

SECTION 1

Freshwater Ecosystems

The types of organisms in an aquatic ecosystem are mainly determined by the water's *salinity*—the amount of dissolved salts the water contains. As a result, aquatic ecosystems are divided into freshwater ecosystems and marine ecosystems.

Freshwater ecosystems include the sluggish waters of lakes and ponds, such as the lake shown in **Figure 1**, and the moving waters of rivers and streams. They also include areas where land, known as a **wetland**, is periodically underwater. Marine ecosystems include the diverse coastal areas of marshes, swamps, and coral reefs as well as the deep, vast oceans.

Characteristics of Aquatic Ecosystems

Factors such as temperature, sunlight, oxygen, and nutrients determine which organisms live in which areas of the water. For instance, sunlight reaches only a certain distance below the surface of the water, so most photosynthetic organisms live on or near the surface.

Aquatic ecosystems contain several types of organisms that are grouped by their location and by their adaptations. Three groups of aquatic organisms include plankton, nekton, and benthos. **Plankton** are the organisms that float near the surface of the water. Two types of plankton are microscopic plants called *phytoplankton*, and microscopic animals called *zooplankton*. Phytoplankton produce most of the food for an aquatic ecosystem. **Nekton** are free-swimming organisms, such as fish, turtles, and whales. **Benthos** are bottom-dwelling organisms, such as mussels, worms, and barnacles. Many benthic organisms live attached to hard surfaces. Decomposers, organisms that break down dead organisms, are also a type of aquatic organism.

Objectives

- ▶ Describe the factors that determine where an organism lives in an aquatic ecosystem.
- ▶ Describe the littoral zone and the benthic zone that make up a lake or pond.
- ▶ Describe two environmental functions of wetlands.
- ▶ Describe one threat against river ecosystems.

Key Terms

wetland
plankton
nekton
benthos
littoral zone
benthic zone
eutrophication

Figure 1 ▶ Lake Louise in Alberta, Canada, is an example of a freshwater ecosystem.





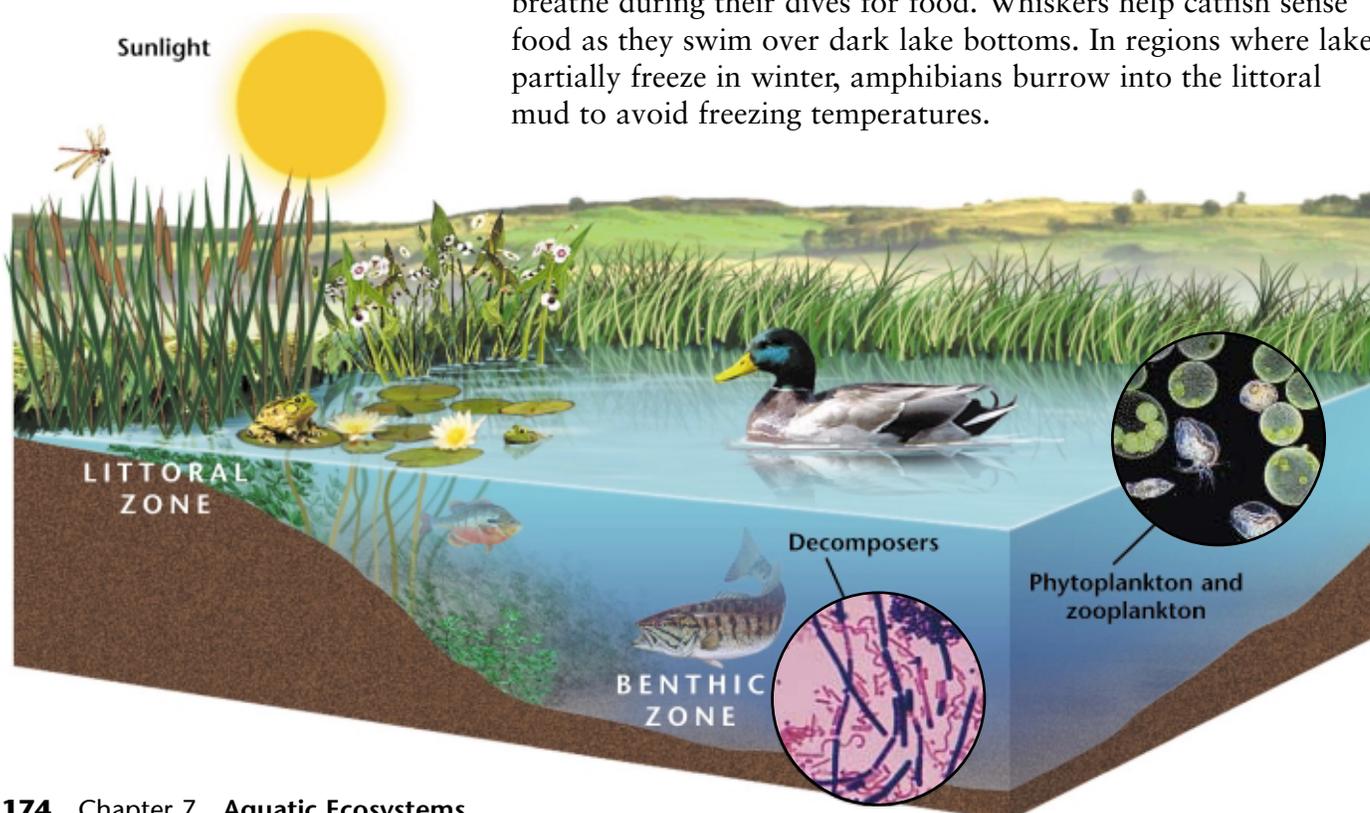
Figure 2 ▶ Amphibians, such as this bull frog, live in or near lakes and ponds.

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Figure 3 ▶ A pond or lake ecosystem is structured according to how much light is available. Tiny plants called *phytoplankton* and tiny animals called *zooplankton* live in open water, where more sunlight is available.



Lakes and Ponds

Lakes, ponds, wetlands, rivers, and streams make up the various types of freshwater ecosystems. Lakes, ponds, and wetlands can form naturally where groundwater reaches the Earth's surface. Beavers can also create ponds by damming up streams. Humans intentionally create artificial lakes by damming flowing rivers and streams to use them for power, irrigation, water storage, and recreation.

Life in a Lake Lakes and ponds can be structured into horizontal and vertical zones. In the nutrient-rich **littoral zone** near the shore, aquatic life is diverse and abundant. Plants, such as cattails and reeds, are rooted in the mud underwater, and their upper leaves and stems emerge above the water. Plants that have floating leaves, such as pond lilies, are rooted here also. Farther out from the shore, in the open water, plants, algae, and some bacteria capture solar energy to make their own food during *photosynthesis*. As shown in **Figure 3**, the types of organisms present in a pond or lake ecosystem depend on the amount of sunlight available.

Some bodies of fresh water have areas so deep that there is too little light for photosynthesis. Bacteria live in the deep areas of the fresh water to decompose dead plants and animals that drift down from the land and water above. Fish adapted to cooler, darker water also live there. Eventually, dead and decaying organisms reach the **benthic zone**, the bottom of a pond or lake, which is inhabited by decomposers, insect larvae, and clams.

Animals that live in lakes and ponds have adaptations that help them obtain what they need to survive. Water beetles use the hairs under their bodies to trap surface air so that they can breathe during their dives for food. Whiskers help catfish sense food as they swim over dark lake bottoms. In regions where lakes partially freeze in winter, amphibians burrow into the littoral mud to avoid freezing temperatures.

How Nutrients Affect Lakes **Eutrophication** is an increase in the amount of nutrients in an aquatic ecosystem. A lake that has a large amount of plant growth due to nutrients, as shown in **Figure 4**, is known as a *eutrophic lake*. As the amount of plants and algae grows, the number of bacteria feeding on the decaying organisms also grows. These bacteria use the oxygen dissolved in the lake's waters. Eventually, the reduced amount of oxygen kills oxygen-loving organisms. Lakes naturally become eutrophic over a long period of time. However, eutrophication can be accelerated by runoff. Runoff is precipitation, such as rain, that can carry sewage, fertilizers, or animal wastes from land into bodies of water.

Freshwater Wetlands

Freshwater wetlands are areas of land that are covered with fresh water for at least part of the year. The two main types of freshwater wetlands are marshes and swamps. *Marshes* contain non-woody plants, such as cattails, while *swamps* are dominated by woody plants, such as trees and shrubs.

Wetlands perform several important environmental functions, as shown in **Table 1**. Wetlands act as filters or sponges because they absorb and remove pollutants from the water that flows through them. Therefore, wetlands improve the water quality of lakes, rivers, and reservoirs downstream. Wetlands also control flooding by absorbing extra water when rivers overflow, which protects farms and urban and residential areas from damage. Many of the freshwater game fish caught in the United States each year use the wetlands for feeding and spawning. In addition, these areas provide a home for native and migratory wildlife, including the blue herons shown in **Figure 5**. Wetland vegetation also traps carbon that would otherwise be released as carbon dioxide, which may be linked to rising atmospheric temperatures. Some wetlands are used to produce many commercially important products, such as cranberries.



Figure 4 ▶ A eutrophic lake, like the one above, contains large amounts of plants as a result of high levels of nutrients.

Figure 5 ▶ Wetlands provide habitat for many plants and animals, including the blue herons shown below.

Table 1 ▼

Environmental Functions of Wetlands

- trapping and filtering sediments, nutrients, and pollutants, which keep these materials from entering lakes, reservoirs, and oceans
- reducing the likelihood of a flood, protecting agriculture, roads, buildings, and human health and safety
- buffering shorelines against erosion
- providing spawning grounds and habitat for commercially important fish and shellfish
- providing habitat for rare, threatened, and endangered plants and animals
- providing recreational areas for activities such as fishing, bird-watching, hiking, canoeing, photography, and painting

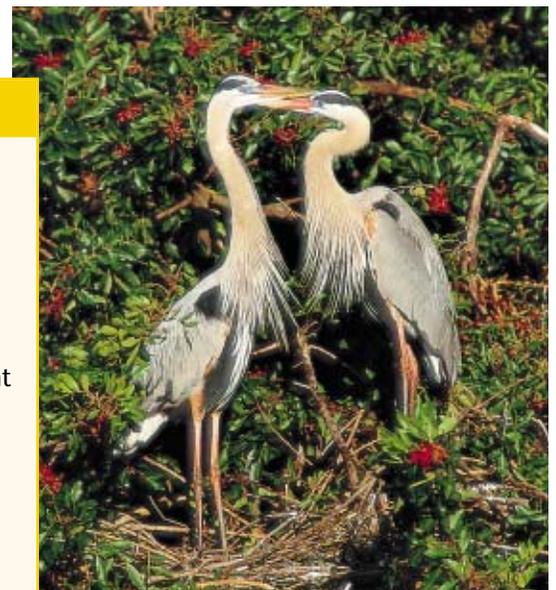


Figure 6 ▶ This map shows the locations of large freshwater wetlands in the United States.



Connection to History

The Florida Everglades Because of the work of many writers, conservationists, and naturalists, former U.S. President Truman dedicated the Everglades National Park in 1947. The park was established to protect the wildlife and habitat of the Florida Everglades. The Florida Everglades is one of only three sites on Earth declared an International Biosphere Reserve, a World Heritage Site, and a Wetland of International Importance. The other two sites are located in Tunisia and Bulgaria.

Marshes As shown in **Figure 6**, most freshwater wetlands are located in the southeastern United States. The Florida Everglades is the largest freshwater wetland in the United States. Freshwater marshes tend to occur on low, flat lands and have little water movement. In shallow waters, plants such as reeds, rushes, and cattails root themselves in the rich bottom sediments. As shown in **Figure 7**, the leaves of these and other plants stick out above the surface of the water year-round.

The benthic zones of marshes are nutrient rich and contain plants, numerous types of decomposers, and scavengers. Waterfowl, such as grebes and ducks, have flat beaks adapted for sifting through the water for fish and insects. Water birds, such as herons, have spearlike beaks that they use to grasp small fish and to probe for frogs buried in the mud. Marshes also attract many migratory birds from temperate and tropical habitats.

There are several kinds of marshes, each of which is characterized by its salinity. Brackish marshes have slightly salty water, while salt marshes contain saltier water. In each marsh type, organisms are adapted to live within the ecosystem's range of salinity.

Figure 7 ▶ A marsh is a type of wetland that contains nonwoody plants.





Figure 8 ▶ The American alligator is a common reptile that lives in marshes and swamps.

Swamps Swamps occur on flat, poorly drained land, often near streams. Swamps are dominated by woody shrubs or water-loving trees, depending on the latitude and climate in which the swamps are located. Mangrove swamps occur in warm climates near the ocean, so their water is salty. Freshwater swamps are the ideal habitat for many amphibians, such as frogs and salamanders, because of the continuously moist environment. Swamps also attract birds, such as wood ducks, that nest in hollow trees near or over the water. Reptiles, such as the American alligator in **Figure 8**, are the predators of swamps and will eat almost any organism that crosses their path.

Human Impact on Wetlands Wetlands were previously considered to be wastelands that provide breeding grounds for insects. Therefore, many have been drained, filled, and cleared for farms or residential and commercial development, as shown in **Figure 9**. For example, the Florida Everglades once covered 8 million acres of south Florida but it now covers less than 2 million acres. The important role of wetlands as purifiers of wastewater and in flood prevention is now recognized. Wetlands are vitally important as habitats for wildlife. Law and the federal government protect many wetlands, and most states now prohibit the destruction of certain wetlands.

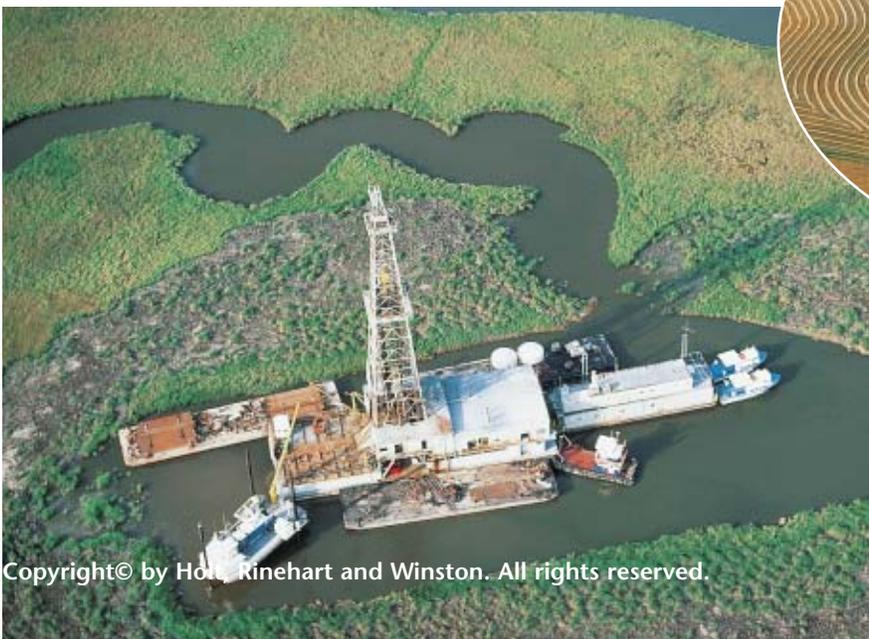
MATH PRACTICE

Wetland Conversion

From 1982 to 1992, approximately 1.6 million acres of wetlands on nonfederal lands in the United States were converted for other uses. Fifty-seven percent of the wetlands were converted into land for development. Twenty percent of the wetlands were converted into land for agriculture. How many acres of land were converted into land for development? How many acres of land were converted into land for agriculture?



Figure 9 ▶ The wetland above has been drained for agricultural purposes. Wetlands such as the one above typically serve as breeding areas for ducks. The oil rig on the left is located in a marsh off the coast of Louisiana.



Rivers

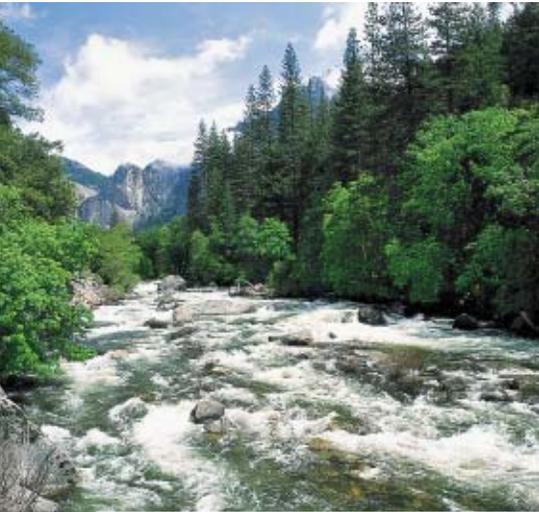


Figure 10 ► The water flow of a river slows and the habitat changes as narrow headwaters give way to wide channels downstream.

Many rivers originate from snow melt in mountains. At its headwaters, a river is usually cold and full of oxygen and runs swiftly through a shallow riverbed. As a river flows down a mountain, a river may broaden, become warmer, wider, and slower, and decrease in oxygen. **Figure 10** compares the water flow of two sections of two different rivers. A river changes with the land and the climate through which it flows. Runoff, for example, may wash nutrients and sediment from the surrounding land into a river. These materials affect the growth and health of the organisms in the river.

Life in a River Near the churning headwaters, mosses anchor themselves to rocks by using rootlike structures called *rhizoids*.

Plankton do not live in the headwaters because the current is too strong for them to float. However, trout and minnows are adapted to the cold, oxygen-rich headwaters. Trout are powerful swimmers and have streamlined bodies that present little resistance to the strong current. Farther downstream, plankton can float in the warmer, calmer waters. Other plants, such as the crowfoot, set roots down in the river's rich sediment. The leaves of some plants, such as the arrowhead, will vary in shape according to the strength of a river's current. Fish such as catfish and carp also live in the calmer waters.

Rivers in Danger Industries use river water in manufacturing processes and as receptacles for waste. For many years, people have used rivers to dispose of their sewage and garbage. These practices have polluted rivers with toxins, which have killed river organisms and made river fish inedible. Today, runoff from the land puts pesticides and other poisons into rivers and coats riverbeds with toxic sediments. Dams also alter the ecosystems in and around a river.

SECTION 1 Review

1. **List** two factors that determine where an organism lives in an aquatic ecosystem.
2. **Compare** the littoral zone of a lake with the benthic zone of a lake.
3. **List** two environmental functions that wetlands provide. How do these functions affect you?
4. **Describe** one threat against river ecosystems.

CRITICAL THINKING

5. **Identifying Relationships** A piece of garbage that is thrown into a stream may end up in a river or an ocean. What effects might one piece of garbage have on an aquatic ecosystem? What effects might 100 pieces of garbage have on an aquatic ecosystem?
6. **Analyzing Processes** Write a short paragraph that explains how fertilizing your yard and applying pesticides can affect the health of a river ecosystem.

WRITING SKILLS