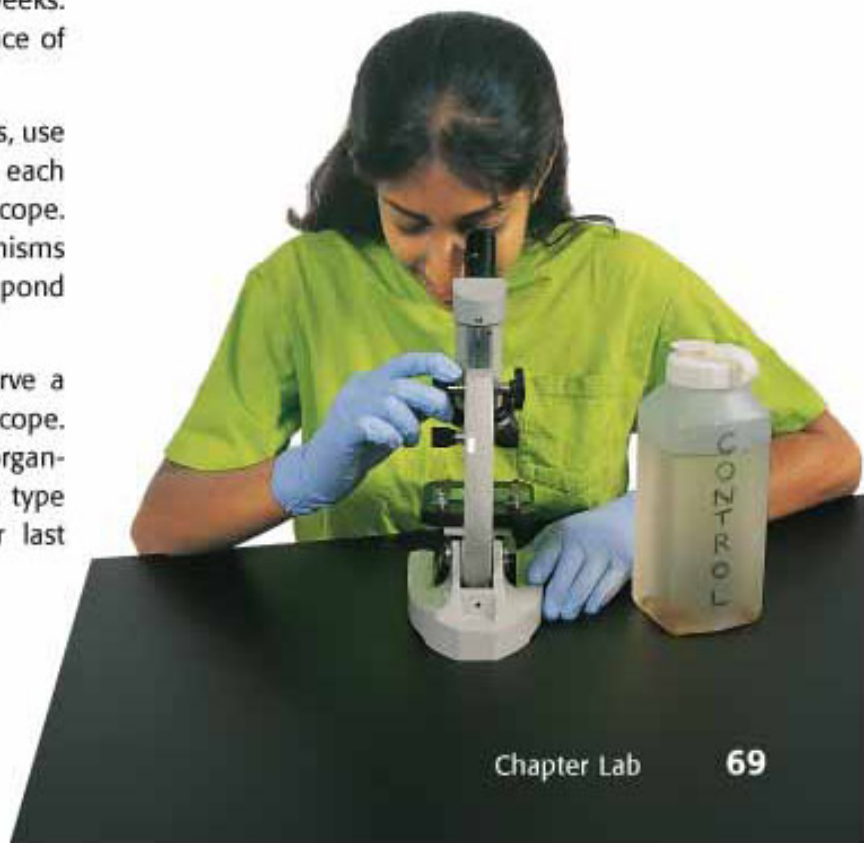
- 8 Observe the jars when you first set them up and once every 3 days for the next 3 weeks. Note the color, the odor, and the presence of organisms. Record your observations.
- 9 When organisms become visible in the jars, use an eyedropper to remove a sample from each jar. Observe the sample under the microscope. How have the number and type of organisms changed since you first looked at the pond water?
- 10 At the end of the 3-week period, observe a sample from each jar under the microscope. Draw at least four of the most abundant organisms, and describe how the number and type of organisms have changed since your last microscope observation.

Analyze the Results

- 1 **Describing Events** After 3 weeks, which jar has the most abundant growth of algae?
- 2 **Analyzing Data** Did you observe any effects on organisms (other than algae) in the jar with the most abundant algal growth? Explain your answer.

Draw Conclusions

- 3 **Drawing Conclusions** What may have caused increased growth in the jars?
- 4 **Evaluating Results** Did your observations match your predictions? Explain your answer.
- 5 **Interpreting Information** Decaying plant and animal life contribute to the filling of lakes and ponds. How might the rapid filling of lakes and ponds be prevented or slowed?





Chapter Review

USING KEY TERMS

- 1 In your own words, write a definition for the following terms: *biome* and *tundra*.
- 2 Use each of the following terms in a separate sentence: *intertidal zone*, *neritic zone*, and *oceanic zone*.

For each pair of terms, explain how the meanings of the terms differ.

- 3 *savanna* and *desert*
- 4 *open-water zone* and *deep-water zone*
- 5 *marsh* and *swamp*

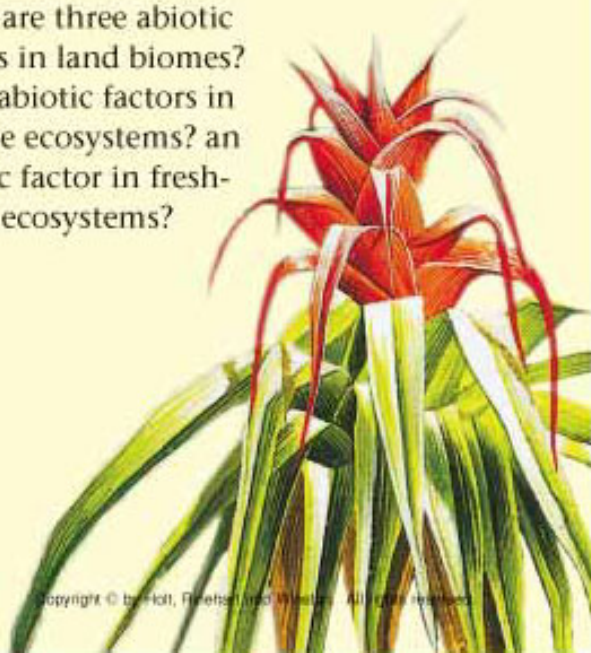
UNDERSTANDING KEY IDEAS

Multiple Choice

- 6 Trees that lose their leaves in the winter are called
 - a. evergreen trees.
 - b. coniferous trees.
 - c. deciduous trees.
 - d. None of the above
- 7 In which major ocean zone are plants and animals exposed to air for part of the day?
 - a. intertidal zone
 - b. neritic zone
 - c. oceanic zone
 - d. benthic zone
- 8 An abiotic factor that affects marine ecosystems is
 - a. the temperature of the water.
 - b. the depth of the water.
 - c. the amount of sunlight that passes through the water.
 - d. All of the above
- 9 _____ is a marine ecosystem that includes mudflats, sandy beaches, and rocky shores.
 - a. An intertidal area
 - b. Polar ice
 - c. A coral reef
 - d. The Sargasso Sea

Short Answer

- 10 What are seven land biomes?
- 11 Explain how a small lake can become a forest.
- 12 What are two factors that characterize biomes?
- 13 Describe the three zones of a lake.
- 14 How do rivers form?
- 15 What are three abiotic factors in land biomes? three abiotic factors in marine ecosystems? an abiotic factor in freshwater ecosystems?

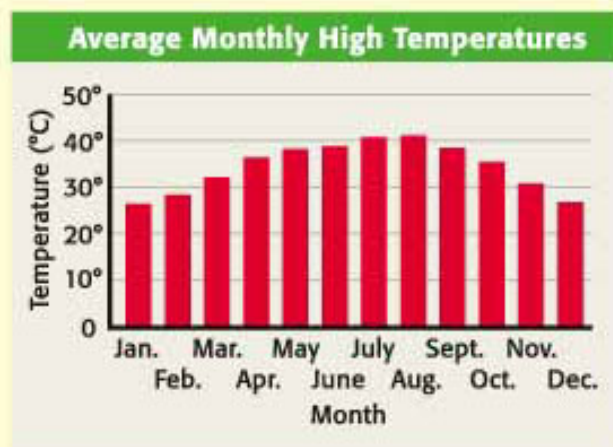


CRITICAL THINKING

- 16 Concept Mapping** Use the following terms to create a concept map: *plants and animals, tropical rain forest, tundra, biomes, permafrost, canopy, desert, and abiotic factors.*
- 17 Making Inferences** Plankton use photosynthesis to make their own food. They need sunlight for photosynthesis. Which of the four major ocean zones can support plankton growth? Explain your answer.
- 18 Predicting Consequences** Wetlands, such as marshes and swamps, play an important role in flood control. Wetlands also help replenish underground water supplies. Predict what might happen if a wetland dries out.
- 19 Analyzing Ideas** A scientist has a new hypothesis. He or she thinks that savannas and deserts are part of one biome rather than two separate biomes. Based on what you've learned, decide if the scientist's hypothesis is correct. Explain your answer.
- 20 Applying Concepts** Imagine that you are a scientist. You are studying an area that gets about 100 cm of rain each year. The average summer temperatures are near 30°C. What biome are you in? What are some plants and animals you will likely encounter? If you stayed in this area for the winter, what kind of preparations might you need to make?

INTERPRETING GRAPHICS

Use the graphs below to answer the questions that follow.



- 21** Which biome is most likely found in the region described by the graphs above? Explain your answer.
- 22** How many centimeters of rain fell in the region during the course of the year?
- 23** Which month is the hottest in the region? the coolest in the region?
- 24** What is the average monthly precipitation for the month that has the highest average high temperature?



Standardized Test Preparation

READING

Read each of the passages below. Then, answer the questions that follow each passage.

Passage 1 Billy has a brochure for a camp that boasts of being the most adventurous summer camp in the world. Billy can't wait to go to the camp and have fun outdoors. To prepare, he checks the supply list, which includes the following: light, summer clothes; sunscreen; rain gear; a heavy, down-filled jacket; a ski mask; and thick gloves. The list seems strange to Billy. He thought he was traveling to only one destination, so why does he need to bring such a wide variety of clothes? Billy rereads the brochure and learns that the campers will "climb the biomes of the world in just three days." The destination is Africa's tallest mountain, Kilimanjaro.

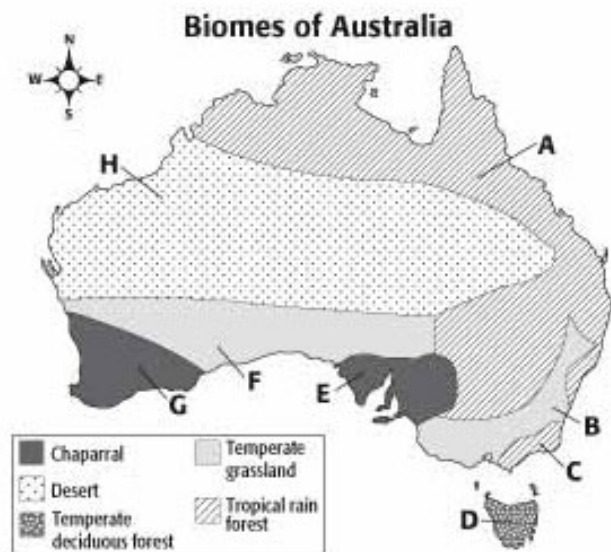
1. In this passage, what does the word *destination* likely mean?
A camp
B vacation
C place
D mountain
2. Based on the passage, which of the following statements is a fact?
F People ski on Kilimanjaro.
G Kilimanjaro is Africa's tallest mountain.
H It rains a lot on Kilimanjaro.
I The summers are cold on Kilimanjaro.
3. Why might Billy wonder if the brochure was advertising only one location?
A The brochure called the camp the most adventurous summer camp in the world.
B The brochure said that he would need light, summer clothes and sunscreen.
C The brochure said that he would need light, summer clothes and a heavy, down-filled jacket.
D The brochure said that the summers are cold on Kilimanjaro.

Passage 2 The layer of soil above the permafrost is too shallow for plants with deep roots to live. Grasses and shrubs can survive there because they have shallow roots. A sheet of mosses and lichens grows beneath these plants. When the soil above the permafrost thaws, the soil becomes muddy. Muddy soil is an excellent place for insects, such as mosquitoes, to lay eggs. Many birds spend the summer in the tundra to feed on these insects. Tundra animals include caribou, musk oxen, wolves, and other large mammals. Smaller animals, such as lemmings, shrews, and hares, also live in the tundra.

1. Based on the passage, what is one reason for the lack of trees on the tundra?
A Trees need more sunlight than is available.
B The roots of trees need more room than is available.
C The soil above the permafrost becomes too muddy for trees.
D Trees need more water than is available.
2. Based on the passage, which of the following statements about permafrost is true?
F It is a thawed layer of soil.
G It is always moist.
H It is always frozen.
I It is shallow.
3. Based on the passage, which of the following statements is a fact?
A Muddy soil is an excellent place for mosses and lichens to grow.
B Birds fly north to reach the tundra in the summer.
C Caribou and oxen are some of the large mammals that live in the tundra.
D The tundra is a beautiful biome that is home to diverse communities.

INTERPRETING GRAPHICS

The map below shows the biomes of Australia. Use the map to answer the questions that follow.



- Which letters on the map correspond to areas that are chaparral?
A A and C
B B and F
C C and E
D E and G
- If you lived in the area marked F, which biome would you live in?
F desert
G temperate grassland
H temperate deciduous forest
I tropical rain forest
- If you wanted to live in a forest, which letters correspond to areas where you could live?
A A, B, and D
B A, C, and D
C B, C, and D
D C, D, and E
- Which letter corresponds to desert?
F A
G D
H F
I H

MATH

Read each question below, and choose the best answer.

- Larry wants to buy a glass tabletop for his science lab at home. The glass tabletop is 1 m wide and 2 m long. How many square meters is the surface of the glass tabletop?
A 2 m
B 2 m²
C 3 m²
D 6 m²
- A scuba diver was exploring a coral reef. She spent 1.5 h exploring on Friday and spent twice as many hours exploring on Saturday. Which equation could be used to find n , the total number of hours that the scuba diver spent exploring on Friday and Saturday?
F $n = 2 + 1.5$
G $n = 1.5 + (2 \times 1.5)$
H $n = 1.5 + 1.5 + 2$
I $n = 2 \times 1.5$
- How do you express $5 \times 5 \times 5 \times 5 \times 2 \times 2 \times 2$ in exponential notation?
A $(5 \times 4) + (2 \times 3)$
B $5^4 \times 2^3$
C $4^5 \times 3^2$
D $5^7 \times 2^7$
- The tropical rain forest receives up to 400 cm of rain per year. The desert receives up to 25 cm of rain per year. Which of the following simplified fractions compares rainfall in the desert to rainfall in the rain forest?
F 1/400
G 1/25
H 1/16
I 16

Science in Action



Scientific Debate

Developing Wetlands

Wetlands are home to many flowering plants, birds, and turtles. Wetlands also play important roles in flood control and maintaining water quality. However, as more people need homes, grocery stores, and other facilities, some wetlands are being developed for construction. State governments often regulate the development of wetlands. Development is not allowed on many environmentally sensitive wetlands. But it is sometimes allowed on wetlands that are less sensitive. However, some people think that all wetlands should be protected, regardless of how sensitive an area is.

Language Arts ACTiViTy

WRITING SKILL

Research wetland development on your own. Then, write a letter in which you describe your opinion about the development of wetlands.

Scientific Discoveries

Ocean Vents

Imagine the deepest parts of the ocean. There is no light at all, and it is very cold. Some of the animals that live here have found a unique place to live—vents on the ocean floor. Water seeps into the Earth between plates on the ocean floor. The water is heated and absorbs sulfuric gases. When the water blasts up through ocean vents, it raises the temperature of the ocean hundreds of degrees! Bacteria use the gases from the ocean vents to survive. In turn, mussels and clams feed on the bacteria. Without ocean vents, it would be much more difficult for these organisms to survive.

Math ACTiViTy

A thermal vent increases the temperature of the water around it to 360°C . If the temperature of the water was 2°C , what is the difference in temperature? By what percentage did the water temperature increase?

Careers

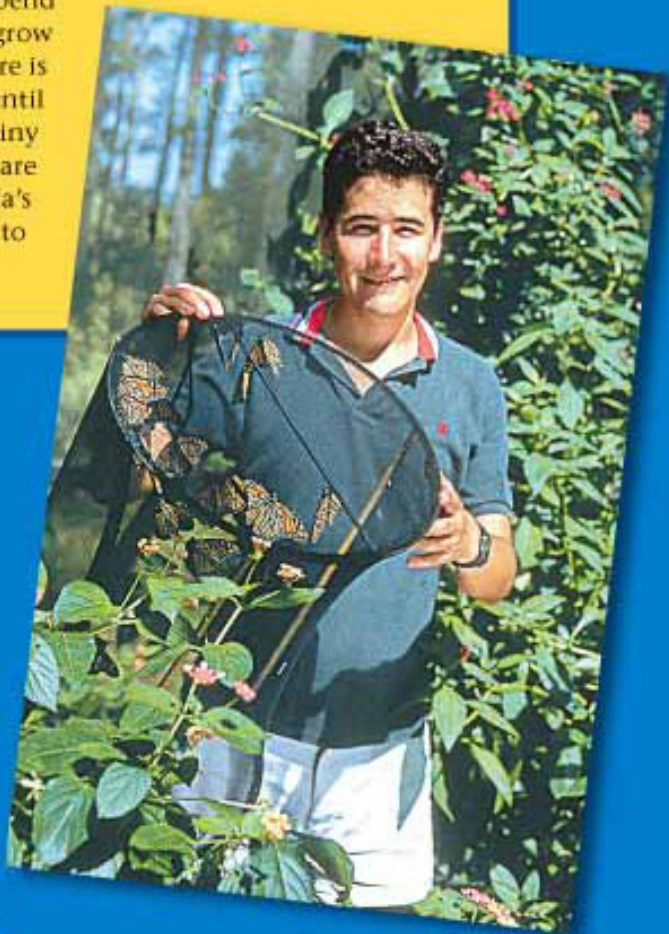
Alfonso Alonso-Mejía

Ecologist During the winter, ecologist Alfonso Alonso-Mejía visits sites in central Mexico where millions of monarch butterflies spend the winter. Unfortunately, the monarchs' winter habitat is threatened by human activity. Only nine of the monarchs' wintering sites remain. Five of the sites are set aside as sanctuaries for monarchs, but these sites are threatened by people who cut down fir trees for firewood or for commercial purposes.

Alonso-Mejía discovered that monarchs depend on understory vegetation, bushlike plants that grow beneath fir trees, to survive. When the temperature is low, monarchs can climb understory vegetation until they are at least 10 cm above the ground. This tiny difference in elevation can ensure that monarchs are warm enough to survive. Because of Alonso-Mejía's discovery, Mexican conservationists are working to protect understory vegetation and monarchs.

Social Studies ACTiViTy

Use your school library or the Internet to research the routes that monarchs use to migrate to Mexico. Draw a map illustrating your findings.



To learn more about these Science in Action topics, visit go.hrw.com and type in the keyword **HLSECOF**.

Current Science

Check out Current Science® articles related to this chapter by visiting go.hrw.com. Just type in the keyword **HL5CS20**.

