Lab zone **Skills Lab**

# Water From Trees

## Problem

How much water do the leaves on a tree give off in a 24-hour period?

## Skills Focus

observing, inferring, calculating

## Materials

- 3 plastic sandwich bags
- balance
- 3 small pebbles
- 3 twist ties

## Procedure

1. Copy the data table into your notebook.
2. Place the sandwich bags, twist ties, and pebbles on a balance. Determine their total mass to the nearest tenth of a gram.
3. Select an outdoor tree or shrub with leaves that are within your reach.
4. Put one pebble into a sandwich bag. Place the bag over one of the tree's leaves as shown. Fasten a twist tie around the bag, forming a tight seal around the stem of the leaf.
5. Repeat Step 4 on two more leaves, using the remaining plastic bags. Leave the bags in place for 24 hours.
6. The following day, examine the bags and record your observations in your notebook.
7. Carefully remove the bags from the leaves and refasten each twist tie around its bag so that the bag is closed tightly.
8. Place the three bags, including pebbles and twist ties, on the balance. Determine their total mass to the nearest tenth of a gram.
9. Subtract the original mass of the bags, ties, and pebbles that you found in Step 2 from the mass you found in Step 8.

| Data Table | |
|---|---|
| Starting mass of bags, ties, and pebbles | |
| Mass of bags, ties, and pebbles after 24 hours | |
| Difference in mass | |

## Analyze and Conclude

1. **Observing** Use the observations you made in Step 6 to account for the difference in mass you found in Step 9.
2. **Inferring** What is the name of the process that caused the results you observed? Explain the role of that process in the water cycle.
3. **Calculating** A single birch tree may give off as much as 260 liters of water in a day. How much water would a grove of 1,000 birch trees return to the atmosphere in a year?
4. **Communicating** Based on what you learned from this lab, write a paragraph explaining why some people are concerned about the destruction of forests around the world.

## Design an Experiment

Write a hypothesis about what would happen if you repeated this activity with a different type of tree. Design a plan to test your hypothesis. *Obtain your teacher's permission before carrying out your investigation.*



Section 4

# Surface Water

## Reading Preview

### Key Concepts

- What is a river system?
- How do ponds and lakes form?
- What changes can occur in lakes?

### Key Terms

- tributary
- watershed
- divide
- reservoir
- nutrient
- eutrophication

### Target Reading Skill

**Outlining** As you read, make an outline of this section. Use the red headings for the main ideas and the blue headings for the supporting ideas.

| Surface Water |
|---|
| I. River systems |
| A. Tributaries |
| B. |
| C. |
| II. Ponds and lakes |
| A. |

Lab zone **Discover Activity**

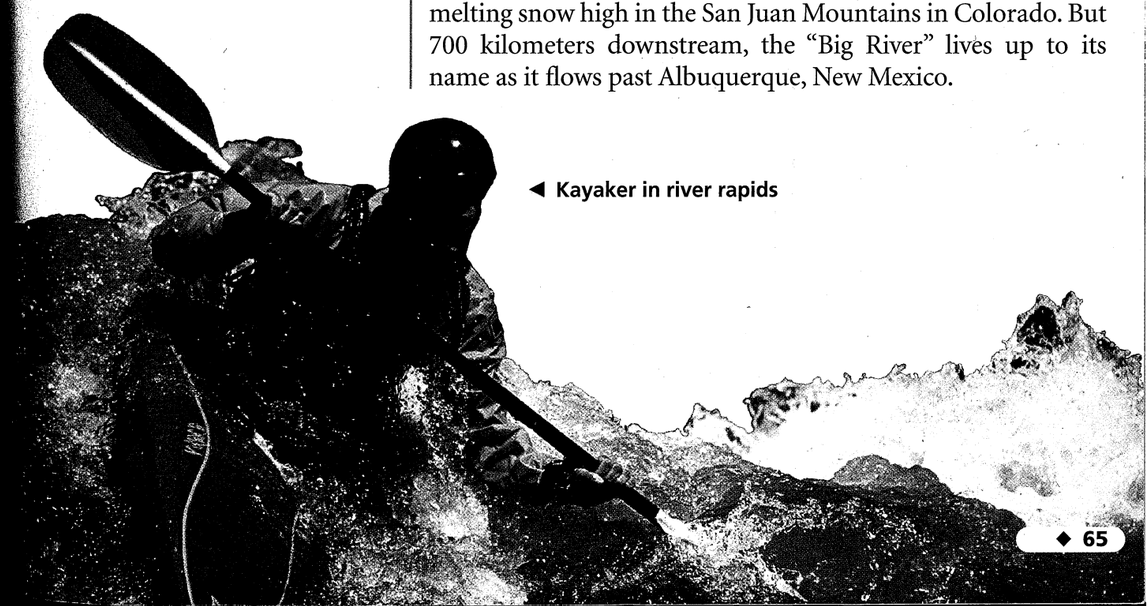
## What's in Pond Water?

1. Using a hand lens, observe a sample of pond water.
2. Make a list of everything you see in the water. If you don't know the name of something, write a short description or draw a picture.
3. Your teacher has set up a microscope with a slide of pond water. Observe the slide under the microscope and add any new items to your list. Wash your hands with soap when you are done.

**Think It Over**

**Classifying** Use one of these systems to divide the items on your list into two groups: moving/still, living/nonliving, or microscopic/visible without a microscope. What does your classification system tell you about pond water?

Imagine that you are a raindrop falling from the clouds to Earth's surface. Down, down, you go and then, splash! You land in the tumbling waters of a fast-moving stream. You are in one of Earth's freshwater sources. Fresh water on Earth may be moving, as in streams and rivers, or still, as in ponds and lakes. All fresh water, however, comes from precipitation. For example, the Rio Grande—the "Big River"—begins as trickles of melting snow high in the San Juan Mountains in Colorado. But 700 kilometers downstream, the "Big River" lives up to its name as it flows past Albuquerque, New Mexico.



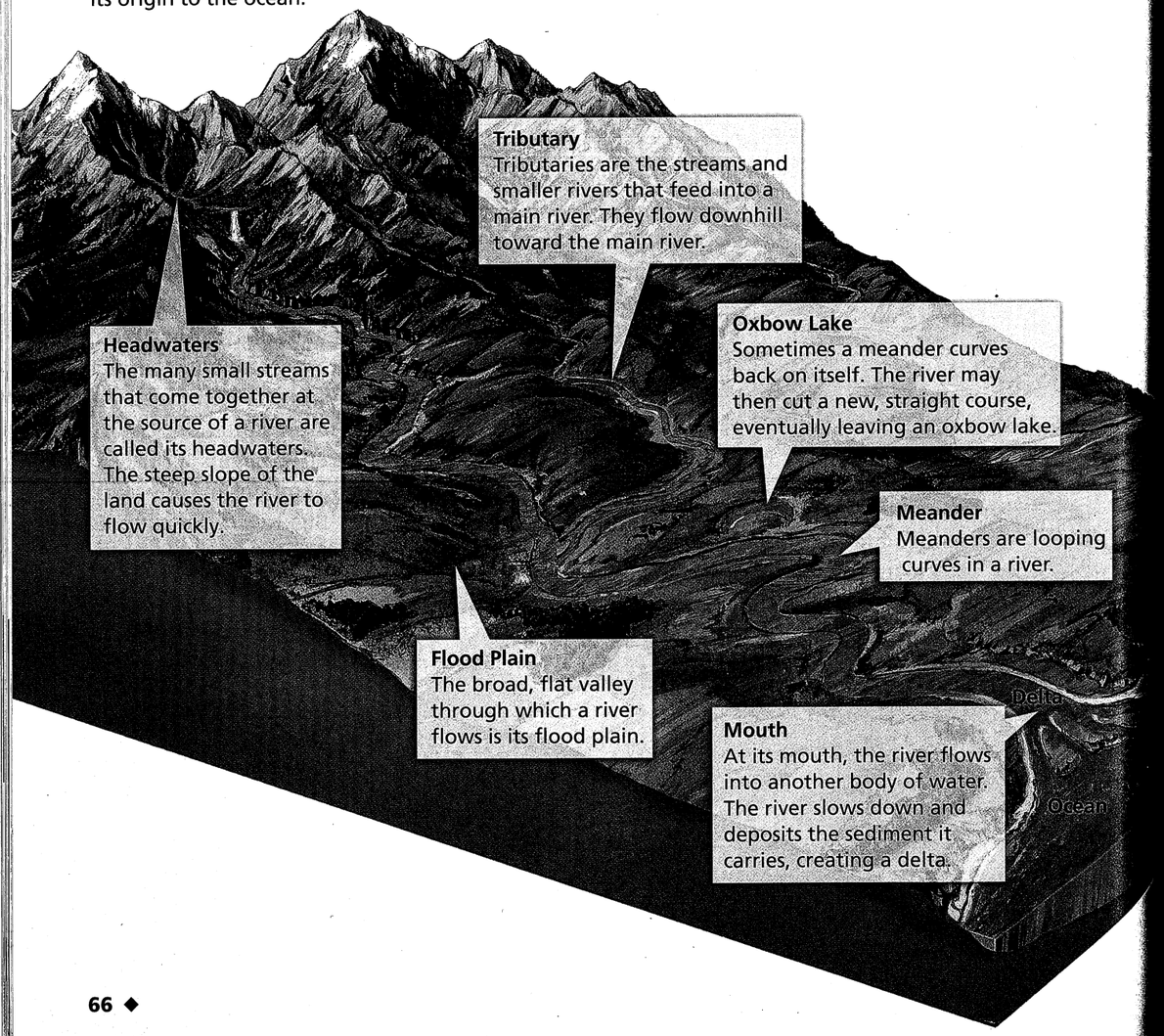
◀ Kayaker in river rapids

## River Systems

If you were hiking in the mountains of Colorado, you could observe the path of the runoff from melting snow. As you followed one small stream downhill, you would notice that the stream reached another stream and joined it. These streams flow into a small river. Eventually this path would lead you to the Rio Grande itself. Figure 18 shows the parts of a typical river.

**Tributaries** The streams and smaller rivers that feed into a main river are called **tributaries.** Tributaries flow downward toward the main river, pulled by the force of gravity. **A river and all its tributaries together make up a river system.**

**FIGURE 18**
**Exploring a River**
Notice the changes that occur as a river flows from its origin to the ocean.





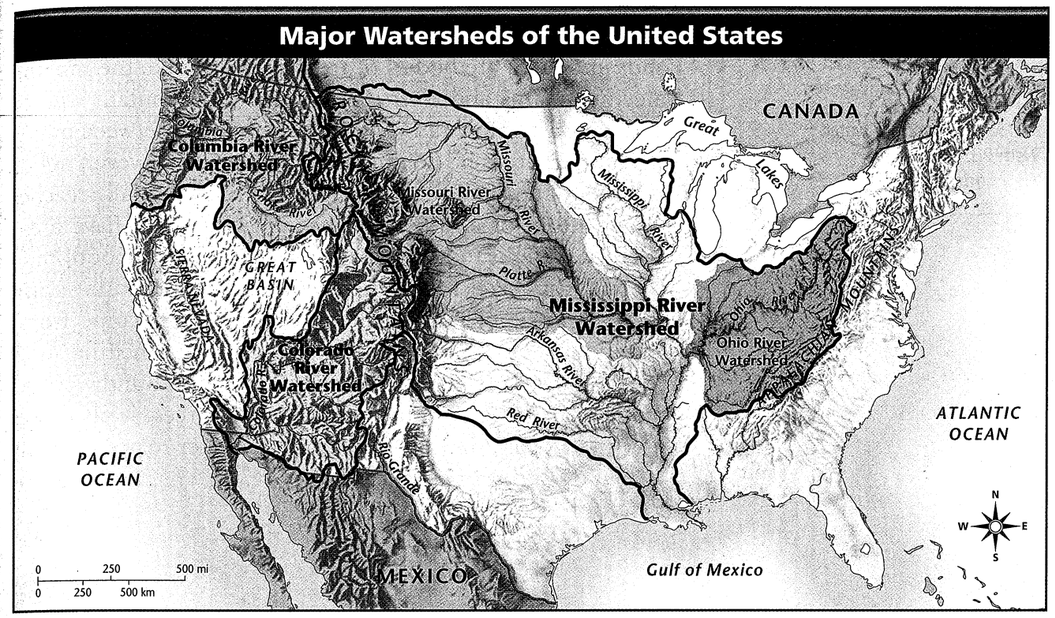




**FIGURE 19**
**Major Watersheds**
This map shows watersheds of several large rivers in the continental United States. Each river's watershed consists of the region drained by the river and all its tributaries. **Interpreting Maps** *What large rivers are tributaries of the Mississippi River?*

**Watersheds** Just as all the water in a bathtub flows toward the drain, all the water in a river system drains into a main river. The land area that supplies water to a river system is called a **watershed.** Watersheds are sometimes known as drainage basins.

As you can see in Figure 19, the Missouri and Ohio rivers are quite large. Yet they flow into the Mississippi River. So large rivers may be tributaries of still larger rivers. When rivers join another river system, the areas they drain become part of the largest river's watershed. You can identify a river's watershed on a map by drawing an imaginary line around the region drained by all its tributaries. The watershed of the Mississippi River, the largest river in the United States, covers nearly one third of the country!

**Divides** What keeps watersheds separate? One watershed is separated from another by a ridge of land called a **divide.** Streams on each side of the divide flow in different directions. The Continental Divide, the longest divide in North America, follows the line of the Rocky Mountains. West of the Continental Divide, water either flows toward the Pacific Ocean or into the dry Great Basin. Between the Rocky Mountains and the Appalachian Mountains, water flows toward the Mississippi River or directly into the Gulf of Mexico.

**Reading Checkpoint** **What is a divide?**

**Lab zone Skills Activity**

### Inferring

The Nile River in Africa flows from south to north. What can you infer about the slope of the land through which the Nile River flows? (*Hint:* Think about the factors that determine how a river system forms.)

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## Ponds and Lakes

Ponds and lakes are bodies of fresh water. Unlike the moving water in streams and rivers, ponds and lakes contain still, or standing, water. How can you tell the difference between ponds and lakes? There is no definite rule. In general, however, ponds are smaller and shallower than lakes. Sunlight usually reaches to the bottom of all parts of a pond. Most lakes have areas where the water is too deep for sunlight to reach the bottom.

**Ponds and lakes form when water collects in hollows and low-lying areas of land.** Where does the water come from? Some ponds and lakes are supplied by rainfall, melting snow and ice, and runoff. Others are fed by rivers or groundwater. As a pond or lake gains water from these sources, it also loses water to natural processes. For example, water may eventually flow out of a body of fresh water into a river. Water also evaporates from the surface of a pond or lake.

**Exploring a Pond** A pond might seem calm and peaceful at first glance. But look closer—do you notice the silvery minnows gliding beneath the surface? Plop! A frog has jumped into the water. The quiet pond is actually a thriving habitat, supporting a wide diversity of living things, as shown in Figure 20.

If you've ever waded in a pond, you know that the muddy bottom is often covered with weeds. Because the water is shallow enough for sunlight to reach the bottom, plants grow throughout a pond. Plantlike organisms called algae also live in the pond. As the plants and algae use sunlight to make food through photosynthesis, they also produce oxygen. Animals in the pond use the oxygen and food provided by plants and algae.

**FIGURE 20**
**Life in a Pond**
From its shallow edges to its muddy bottom, a pond is rich with life.
**Inferring** *Why can plants grow throughout a pond?*

The shore is edged with grasses and trees that require a lot of water, such as willows and maples. These plants provide shelter and nesting places for red-winged blackbirds and other birds.

Some of the most important pond dwellers are the smallest. Microscopic algae are the pond's basic food producers.

A slender-bodied pickerel waits among the duckweed to grab a meal of insects at the water's edge.

The roots of water lilies cling to the pond bottom, while their leaves float on the surface. Sponges live under the leaves. Dragonflies pause on top to rest.

Frogs lay eggs in the shallow water near shore. They hatch in the water as tadpoles and move to the land as adults.

Sunfish and perch live in both the weedy shallows and the deeper waters of the pond.

Snails find food on the soft bottom of the pond.

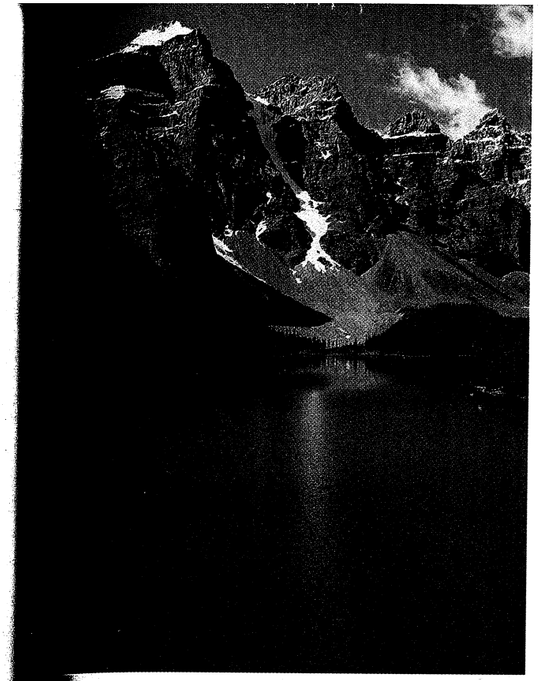
Crayfish lie buried in the mud, waiting for bits of food to drift down.

FIGURE 21

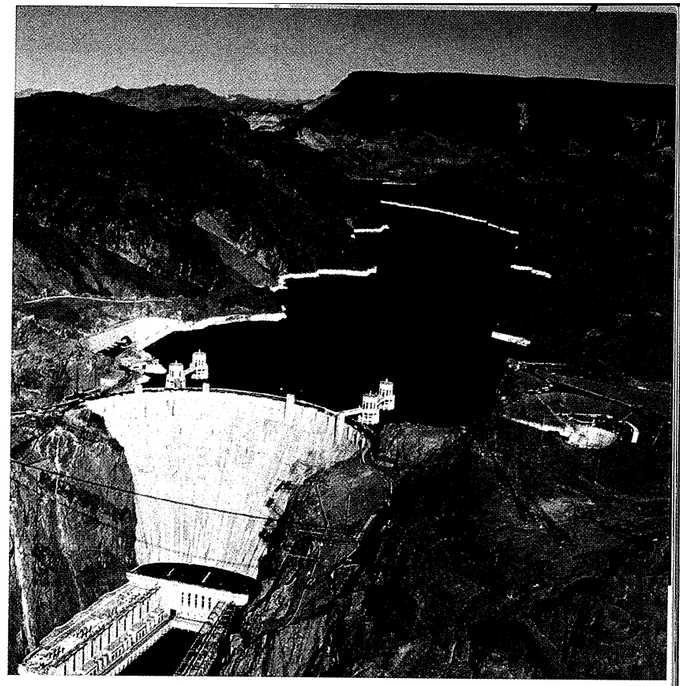
## Types of Lakes

A lake can be formed either by a natural process or by human efforts. **Interpreting Photographs** *What are three ways that lakes are formed?*

**Volcanic Lake**
Volcanic lakes such as this one in Costa Rica form when water fills the craters of old volcanoes.



**Glacier-Made Lake**
Lake Louise in Alberta, Canada, was formed by the movements of glaciers.



**Human-Made Lake**
The Lake Mead reservoir is part of the Hoover Dam complex in the southwestern United States.

**Exploring a Lake** Suppose you were shown a picture of a sandy beach. Waves are breaking on the shore. The water stretches as far as the eye can see. Gulls are screeching overhead. Where was the picture taken? Your first guess might be the ocean. But this immense body of water could actually be a lake! You could be viewing a photo of a beach in Indiana, on the shore of Lake Michigan.

Most lakes are not as large as Lake Michigan. But recall that lakes are generally deeper and bigger than ponds. A lake bottom may consist of sand, pebble, or rock, whereas the bottom of a pond is usually covered with mud and algae.

In the shallow water near shore, the wildlife of a lake is similar to that of a pond. Water beetles scurry over the slippery, moss-covered rocks. Loons and kingfishers pluck fishes from the open water. But sunlight does not reach the bottom of a deep lake, as it does in a pond. As a result, only a few organisms can live in lake's chilly, dark depths. There are no plants, but mollusks, such as clams, and worms move along the lake bottom. They feed on food particles that drift down from the surface. Deep lake waters are also home to large, bony fishes such as pike and sturgeon. These fishes eat the tiny bottom-dwellers. They also swim to the surface to feed on other fishes and even small birds.

**Lab zone Skills Activity**

### Classifying

Crumple up a piece of wax paper. Straighten out the paper to model a landscape with hills and valleys. Use a permanent marker to draw lines along the highest divides of the landscape. Then draw circles where lakes and ponds will form on the landscape. Place the wax paper in a sink and sprinkle water over the landscape to simulate rain. Observe where the water collects. Which areas would you classify as ponds? Which would be lakes? Explain your reasoning.

**Lake Formation** As you read earlier, lakes and ponds form when water collects in hollows and low-lying areas of land. Let's take a closer look at some natural processes that can result in the formation of a lake. A river channel, for example, can form a lake as it changes over time. It bends and loops as it encounters obstacles in its path. Eventually, a new channel might form, cutting off a loop. The cut-off loop may become an oxbow lake.

Some other natural lakes, such as the Great Lakes, formed in depressions created by ice sheets that melted at the end of the Ice Age. Other lakes were created by movements of Earth's crust. Such movements formed the deep valleys in central Africa that lie below Lake Tanganyika and Lake Victoria. Still other lakes are the result of volcanoes. An erupting volcano can cause a flow of lava or mud that blocks a river and forms a lake. Some lakes form in the empty craters of volcanoes.

People can also create a lake by building a dam across a river. The lake may be used for supplying drinking water, for irrigating fields, and for recreation. A lake that stores water for human use is called a **reservoir.**

**Reading Checkpoint** **What is a reservoir?**

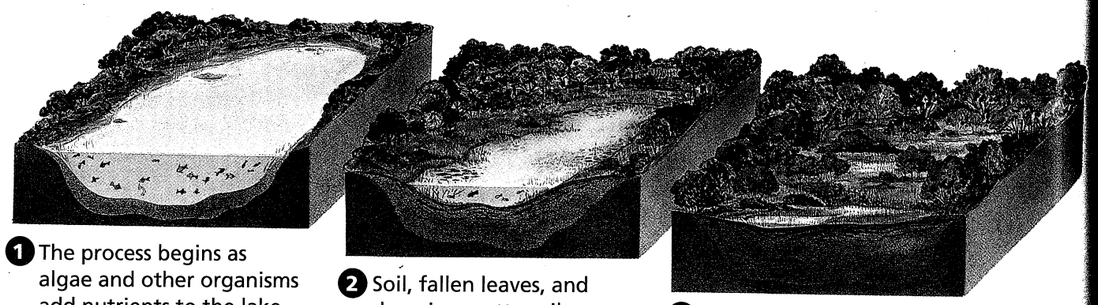
## How Lakes Can Change

A maple tree in fall looks very different than it does in the summer. The green leaves change to brilliant shades of red, orange, and yellow. Lakes can change with the seasons, too. Lakes change for many reasons. **In addition to seasonal changes, a lake can undergo long-term changes that may eventually lead to its death.**

**Seasonal Changes** Seasonal changes in lakes are common in cool, northern areas of North America. In summer, the sun warms the upper layer of water in a lake. The warm water floats on top of the cooler, denser, lower layer. But in fall, the top layer cools off, too. As the top layer cools, it becomes denser and sinks. This causes the lake waters to mix. This mixing, also called lake turnover, causes materials to rise from the lake bottom. Lake turnover refreshes the supply of nutrients throughout the lake. **Nutrients** are substances such as nitrogen and phosphorus that enable plants and algae to grow.

**Long-Term Changes** The second type of change that may occur in a lake happens over a long period of time. The organisms in a lake constantly release waste products into the water. The wastes and the remains of dead organisms contain nutrients such as nitrates and phosphates. Algae feed on these nutrients. Over many years, the nutrients build up in the lake in a process called **eutrophication** (yoo troh fih KAY shun). As eutrophication causes more algae to grow, a thick, green scum forms on the surface of the water. Recall that algae are present in ponds as well as lakes. So eutrophication can also occur in ponds.

**FIGURE 22**
**Long-Term Changes in a Lake**
Lakes and ponds change gradually over time. **Relating Cause and Effect** *What effect does an increase in nutrient levels have on a lake?*



1. The process begins as algae and other organisms add nutrients to the lake. These nutrients support more plant growth.
2. Soil, fallen leaves, and decaying matter pile up on the bottom of the lake. The lake becomes shallower and marshy.
3. Eventually, the plants completely fill the lake, creating a grassy meadow.



**Death of a Body of Fresh Water** When the algae layer becomes so thick that it blocks out the sunlight, plants in the lake or pond can no longer carry out photosynthesis. They stop producing food and oxygen, and they die. As dead organisms in the water decay, the amount of oxygen in the water decreases. Many of the fishes and other water animals no longer have enough oxygen to live. Material from decaying plants and animals piles up on the bottom, and the lake or pond becomes shallower. The sun warms the water to a higher temperature and more plants take root in the rich bottom mud. Eventually, the body of fresh water becomes completely filled with plants. The remaining water evaporates, and a grassy meadow takes the place of the former lake or pond.

Eutrophication is not the only change that can lead to the death of a lake or pond. Sometimes, water may leave a pond more rapidly than it enters it. This can happen when the source of water for a pond—a stream, for example—dries up or is cut off from the pond by natural processes such as erosion. In addition, streams and rivers carry sediments into ponds or lakes. Over a long period of time, these sediments can fill in the body of water.

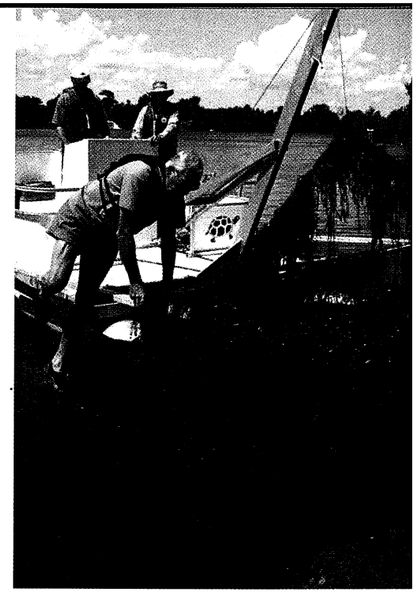


**FIGURE 23**
**Slowing Eutrophication**
In some locations, a community will periodically pull plants out of a pond or lake in order to prolong its life.

**Reading Checkpoint** **What kinds of materials can build up over time at the bottom of a lake?**

## Section 4 Assessment

**Target Reading Skill Outlining** Use the information in your outline to help you answer the questions below.

### Reviewing Key Concepts

1. a. **Identifying** What bodies of water make up a river system?
   b. **Summarizing** How is a watershed related to a river system?
   c. **Applying Concepts** How could you determine the boundaries of a river system by studying a map of the United States?
2. a. **Reviewing** How are lakes different from ponds?
   b. **Explaining** Explain how ponds and lakes form.
   c. **Comparing and Contrasting** What is the major difference between a reservoir and most other types of lakes?
3. a. **Explaining** What causes lake turnover?
   b. **Sequencing** Describe the changes that take place at each stage of eutrophication.

### Lab zone At-Home Activity

**The Knuckle Divide** Have a family member make a fist and put it on a paper towel, knuckles facing up. Dribble water from a spoon so that it falls onto the person's knuckles. As you both observe how the water flows over the hand, explain how the knuckles model a mountain range. Which parts of the hand represent a watershed?