1.1 Sustainability

Key Terms
ecosystem
sustainable ecosystem
biotic
abiotic
lithosphere
hydrosphere
atmosphere
biosphere
nutrients
aquatic ecosystem
terrestrial ecosystem
eutrophication

On Easter day in 1722, a Dutch ship landed on a small treeless island in the South Pacific. A small population of people lived on the island. Along the coast, there were many giant rock statues of human forms, shown in **Figure 1.1**. Some of these statues were as tall as 10 m. How could so few people put together so many large statues?

The Mystery of Easter Island

Many scientists theorize that there was once a thriving population of people on Easter Island, as well as thick forests. The people had come from other islands in the South Pacific, thousands of kilometres away. They built houses, planted crops, and raised the animals they had brought with them. They also built the giant rock statues.

To move the statues from the rock quarry to the coast, they cut down trees and made wooden frames. In addition, the islanders cut down trees to clear the land for their crops and to burn the wood for warmth. Eventually, the last tree was cut down. The loss of trees led to erosion, a loss of plants for food, and no materials for making boats for fishing—or escape. Without the supporting forest, the island could no longer sustain the human population. Their standard of living declined, and their society began to die off. The disappearance of the forests also led to the disappearance of other island residents, such as birds.

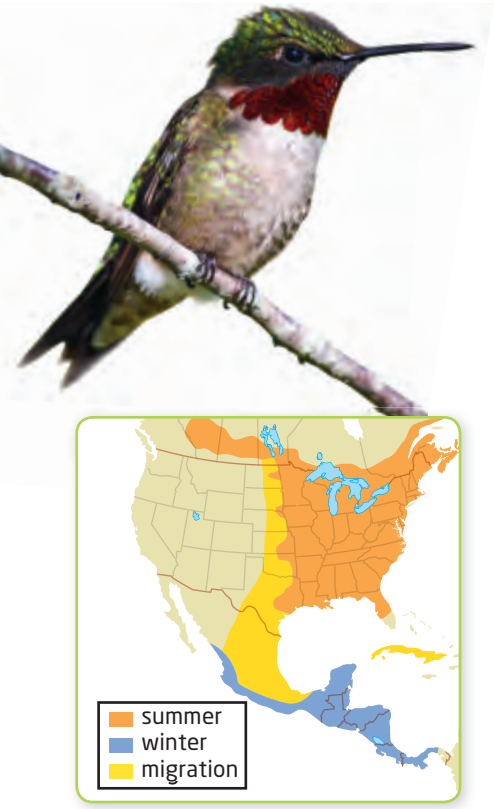
ecosystem all the interacting parts of a biological community and its environment

sustainable ecosystem an ecosystem that is capable of withstanding pressure and giving support to a variety of organisms

The Need for Sustainable Ecosystems

The forests that once grew on Easter Island are an example of an ecosystem. An **ecosystem** includes all the interacting parts of a biological community and its environment. The prefix *eco-* is from the ancient Greek word for home. This is a fitting prefix, since ecosystems are the natural homes of the many organisms that live in them. When the term **sustainable ecosystem** is used, the word *sustain* has two meanings: to endure and to support.

Figure 1.1 The cost of erecting these massive statues was the destruction of the sustaining forests on Easter Island.



Ecosystems and Survival

"To endure" means to continue in the same state. Sustainable ecosystems endure, but they also support a wide variety of organisms. The Easter Islanders' use of their forest ecosystem was unsustainable. Under the pressure of the tree cutting, the ecosystem could not endure, nor could it support many of the organisms, including humans, on the island.

All organisms require sustainable ecosystems for survival. Many organisms depend on more than one ecosystem to survive. Ruby-throated hummingbirds, shown in **Figure 1.2**, spend the summer in gardens and along the edges of forests of eastern Canada. In the fall, they fly thousands of kilometres to spend the winter in the tropical forests of Central America. In the spring, they begin the long flight back to Canada. Along the way, they stop to drink water, eat nectar and insects, and rest. Because these birds, and many others, migrate long distances every year, they are dependent on the many ecosystems along their migratory route for food and shelter.

Figure 1.2 Ruby-throated hummingbirds fly north from Mexico each spring. Along the way, they need resources from sustainable ecosystems to survive.

STSE Case Study

The Disappearing Eel

The American eel, shown on the right, was once one of the most abundant fish in the St. Lawrence River. The species was so plentiful that there are accounts from the mid-1600s of a person catching 1000 eels in one night with just a spear! Today, the situation has changed. The estimated number of American eels in the St. Lawrence and Great Lakes has decreased by more than 90 percent.

American eels found in the Great Lakes are long, snake-like fish. They are a native species and have an important role in the Great Lakes ecosystem. Eels eat insects, crustaceans, fish, frogs, and dead animals. They are prey for other fish, birds, and mammals.

American eels migrate great distances and change dramatically during their life cycles, as shown on the next page. Eels are catadromous: they spend most of their lives in fresh water, but return to the sea to lay eggs. Both saltwater and freshwater species and their ecosystems are affected by a decrease in the eel population.

Because the eel's life cycle is so long and covers so much distance, the species encounters many threats. Many mature eels do not complete their journey down the St. Lawrence River and back to the Sargasso Sea.

The appearance of an American eel changes many times as it makes its long journey from the Sargasso Sea to the Great Lakes.

About 40 percent of these eels are shredded and killed in dam turbines in the river. Dams also block young eels migrating upstream toward the Great Lakes.

Overfishing has contributed to the decline of American eels. Ontario cancelled its eel fishery in 2004, but eel fishing takes place elsewhere. Overharvesting of seaweed, which makes up the spawning habitat for eels, could also be contributing to a decrease in eels. Chemical contaminants may be affecting eel fertility. Governments, industry, and scientists are working together to decrease the threats that eels face at different points in their life cycles.

Parts of an Ecosystem

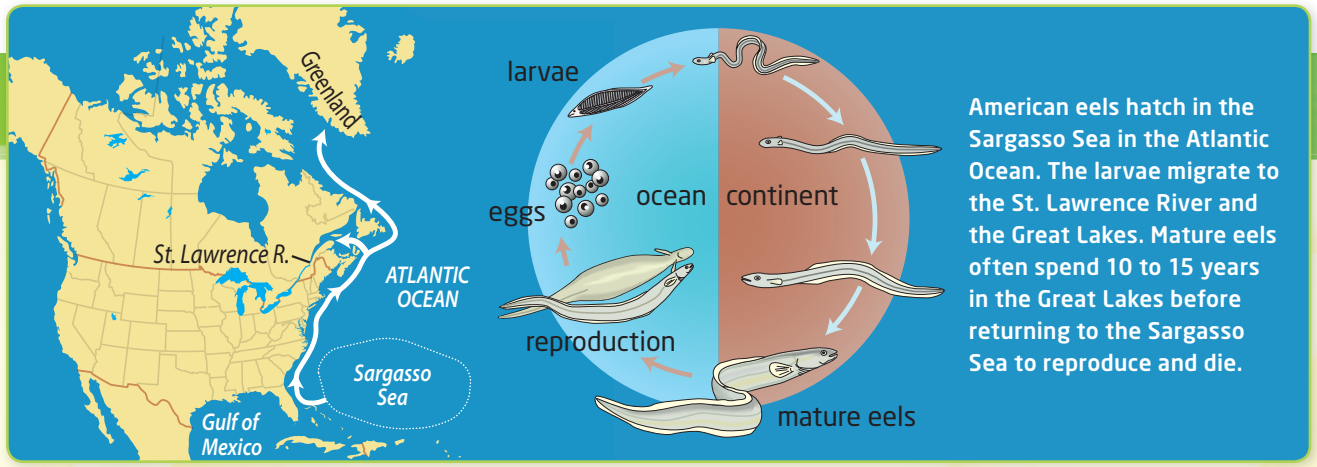
Ecosystems can cover large areas of land or water, such as the boreal forest system in Ontario. Ecosystems can also be small, such as a rotting log or a pool of water. Every ecosystem has biotic and abiotic parts. **Biotic** refers to the living parts of an ecosystem. The biotic parts of an ecosystem include plants, animals, and micro-organisms. **Abiotic** refers to the non-living parts of an ecosystem. The abiotic parts of an ecosystem include water, oxygen, light, nutrients, and soil.

biotic the living parts of an ecosystem

abiotic the non-living parts of an ecosystem

Learning Check

1. Describe the ways in which the people's use of trees on Easter Island was unsustainable.
2. What is the two-part meaning of the word *sustain*?
3. Use the map in **Figure 1.2** to explain how ruby-throated hummingbirds are dependent on more than one ecosystem.
4. List some biotic parts of the ecosystem in which you live.



American eels hatch in the Sargasso Sea in the Atlantic Ocean. The larvae migrate to the St. Lawrence River and the Great Lakes. Mature eels often spend 10 to 15 years in the Great Lakes before returning to the Sargasso Sea to reproduce and die.

How Can We Help the American Eel?

- Commercial fishers are helping scientists capture and tag large eels.
- Ontario Power Generation is shipping eels down the St. Lawrence and releasing them in Lac St. Pierre in Québec, so that the eels do not have to pass through dam turbines.
- The First Nations along the St. Lawrence River have agreed to stop all harvesting and work with the Department of Fisheries and Oceans and other agencies to ensure this species is protected.
- Hydro Québec, New York Power Authority, and Ontario Power Generation have built eel ladders at their St. Lawrence River dams to help eels migrate upstream.

Your Turn

1. Why is the American eel an important part of the ecosystem of the St. Lawrence River and Great Lakes?
2. Identify different stakeholders affected by the decline of the American eel (for example, commercial fishers, Aboriginal peoples, workers in the power industry). Write a short paragraph to describe the issue from the point of view of one of the stakeholders.
3. Create a poster for a campaign to raise public awareness about the American eel. Your poster should highlight the importance of the eel to the health of the Great Lakes ecosystem and the historical significance of the American eel to Aboriginal peoples and Ontario's fishing industry.

Biotic Characteristics of an Ecosystem

The biotic characteristics of an ecosystem include all the living things, such as plants, animals, fungi, bacteria, and protists, in an ecosystem. They also include all the interactions among the living things in the ecosystem. Examples of such interactions, shown in **Table 1.1**, include *symbiosis, predation,* and *competition.*

Table 1.1 Biotic Interactions

Biotic Interaction	How It Works
Symbiosis 	Symbiosis is the interaction between members of two different species that live together in a close association. Although you cannot see any interaction from the surface, the mushrooms in the photograph help the nearby trees absorb water and nutrients from the soil. Masses of mushroom tissue surround the roots of the trees, increasing the area that the roots cover and thus increasing their absorption. The mushroom tissue also helps to prevent the roots from drying out. The mushrooms benefit as well. The mushrooms get food, in the form of sugar, produced by the trees.
Predation 	Predation occurs when one organism consumes another organism for food. The organism that is consumed is called the prey. The organism that eats the prey is called the predator. The river otter shown in the photograph is a predator. Its prey includes fish, crabs, frogs, and turtles. The river otter is also prey for other predators, such as coyotes. In this way, organisms are linked together through the food chain. The relationship between predators and their prey can influence the population of both the predator and the prey, as well as affect the entire ecosystem in which they live. You will read more about predation later in this chapter and in Chapter 2.
Competition 	Competition occurs when two or more organisms compete for the same resource, such as food, in the same location at the same time. The dandelions in the photograph compete with the grass for the same resources. The dandelions may block out light that the grass needs to survive. They may also soak up more water or nutrients from the soil, leaving less for the grass. Competing for resources takes energy. Energy expended on competition is energy that is taken away from other important life processes, such as growth and reproduction. Competition can influence the population size and success of a group of organisms. Sometimes, one group of organisms is outcompeted by another group. You will read more about competition and how it influences populations in Chapter 2.

Activity 1-2

What Symbol Would You Choose?

The statues on Easter Island have probably become one of the best-known symbols for the idea that cultural short-sightedness can lead to unsustainable ecosystems. Sometimes symbols can be biotic factors. For example, the polar bear has recently been used as a symbol to alert people to the consequences of global warming. Other times, a symbol may represent an abiotic factor, such as water or space. What symbol would you choose to represent an environmental issue occurring right now?

Materials

- construction paper
- coloured markers
- scissors
- tape or glue
- Internet access
- computer lab

Procedure

1. Design a symbol or an image to represent the world's current environmental problems.
2. Design another symbol or image to represent a future of increased environmental awareness.
3. Share your designs with your classmates.

Questions

1. How did your designs differ from your classmates' designs?
2. What symbol from our society would you choose to represent our current relationship with the environment? Explain your choice.

Making a Difference

In Grade 9, Yvonne Su discovered that her Newmarket school was not recycling because it lacked the resources. Yvonne felt a responsibility to do something. She and her friends, with the help of some teachers, decided to tackle the recycling themselves, so they started a recycling and environmental club. Yvonne has been involved in environmental activities ever since.

"As Grade 9s, my friends and I didn't know where to turn to learn more about our planet. After speaking to some teachers, we found out that our greatest resources were right in front of us—our science classes."

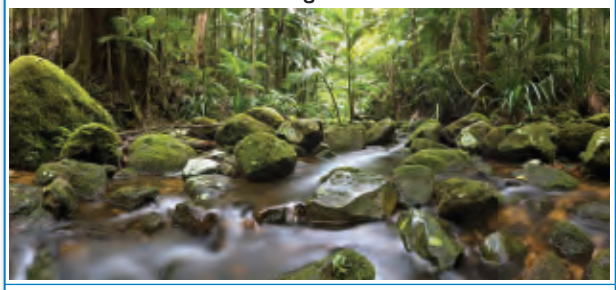
The more Yvonne and her friends learned, the more they wanted to share their knowledge. They organized campaigns about environmental issues at their school. Then they took their campaigns to schools across Canada. Yvonne was named one of Canada's Top 20 Under 20 in 2007. She is now studying environmental science at the University of Guelph.

What changes would you suggest making at your school to help the environment?

Abiotic Characteristics of an Ecosystem

The abiotic characteristics of an ecosystem, described in **Table 1.2**, are as important as the biotic characteristics. The abiotic characteristics are the factors that living things need to survive.

Table 1.2 Abiotic Characteristics of an Ecosystem

Abiotic Characteristic	Why It Is Important	Effects on Sustainability
Water 	All organisms need water to survive. Plants take up water through their roots. Some animals need water to help regulate their body temperature. Animals also use water to get rid of wastes. Many organisms live in freshwater and saltwater ecosystems.	Both natural processes and human activities can affect the amount and quality of water in an ecosystem. Water sources can dry out during long, hot periods with no rain. Chemicals from industries and agriculture can contaminate water.
Oxygen 	Many organisms, including plants and animals, need oxygen for their life processes. Aquatic organisms get oxygen from water.	Sometimes, as a result of human activities, oxygen levels in water can get so low that fish and other organisms cannot survive.
Light 	Plants and other organisms such as algae need light for photosynthesis, a life process in which organisms produce their own food.	The amount of light that an ecosystem receives can vary. Plants near the floor of a forest may be shaded by taller trees. Light in an aquatic ecosystem can be affected by the amount of sediment in run-off.
Nutrients 	All organisms need nutrients to grow. For example, plants and animals need nitrogen and phosphorus.	Nutrient levels in an ecosystem can become unbalanced as a result of human activities.
Soil 	Soil provides nutrients for plants and a habitat for many micro-organisms.	Top layers of soil, which contain the most nutrients, can be washed away if there is heavy rain or if too many trees have been cut down.

Cycling of Matter and Earth's Spheres

Hummingbirds consume water, insects, and nectar to survive. The water, insects, and nectar, as well as the hummingbird itself, are different forms of living and non-living matter. The hummingbird uses the matter it consumes to fly, build muscle, reproduce, and carry out other life processes. Ecological processes move matter from the biotic and abiotic parts of an ecosystem, and back again, in continuous cycles.

At any time, matter can occupy one of the four spheres that make up Earth. The hard part of Earth's surface is the **lithosphere**, from the Greek word for stone. The salt water in the oceans and the fresh water on the continents form the **hydrosphere**. The Greek word *hydro-* means water. The layer of air above Earth's surface is the **atmosphere**, from the Greek word *atmos-*, which means vapour.

Figure 1.3 shows the lithosphere, hydrosphere, and atmosphere. In this image of North Africa and Europe, the lithosphere is best represented by Earth's largest desert, the Sahara. The North Atlantic Ocean and the Mediterranean Sea represent the hydrosphere, and the light from the Sun shows the thin layer of gases that make up the atmosphere.

Study Toolkit

Word Families Make a word family web to show how the vocabulary words on this page are related.

lithosphere the hard part of Earth's surface

hydrosphere all the water found on Earth, including lakes, oceans, and ground water

atmosphere the layer of gases above Earth's surface

Earth's Biosphere

The lithosphere, hydrosphere, and atmosphere are abiotic spheres that are found on other planets, as well as Earth. Mars has all three spheres, although its hydrosphere is mostly ice and its atmosphere has very little oxygen. There is a fourth sphere at Earth's surface, however, that no other planet in the solar system is known to have—a biosphere.

The **biosphere** is the living surface of Earth, but it is not separate from the abiotic spheres. After all, many life forms are found underground, in both fresh water and salt water, and in the atmosphere as well.

biosphere the regions of Earth where living organisms exist

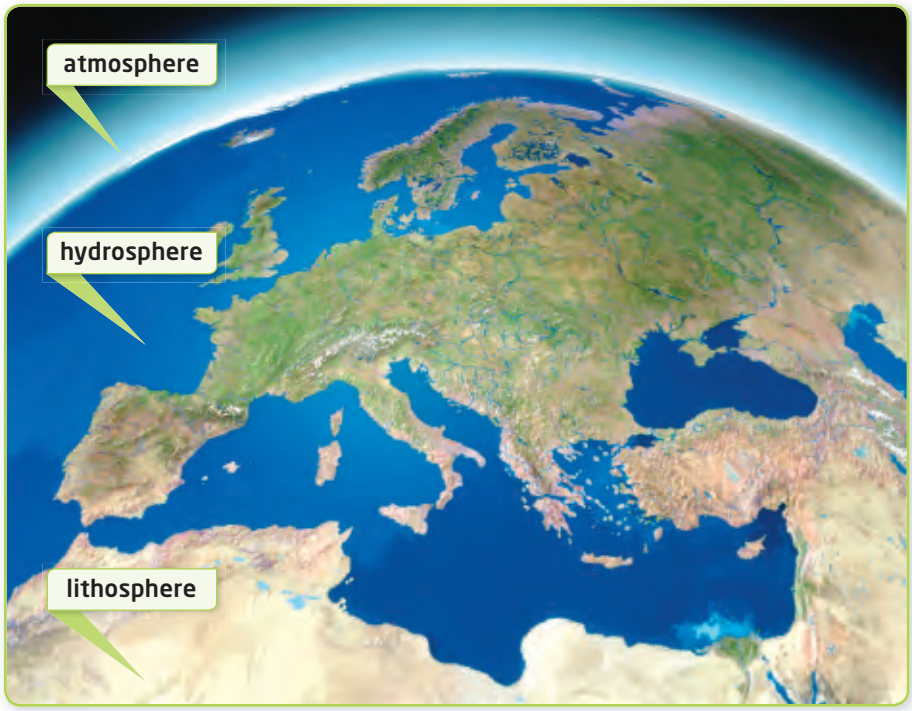


Figure 1.3 In this image of Earth, all four spheres are visible. The biosphere is all around us. It exists everywhere you can see in the photograph (except in space). Through ecological processes, matter moves among the spheres.

Nutrient Cycles

nutrient a chemical that is essential to living things and is cycled through ecosystems

Ecosystems provide living things with the matter they need, including nutrients. **Nutrients** are chemicals that are needed by living things and are continually cycled through ecosystems. Examples of nutrients include water, carbon, nitrogen, and phosphorus.

The Water Cycle

Perhaps the biosphere's most vital abiotic cycle is the water cycle. **Figure 1.4** shows how water moves between the hydrosphere and the atmosphere as the Sun's rays evaporate huge amounts from oceans and other bodies of water at Earth's surface. As the water vapour rises in the atmosphere, it cools and condenses. Clouds form from condensed water droplets. Eventually, the water falls back to the lithosphere as precipitation (rain or snow, for example). As the water returns to the oceans through river systems and the ground, it erodes rocks and picks up other materials. It is also absorbed by plants and other organisms, or consumed by animals. In this way, it enters the biosphere. The movement of water among Earth's spheres is critical to the operation of sustainable ecosystems.

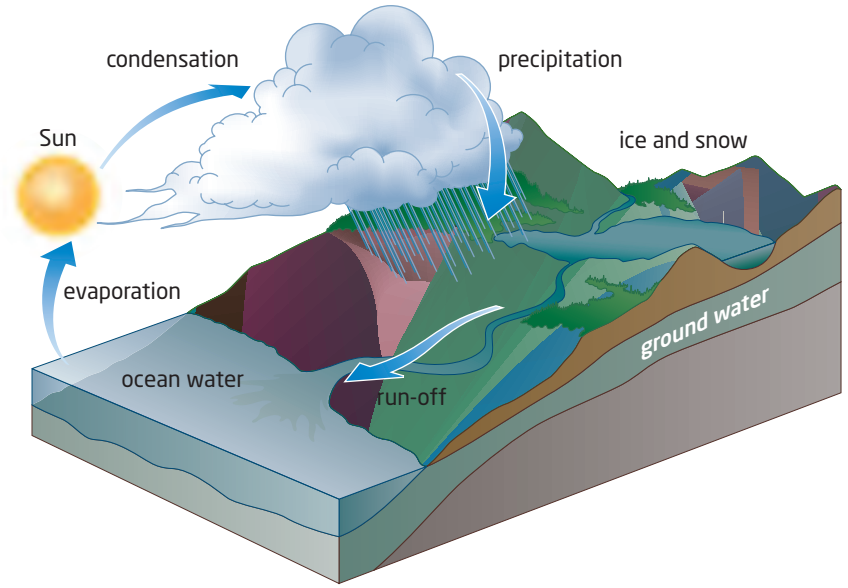


Figure 1.4 Water continually cycles through the hydrosphere, atmosphere, lithosphere, and biosphere through the processes of evaporation, condensation, and precipitation.

The Carbon Cycle

Carbon is another essential nutrient for all living things. **Figure 1.5** shows the carbon cycle. Like water, carbon moves through Earth's spheres as it is cycled through ecosystems. Carbon dioxide, a gas, moves from the atmosphere into the biosphere and back again. Carbon dioxide also moves back into the atmosphere when organisms die and their bodies decompose. Carbon enters the lithosphere when the remains of organisms are trapped underground. After millions of years, these remains are converted into fossil fuels, such as coal, oil, and natural gas. Carbon dioxide is returned to the atmosphere when humans burn the fossil fuels for energy.

NATIONAL GEOGRAPHIC

VISUALIZING THE CARBON CYCLE

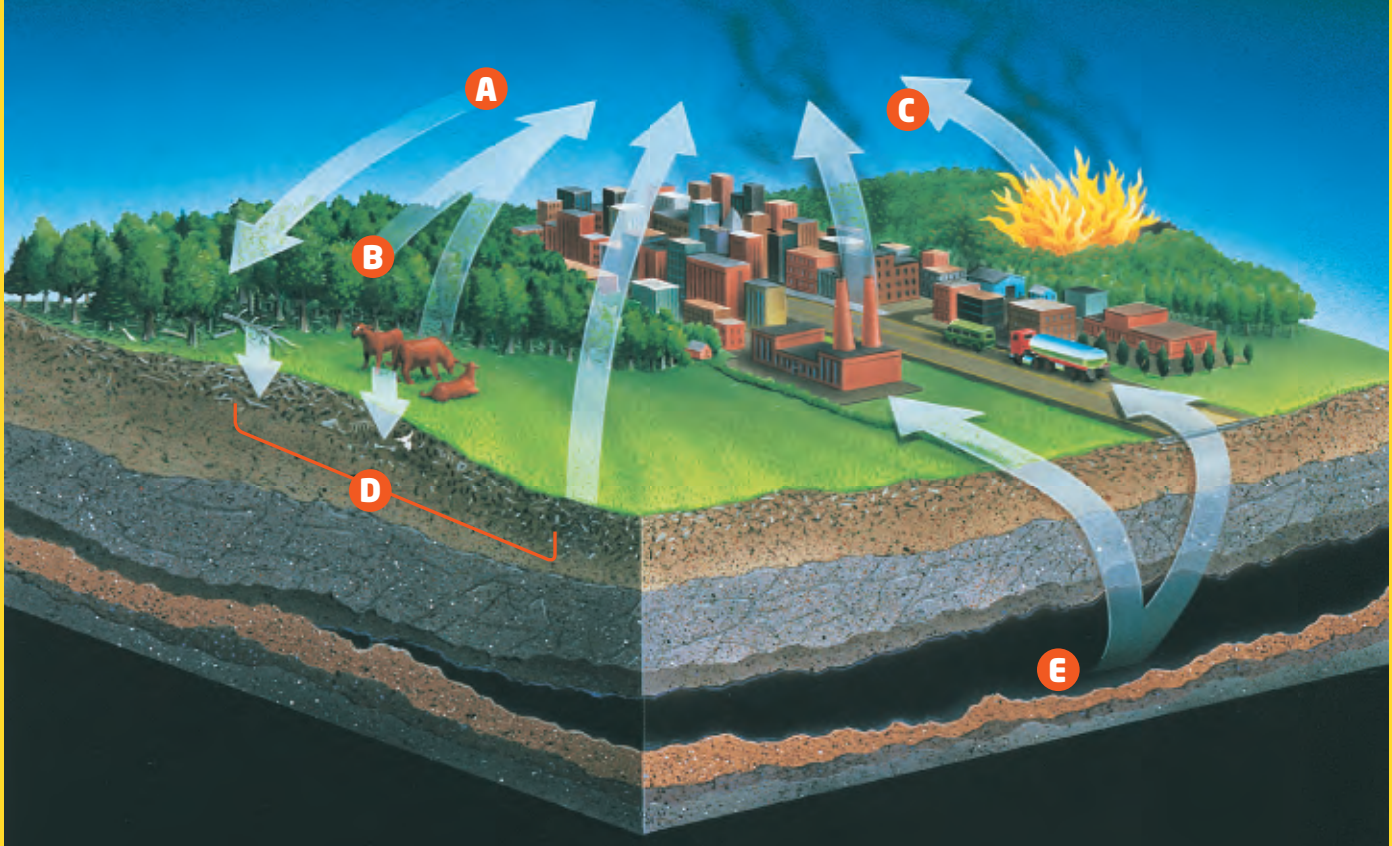
Figure 1.5

Carbon–in the form of different kinds of carbon-containing molecules–moves through an endless cycle. The diagram below shows several stages of the carbon cycle. It begins when plants and algae remove carbon from the environment during photosynthesis. This carbon returns to the atmosphere via several carbon-cycle pathways.

A Air contains carbon in the form of carbon dioxide gas. Plants and algae use carbon dioxide to make sugars, which are energy-rich, carbon-containing compounds.

B Organisms break down sugar molecules made by plants and algae to obtain energy for life and growth. Carbon dioxide is released as a waste.

C Burning fossil fuels and wood releases carbon dioxide into the atmosphere.



D When organisms die, their carbon-containing molecules become part of the soil. These molecules are broken down by fungi, bacteria, and other decomposers. During this decay process, carbon dioxide is released into the air.

E Under certain conditions, the remains of some dead organisms may gradually be changed into fossil fuels, such as coal, gas, and oil. These carbon compounds are energy rich.

The Nitrogen Cycle

Earth's atmosphere is 78 percent nitrogen (N_2). But most organisms cannot use nitrogen in the form in which it exists in the atmosphere. Therefore, as shown in **Figure 1.6**, an important part of the nitrogen cycle involves processes that convert the nitrogen into usable forms.

terrestrial ecosystem an ecosystem that is land-based

aquatic ecosystem an ecosystem that is water-based, either fresh water or salt water

For example, in **terrestrial ecosystems**, some soil bacteria convert nitrogen into ammonium. Other types of soil bacteria convert the ammonium into nitrate. Plants absorb both forms of nitrogen through their roots, but most of the nitrogen absorbed is in the form of nitrate. Nitrogen is passed from one level of the food chain to the next as organisms eat and then use nitrogen in their bodies.

In **aquatic ecosystems**, cyanobacteria convert nitrogen into ammonium, which is then absorbed by plants. Nitrogen, in the form of ammonium and nitrate, can also enter both aquatic and terrestrial ecosystems when humans fertilize soil. Bacteria, found on land and in water, convert nitrate back into nitrogen gas, returning it to the atmosphere. As well, nitrogen is returned to the atmosphere as ammonia during volcanic eruptions and when fossil fuels are burned.

In a sustainable ecosystem, the amount of nitrogen converted into usable forms is equal to the amount of nitrogen returned to the atmosphere. Excess nitrate and ammonium eventually enter the lithosphere, becoming part of rocks. This nitrogen returns to the atmosphere only after many centuries, when rocks are broken down into smaller pieces.

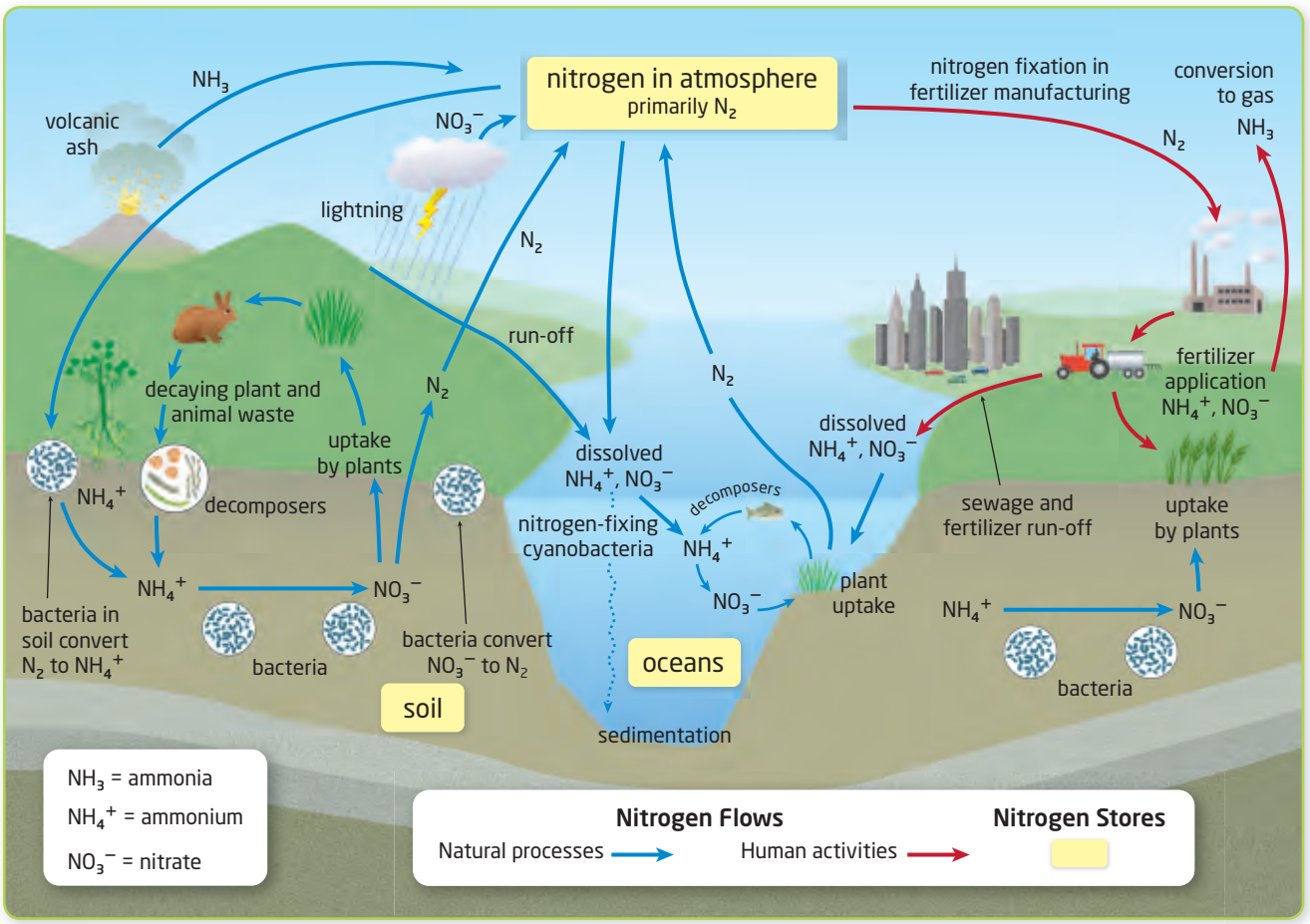


Figure 1.6 Nitrogen, a nutrient important to living things, moves through the atmosphere, hydrosphere, biosphere, and lithosphere in the nitrogen cycle.

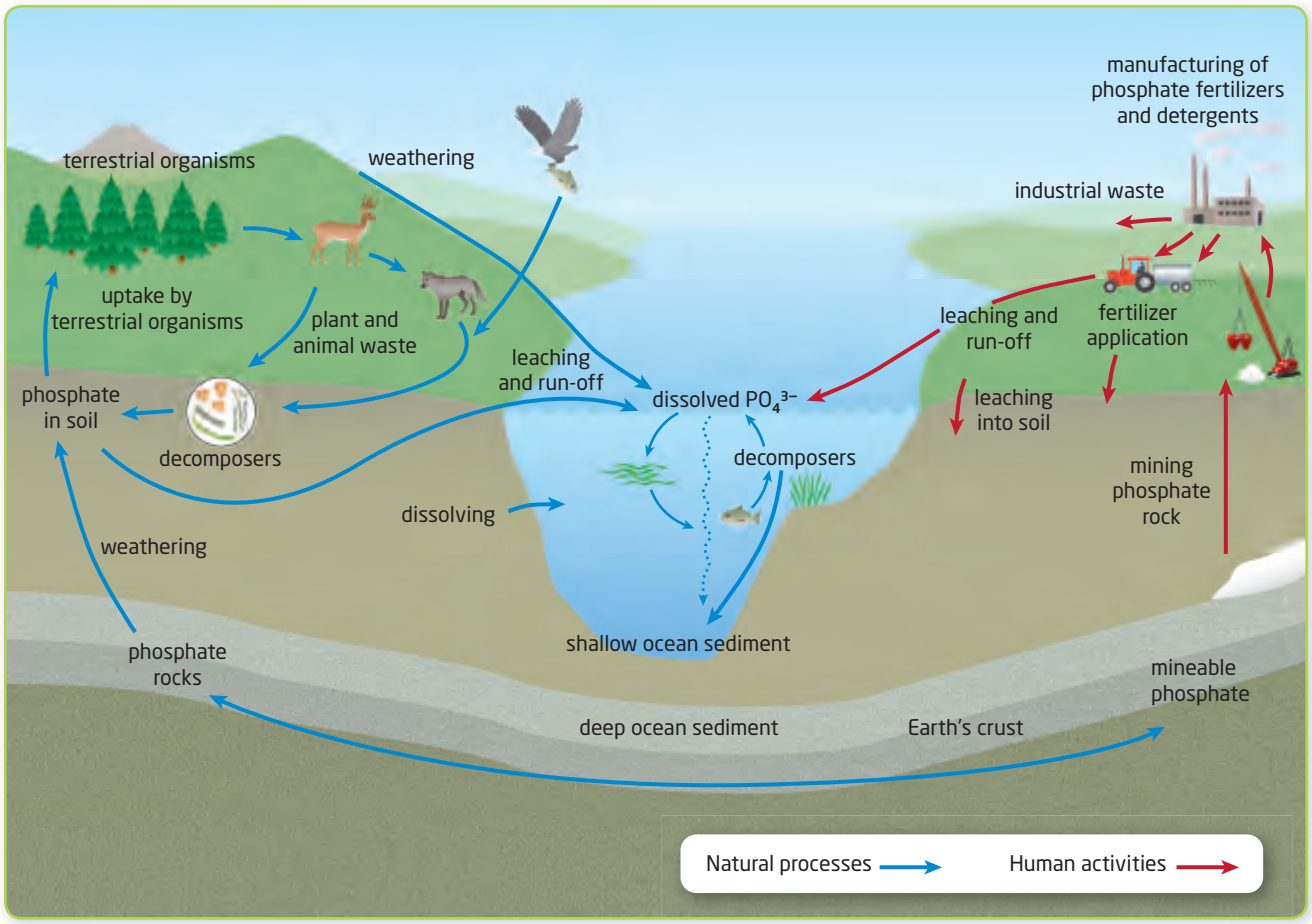


Figure 1.7 Phosphorus moves through the hydrosphere, biosphere, and lithosphere in the phosphorus cycle.

The Phosphorus Cycle

Unlike carbon and nitrogen, which both exist as gases in the atmosphere, phosphorus is stored in the lithosphere. As shown in **Figure 1.7**, phosphorus is stored in rocks and in sediment on the ocean floor. When rocks are broken down into smaller pieces through the natural process of weathering, phosphorus, in the form of phosphate (PO_4^{3-}), is released into the soil. As well, humans mine Earth's surface for phosphate rock. The phosphate rock is used to make fertilizers and detergents, which also release phosphate into the soil. Once in the soil, the phosphate is absorbed by plants through their roots. The phosphate continues to move through the biosphere as animals eat the plants and other animals. As decomposers, bacteria break down dead organisms and animal waste, releasing the phosphate back into the soil. Thus, bacteria ensure that phosphorus is continually recycled within the biosphere.

Phosphate enters aquatic ecosystems through leaching and run-off from land. The rest of the cycle is similar to what occurs on land. Aquatic plants absorb the phosphate and are later consumed by animals. Bacteria then return the phosphate to the water when they break down organic matter.

Some of the phosphate that enters aquatic ecosystems in run-off settles to the bottoms of rivers, lakes, and oceans. As in the nitrogen cycle, phosphate that becomes part of the sediment is not usually returned to the biosphere for many centuries.

Human Activities and Nutrient Cycles

Suggested Investigation

Plan Your Own Investigation 1-A, Fertilizers and Algae Growth, on page 37

As you have read, human activities can throw off the balance in a sustainable ecosystem by affecting nutrient cycles. For example, aquatic ecosystems suffer when run-off has high amounts of agricultural fertilizers.

Fertilizers and the Phosphorus Cycle

In the mid-20th century, many aquatic ecosystems developed excessive algae growth. In Lake Erie, the amount of algae increased by as much as 30 times, upsetting natural balances. The process of **eutrophication** [pronounced u-tro-fi-KAY-shun], in which deposits of excess nutrients cause an overgrowth of algae, is very slow when natural. The alarming rate of eutrophication during the mid-20th century suggested, however, that human activities were the cause.

eutrophication a process in which nutrient levels in aquatic ecosystems increase, leading to an increase in the populations of primary producers

In 1968, 58 of Ontario's thousands of lakes were chosen to be the Experimental Lakes Area (ELA). Government and university researchers from around the world used this area for experiments to understand more about lake ecology. Ecologists added large volumes of different nutrient combinations. They found that when excess phosphorus was added to the water, the result was eutrophication, as shown in **Figure 1.8**.

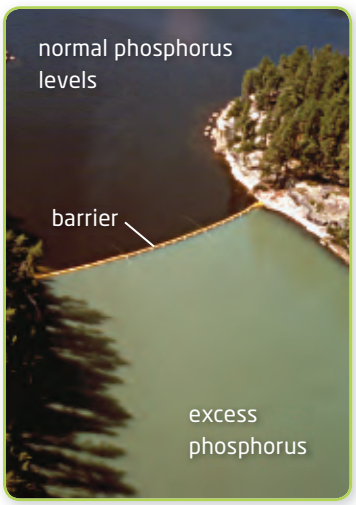


Figure 1.8 Ontario's Experimental Lakes Area was used to learn more about the causes of eutrophication.

How does excess phosphorus end up in bodies of water? Not all the fertilizers that are applied to farmlands are taken up by the crop plants. So, excess fertilizers enter the ground and are transported by water to nearby aquatic ecosystems. **Figure 1.9** illustrates the steps involved in eutrophication, as well as its consequences.

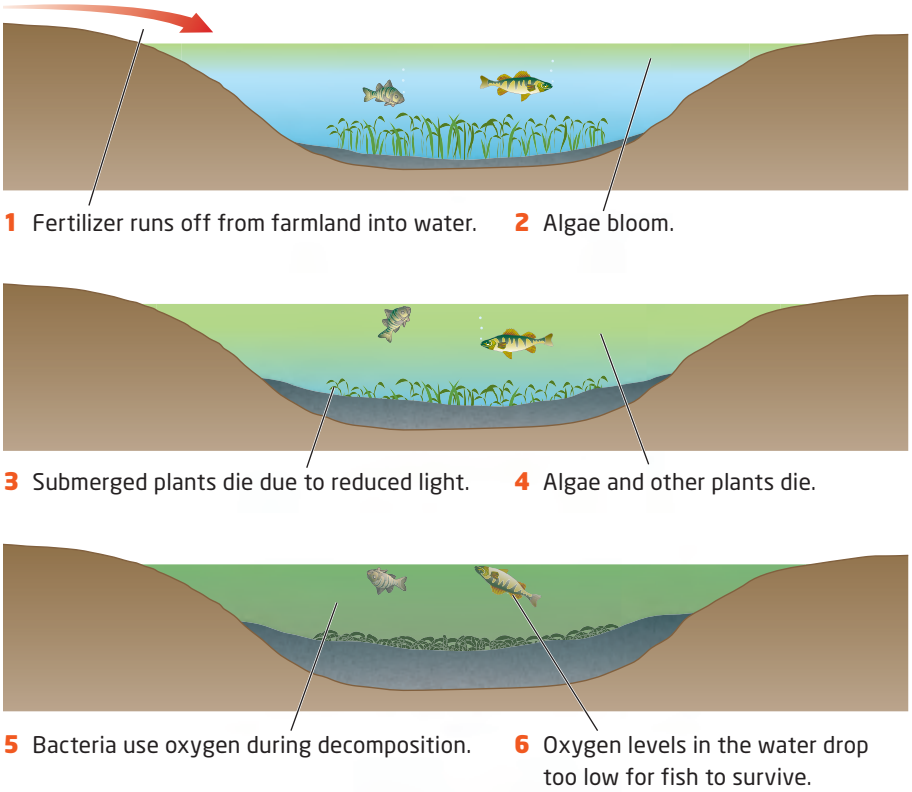


Figure 1.9 When nutrients that are normally limited are added in excess amounts, the balance in an aquatic ecosystem is upset by eutrophication.

Learning Check

5. What is eutrophication?
6. Which nutrient was found to be the main cause of eutrophication in northern Ontario lakes?
7. What is one possible source of excess phosphorus in aquatic ecosystems?
8. Suppose that you have a small fishpond in your backyard. You work hard to get your lawn looking thick and green. By the end of the summer, your lawn looks great, but the water in your fishpond is green and the fish are dead. Infer what happened.

Suggested Investigation

Plan Your Own Investigation 1-D, Can a Plant Have Too Much Fertilizer?, on page 42

Science and Social Policy

As a result of the work of the ecologists at Ontario's ELA, a multibillion-dollar phosphorus control program was established for the Great Lakes and St. Lawrence River region. In 1972, both Canada and the United States signed the Great Lakes Water Quality Agreement. In accordance with this agreement, both countries worked "to restore and maintain the chemical, physical, and biological integrity of the waters of the Great Lakes Basin Ecosystem." Although Lake Erie still suffers from pollution and algal blooms, like the one shown in **Figure 1.10**, the amount of phosphorus in the lake has decreased by more than 50 percent.

Figure 1.10 This satellite image shows an algal bloom in the western basin of Lake Erie in September, 2008.

Go to **scienceontario** to find out more

Environmental Farm Plans

Another way that the impacts of phosphorus have been reduced is through *environmental farm plans*. Farmers volunteer to be part of a program in which particular environmental impacts of a family's farm are examined. Then a plan to reduce some of these impacts is developed. Since 1993, over 27 000 farmers have participated in the program. In Ontario, the Ontario Farm Environmental Coalition manages the program.

Pesticides and By-Laws

Most scientific research is not meant merely to satisfy curiosity. It is meant to provide crucial information for modern societies, where it is used by citizens, governments, business, and even courts. For example, in 1991, the town of Hudson, Québec, passed a by-law banning the use of non-essential pesticides by home-owners and businesses. Two lawn-care companies challenged the by-law in court. The case went all the way to the Supreme Court of Canada. In 2001, the Supreme Court ruled to uphold the anti-pesticide by-law. A similar situation occurred in 2005, after the city of Toronto passed a by-law modelled after Hudson's. Manufacturers of pesticides challenged the by-law in court. Once again, the Supreme Court of Canada ruled to uphold the by-law.

Section 1.1 Review

Section Summary

- Sustainable ecosystems endure, and they sustain the organisms that live within them.
- Matter, including nutrients such as nitrogen, constantly moves through Earth's spheres.
- Human activities that increase the amount of nutrients reaching a terrestrial or aquatic ecosystem can upset the nutrient balance in the ecosystem.
- Decisions and actions that are taken to protect the health of ecosystems may involve international agreements and court decisions.

Review Questions

K/U **1.** What is a sustainable ecosystem?

C **2.** Draw a flowchart to show how the collapse of the forest ecosystem on Easter Island affected the human population that lived there.

K/U **3.** Identify and describe three abiotic characteristics of ecosystems. Give an example of how each characteristic could be affected by a human activity.

C **4.** Draw the nitrogen cycle. Explain the role that bacteria play in this cycle.

C **5.** The phosphorus cycle is an important part of sustainable ecosystems.

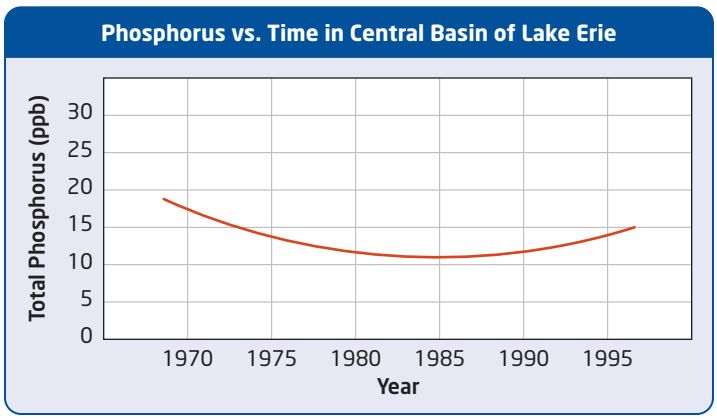
a. How can human activities affect the phosphorus cycle?

b. Suggest a way that eutrophication due to human activities can be avoided.

T/I **6.** How can scientific research influence society to push for change? Include specific examples in your answer.

A **7.** Farmers, fertilizer companies, governments, and consumers all play a role in helping to reduce nutrient pollution of aquatic ecosystems. List positive actions that each group could take.

A **8.** Use the data in the graph on the right to describe how phosphorus levels in the Central Basin of Lake Erie have changed over the last 30 years.



The graph shows the average amount of phosphorus during the months of June, July, and August in the Central Basin of Lake Erie for a 30-year period.