2.1 Waves and Tides

In Figure 2.1, waves splash onto the ocean's shore at low tide. Above the line of waves, you can see another line on the shore where the waves hit at high tide. Waves and tides are two examples of ways in which water moves.

Waves are movements on the surface of the water. Tides are the regular rising and falling of very large bodies of water. You can also see in Figure 2.1 evidence of erosion caused by the waves. Make a sketch of what you see in Figure 2.1. Label it to show where the waves are coming from, the effect they have had on the shore, high tide level, and low tide level. As you read through this subsection, add information on waves and tides to your diagram.

What Is a Wave?

If you have ever been to the ocean or a lake, you know that the water's surface is constantly moving. On calm days, waves lap along the shore. On stormy days, they crash against it. But even small bodies of water—right down to puddles—have waves sometimes. How do these waves form?

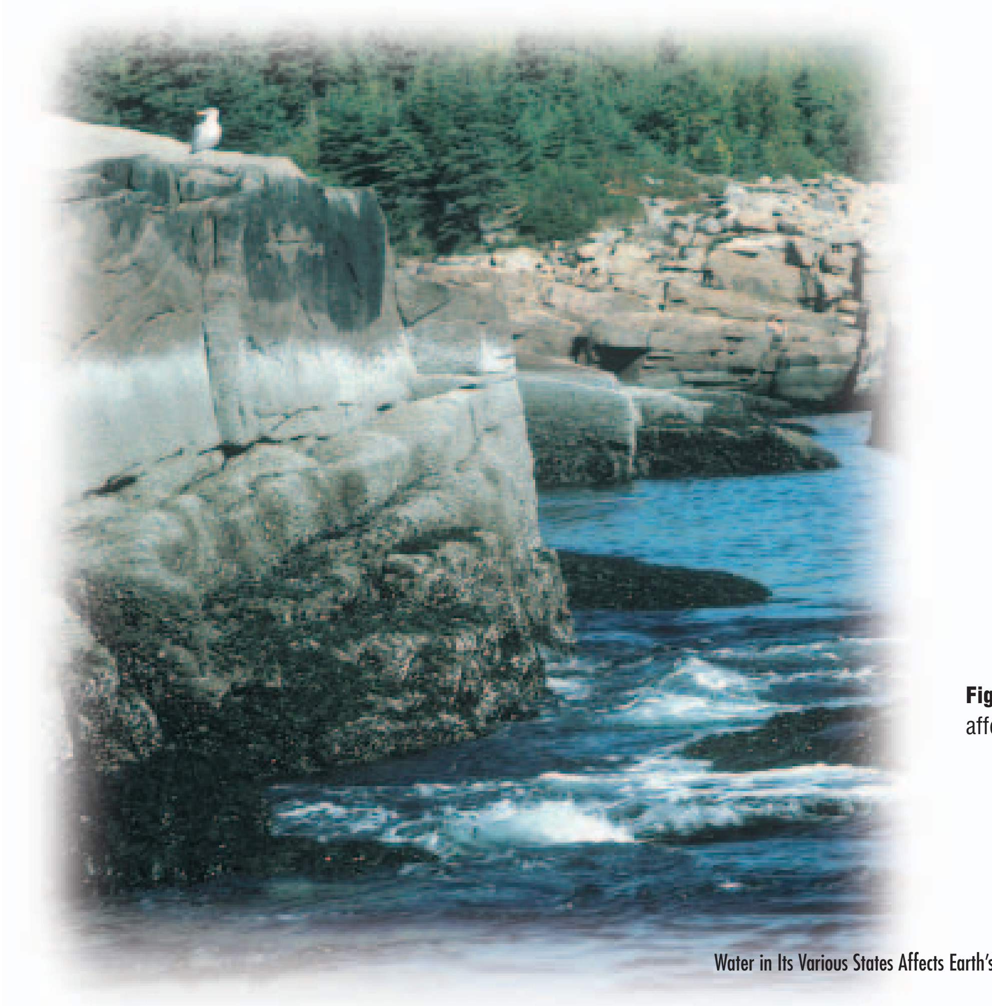

Figure 2.1 Waves and tides both affect the shape of the shoreline.

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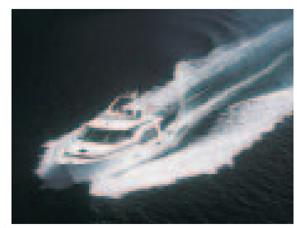
Boats and Shore Erosion

A large cruiser travelling at 8 knots (14.8 km/h) will cause a wash big enough to sink small boats, damage moored ones, and contribute to shore erosion. In waterways where major bank erosion is occurring, you may see "NO WASH" signs displayed. This means that boat drivers must slow down so that no waves are created that could damage the shore.



Boats create waves called "wash" that can affect other boats and the shore.

The Movement of Water Waves

Waves are changes in patterns that move along the water's surface. The water itself does not move very far, but waves can move thousands of kilometres across the surface of the ocean. You can use a rope as a model of wave motion. In Figure 2.3, a student is shaking a rope to create waves. The waves move through the rope, but the rope itself doesn't go anywhere.

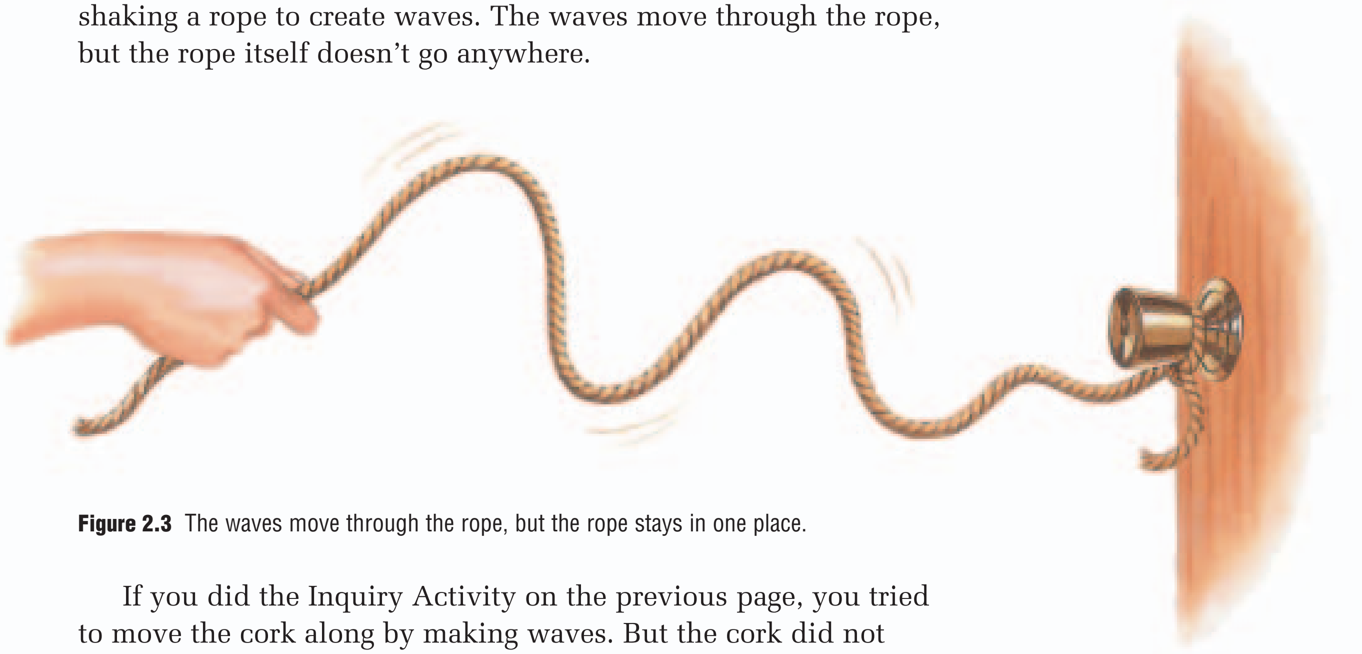


Figure 2.3 The waves move through the rope, but the rope stays in one place.

If you did the Inquiry Activity on the previous page, you tried to move the cork along by making waves. But the cork did not move along, only the wave did. You may have observed the cork moving in a small circle. Within the wave, the water particles move in a circular motion as shown in Figure 2.4. But the water particles themselves do not move long distances.

Causes of Water Waves

Most waves are caused by the wind. The stronger the wind, the bigger the waves. Out in open water, waves appear as up-and-down water movements. If you were in a boat, you would feel this up-and-down movement as the waves passed under your boat. Near the shore, the water becomes shallower, and the lower part of the waves drags on the bottom of the ocean or lake. This slows the waves down, and the tops of the waves rise up and eventually break, crashing onto the shore. This is where waves do the most damage.

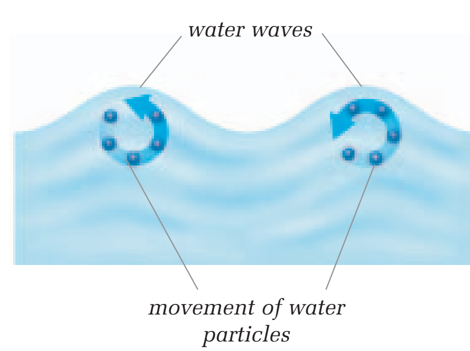


Figure 2.4 A wave moves along the surface of the water, but the water itself moves only in a tiny circle in one place.

Effects of Waves on Shorelines

The force of waves crashing against a shoreline can change the shape of the shore, whether it's hard rock or soft sand. Large waves erode away the shore. But small waves move gently onto the shore. They can deposit sand or other materials near the shore. Figures 2.5 and 2.6 show some examples of the effects of waves on coastlines.

Figure 2.5 Percé Rock is the most famous landmark on the Gaspé Peninsula in Quebec. Wave erosion has pierced a hole through the rock and is gradually eroding away the whole rock.

Figure 2.6 Waves are eroding and depositing gravel along these beaches in Nova Scotia. Gravel ridges are being deposited out in the water, as gravel is being eroded from the land.

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Tsunamis

Earthquakes can create huge ocean waves, called *tsunamis*. Although these waves are large, they are spread out over a long distance. Because of this, they are not very noticeable in the open ocean. Once they begin to slow down in shallow water, however, they can grow as high as a 15-storey building. Find out how an earthquake causes a tsunami.

- Why do we hear of tsunamis in the Pacific Ocean more than anywhere else?
- How does the tsunami warning system in the Pacific Ocean work?

What Are Tides?

Figure 2.7 Why does the water level change in this bay?

The two photos in Figure 2.7 were taken at the same spot about 6 hours apart on the New Brunswick coast. What happened to the water in the bay? Where did it go? If you waited another 6 hours, how much water would be in the bay?

Because New Brunswick is on the shore of the ocean, the water level along its coast changes regularly every day. This change in water level is called the **tide**. People who live beside the ocean are used to seeing and working around high and low tide. High tide is the highest water level along the coast, and low tide is the lowest water level. In most places, there are two high tides and two low tides a day.

The Causes of Tides

The main cause of tides is the gravitational force of the moon. Figure 2.8 shows how tides occur. The side of Earth that is closest to the moon feels the strongest pull from the moon's gravity. This is where the bulge of water is the largest. But other forces are also at work, resulting from Earth's and moon's rotations. These forces cause another, smaller bulge on the other side of Earth at the same time. The two large bulges, on either side of Earth, are the high tides.

As the moon orbits Earth, it pulls the large bulge of water along. At the same time, Earth is spinning in its rotation, *and* orbiting around the sun. All of these movements combine to create two low tides and two high tides every 24 hours and 50 minutes. Because every day is 24 hours, this means that low tide or high tide is 50 minutes later every day. People who live along the ocean use guides called tide tables to tell them when the tides occur, and how high or low they will be that day.

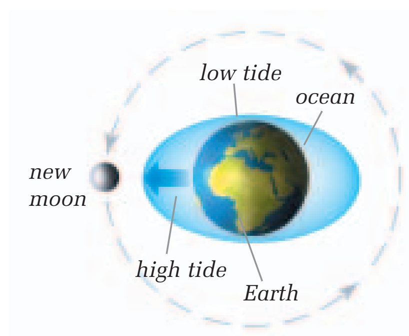

Figure 2.8 The gravitational force of the moon is the main reason for ocean tides on Earth.

CHECK AND REFLECT

1. Describe the movement of water in a wave.
2. What happens to waves in a lake as they get closer to shore?
3. We usually think of waves on lakes and oceans. Can rivers have waves? If so, what causes them?
4. What causes tides?
5. Look at your drawing of the shoreline that you started at the beginning of this subsection. If you haven't already done so, add information from this subsection to it. Did you learn anything in this subsection that surprised you? What was surprising about it? How would you explain this new idea to another student?

Careers and Profiles

GLACIOLOGIST

Glaciologists are scientists who would rather spend a summer cooling their heels on ice than soaking up the sun on a southern beach. They study glaciers, investigating how glaciers move and their connection to world climate.

Glaciologists use radar to find out what the ground is like under a glacier. When they have gathered enough data, they design computer programs that describe the movement of glaciers and predict how and why glaciers change.

Glaciologists exploring an ice cave

1. Why is it important to understand the natural environment?
2. What do you think would be the most interesting part of a glaciologist's job? Why?
3. List three important skills a person would need to be a successful glaciologist.

2.2 Erosion and Deposition

Think about a river or stream in or near your community. How fast does it flow? Is the water clear or muddy? Does it flow straight or does it wind its way through the area? The answers to these questions would describe some of the characteristics of your stream or river. Scientists use these characteristics to help them understand where different types of organisms might live in a river and how they might be affected by human activities. Engineers use these characteristics in building dams and bridges.

Stream Characteristics

To learn more about a stream or river, you would develop a *profile* of it. A stream's profile is a description of its characteristics. How fast does it flow? How steep is the stream's channel? How is it eroding its banks? Each stream has a pattern of flow that is shaped by its characteristics. **Stream characteristics** include the rate of water flow and the slope of the stream's bed. Rivers can be described with these same characteristics. Figure 2.10, after the next Inquiry Activity, is an example of a river's profile.

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Hot Springs

Rivers and streams carry and deposit sediments on Earth's surface. Hot springs bring dissolved sediments up from within Earth and deposit them on the surface. The water of the hot springs comes from deep underground, where the temperature of the rocks is higher than at the surface. From earlier studies, you know that warm or hot water can dissolve more solute than cold water. As the hot water passes through rocks and soil, it dissolves more and more minerals. But once it reaches the surface, it cools down. As it cools, it can no longer keep so much solute in solution, so it deposits the sediment near where it emerges from the ground.

These terraces of calcium carbonate are deposited by the hot water from hot springs in Nahanni National Park.

Profile of a River

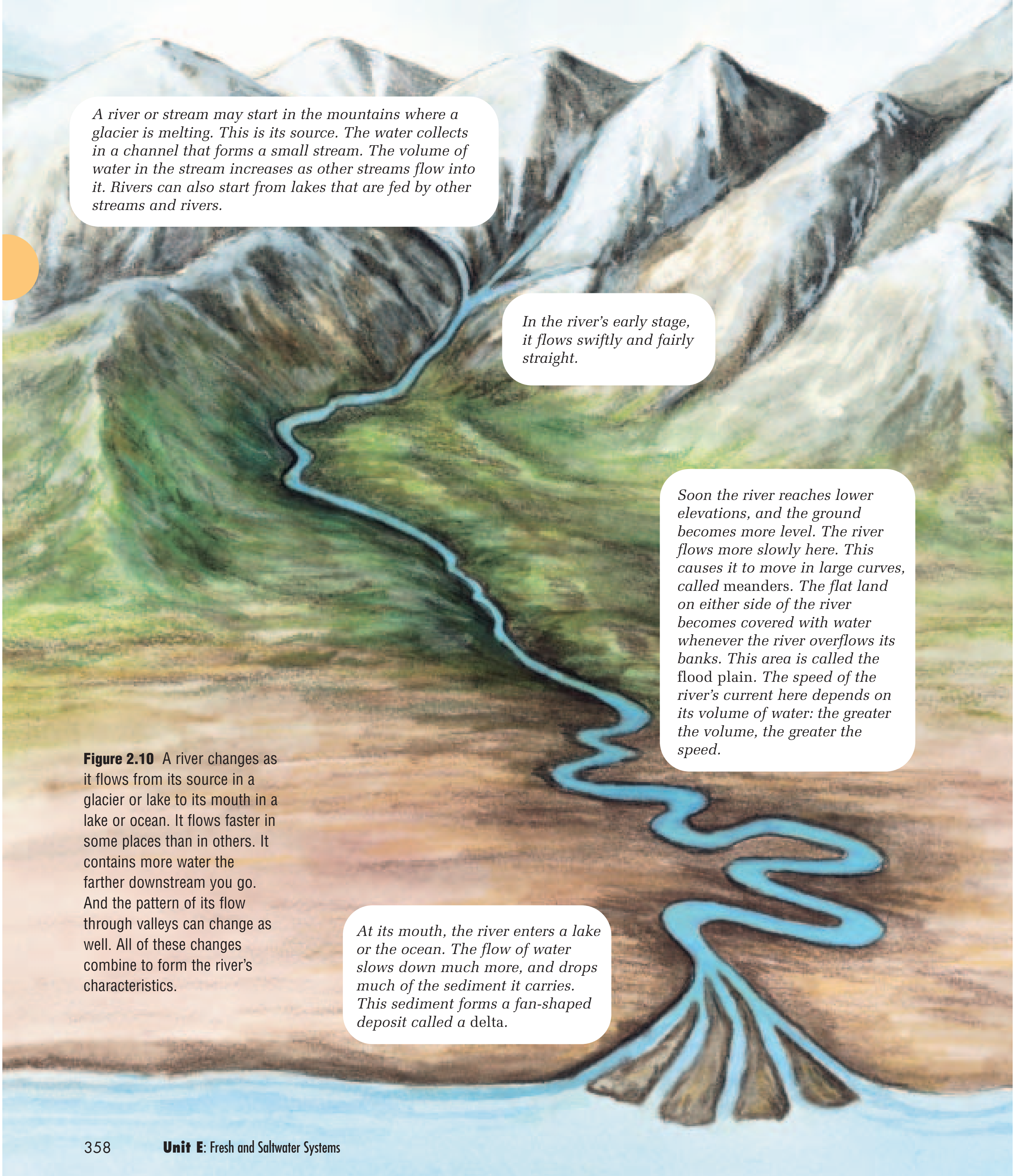

Figure 2.10 A river changes as it flows from its source in a glacier or lake to its mouth in a lake or ocean. It flows faster in some places than in others. It contains more water the farther downstream you go. And the pattern of its flow through valleys can change as well. All of these changes combine to form the river's characteristics.