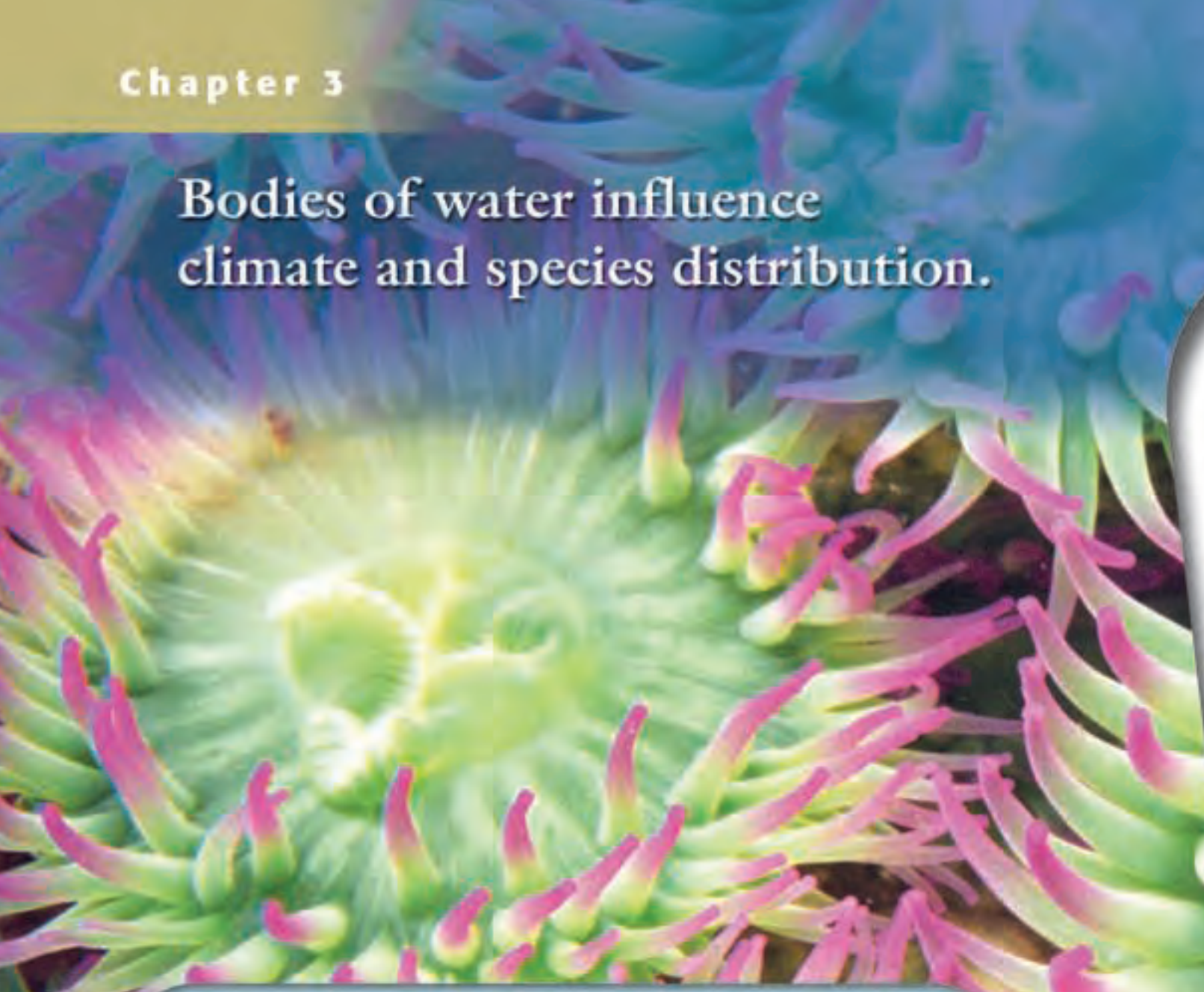
Chapter 3

Bodies of water influence climate and species distribution.



Covering 75 percent Earth's surface, it can be no surprise that the oceans have a tremendous influence on Earth's environment. Both the Earth's fresh water and salt water are home to thousands of different species such as this sea anemone. Scientists can study the diversity of plants and animals to determine the health of water environments such as streams and oceans, as a high diversity of species usually means a healthy water environment. The disappearance of even a small, seemingly insignificant species could indicate a change in the water's quality.

In this chapter, you will learn how the oceans affect the climates of coastal areas and about the great variety of organisms that inhabit Earth's aquatic environments. You will also learn about how human action can damage those environments and even complete water systems.

What You Will Learn

In this chapter, you will

- **describe** how winds and ocean currents influence regional climates
- **describe** the ways in which human activities can alter the water cycle
- **explain** how water quality problems in marine environments can affect all living things

Why It Is Important

Learning how the ocean affects Earth helps us better understand its critical role in our daily lives. Knowing how human activities can affect the quality of Earth's water systems will help you develop a better awareness of the importance of protecting global water resources.

Skills You Will Use

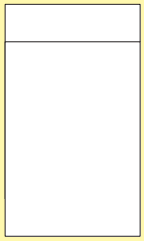
In this chapter, you will

- **evaluate** the effect of human activities on water quality and quantity
- **explain** the role of ocean currents on Earth's climates
- **determine** how aquatic plants are affected by an increase in nutrients
- **evaluate** biotic and abiotic indicators of water quality

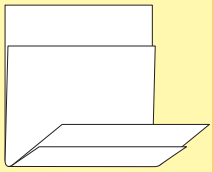
FOLDABLES™
Reading & Study Skills

Make the following Foldable to demonstrate your learning in Chapter 3.

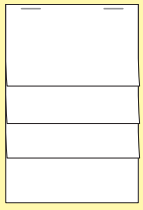
STEP 1 **Collect** 2 sheets of letter-size paper and layer them about 2.5 cm apart vertically. Keep the edges level.



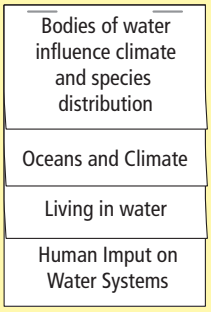
STEP 2 **Fold** up the bottom edges of the paper to form 4 tabs.



STEP 3 **Fold** the papers and crease well to hold the tabs in place. **Staple** along the fold.



STEP 4 **Label** the tabs as shown.



Show You Know As you read the chapter, take notes under the appropriate tab to *explain* how oceans affect climate, *illustrate* different aquatic habitats, and *describe* how humans have impacted water systems.

3.1 Oceans and Climate

Surface currents in the ocean carry heat from one place to another. Warm currents begin near the equator, where the Sun's heat is more intense. As these warm currents circulate, they affect the climate and sea life of the regions to which they move. Deep, cold ocean currents travel from the polar regions and also influence the climate of various regions, just like the warm surface currents.

Key Terms

climate
convection
specific heat capacity
weather

The weather might be one of the first things you notice after you wake up. It could be raining, or the sun might be shining. Weather is the short-term conditions in the atmosphere at a specific place and time. **Weather** can be described in terms of temperature, wind speed and direction, air pressure, and moisture (precipitation). When weather conditions for a particular region are averaged over a long period of time (for about 30 years), its main characteristics are together referred to as its **climate**. Oceans play a critical role in influencing climates all over the world.

Warm and Cold Currents

If you study a map of the world, you will see that Britain is as far north as Hudson Bay. However, Britain's climate is much milder than the climate near Hudson Bay. In southwest England, the winter seasons are mild enough to allow subtropical palm trees to grow! How can Britain be mild when Hudson Bay is so much cooler? The mild climate is mainly due to the warm waters of the Gulf Stream Current. The Gulf Stream Current starts in the Caribbean Sea and flows north along the east coast of North America and past Newfoundland and Labrador. Then, it turns northeast and crosses the Atlantic Ocean. The Gulf Stream Current carries warm water to Iceland and the British Isles (see Figure 3.1). For places like Iceland, which has 10 per cent of its land covered by glaciers, the warm waters of the Gulf Stream Current means its harbours are ice-free.

Figure 3.1 Map of the North Atlantic Ocean showing major currents (not to scale).

Suggested Activity

Think About It 3-1B on page 87.

Warm ocean currents affect climate by transferring their heat to the atmosphere. Water has a very high **specific heat capacity**, which means that it takes a large amount of heat to increase its temperature a small amount. Water's specific heat capacity also means that it releases heat slowly. As a result, it takes a relatively long time to cool down. Therefore, large bodies of water act as heat reservoirs in the winter by remaining warmer than the land nearby. The difference in temperature between the water and land affects the weather systems near the shoreline. These systems produce breezes that alter the processes of evaporation and condensation near the shoreline.

While warm currents flow from the equator, cold currents flow from the Arctic and Antarctic regions. Cold currents also affect the climate by drawing heat from the air. For example, the Labrador Current flows south from Baffin Bay along the east coast of Labrador and Newfoundland (see Figure 3.1). This cold current moderates the summer temperatures in the province, keeping the days cool. On the west coast of Canada, a warm current flows northwards from California, resulting in mild, but wet winters.

internet connect

Of all the major Canadian cities, St. John's has the most fog, rain, snow, wind, and cloudy days! To find out more about how the ocean currents affect Newfoundland and Labrador's climate, go to **www.discoveringscience8.ca**

Figure 3.2 The icy waters of the Labrador Current affect the east coast climate. Cool temperatures and fog are common along the coast of Labrador.

Reading Check

1. What is the difference between climate and weather?
2. Water has a high specific heat capacity. What does that mean?
3. How does a cold current moderate summer temperatures on land?
4. How does a warm current moderate winter temperatures on land?

3-1A Learning How Liquids Lose Heat

Find Out ACTIVITY

Teacher Demonstration

The high specific heat capacity of water plays a role in how oceans affect temperatures and climates. In this activity, you will compare the rate at which three different liquids heat up. Your teacher will perform the activity and you will record, and then plot, the data.

Safety

- Be careful when handling hot equipment.

Materials

- graph paper
- hot plate
- 600 mL beaker
- water
- 3 test tubes
- 3 thermometers
- 3 liquids: water, salt water, and vegetable oil
- 3 ring clamps
- ring stand
- watch or clock

What to Do

1. Copy the table below into your notebook. Give the table a title.

Time (min)	Temperature (°C) Water	Temperature (°C) Salt Water	Temperature (°C) Cooking Oil
0			
0.5			
1.0			
1.5			
2.0			

2. Your teacher will set up the activity as shown here. The three test tubes, each with a different liquid, will be heated in the beaker of water.

Procedure Step 2.

3. Your teacher will call out the thermometer readings every 30 s, starting at 0 min when the test tubes are placed into the beaker of water. Record the temperatures for about 5 min.
4. Your teacher will then remove the test tubes from the beaker and let them cool down. Record the temperatures every 30 s for about 5 min.
5. Plot your data on a temperature vs. time graph, with the temperature (°C) on the *y*-axis and the time (min) on the *x*-axis. Make the graph lines for each liquid a different colour.
6. Clean up and put away the equipment you have used.

What Did You Learn?

1. Which liquid heated up the quickest?
2. Which liquid kept its heat the longest (that is, which one cooled down the slowest)?
3. What do the results in your graph suggest about the specific heat capacity of water, salt water, and oil?

The Transfer of Heat Affects Weather

The oceans, the atmosphere, and weather all influence each other. Part of this close relationship is tied to the process of convection. As the Sun heats the surface of the ocean, some of this heat is transferred to the air above. As air over warm ocean water is heated, its air particles become less dense by spreading out and rising upward. When these air particles reach the cooler levels in the atmosphere, they lose their heat and start to come closer together. The denser, cooler air then sinks back toward the ocean surface. Here it gets reheated and the cycle starts again. This process of heat transfer in air is called **convection**. Air is constantly moving up or down, creating weather above the oceans. This movement of air can cover large distances. In Figure 3.3, you can see that as air is heated over the warm waters of the equatorial Pacific Ocean, it rises up near land such as Australia and Indonesia, causing precipitation. As the air begins to cool, it is carried east by upper level winds, where it cools. As the air cools, it becomes denser, and falls near the west coast of parts of North, Central, and South America, creating a dry climate.

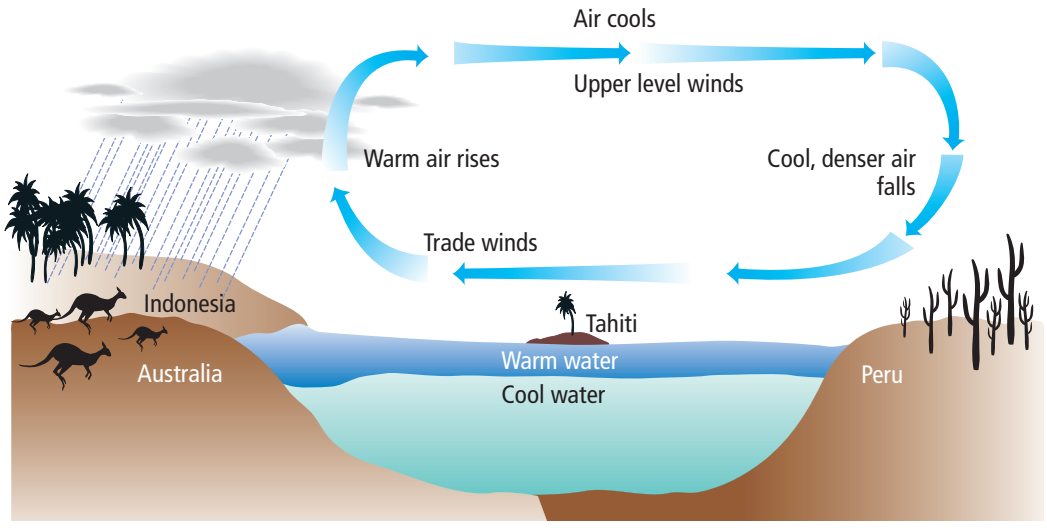


Figure 3.3 The process of convection creates weather patterns over a large area of Earth.

El Niño and La Niña

Good examples of how changes in the ocean can affect climatic change are the phenomena called El Niño and La Niña. The tropical waters of the Pacific Ocean near the equator receive more sunlight than any other area on Earth. Much of the Sun's energy is stored in the form of heat, making these waters very warm. The warm waters are usually carried westward by the Pacific trade winds and allow the deeper, cooler waters to move in and rise up. In springtime, the trade winds slow down, and the Pacific Ocean waters increase in temperature because the

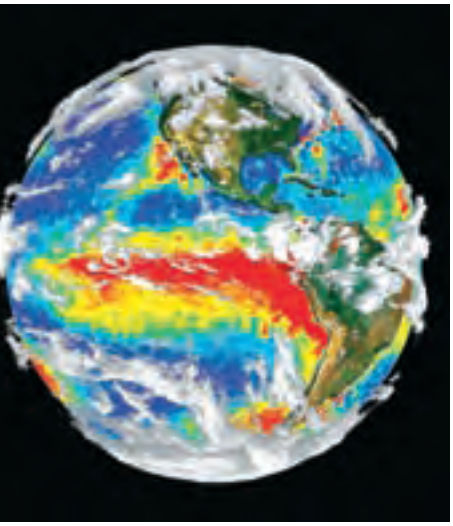


Figure 3.4 This satellite image of the Pacific Ocean during El Niño shows the band of warm water [red] that changes weather patterns.

deep, cool water does not rise. Within a few weeks, the trade winds pick up again and the temperature returns to its normal value.

Every three to seven years, however, the trade winds do not increase after having slowed down. For a period of several months, the surface waters continue to rise in temperature and do not move west, preventing cooler waters from upwelling (rising up). These warmer-than-normal waters lead to unusual weather patterns. El Niño has been responsible for changing patterns of rainfall around the world, and for creating conditions that have led to droughts and fires in Australia, Africa, and Central America. In other areas of the world, such as Peru, Chile, and the western coast of North America, El Niño can bring severe storms and flooding.

A phenomenon that often follows El Niño is La Niña. La Niña is caused by the opposite conditions of El Niño. During La Niña, the equatorial trade winds increase, allowing continuous upwelling of cooler water. These unusually cold ocean temperatures bring reverse conditions from that of El Niño. Heavy rains are brought to Australia, Africa, and South America. Marine life flourishes as the upwelling brings up nutrients that allow microscopic plant organisms called phytoplankton–the main source of fish food–to grow. Scientists are working hard to predict El Niños and La Niñas because of their wide-ranging effects on the world's climates.

Word Connect

El Niño is Spanish for "little boy" and La Niña is Spanish for "little girl."

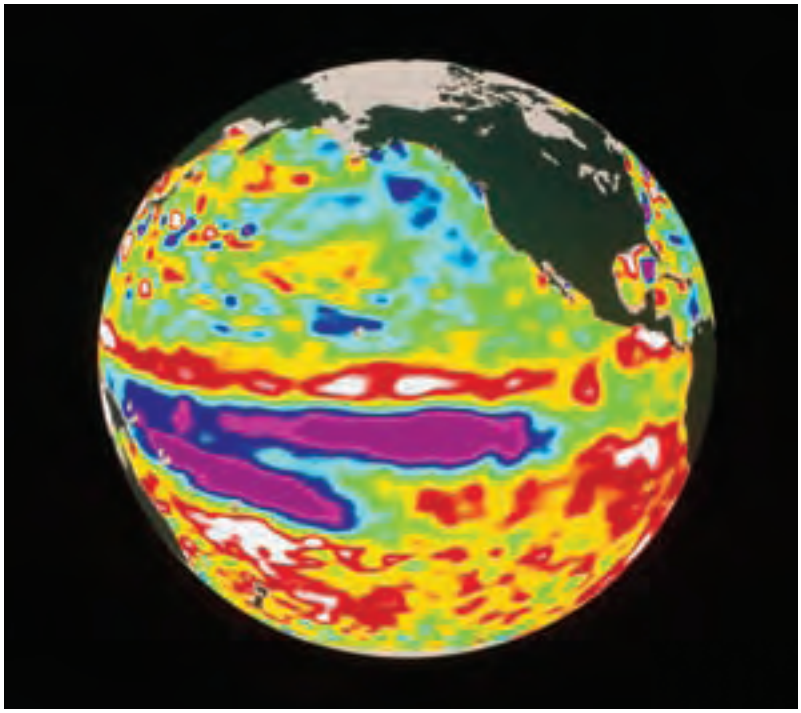


Figure 3.5 Compare this satellite image of the Pacific Ocean during La Niña to the one above during El Niño. Here you can see the band of cool water (in blue and pink) that sits around the equator.

Reading Check

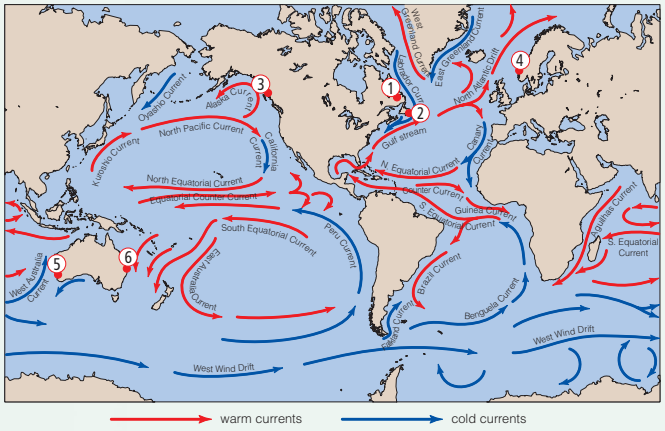
1. What is convection?
2. How does the transfer of heat create weather?
3. What causes El Niño?
4. What causes La Niña?

3-1B Currents and Climate

Think About It

As you have read, the oceans have a great influence on climate, especially along the coasts of continents. Sometimes communities that are closer to the poles than other communities can be warmer due to the effect of currents.

What to Do



The map above has been numbered to show the location of various communities. In the chart below, you will find the corresponding city name, latitude, its minimum low temperature for January, and the maximum high temperature for July.

1. Locate all of the cities on the map.
2. What current runs beside each city? Is it a warm (red arrow) current, or a cold (blue arrow) current?
3. Happy Valley-Goose Bay, NL, and Prince Rupert, BC are only a little over 1° apart in latitude (one latitudinal degree is equal to 110.9 km). Yet, the winters are much colder in Happy Valley-Goose Bay. Why do you think this is?
4. Compare the minimum and maximum temperatures of St. John's, NL and Bergen, Norway. How can you explain the difference in temperatures even though Bergen is almost 13° (about 1 420 km) further north?
5. Compare the minimum and maximum temperatures of Perth and Brisbane in Australia. Why do you think there is little difference between their minimum and maximum temperatures? Why might Perth be slightly colder than Brisbane?

Map Number	City	Latitude	Minimum low –January (°C)	Maximum high –July (°C)
1	Happy Valley-Goose Bay, NL	53.19N	–21	21
2	St. John's, NL	47.37N	–7	20
3	Prince Rupert, BC	54.18N	–2	16
4	Bergen, Norway	60.23N	2	15
5	Perth, Australia	31.56S	17	18
6	Brisbane, Australia	27.23S	21	21

Newfoundland and Labrador: "If you don't like the weather, just wait a few minutes."

Newfoundlanders and Labradorians often start conversations with reference to the weather, and it's no wonder why they do this. The climate of this Atlantic province is as diversified as it is unpredictable.

Labrador: "When the wind is from the East, it's neither good for man nor beast."

Labrador is located on the northeast corner of North America and is also bordered by the cold waters of the North Atlantic. Unlike Newfoundland, much of Labrador is sheltered from the affects of the Atlantic Ocean because some areas are blocked by the Torngat Mountains in the north and the Mealy Mountains in the south. Summer temperatures can be 3 to 5°C warmer than on the coast. The Labrador coast, however, does experience the influence of the Labrador Current which brings cool winds, precipitation, and fog when easterly winds blow the Atlantic air toward land.

Its geographical position makes Labrador a snowy place, with the ground being snow-covered for up to six months, even in the southern section. Churchill Falls often wins the title of the "snowiest place in Canada," receiving over 480 cm each year! Despite its climate being more Arctic than Atlantic, Labradorians are proud of their unique weather.

Newfoundland: "No weather is ill if the wind is still."

It is often said that to understand Newfoundland is to understand the sea, and this could not be more true in relation to the weather of this part of the province. As few communities in Newfoundland are more than 100 km from the ocean, most of the island's population feel the moderating effects of the Atlantic Ocean. The meeting of the Labrador Current with the Gulf Stream Current keeps summer temperatures a little cooler and winter temperatures a little more mild than the rest of Canada.

Newfoundland is also one of the stormiest parts of the North American continent. As storms pass from west to east across Canada, or from south to north as they travel up the east coast of the United States, storms pass over Newfoundland on their way out to the North Atlantic. Newfoundlanders are well seasoned when it comes to tropical storms, silver thaws (also known as "glitter" or "sleet"), and winter blizzards.

There is little doubt that Newfoundlanders and Labradorians are among the most experienced and hearty when it comes to encountering diverse, unpredictable, and often harsh weather conditions.

Checking Concepts

1. Define specific heat capacity.
2. What does specific heat capacity have to do with the effect of oceans on weather and climate?
3. Weather can be described in terms of several measures. Name four.
4. Explain the difference between weather and climate.
5. How can events in the Pacific Ocean such as El Niño affect people living in another part of the world?
6. Describe how the Gulf Stream Current affects the climate of Britain. Include the term "specific heat capacity" in your explanation.

Understanding Key Ideas

7. Why are some currents warm and others cold?
8. Explain how the Labrador Current affects the summer temperatures of Newfoundland and Labrador.
9. What do the Labrador Current and the Gulf Stream Current have to do with the frequency of fog in Newfoundland and Labrador?
10. How can Happy Valley-Goose Bay in Labrador, and Prince Rupert in British Columbia have such different climates even though they are almost on the same degree of latitude (or same distance from the North Pole)?

Pause and Reflect

As you learned in this section, climates of some areas that are far away from the equator are made comfortable by warm water carried to the areas by ocean currents. Write a paragraph describing what would happen to those climates if water had a lower specific heat capacity than it does.

3.2 Living in Water

Not all aquatic environments, or habitats, are the same. Some are salt water, some are fresh water, and some are a mixture of both salt water and fresh water. Aquatic habitats may be warm or cold, shallow or deep, light or dark. The water in the habitat may be moving, as in a stream, or motionless, such as water deep in a lake.

The diversity, or variety of life, varies from habitat to habitat. The ocean environment, for example, is vast. More than one million species of plants and animals are distributed throughout its various habitats. As scientists continue to explore the oceans, they are discovering even more species of marine life.

Key Terms

bioindicator species
bioluminescence
estuary
phytoplankton
wetland
zooplankton

Freshwater Environments

Freshwater environments range from deep, glacier-fed lakes and fast moving streams to shallow, weedy bogs. Some animals spend their entire life in the same body of fresh water. Others need both freshwater and saltwater environments to survive. Salmon, for example, spend most of their life swimming in the open ocean, but return to freshwater rivers to spawn. This section describes the variety of life that is found in lakes, ponds, wetlands, rivers, streams, and estuaries.

Word Connect

"Plankton" comes from the Greek word *planktos*, meaning "wandering or drifting." Because most plankton have very little ability to swim, they rely on currents to transport them around.

Lakes and Ponds

More than 8 percent of the area of Newfoundland and Labrador is occupied by ponds and lakes, making freshwater life an important part of the province's ecosystems. Much of the life in a lake or pond can be found near the shore, where the water is shallow and there are many nutrients for the plants and animals. Insects, plants with roots, and small fish are abundant in this area. In the sunlit waters away from the shore are the small, freefloating organisms called plankton. There are two types of plankton: phytoplankton (plant) and zooplankton (animal). **Phytoplankton** are microscopic plants that produce their nutrients through photosynthesis. **Zooplankton** are tiny animals that eat other types of plankton for food.

Together, these types of plankton form the first link in the aquatic food chain, providing food for everything from insects to fish. Lakes and ponds are also home to amphibians, such as green frogs, and a variety of larger fish in the deeper areas of the water. As well, various mammals and birds may establish a home base along lake or pond shorelines (see Figure 3.6). Beaver and muskrat are two common examples in Newfoundland and Labrador.

Lakes and ponds serve an important purpose in the water cycle by catching and storing run-off. These bodies of fresh water also benefit the environment in many ways, but especially by providing a habitat (home) for a great variety of plants and animals, and supporting rooted plants, which clean the water through natural processes.

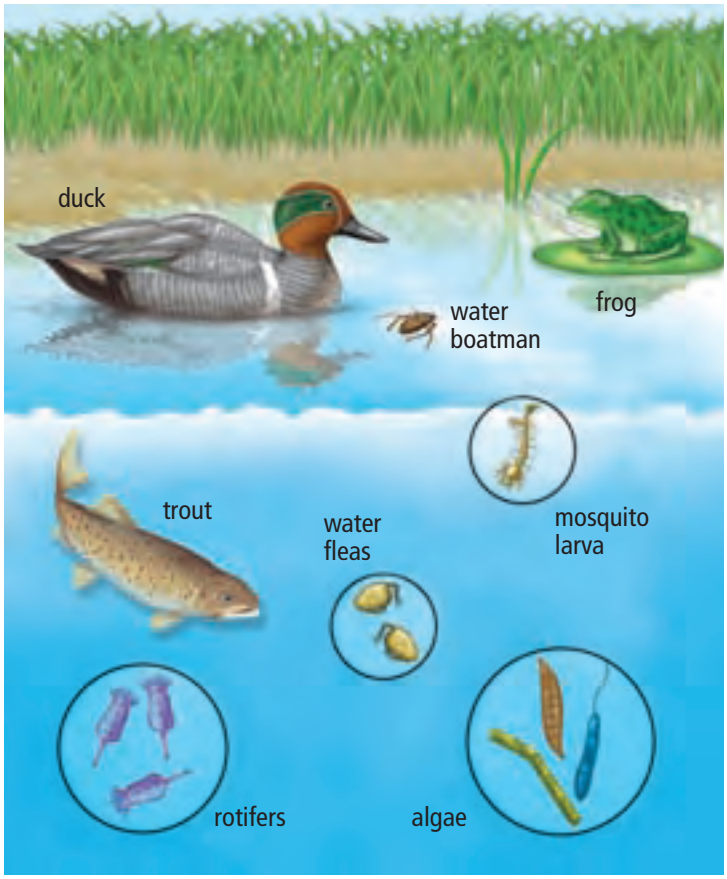


Figure 3.6 A lake habitat contains numerous species.

Life in Rivers and Streams

Most rivers and streams are quite shallow and often contain sediments eroded from the land. Some rivers are clear, while others are so murky (turbid) that you cannot see the bottom. Streams and rivers usually alternate between areas where the water is calm and areas where the water is moving quickly. Riffles (fast-moving water) occur where the riverbed is made of rocks and gravel that is resistant to erosion by the flowing water. Here the water depth is shallow and the speed of the water is faster. Pools form below riffles where the riverbed is made of more fine-grained sediment. The water becomes deeper here, and moves much more slowly.

The types of organisms found in the fast-moving waters of rivers depend on the temperature of the water, its speed, and the amount of sediment in the water (turbidity). Plants such as weeds, mosses, and algae are common in rivers. A large number of insects are also found on or in rivers, and many, such as the caddisfly, lay their eggs along the riverbed.

Figure 3.7 River habitat

Did You Know?

Animals that live in habitats where the water moves very quickly are often small and flat. These adaptations prevent organisms such as the Riffle Beetle from being swept away in the current. Many of these animals cling to rocks or hide under stones.

Did You Know?

Sphagnum moss (peat moss) can can absorb and hold 20 times its own weight in water! This is an example of how wetlands can retain water and release it slowly back to the land.

In some streams, the bottom is home for snails and worms. The fish in streams, such as brook trout, brown trout, and ounaniche (pronounced wi-na-neesh) feed off the smaller organisms.

Life in Wetlands

One quarter of all the wetlands in the world are located in Canada. A **wetland** is a lowland area that is saturated with water for part or all of the year. For most of the last century, wetlands were not considered a valuable part of nature. As a result, a large percent of the wetlands in most provinces have been lost to industrial and urban residential development. Wetlands have also been lost to recreational use of all-terrain vehicles (ATVs).
It has only been in the past few decades that people have realized the important role that wetlands play in the whole environment. Wetlands contribute to the environment in many ways:

- The vegetation acts as filters for removing pollutants from the water.
- Wetlands hold a huge quantity of water, which helps prevent flooding.
- They act as a resting point for many migrating birds.
- The thick vegetation of wetlands helps keep shorelines stable (they act as buffers) and minimizes erosion.

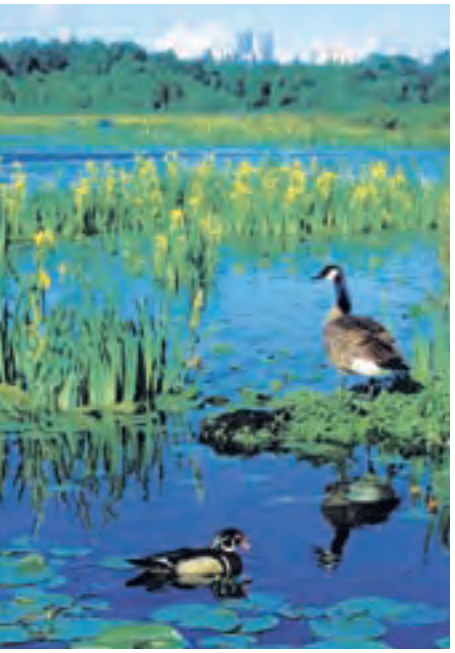


Figure 3.8 Urban development threatens many wetlands.

Life in Estuaries

An **estuary** is an area of wetland that builds up where a river meets the ocean. Nutrients that come from the land, rivers, and the ocean accumulate in estuaries. This makes estuaries ideal environments for both plants and animals. The nutrients are distributed throughout the estuaries by winds, currents, and tides. The action of tides also flushes pollutants and debris out of estuaries. Water in an estuary is "brackish," meaning it is a mixture of fresh and salt water.

Did You Know?

Wetlands make up 18 percent of the province of Newfoundland and Labrador.

The Grand Codroy Ramsar Site on the island of Newfoundland is a 925 hectare estuary. It provides habitat for 19 species of waterfowl and 27 types of rare plants. The importance of this estuary for wildlife was recognized in 1987 when it was declared a Wetland of International Importance.

Bioindicator Species

Did you know that many species that are found in and around freshwater environments can also help us determine the health of the water? Many different kinds of plants, birds, and fish can help us monitor the health of ecosystems. Invertebrates (animals without backbones), such as clams and insects are also useful for this purpose. For instance, changes in the numbers of stonefly, caddisfly, and mayfly larvae that live in streams can tell us about the amount of pollution present in the water. These organisms are called **bioindicator species**. They are generally better at detecting changes in water quality than are testing instruments made by people. They are very sensitive to pollution, so their absence often indicates that the water may be polluted.

Figure 3.9 The Grand Codroy Estuary on the island of Newfoundland is an important home for many species of waterfowl and rare plants.

Saltwater Environments

Oceans form the world's largest aquatic habitat. Oceans differ from lakes not only because they are salty, but also because oceans are deeper and have much more water movement due to tides, currents, and waves.

Even though there is life throughout the ocean and in a variety of ocean environments, the greatest abundance of marine organisms are found in the top 180 m of water. This is the average depth to which light can penetrate in the ocean. Aquatic plants can grow only in the part of the water where light can penetrate. As a result, more than 90 percent of marine life occurs on the continental shelves where the greatest source of food is located.

Almost 10 percent of all sea creatures live in total darkness deep in the ocean. Some of them rely on bioluminescence to find food, attract a mate, or scare away predators. **Bioluminescence** is the ability of certain marine fish and invertebrates to light up part of their bodies through a chemical reaction. Bathocyroe, for example, can produce blue and green luminescence (see Figure 3.10).

Suggested Activity

Find Out Activity 3-2B on page 96.

Did You Know?

Comprising over 3000 square kilometres, the Lake Melville Estuary is the largest estuary in Newfoundland and Labrador.

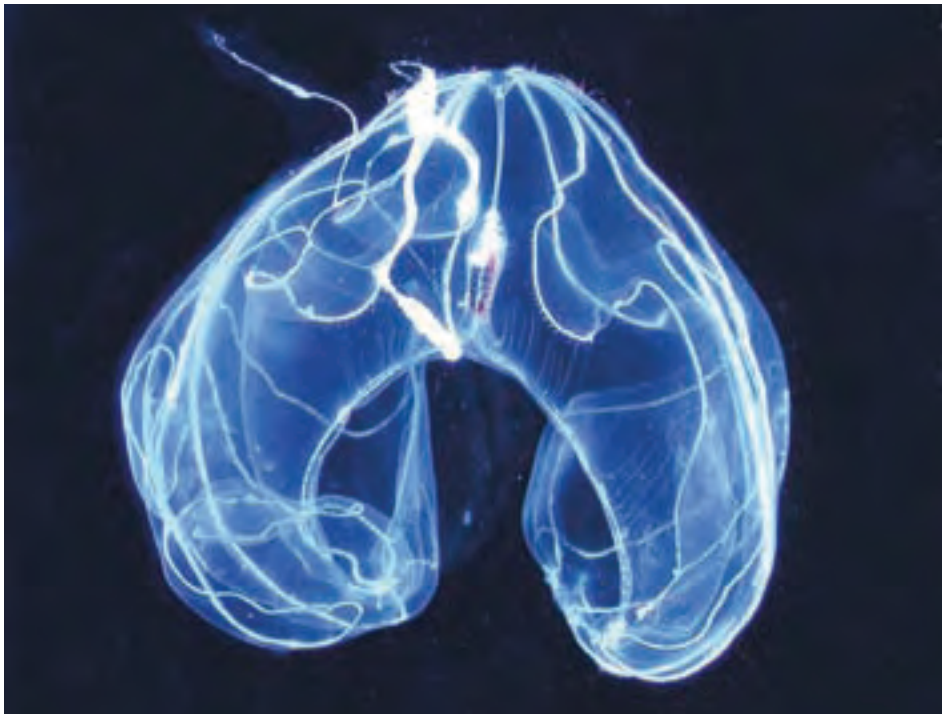


Figure 3.10 Deep water organisms, such as this bathocyroe, often rely on bioluminescence for survival.

internet connect

The heart of an adult blue whale is as large as a small car. Find out more about the blue whale and other ocean creatures by going to **www.discoveringscience8.ca**

The ocean is home not only to single-cell organisms, but also to the largest mammal on Earth, the blue whale. Between those two extremes is a huge variety of life of every shape and size. Shallow warm waters close to the equator are preferred by tropical corals, which in turn, provide habitat for countless small fish and plants. Large fish such as tuna and halibut are found in colder, deeper water. Life can even be found in the darkest, coldest parts of the ocean. Sea sponges and sea cucumbers live on the ocean floor, feeding off the plankton, microscopic plants, dead sea creatures, and other organic (plant or animal) material that drops from the surface layer.

Reading Check

1. Name four types of freshwater environments.
2. Explain three ways in which wetlands are important.
3. Why is an estuary an ideal location for plants and animals?
4. Where is the greatest abundance of life found in the ocean?
5. What is bioluminescence?

3-2A Abiotic Factors

Find Out ACTIVITY

You often hear about the effects of people on marine and freshwater life, but there are also non-human factors that influence where and how organisms live and grow. Non-living factors that affect organisms in an ecosystem are called abiotic factors. They can include such factors as temperature, type of bottom surface in a river or ocean, oxygen availability, amount of sunlight, current speed, and climate. In this activity, you will be researching the effect of abiotic factors on the distribution of a species in a freshwater or marine environment.

Freshwater Species

- caddisfly larvae
- dragonfly larvae
- salmon
- mud trout (Speckled trout)
- American eel
- leeches

Marine Species

- snow crab
- scallops
- halibut
- cod
- capelin
- octopus

What to Do

1. You will work in groups of three or four.
2. With your classmates, choose a species from the list provided above. If there is a species you would like to study that is not listed, be sure to get the approval of your teacher before proceeding.
3. Using resources in your library and the Internet, research the species you have chosen. Topics you should consider are: what part of the freshwater or marine environment they live in; what they feed on; their predators; and how they adapt to living in that part of the water environment. Assign each member of your group a topic to research. Record all of your information in your notebook.
4. As you gather information, begin to look closely at how abiotic factors affect your species. For example, does water temperature affect where they live?
5. After gathering your information, as a group decide how you are going to present your research to your class. You may want to consider a computer, poster, or overhead presentation.
6. Prepare a five minute presentation on how abiotic factors affect the species you have studied.

3-2B Too Much of a Good Thing

SkillCheck

- Recording
- Analyzing
- Interpreting
- Communicating

Humans can affect the amount of nutrients that enter aquatic systems. Dish detergent, food, soaps, sewage, and fertilizers are all sources of nutrients that humans often contribute to water systems. How do you think the growth of aquatic plants will be affected by an increase in nutrients?

Safety

Fertilizers are toxic substances. Avoid getting them on your skin and wear protective safety goggles and a lab jacket.

Materials

- six 1 L beakers or canning jars
- 1 L beaker with lid
- 250 mL measuring cup
- graduated cylinder
- chlorine-free tap water (allow tap water to sit for two days to eliminate chlorine)
- pond water
- 8-24-8 uncoloured fertilizer
- masking tape
- stirring rod
- index card
- felt marker
- test kit to measure dissolved oxygen, nitrates, and/or phosphates (optional)
- microscope (optional)

Question

How do fertilizers affect the growth of aquatic plants? Form a hypothesis.

Procedure

1. Read through the procedure steps and make a data table to record your results.
2. Fill each beaker with 500 mL of chlorine-free tap water.
3. Add 100 mL of pond water to each beaker.
4. Make a solution of plant fertilizer by adding 15 mL of fertilizer to 1 L of chlorine-free water. This is the stock fertilizer solution.

5. Use the masking tape to label each beaker A to F. Add fertilizer solution to the beakers as follows: Beaker A – 1 mL; Beaker B – 2 mL; Beaker C – 4 mL; Beaker D – 8 mL; Beaker E – 16 mL. Beaker F does not get fertilizer solution.
6. To ensure that all of the beakers have the same amount of water, add the following amounts of chlorine-free water to the beakers: Beaker A – 15 mL; Beaker B – 14 mL; Beaker C – 12 mL; Beaker D – 8 mL; Beaker E – 0 mL; Beaker F – 16 mL.
7. Place all of the beakers in sunlight.

8. On the index card, write the word TURBIDITY using the same size letters as shown here. Turbidity measures the clearness of the water. (While a high degree of turbidity is often a sign of polluted water, there may be other reasons for murky water as well.) To measure turbidity, try to read the word on the card by looking at it through the beaker of water.
   - If the print in easy to read, the turbidity measure is clear.
   - If the print is fuzzy, the turbidity measure is slightly cloudy.
   - If the print can be seen but not read, the turbidity measure is very cloudy.
   - If the print cannot be seen, the turbidity measure is opaque (cannot be seen through).
9. At the same time every day, check the colour and measure the turbidity of the water in each beaker. Record your results in your data table.
10. If you have the equipment, measure the dissolved oxygen, nitrates, and phosphates in each beaker. Record your results in your data table.
11. If you have a microscope, look at a drop of liquid from each beaker each day and record the organisms that you see.
12. Continue to record your results for two weeks.

Analyze

1. Which beaker was clearest? Which beaker was the most turbid?
2. How did the increase in the amount of fertilizer added to a beaker affect the growth of algae in the beaker?
3. Do you consider any of the water in the beakers to be polluted? Explain your answer.
4. Which variable was the dependent (responding) variable in this investigation? Which variable was independent (manipulated)?

Conclude and Apply

5. The fertilizer that you used in this experiment contains phosphates. Soaps and detergents used to contain phosphates. In recent years, most manufacturers have made them phosphate-free. Why do you think this change has been made?
6. Write a statement explaining how too much plant growth in an aquatic habitat may have negative effects.

NATIONAL GEOGRAPHIC

VISUALIZING BIOLUMINESCENCE

Many marine organisms use bioluminescence as a form of communication. This visible light is produced by a chemical reaction and often confuses predators or attracts mates. Each organism on this page is shown in its normal and bioluminescent state.

▼ **KRILL** The blue dots shown below this krill are all that are visible when krill bioluminesce. The krill may use bioluminescence to confuse predators.

▲ **JELLYFISH** This jellyfish lights up like a neon sign when it is threatened.

◀ **BLACK DRAGONFISH** The black dragonfish lives in the deep ocean where light doesn't penetrate. It has light organs under its eyes that it uses like a flashlight to search for prey.

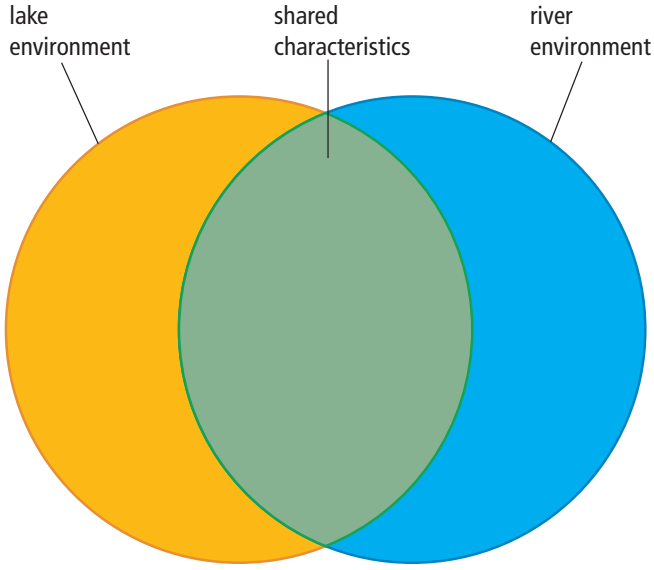
▲ **DEEP-SEA SEA STAR** The sea star uses light to warn predators of its unpleasant taste.

Checking Concepts

1. Name the two types of plankton and what each name means.
2. What role does plankton play in lake and pond environments?
3. (a) What are wetlands?
   (b) What value do the wetlands have?
4. Canada is home to what percentage of the world's wetlands?
5. What is an estuary?

Understanding Key Ideas

6. River and lake environments are different from each other. Copy the Venn diagram below into your notebook, and then complete it by listing the characteristics that are different between the two environments, as well as those characteristics that they share.



7. Describe how organisms that live deep in the ocean use bioluminescence.
8. What human activity might cause an algal bloom (an explosion in the algae population) in a lake?

Pause and Reflect

From what you have learned about estuaries in this section, how do you think activities such as residential development (building houses), commercial shipping (transporting goods by boat), and recreation (sport fishing and hunting) can harm estuaries? Write down your ideas under three headings: Effects of Residential Development, Effects of Commercial Shipping, and Effects of Recreation.

3.3 Human Impact on Water Systems

Water is essential to the survival of every organism on Earth. Yet many factors, natural and human-related, can interfere with the water cycle and the quality of the water at various stages of the cycle. When this happens, the life that exists in aquatic environments can change, often not for the better. Human activities are a particular concern because they can lead to rapid and sometimes devastating changes in the water resource on which we all rely, especially clean drinking water.

Key Terms

acid precipitation
aquaculture
invasive species
overfishing

For centuries, people have used rivers and oceans as dumping grounds for garbage, sewage, and other unwanted material such as industrial waste and waste water. We are only learning now that even though organisms living in the water can break down a great deal of the waste materials, we are simply putting too much material into the system.

Water is considered a renewable resource because it is recycled in the water cycle. People get their water from ponds, lakes, rivers, and ground water (water wells). However, in many places in the world, we are using water faster than it can be recycled. In this section, you will learn about some of the different factors that can affect the water cycle and the problems that humans are creating for their water supply, and the marine life in our oceans.

3-3A How Do Your Actions Affect the Ocean?

Think About It

As we go about our day-to-day life, we generally do not think about what impact our activities and actions may be having on the environment, either immediately or at some time later. Yet many of the activities that are part of our daily routine could have a great impact on environments—even those far away from where you live. Being aware of how our actions affect other things in the world is a first step to taking responsibility for their outcomes. Some outcomes can be good and some can be bad.

Consider how your actions might be affecting the ocean. Think of all the things you do from the time you get up in the morning until the time you go to bed at night. Make a two-column table with the headings "Activity" in the left column, and "How It Affects the Ocean" in the right column. Write down as many examples as you can. Share your answers with the class.

Sources of Water Pollution

Pollution is a term that refers to any of numerous types of harmful materials that are released into the environment through natural or human activities. Air, soil, and water can all become polluted. Pollution can be caused directly (point sources) or indirectly (non-point sources).

Point sources

Point sources of pollution are those that come from a small, specific area, such as a landfill leak or a factory or mill pumping waste water into a river. This type of pollution is easy to identify because the material can be traced to the source. Other point sources include oil spills, underground storage containers for gas stations, sewage systems, and waste water treatment plants.

Non-point sources

Have you ever noticed the dark, shiny area that runs down the middle of the road? This dark band on the pavement is the result of rubber residue and oil that has leaked from cars and trucks. Eventually, rain washes this material into storm drains and sewers, and the contaminated water is carried to a river and then to the ocean. Just 1 L of oil can pollute 1 million litres of water. It is not just oil that gets washed into storm drains. Pesticides and fertilizers from lawns, farmer's fields, and golf courses, animal wastes from parks and farms, and run-off from city streets and driveways are also problems.

These are all examples of non-point sources of pollution. Non-point sources of pollution are those that come from many different sources, not just one. There are a number of ways that such pollution can get into the water system. This makes non-point sources a difficult type of pollution to control. Many small sources can combine to cause major environmental damage.

Figure 3.11 Point sources of pollution, such as this factory's waste water, are easier to identify than non-point sources.

Figure 3.12 When human activities negatively impact the environment, all species suffer.

The Effects of Water Pollution

Humans have the greatest effect on the quality of the world's water supply through both population growth and expanding industrial development. Any negative effect on water is, in turn, felt by all the organisms depending on it, including humans.

Figure 3.13 Non-biodegradable wastes often get washed up on shores. They are hazardous to both marine and land animals.

Oceans have long been a favourite dumping ground for large amounts of human waste because they are so large and once seemed bottomless. Although there are laws today to try and stop people from doing those things, many problems still exist.

Most pollution in the world's oceans is found along the coasts of continents, which is where most of the world's population lives. Environments such as beaches and estuaries are particularly sensitive because the pattern of water flow can cause pollutants to become trapped. Solid waste is also a major problem in oceans. If the material dumped is non-biodegradable (meaning it cannot decompose naturally), it will float on surface currents of the oceans until it washes up on shore. A plastic coffee cup or bottle may last for tens of thousands of years. Many different types of sea life die each year after becoming tangled up in plastic bags, plastic can holders, and fishing line. Larger mammals such as dolphins and whales often die by mistaking plastic materials for food.

Did You Know?

Beluga whales in the St. Lawrence and Saguenay Rivers have been found with levels of toxins (poisonous chemicals) almost 100 times the levels found in their Arctic Ocean relatives. Marine biologists have traced the toxins to industrial wastes and farm pesticides that are first eaten by the belugas' favourite food, the American eel.

Acid precipitation

Pollutants can also enter water systems when toxic substances are released into the air. Pollution can then fall from the sky in the form of dissolved chemicals. Nitrogen oxides and sulfur dioxide get into the atmosphere as a result of the burning of fossil fuels such as gasoline, oil, and coal. The chemicals combine with water in the atmosphere to form sulfuric acids and nitric acids. When this material falls to Earth, it is called **acid precipitation** (see Figure 3.14). Acid precipitation can be more acidic than vinegar. Winds carry atmospheric pollution from industrial areas to lakes, forests, and oceans, and slowly kill or damage plant and animal life. Although Newfoundland and Labrador does not have a large percentage of industrial activity, the province does receive high amounts of acid precipitation due to the mid-latitude westerlies that blow across Canada and along the eastern seaboard from west to east.

Acidity, the strength of an acid, is measured on a 14-point "pH" scale (see Figure 3.15), which indicates whether a substance is acidic or basic (alkaline). For example, vinegar has a pH of 2.8. Detergents used for washing clothes are basic, with a pH of about 10. Neutral materials, those that are neither acidic nor basic, have a pH of 7.0. Normal rainwater has a pH of 5.6. Precipitation is considered to be "acid" when it has a pH of less than 5.6.

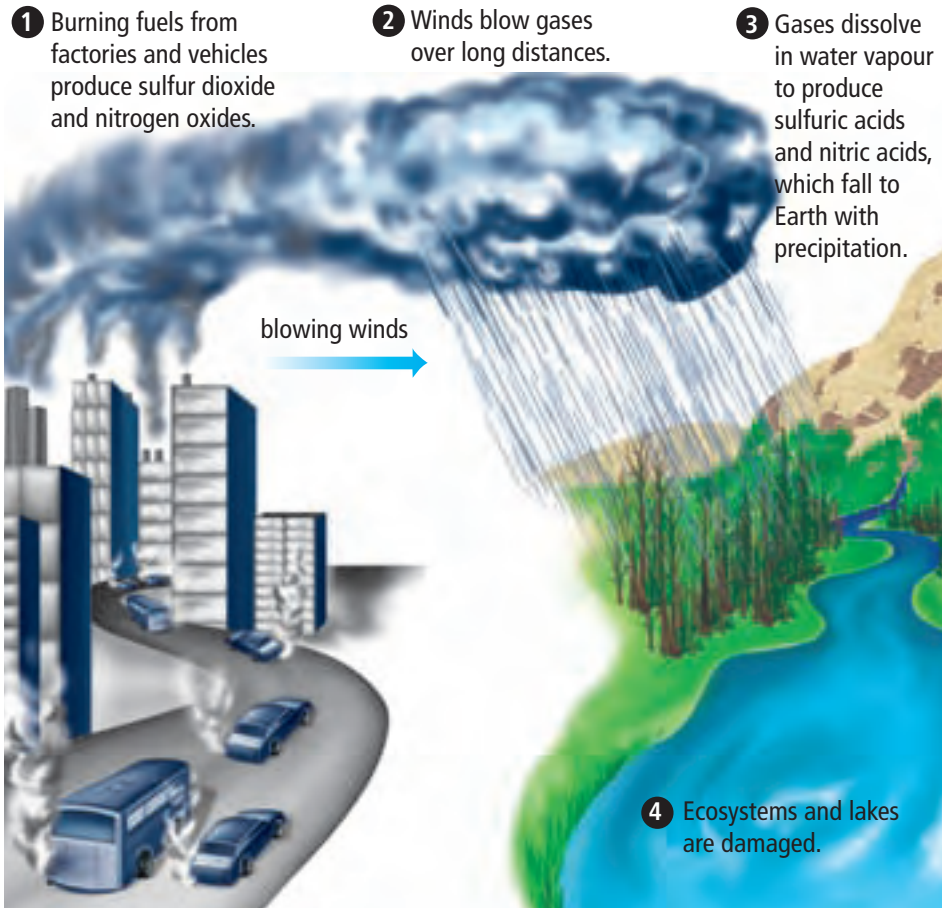


Figure 3.14 Polluting gases enter water systems when acid precipitation is produced.

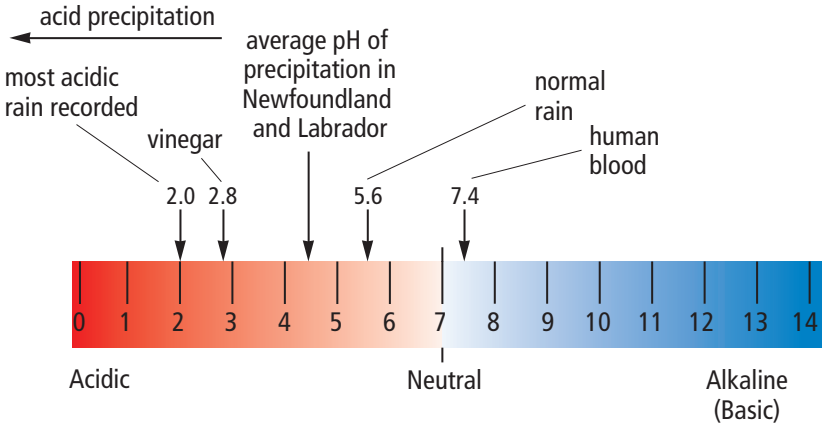


Figure 3.15 The pH scale.

Suggested Activity

Core Lab 3-3B on page 108.

Reading Check

1. What is the difference between a point source and non-point source of pollution?
2. Give an example of a point source and a non-point source of pollution.
3. Where is most of the ocean's pollution found? Why?
4. How is acid precipitation created?
5. How does atmospheric pollution reach lakes, forests, and oceans?

internet connect

More than 80 percent of Canadians, including those who live in Newfoundland and Labrador, live in areas with high acid rain pollution levels. Find out more about acid rain in your area. Go to **www.discoveringscience8.ca**

Offshore Oil Industry and the Marine Environment

When you think of oil pollution in the ocean, it is easy to assume that large offshore oil rigs, such as the Hibernia GBS, would be the main polluters. While occasional leaks and spills do happen, offshore drilling operations contribute 2.1 percent of the total waste oil in the oceans each year. Most waste oil that is found in the ocean comes from drainage from cities and farms, untreated waste disposal from factories and businesses, and recreational boating. While oil rigs may be the lowest contributor, any amount of oil is dangerous to the marine life that exists in the oceans.

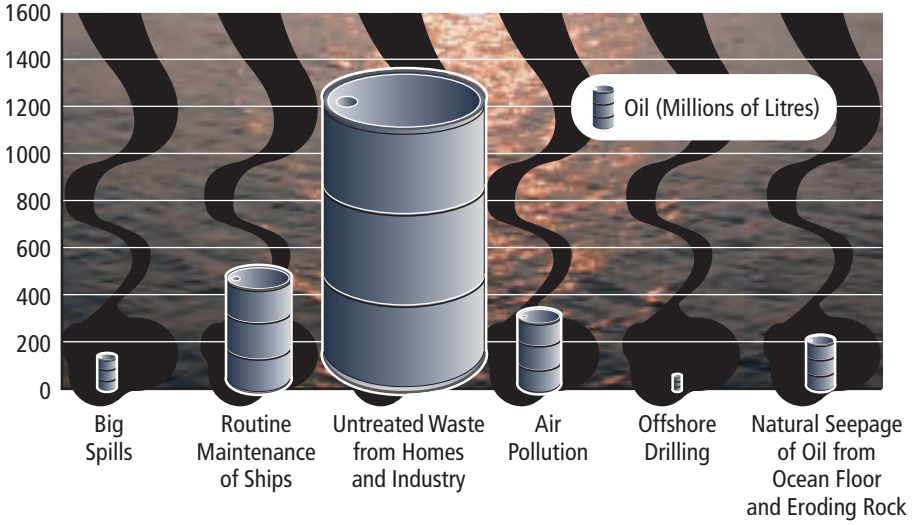


Figure 3.16 Each year, people and industries allow more than 2 672 000 000 L of oil to spill into our oceans.

Suggested Activity

Think About It Activity 3-3C on page 112.

Scientists are also concerned about the effects on marine life that come from the seismic testing that is used to locate oil deposits under the sea floor. Seismic testing sends out a high pressure burst of air, like a shock wave, down through the sea floor. By the rate of travel of the wave through the ocean bed, scientists can determine if there is a possibility of oil. These shock waves, however, destroy fish eggs and larvae, cause fish to leave the area, and disrupt the migration paths of whales. Because the waters off the coast of Newfoundland and Labrador are breeding grounds for many species of fish, and 22 species of whales, seismic testing remains an important topic of concern for scientists.

Invasive Species

On land or in water, animals exist in a delicate food web. This web keeps animal populations in balance. If a new or foreign species is introduced to this web, it can cause damage to the entire food web. New or foreign species are called **invasive species**. In the oceans, cargo ships can introduce a foreign

species to a new area as they travel from place to place. Ships all have a compartment called a bilge, which collects dirty water from the ship. When the bilge is full, ships must release this water into the ocean. While most ships have filters to help clean the dirty water before it enters the ocean, it still may contain parasites and organisms that are foreign to an area. These new species disrupt the existing food web, which can throw marine populations out of balance. As a new species, they do not have a natural predator, yet they feed on the native organisms. The population of the invasive species increases, and further disrupts the food web.

An example of an invasive species along the Atlantic coast is the Green Crab in Placentia Bay. The crab's native home is in the waters around Europe and North Africa, and is thought to have been introduced to the Atlantic waters through bilge release. It caused a rapid decline to the native Rock Crab that live in the bay, and eats clams, mussels, oysters, scallops, and even lobsters. In Placentia Bay, the Green Crab does not have any natural predators, meaning that its potential to continue as a local problem in the future is very high.

Figure 3.17 Invasive species, such as the Green Crab, disrupt the natural balance of the ocean's food web in Placentia Bay and other Canadian coastal areas.

Overfishing

When explorer John Cabot arrived off the shores of Newfoundland, he reported that he could scoop up buckets of cod from the ocean from his ship. Five hundred years later extremely low numbers of cod forced the Canadian government to ban cod fishing on the Grand Banks, and put thousands of Newfoundlanders and Labradorians out of work. What happened to all the cod? Through a process called **overfishing**, more cod were continuously taken than could be replaced by reproduction.

A large reason why overfishing can happen is due to new technologies that allow fishing vessels to catch more fish. Large ships, called factory freezer trawlers, can stay out at sea for over a month at a time. They have the capabilities to freeze or can fish right on the ship. This means they do not have to return to port until the ship is full of fish that is ready for consumers. Another example of new technology that can lead to overfishing is sonar technology. It used to be a matter of luck whether a fishing vessel would get a good catch. Now, fish-finding sonar allows vessels to locate fish with much more accuracy, further depleting the population.

The use of trawlers is also a fishing technique that is causing concern among scientists. Trawling is a fishing process where a

large net is towed behind a fishing vessel. Vessels either trawl in mid-water, or on the ocean floor. One problem with trawling is that marine life, other than the fish that is wanted, gets caught in the nets. For example, for every one tonne of shrimp that are caught to be sold, three tons of other fish are killed and thrown away. Another issue with bottom-trawling on the sea floor is the wide spread damage to marine life and habitats that occurs as the steel frame that holds the net is dragged along the ocean bottom.

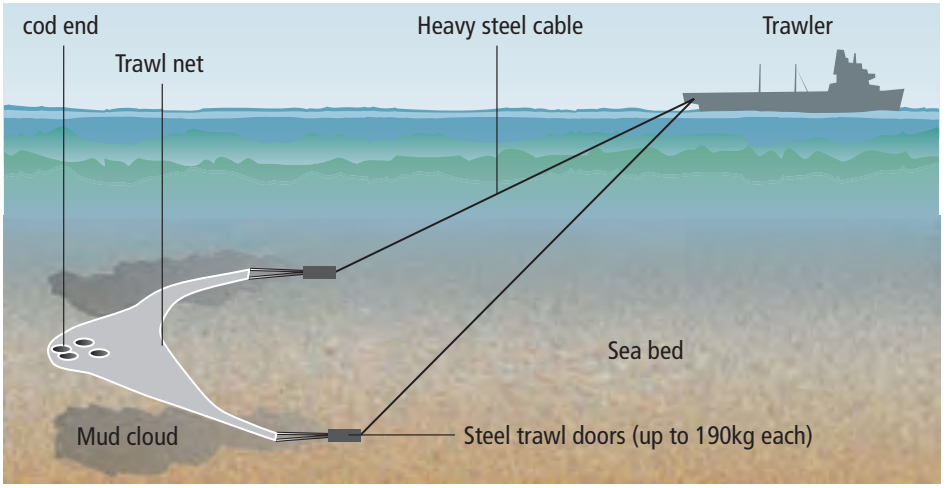


Figure 3.18 Deep sea trawling not only causes damage to the sea floor, but it also can catch other marine life such as dolphins, sea turtles, and many others.

Many countries, including Canada, have put laws in place to prevent overfishing and bottom trawling in waters that are under their control. The problem remains, however, that in international waters, there is very little regulation over how vessels catch fish, or how much they catch. This means fishing vessels from some countries overfish in the open waters, and ignore the consequences of what they are doing to the marine environment.

Aquaculture

Also called aquafarming, **aquaculture** is the growing and harvesting of marine species in a controlled marine area. Aquafarms are usually built in sheltered marine areas such as in a bay. Species such as salmon, rainbow trout, codfish, shellfish, and aquatic plants are cared for until they can be shipped to market. There are so many aquacultures now that they supply one third of all the fish people consume in the world. When created and maintained properly, aquacultures are a way to reduce the fishing pressure on wild fish. With the growing number of aquacultures in the world, however, they are also creating problems for the marine life that surrounds them. Farmed fish sometimes escape

out into the open waters. If a large number of fish escape, or if the escaped fish are foreign to that area, they can cause serious damage to the existing marine life. Diseases and parasites are another issue that can affect aquacultures and be spread to wild fish in the oceans.

Figure 3.19 Aquacultures, such as this rainbow trout farm in Milltown, Newfoundland and Labrador are increasing in numbers as wild fish stocks continue to be depleted in the oceans from overfishing.

Reading Check

1. Why is seismic testing for oil a concern for ocean scientists?
2. Where does most of the oil that ends up in the ocean come from?
3. Why can invasive species be harmful?
4. Name two types of technologies that have led to overfishing.
5. Describe one positive and one negative aspect about aquacultures.

Explore More

The conditions of our oceans are becoming a focus for many action groups around the world. In Newfoundland and Labrador, Ocean Net is dedicated to helping reverse the pollution of the world's oceans. Find out more about what Ocean Net is doing at **www.discoveringscience8.ca**

3-3B Water Health Test

Core Lab

SkillCheck

- Observing
- Interpreting
- Analyzing
- Communicating

Safety

- Conduct this investigation only under the supervision of your teacher
- Remain in shallow water at all times.

Materials

- field guide of aquatic organisms
- plastic spoon
- magnifying glass
- deep pan
- long-handle dip net
- rubber boots
- pencil
- notebook
- water testing kit

In order to find out about the health of a freshwater or saltwater environment, biologists need to examine the water. They must observe what sorts of organisms live in the ecosystem, and run tests on the water for levels of pollution. In Lab A, you will be studying a local stream to see if it is healthy. In Lab B, you will be studying the quality of a marine environment.

LAB A – Freshwater Environment

Part 1: Bioindicators

Work in a group of four or five students. Under the supervision of your teacher, you will visit a local stream to sample the bottom sediments. The bottom sediment will include different kinds of organisms that can be used as indicators of water quality.

Procedure

1. Using the long-handle dip net, take a sample of the bottom sediment and place it in the pan. The sediment may include mud, gravel, and small stones. Do not dig too deeply. Only sample the first 2–3 cm of sediment. Also add some water to the pan.
2. With your magnifying glass, examine the sediment in the pan. Gently move the sediment around and use your field guide to identify the organisms. Record your observations in your table. After completing your observations, carefully return all organisms to their natural habitat.
3. The best place to look for bioindicator species is in shallow parts of the stream where there is gravel or rocks. Gently turn over some rocks to see what organisms may be underneath. Try looking in several shallow parts for different species and carefully collect them with the long-dip handle net. CAUTION! Some streams can be very dangerous. Only visit a stream that your teacher has approved, and with the whole class.
   Biological Indicators: Collect and identify 10 organisms (they do not have to be the same). Refer to the biotic index chart and assign each organism a number of points.

Organism	Points	Organism	Points
1.		6.	
2.		7.	
3.		8.	
4.		9.	
5.		10.	

Part II Abiotic Tests

You will use a water testing kit to examine several water qualities.

Procedure

1. Create a chart in your notebook like the one below.

   A. General Weather Conditions:

   B. Air Temperature: _____ 0°C.

   C. Water Temperature: _____ 0°C

   D. Water pH: _____

   E. Turbidity: _____

   F. Dissolved Oxygen: _____ mg/L

   G. Phosphates: _____µg/L

2. Measure the air and water temperature. Record your results.
3. Follow the instructions in the kit for measuring pH levels. Record your results.
4. Make a qualitative measurement of the turbidity of the water simply by looking at how cloudy or "muddy" the water looks (make sure that you are not so close to another group that their activities are stirring up the water you are testing). Then, follow the instructions in the kit for measuring turbidity. Record your results.
5. Follow the instructions on the dissolved oxygen kit to determine how much oxygen is in the water. Record your results.
6. Follow the instructions in the kit for measuring phosphates. Record your results.
7. Wash your hands after this investigation.

Analyze – Bioindicator Species

1. How many species of organisms did you identify?
2. How many of each species were there in your sample?
3. Based on the bioindicator species, calculate the total biotic index of the stream using the chart on the next page.
4. Based on your total biotic index, what is the water quality rating for this stream? Use the following guide to help determine the quality:

   0-10: very poor water quality

   11-16: poor to intermediate water quality

   17-22: intermediate water quality

   23-30: good water quality

Analyze – Abiotic Factors

5. Based on the abiotic measurements, how would you rate the water quality of your local stream?
6. Each group will prepare a five minute presentation on their findings and their overall conclusion on the water quality of the stream. You may want to use charts or diagrams to present your findings.

Conclude

7. Did all groups come to the same conclusion about the quality of the stream? Did any groups find anything different?
8. Why might bioindicator species be more reliable than abiotic water testing to determine the quality of a freshwater system?

Biotic Index for Water Quality	
Chironomid Midges Physa snails (left-handed opening) Leeches (0.5 - 10 cm long) Aquatic earthworms (Oligocheates) (1 mm - 10 cm long) thin and threadlike	High Tolerance of Pollution 1 Point
Fingernail Clams Flatworms Crane Fly larvae (0.2 - 3 cm long) Snails (right-handed opening) Predaceous Diving Beetles (Dytiscids) larvae and adults Amphipods Dragonfly nymphs Damselfly nymphs (up to 2 cm long) Caddis Fly larvae with cases attached to substrate gills visible (a) or gills not visible (b) a b	Moderate Tolerance of Pollution 2 Points
Mayfly nymphs Caddis Fly larvae with moveable cases Riffle Beetles (Elmids) larvae and adults (2 - 5 mm long) Stonefly nymphs Freshwater Limpets (0.2 - 0.4 cm diameter) Crawling Water Beetles (Haliplids) Freshwater Sponges Black Fly larvae	Low Tolerance of Pollution 3 Points

Inquiry Focus

LAB B – Saltwater Environment

Work in a group of four or five students. Under the supervision of your teacher, you will visit an ocean to sample and test the water. You will use a water testing kit to examine several water qualities.

Safety

- Conduct this investigation only under the supervision of your teacher
- Remain in shallow water at all times.

Materials

- rubber boots
- pencil
- notebook
- water testing kit (should include tests for temperature, salinity, dissolved oxygen, pH, and turbidity)

Procedure

1. Measure the air and water temperature. Record your results.
2. Follow the instructions on the dissolved oxygen kit to determine how much oxygen is in the water. Record your results.
3. Follow the instructions in the kit for measuring pH levels. Record your results.
4. Follow the instructions in the kit for measuring salinity levels. Record your results.
5. Wash your hands after this investigation.

Analyze

1. Based on the abiotic measurements, how would you rate the quality of the ocean water?
2. Each group will prepare a five-minute presentation on their findings and their overall conclusion on the water quality of the ocean. You may want to use charts or diagrams in your presentation.

Conclude

3. Did all groups come to the same conclusion about the quality of the stream? Did any groups find anything different?

3-3C Not An Easy Decision

Think About It

In making decisions about activities that happen in the ocean, it is not always easy to get different groups and people to agree on one action. In this activity, you will be examining and playing the roles of the different people and groups that are involved when a new oil rig is proposed off the shores of Newfoundland and Labrador. You will find that it is not always easy to decide who is right and who is wrong.

What to Do

1. Form groups of 5 with your classmates.
2. Your teacher will come around and letter you from A to E.
3. According to your letter, you will be assigned the following roles.

   A's – Marine biologist. Your concern is the marine life and habitats that may be harmed by the building of a new offshore oil rig. You have scientific facts and figures that support your arguments. Be ready to counter-argue business arguments about profits and jobs.

   B's – Oil company president. You are in charge of the oil company that wants to build the offshore oil rig. You have estimates on the number of jobs and money that will be brought to the province as a result of the oil rig being built and put into production. You need to be prepared to counter-argue environmentalists and scientists.

   C's – Premier of Newfoundland and Labrador. You have a very tricky role of balancing the needs of your province (jobs and money) with the need to protect fisheries and marine life. You are not only responsible to your people, but you also have to be environmentally responsible too. You are in your job because of public opinion, so you don't want to lose your popularity.

   D's – Environmentalist. You are dedicated to helping marine life. You have seen oil slicks that have killed or hurt many seabirds and marine animals. Be ready to have evidence to support your arguments.

   E's – Fisher. Your business is tied to the sea, so you want what is best for marine populations. Yet a new oil rig would give you the possibility of earning money during the winter season. You must carefully think about all the arguments and your own personal needs.
4. You will be given a research period in the library. Using books, newspapers, and the Internet, find information that will help you argue your cause about the possible oil rig. Record all of your supporting information in your notebook.
5. Go over the rules of debating with your teacher.
6. Each member of the group will be given one minute to make a statement regarding their position on the proposed oil rig. Roles C and E may not have a position until they hear the arguments.
7. Using good debating manners, disagree or agree with their point. Each member of the group must have equal opportunity to speak.
8. After 15 minutes, the teacher will call an end to the debate. At this time you will take a vote in each group as to whether the oil rig will be built or not.

Analyze

1. How many groups decided to build the oil rig? How many groups decided that it should not be built?
2. What were the strongest arguments for each side of the debate?
3. In making big decisions such as whether to build this offshore oil rig, what other factors influence our decisions other than scientific facts?

Science Watch

Pollution in the Open Ocean

Over 500 years ago, when Christopher Columbus and his crew were sailing across the Atlantic Ocean, they thought they were nearing land because they saw a mass of floating vegetation. They soon discovered that they were nowhere near land, and were seeing a large growth of floating seaweed similar to that shown in the photograph below. The seaweed looked like tiny yellow grapes so Columbus named it sargazo for "sea grapes." The area is now known as the Sargasso Sea.

The part of the seaweed that Columbus thought looked like little yellow grapes are really small, air-filled sacks, that cause the seaweed to float

Nearly 500 years later, Australian yacht captain, Ian Kieman was excited because a yacht race was going to take him to the famous Sargasso Sea. However, when he arrived there, he was shocked at what he saw. The once beautiful Sargasso Sea was littered with garbage with everything from empty toothpaste tubes to plastic bags. How did rubbish get to the Sargasso Sea and what makes it stay there, in the middle of the ocean?

The rubbish remains in the Sargasso Sea for the same reason that the seaweed stays there. The Sargasso Sea is surrounded by ocean currents that form a loop as shown in the map below. The Gulf Stream flows across the Atlantic Ocean becoming the North Atlantic Drift. Part of that current joins the Canary Current which connects with the North Equatorial Current. The currents form a continuous loop. Anything that is carried from any of the land masses and drifts to the inner edge of the loop reaches a very calm sea. There is so little motion of air or water inside the loop and most things that reach the centre remain there.

The conditions in the Sargasso Sea are so calm, that sailing ships sometimes became trapped there due to lack of wind.

As you have read, plastics are a major problem in ocean pollution. Even the tiny polyethylene (plastic) pellets that are used in the manufacture of many items are a common pollutant. In one survey, researchers calculated that every square kilometre of the Sargasso Sea contained between 3000 and 4000 floating pellets. Marine life ingest these pellets as they think they are food. One dead sea turtle was found to have over a thousand pieces of plastic in its stomach and intestines.

Another serious pollutant in the Sargasso Sea is tar balls. These balls form when spilled oil clumps together and floats on the ocean surface. The oil accumulates when there are oil spills, when tankers clean their cargo holds, and from run off from rivers that flow into the ocean.

When yacht captain, Ian Kierman returned to Australia after his yacht race, he was so disturbed about the conditions in the Sargasso Sea that he started a "Clean Up Sydney Harbour Day" at home. Soon he expanded the organization and formed "Clean Up Australia Day." Then he worked with the United Nations Environment Programme to form a "Clean Up the World Weekend." Today approximately 35 million people in 100 countries participate in Clean Up the World Weekend each year.

Questions

1. Why is the Sargasso Sea calm?
2. How can cleaning up a harbour near your home be a way to help reduce pollution in the Sargasso Sea?

Science Watch

Think Globally, Act Locally: Watching Our Waterways

For generations, Aboriginal people have used the rivers of Newfoundland and Labrador for transportation, as a food source, and as a supply of drinking water. The first European explorers travelled into the Canadian wilderness using rivers as highways. Even today, the economy of the province remains closely linked to its rivers, which are used for generating electricity, and providing people with a wide variety of recreational activities.

How can we show our appreciation for the rivers that contribute so much to our lives? One way is to hold a celebration. The United Nations has designated September 25 as World Rivers Day. Every year on that day, millions of people in countries around the world join together to celebrate their waterways. The person who first came up with the idea is Mark Angelo, who was head of the Fish, Wildlife, and Recreation Program at the British Columbia Institute of Technology in Burnaby in 1980. He, with the support of others, wanted to find a way to help the public understand the importance and fragile nature of the rivers around them. Their focus was just local at first, but soon people all across Canada were holding events to celebrate their rivers. Before long, that one good idea started by a single person turned into a worldwide environmental event.

Another way we can show our appreciation for rivers is to monitor them to ensure they stay healthy. Because there are so many rivers in the province, many of which are very long, it takes numerous people to check them. Newfoundland and Labrador has many non-profit organizations that are dedicated to monitoring and restoring the health of rivers and streams. Such groups as ACAP (Atlantic Coastal Action Program) Humber Arm Environmental Association, Inc., the Upper Lake Melville Environmental Society, and SPAWN (Salmon Preservation Association for the Waters of Newfoundland) all dedicate time to monitoring the province's rivers and streams. Some of the features they monitor are listed below.

Feature	Description
Water quality	Testing can reveal whether dissolved minerals and chemicals are present, or exist in unsafe amounts, in the water.
Stream invertebrates (spineless animals that live on river bottoms)	The amount and types of invertebrates in a river or stream indicate the quality of stream water and whether the water provides a good habitat for animals.
Riverbank vegetation	The quantity and types of vegetation living on the edges of rivers and streams indicate the health of the waterway as a habitat for plants and animals.
Salmonids	Monitoring the quantity and health of small fish can indicate whether the water in a river or stream is clean, and whether the watershed that feeds the river is free from pollutants.

Questions

1. Why are rivers an important part of the economy of Newfoundland and Labrador?
2. How does vegetation on the side of a stream contribute to the health of that stream?
3. People all over the world share environmental concerns over issues such as the pollution of waterways. What do you think it means to "think globally, act locally"?

Checking Concepts

1. List two ways humans can affect water quality.
2. Describe two human activities that affect the quantity of water in a water system.
3. (a) What is the difference between point sources of pollution and non-point sources?
   (b) Give three examples of each.
4. Why is a point source of pollution easier to control than a non-point source?
5. How does acid precipitation affect more than just the people living in the area it falls onto?

Understanding Key Ideas

6. The world's oceans are very large compared to the world's land masses, but why is it not a good idea to use the oceans as a garbage dump?
7. How has technology influenced the process of overfishing?
8. If a species is suddenly added or removed from an ecosystem, what can happen?

Pause and Reflect

In this section, you have read about the value of Earth's water resources and what can happen if water quality is damaged. Just as important for humans and all living things is the availability of clean water. Once in a while, some areas in Newfoundland and Labrador have water restrictions. This means that normal water use must be cut back to prevent the supply from running out. What would you do if the water supply in your area became extremely low and you had to limit your consumption? In your notebook, draw a table like the one below and give it a title. Then, fill in the table with the activities from the data chart provided, deciding how you would categorize each activity (essential, limited, or non-essential).

Activities That Use Water		
Essential (activities that cannot be stopped)	**Limited (activities that can be continued with limited amounts of water)**	**Non-essential (activities that can be stopped completely until water supply is refilled)**

Amount of Water Used for 10 Typical Activities

Activity	Average Amount of Water Used Per Day (L)
Eating/drinking	~2
Washing hands	1
Brushing teeth	4
Flushing toilet	19
Shower	114
Bath	151
Washing the car	76
Watering the lawn	1900/hour
Washing dishes (machine)	57
Laundry (machine)	114/load

Prepare Your Own Summary

In this chapter, you investigated how the ocean affects different climates, various aquatic environments, and how changes in water quality can affect living things. Create your own summary of key ideas from this chapter. You may include graphic organizers or illustrations with your notes. Use the following headings to organize your notes:

1. Oceans and climate.
2. Living in water.
3. Human impact on water quality.

Checking Concepts

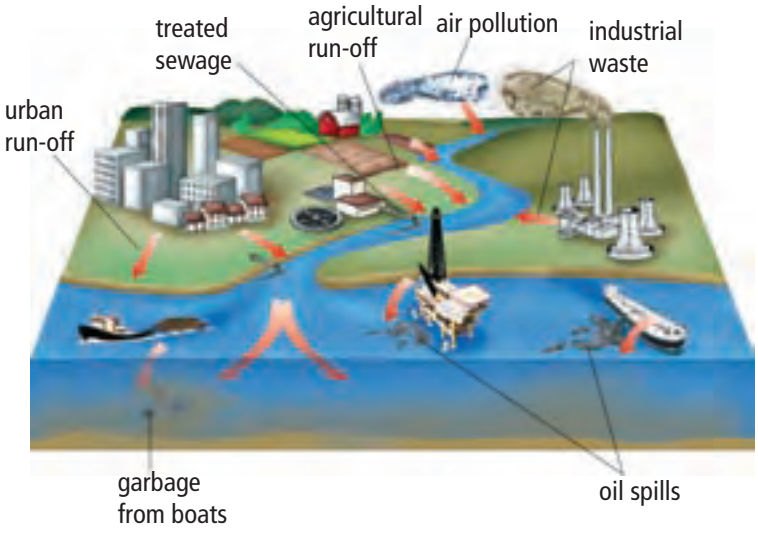
1. List four ways that wetlands contribute to a healthy environment.
2. If estuaries make up only a small percentage of Newfoundland and Labrador's area, why are they so important?
3. Why do most marine organisms live in the uppermost zone of the ocean?
4. What is meant by a point source of pollution?
5. List three non-point sources of pollution.
6. Why can we not just leave it to natural processes to decompose pollutants dumped in the oceans?
7. Describe how acid precipitation becomes part of the water cycle.
8. What effects can acid precipitation have on the natural environment?

Understanding Key Ideas

9. St. John's, NL sits at 47.37° latitude. Thunder Bay, ON is at 48.22°. While the average coldest temperature for St. John's in January is –7°C, it is –20°C in Thunder Bay. What explanation can you find to explain the temperature difference?
10. The Funk Island Ecological Reserve that is located 60 km off the Northeast coast of the island of Newfoundland, is an island that has been designated as ecologically important because of the number of seabirds that nest there. It is so important that only scientists and researchers are allowed to go on the island. Why do you think it is important to keep most people away from the island? What damage could happen if people were allowed to go on the island all the time?
11. The Newfoundland and Labrador Environment Protection Act states that no person shall "...apply, abandon, deposit, empty, pour, pump, dump, discard or otherwise dispose of used oil or used grease on public or private land, including a highway, road, lane, trail, bridge, parking area or quarry, for any purpose, including dust suppression; ...". What damage could pouring used oil along the side of a highway cause to the environment?
12. Imagine that you suspect the river in your community to be polluted. List the steps you would take to determine if the river is polluted or not.

13. Copy the table below into your notebook and give the table a title. Then, using the diagram below to guide you, fill in the table. List as many sources of ocean pollution as you can, identify whether the source is point or non-point, and suggest how the pollution problem might be solved.

Ocean Pollution		
Source of Pollution	**Point or Non-point**	**Suggestion for Solving Problem**
1.		
2.		
3.		



14. Why can your drinking water be affected by pollution in areas thousands of kilometres away from you?
15. In the search for offshore oil, companies must first use seismic testing, and then they must do exploratory drilling to see if there is enough oil to extract and make a profit. How would both of these procedures cause damage to aquatic life and habitats?

Pause and Reflect

In 1982, a United Nations committee developed the Law of the Sea treaty. This treaty or agreement tried to set rules for all coastal countries to follow in using the world's oceans and its resources. It also laid out responsibilities for looking after the oceans. Not all countries of the world agreed to the treaty. Do you think all countries should have to sign an agreement? Write a mock letter to the United Nations explaining your point of view.

Unit Summary

1 The water cycle plays a vital role on Earth.

- Water is distributed throughout the world, in the oceans, on the land, and in the ground. (1.1)
- Ocean water is different from fresh water. (1.2)
- There is a limited supply of usable fresh water. (1.3)

2 Oceans control the water cycle.

- Features of the ocean basins were created by tectonic processes. (2.1)
- Technology allows humans to explore the ocean to tremendous depths. (2.1)
- Ocean currents are created by a number of factors. (2.2)
- The effects of water can directly or indirectly change the surface of Earth. (2.3)

3 Bodies of water influence climate and species distribution.

- Ocean waters influence the world's climates. (3.1)
- There are a variety of freshwater and saltwater environments on Earth. (3.2)
- Bodies of water influence species distribution. (3.2)
- Humans are affecting the quality of water on Earth. (3.3)

Key Terms

- atmosphere
- crevasse
- density
- drainage basin
- freezing point
- glacier
- global warming
- gravity
- ground water
- hydrosphere
- iceberg
- lithosphere
- run-off
- salinity
- water cycle

Key Terms

- abyssal plain
- bays
- breaker
- continental shelf
- continental slope
- Coriolis effect
- crest
- density current
- headlands
- neap tide
- ocean current
- ocean ridges
- spring tide
- swell
- thermocline
- tidal range
- tide
- trench
- trough
- tsunami
- upwelling
- wavelength

Key Terms

- acid precipitation
- aquaculture
- bioindicator species
- bioluminescence
- climate
- convection
- estuary
- invasive species
- overfishing
- phytoplankton
- specific heat capacity
- weather
- wetland
- zooplankton

Project

Being at Home at the Bottom: Designing an Underwater Community

In this unit, you have learned much about the importance of the oceans on our planet. Humans have studied them from research vessels on the water's surface, from satellites high above Earth, and from submarines and remote-controlled vessels thousands of metres down. Some submarines can stay under water for a few months. The one thing humans have not yet done is live under the sea for years at a time.

Problem

Your challenge is to design an underwater community that you and several other adventurers could live in year round. The purpose of the facility is to serve as a research station so that people can learn much more about the ocean environment. In making your design, you will need to consider all you have learned in this unit about ocean currents, temperatures, and salinity, marine organisms, and the nature of the ocean floor. Your community must be located somewhere on the bottom of the Atlantic Ocean, but where in the Atlantic is completely up to you.

Criteria

You must complete three drawings.

- A vehicle specially designed to take people and supplies from the ocean's surface down to the community.
- A self-contained research facility.
- The community itself.

Procedure

1. Working in a group with two or three other classmates, decide what you would like to study at the bottom of the ocean. Look through the unit again if you need some ideas.
2. Decide where you would like to be located in the ocean. Research some locations that would be suitable for the focus of study you have chosen. Use a variety of sources to help you decide, such as maps, atlases, libraries, and the Internet. Your teacher will give you some guidance, or go to www.discoveringscience8.ca for suggestions.
3. Decide the number of people you will need in your community and what occupations and skills those people should have. Remember that your community must be able to meet all the needs of your underwater crew. Therefore, you must have plans for emergencies and accidents.

Report Out

1. Present your designs to the class. Compare your design and location with what your classmates chose.
2. Answer each of the following questions with a brief paragraph in your notebook:
   (a) What was the hardest thing to plan for in your underwater community?
   (b) When you compared your community with other groups' designs, did you notice anything you were missing? What would you change in your design to make your community better?
   (c) What did you learn from this activity:
   (i) about the ocean?
   (ii) about working in groups?

Wrestling Energy from Waves

Using the energy of oceans to provide electricity has been a tempting idea for years. Some researchers have estimated that if we could capture just a couple of hours' worth of the wave energy that pounds the coastlines of the world on any given day, we would have enough energy to power all the households in Newfoundland and Labrador for a whole year. Until recently, however, technology did not exist that could make this possible. Now, more than 100 companies around the world are racing to be the first to safely, efficiently, and cheaply harness the energy of the oceans.

Background

Using the oceans as a source of energy is appealing for two important reasons: ocean water is in good supply and the amount of energy available is tremendous. The main challenge is in designing the best way to harness that energy in a way that is not too costly, or does not harm the environment.

Currently, scientists are concentrating on three sources of energy from the oceans:

Energy Source	Description
Ocean currents	The force of undersea currents moves paddles or blades around a wheel, converting the energy of the currents into electricity.
Ocean waves	Floating machines transfer wave energy into electricity.
Tidal currents	Spinning wheels (turbines) convert tidal power to electricity.

Tidal power station in La Rance, France

Find Out More

Choose one source of ocean energy from the table and research the methods used to convert the energy to electricity. Use the Internet (start at www.discoveringscience8.ca), magazines, and newspapers. In addition, you may want to contact Memorial University (the Department of Physics and Physical Oceanography).

Report Out

Create a poster to display the results of your research. Be sure to include some information on historical attempts to harness ocean energy.

Organize a debate on the pros and cons of trying to use ocean energy. Consider the following factors:

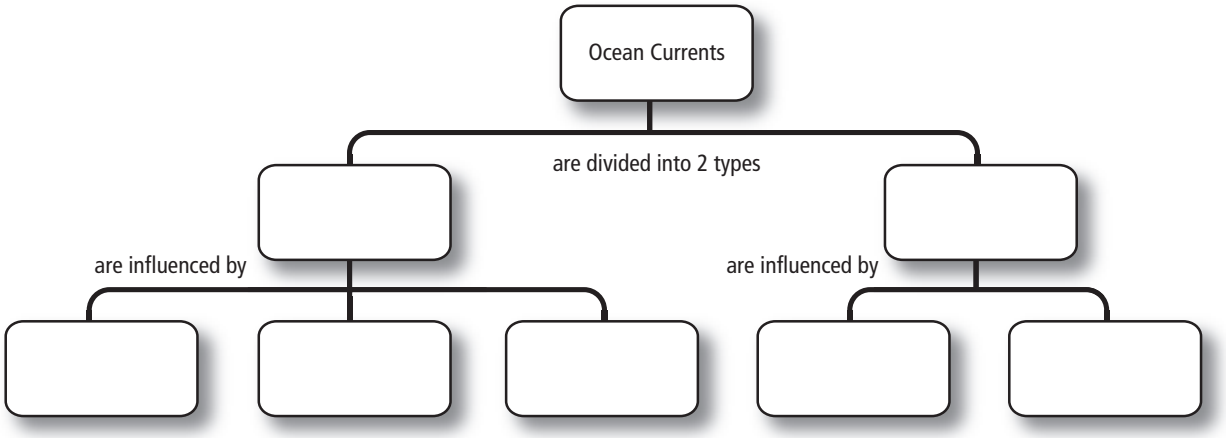
(a) environment (Will the method affect sea life in any way?)

(b) transportation (How will the method affect water transportation?)

(c) recreation (Will the method affect people's enjoyment of the beach or water?)

Visualizing Key Ideas

1. Copy and complete the diagram below using the following vocabulary:
surface current, Coriolis effect, uneven heating in the atmosphere (winds), temperature, salinity, deep water current, shape of continents



Using Key Terms

2. Copy the following table into your notebook. Then, write each term from the vocabulary list below in the appropriate column.

Found Only in the Oceans	Found on Land and in the Oceans

(a) abyssal plain
(b) continental slope
(c) mountains
(d) volcanoes
(e) tectonic processes

3. Classify each of the following descriptions as being a point source of pollution or a non-point source of pollution. Put a check mark in the appropriate column.

	Point Source of Pollution	Non-point Source of Pollution
(a) An ocean tanker spills thousands of litres of oil.		
(b) Oil and grease run off from city streets.		
(c) Fertilizers from farms leak into rivers.		
(d) A landfill leaks toxins into groundwater systems.		
(e) Industrial waste flows through storm sewers into rivers.		

Checking Concepts

1

4. Where is most of Earth's fresh water located?
5. What is the main difference between water found in the ocean and water found in a lake?
6. How is water naturally stored in the ground?
7. What is happening to most glaciers today?

2

8. What are the large, flat areas of ocean basins called?
9. Name three types of technology that are helping us to explore ocean basins.
10. Name three factors that affect surface currents in the ocean.
11. Describe what happens when cold, dense water meets warm, less dense water.
12. Define and illustrate the following wave features:
    (a) wave length
    (b) wave height
    (c) crest
    (d) trough

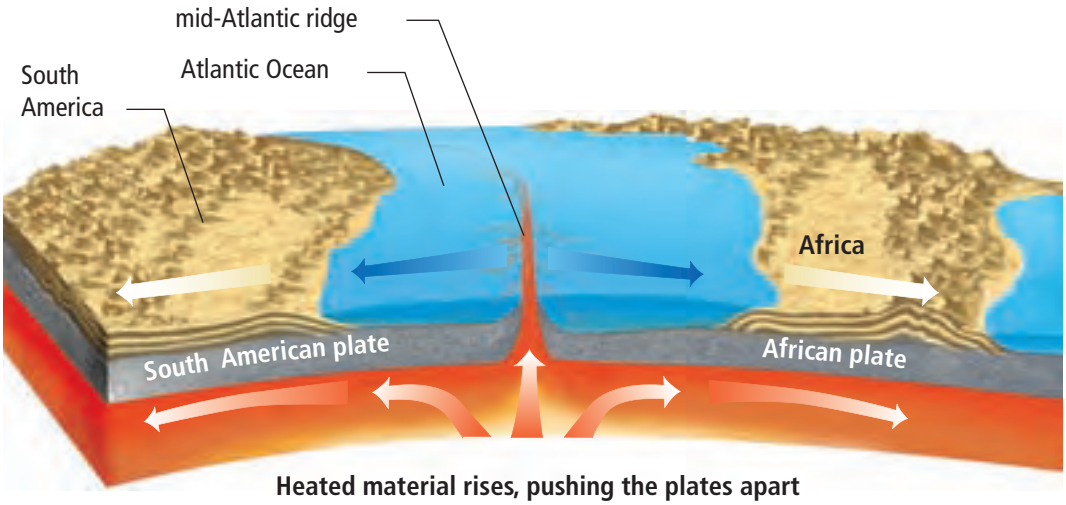
3

13. Compare and contrast weather and climate.
14. How are ocean currents related to climate?
15. What are wetlands?
16. How is acid precipitation created?
17. Name three problems that humans have created in the Atlantic Ocean.

Understanding Key Ideas

18. Besides erosion by rivers, describe two other ways the surface of the land can be changed by water. Give examples from Newfoundland and Labrador's coast.
19. Describe how the shape of a headland compares with the shape of a bay.
20. Explain the following statement: "Climate is affected by ocean water's high specific heat capacity."
21. (a) Explain the connection between weather and climate.
    (b) Predict what would happen to climates if ocean currents suddenly stopped.
22. Outline the similarities and differences between wetland environments and estuary environments.
23. The salinity of ocean water at the equator is high because the Sun causes water to evaporate, leaving salt behind. If this was the only process acting on ocean water, there would be far more salt than water in oceans. Explain why this is not happening.

24. The figure below shows the location of South America and Africa on opposite sides of the Mid-Atlantic Ridge. The continents are about the same distance away from the ridge. The oldest rock on the ocean floor is about 200 million years old, and can be found at the continental margins. What do the present locations of South America and Africa suggest about their locations 200 million years ago?



Heated material rises, pushing the plates apart as they produce new sea floor material.

25. Winds have a great effect on the surface currents of the oceans. Deeper down in the ocean, however, the effect of wind is minor, but there is still much movement of the water. Write a short paragraph describing the factors that cause currents in deep ocean water.

26. Explain why weather along a coast is different from weather farther inland.

27. What factors affect the variety and productivity of plants and animals in a freshwater environment?

28. As you have learned in this unit, most glaciers around the world are receding (because they are melting). The table below shows the amount a particular glacier has receded over a five-year period.

Year	Amount Glacier Has Receded (m)
2001	3.0
2002	2.5
2003	4.0
2004	6.8
2005	7.3

(a) Graph the data for the receding glacier in a properly labelled graph.

(b) Connect the dots with a smooth line. What does the slope of the line indicate about the amount the glacier has receded in recent years?

(c) Why do you think the glacier has receded by different distances each year?

(d) With a different coloured pen from what you used in (b) above, draw a straight "best-fit" line through the points. The slope of the line will give you the average rate the glacier has receded during this period of time. Calculate the average using the formula: slope = rise/run. What is the average rate the glacier has been receding per year?

(e) If the glacier is 2.0 km long right now, how long will it take to completely disappear if its average rate of receding does not change?