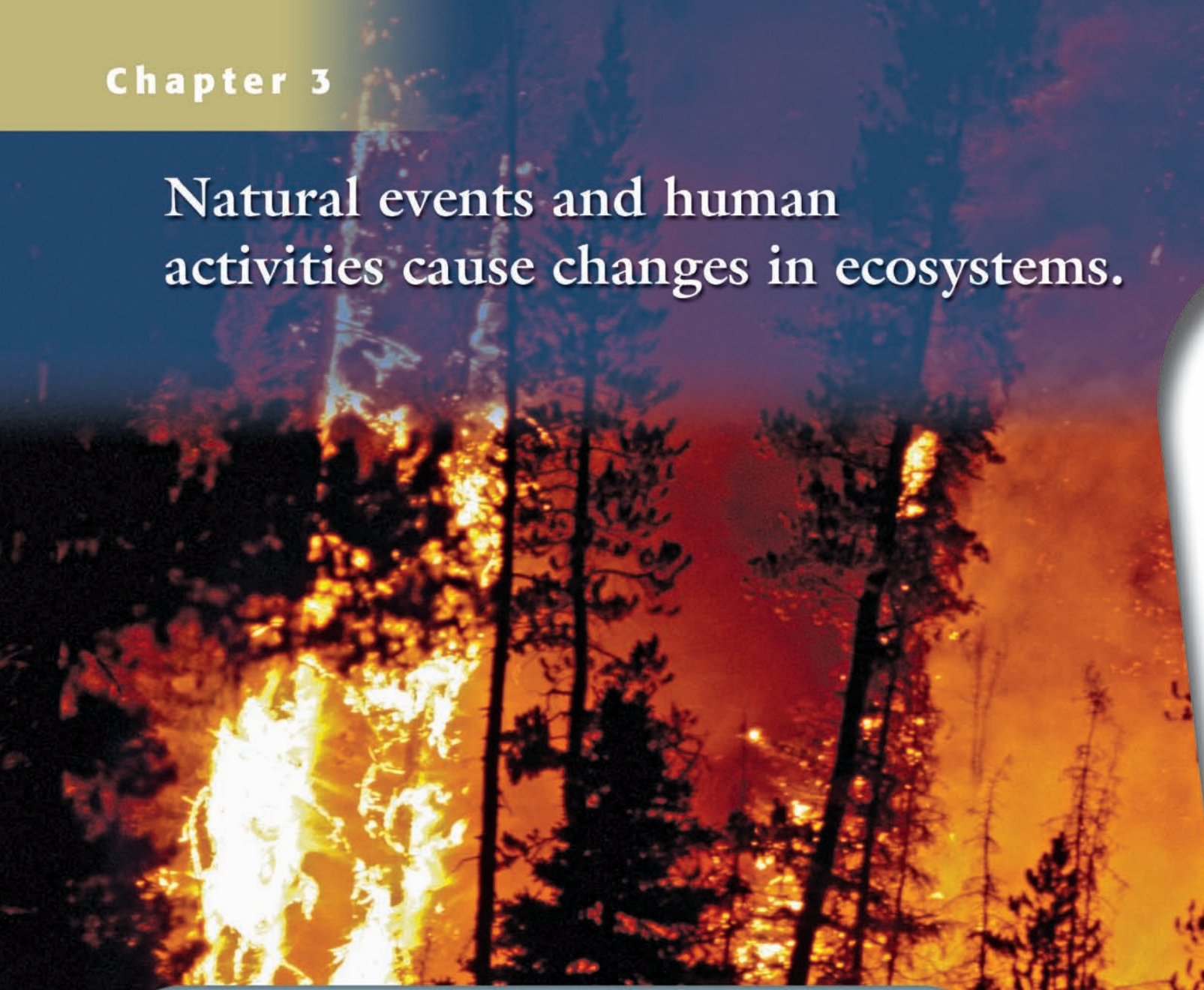
Chapter 3

# Natural events and human activities cause changes in ecosystems.



A raging fire quickly destroys this forest ecosystem. After the fire has passed, many species of plants and animals that live in the forest will not be able to survive in the changed environment where trees have been killed. Over a period of years, however, the forest ecosystem will develop again in the burned-out area.

In this chapter, you will study the process by which ecosystems change over time. Human activities such as logging, farming, mining, and dam-building have altered large areas of landscape. What happens to different species when cities, highways, and farmland replace natural ecosystems? What effects do human activities have on ecological processes? You will explore ways to reduce human impacts and conserve the natural environment.

## What You Will Learn

In this chapter, you will

- **describe** the process of succession
- **investigate** the impact of human activities on ecosystems
- **debate** the pros and cons of conservation
- **explain** how ecosystems can be monitored

## Why It Is Important

Changes in ecosystems can lead to loss of habitats and the species that live in them. Understanding how ecosystems change helps us to conserve and protect the natural environment.

## Skills You Will Use

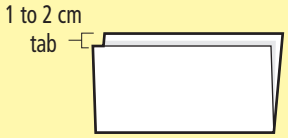
In this chapter, you will

- **model** the process of succession
- **predict** the impact of disturbances on ecosystems
- **communicate** your understanding of habitat conservation

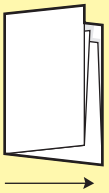
**FOLDABLES™**
Reading & Study Skills

**Make the following Foldable to take notes on what you will learn in Chapter 3.**

**STEP 1** **Fold** an 8.5 × 11" sheet of paper along the long axis, leaving a 1 to 2 cm tab along the top.

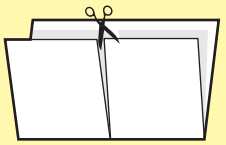



**STEP 2** **Fold** the paper in half along its length.

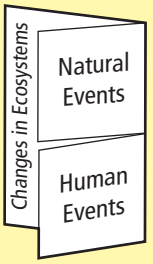


**STEP 3** **Unfold** the sheet and **cut** the bottom tab along the fold line as shown.

**STEP 4** **Turn** the Foldable so the narrow tab is along the left side.



**STEP 5** **Label** the Foldable as shown, with "Changes in Ecosystems" written along the left tab, "Natural Events" on the top tab, and "Human Events" on the bottom tab.




**Organize** List examples of natural events and human events on the front tabs of the Foldable, and describe the causes and effects of these events under the tabs. A similar Foldable could be made to compare primary and secondary succession, or to examine benefits and drawbacks of conservation efforts.

# 3.1 Natural Disturbances and Succession

Ecosystems may be disturbed by natural events such as storms and floods and by human activities such as logging and fishing. An area of bare rock can gradually change over centuries into a complex community of species by the process of succession. Each biological community alters its habitat and is replaced in time by populations of other biological communities.

## Key Terms

climax community
pioneer species
primary succession
secondary succession
succession

Ecosystems are always changing. Sometimes, a change is rapid and destructive. For example, floods, landslides, and hurricanes can wipe out most of the animals and plants over large areas of land. Human activities can be just as damaging. For instance, paving a parking lot creates an area that is bare of life.

**Figure 3.1** This abandoned parking lot has become a habitat for plants adapted to dry, open spaces.

What happens to an ecosystem after it has been damaged by natural events or human activities? Figure 3.1 gives a clue. It shows wild plants growing up through cracks in an abandoned parking lot. If left undisturbed, any area of bare land starts to change as organisms begin to live there.

The first organisms to establish themselves are adapted to survive in dry, exposed areas. As they grow, they change the environment and create habitats for other organisms. For example, the plants in Figure 3.1 provide food and shelter for insects. The insects in turn attract birds and other animals that feed on them. The process by which a biological community changes over time is called **succession.**

# 3-1A Modelling Succession in a Bottle

Find Out ACTIVITY

Succession can take place in small areas and large areas. It can occur in a short period of time or over many years. In this activity, you will establish an aquatic ecosystem in a bottle. Then you will observe how your ecosystem changes as it slowly becomes drier.

## Safety

- Wash your hands thoroughly after handling the materials in this activity.

## Materials

- 2 L clear plastic bottle with the top cut off, or large-mouthed jar
- potting soil
- ruler
- water
- small aquatic plant
- 50 mL wild birdseed mix

## What to Do

1. Put soil in the bottom of the container to a depth of about 5 cm.
2. Add water to a depth of 7.5 cm.
3. Place the container near a window in an area where it can stay undisturbed for a few weeks. Let the contents settle overnight.
4. Plant an aquatic plant in the container. Although water will evaporate over time, do *not* add more water to the container.
5. Once a week, add three or four seeds from the wild birdseed mix to the container. Record your observations each week.
6. After three or four weeks, add small amounts of water regularly, as you would when watering a houseplant. Continue to record your observations.

## What Did You Find Out?

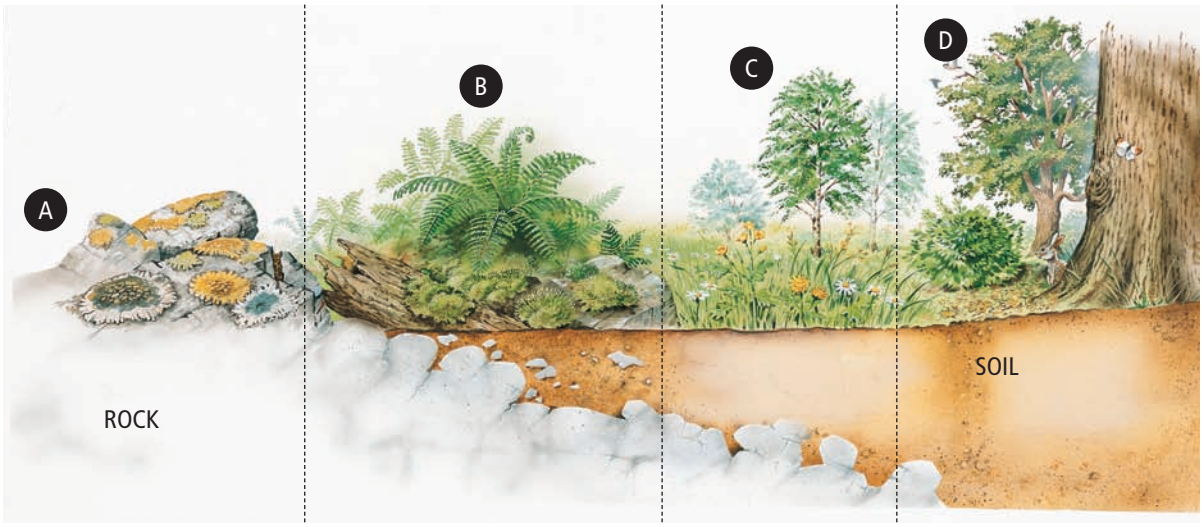
1. Describe what you observed in your container
   (a) before step 5.
   (b) after step 5.
2. Why were you asked not to add water in the initial part of this investigation?
3. Compare the ecosystem in the container at the end of your activity with the ecosystem at the start. Describe both the similarities and the differences.
4. How well do the changes that you observed in the container model succession? Give reasons for your answer.
5. Design your own investigation to observe the effect of a particular environmental change on an ecosystem in a container.

## Primary Succession

Just over 10 000 years ago, most of Canada was covered with glaciers. When the glaciers melted, the landscape consisted mainly of bare rock and gravel covered by millions of lakes and ponds. How did this landscape turn into the forests, grasslands, and other ecosystems that we see today?

Organisms that can live in a habitat without soil or shelter include bacteria, mosses, and lichens. Carried by wind or on the feet of birds, lichens can settle and grow on bare rocks as long as they have a supply of water and light. Species that can establish themselves in areas with little or no soil and few nutrients are called **pioneer species.**

Figure 3.2 shows how a simple community of pioneer species can change over time. The sequence of changes that starts with bare rock and eventually develops into a complex community of plants and animals is known as **primary succession.**




A Lichens grow on bare rock. They produce acids that start to break down the rock. Particles of rock and decaying matter from dead lichens begin to form soil.

B The resulting soil is thin and does not have many nutrients. However, plants such as small mosses and ferns can tolerate these conditions. The plants and soil create habitats for insects and other small animals.

C Organisms add more decaying matter and build up the soil. Deeper soils hold water and allow grasses and other plants to grow. More species of animals find food and shelter.

D Taller shrubs create shade. Their deep roots help stop soil erosion. Different communities of plants and animals replace earlier ones. Bushes and trees provide niches for a greater diversity of species.

**Figure 3.2** Many ecosystems change and develop over centuries by the process of primary succession.

Does the process of succession ever stop? If an area is not disturbed, it eventually produces a **climax community.** This is a diverse group of species that form a stable ecosystem which can remain relatively unchanged for centuries. Examples of climax communities in Canada include the northern boreal forest and the prairie grasslands.

## Secondary Succession

Figure 3.3 shows a forest just after a fire has burned through it. Before the fire, the forest provided a cool, damp, and shady habitat. Now the forest has only blackened tree trunks and a thick layer of ashes on the ground. Sunlight is now able to reach the ground. There are no leaves or branches to soften the intensity of rain when it falls. As a result of the fire, the abiotic conditions of this area have changed. This change has a potent impact on the numbers and species of organisms that visit and populate the area.

Figure 3.4 shows a forest several weeks after a fire. Wildflowers have grown up in the sunny, open spaces between the dead tree trunks. Over time, taller shrubs will grow where the wildflowers once thrived. Trees will begin to grow from seeds left behind in the soil after the fire, or brought by the wind or by animals. After many years, the forest ecosystem will be restored to the type of ecosystem that existed before the fire. The re-growth of a community in an area that has changed dramatically after a disturbance such as fire is an example of **secondary succession.**

**Secondary succession** is the process by which an ecosystem changes after it has been disturbed. Because the disturbed area is often surrounded by undamaged biological communities, the development of a climax community such as a forest through secondary succession can occur in a matter of years rather than hundreds of years.

Another example of secondary succession in Newfoundland and Labrador sometimes occurs after an area of forest is flooded by a beaver dam. After the dam is abandoned, the shallow beaver pond may, over time, become filled in by soil that is washed in from the surrounding land. This may lead to formation of a bog. As the bog dries out, shrubs and trees take root. Eventually, a forest ecosystem develops again. In many parts of the province, however, abiotic conditions such as the underlying rock, soil acidity or alkalinity, and amount of precipitation do not allow trees and other forest plants to grow. In these areas, a bog forms the climax community.

**Figure 3.3** The leaves and branches have been burned off the trees by a forest fire, and the ground is covered with ash.

**Figure 3.4** Several weeks after a fire, wildflowers grow among the tree trunks in the bright, open space.

### Reading Check

1. What is the difference between primary succession and secondary succession?
2. In your own words, define "pioneer species."
3. What is a climax community?

# 3-1B Secondary Succession from Beaver Pond to Bog to Forest

Think About It

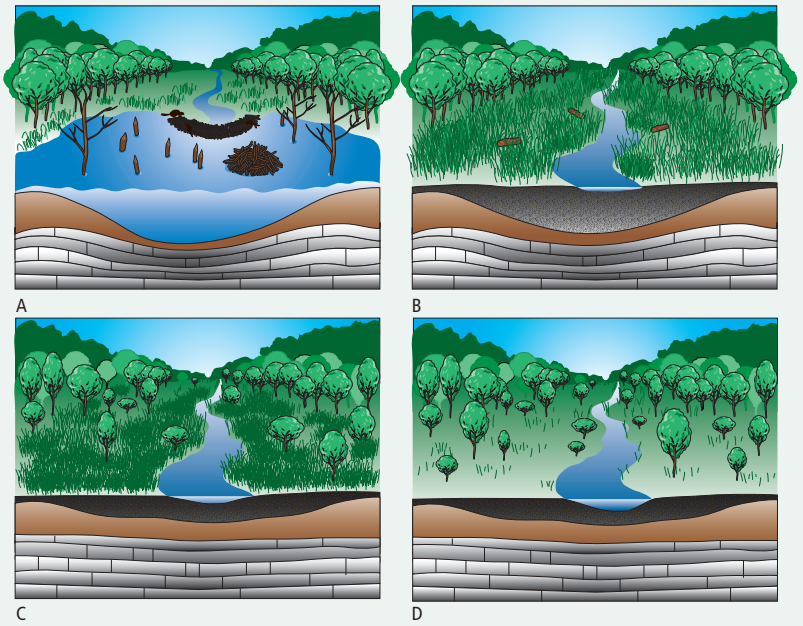
A beaver dam like the one shown here blocks a river. The water rises and floods the surrounding forest. The resulting beaver pond kills trees and shrubs by drowning their roots. After a beaver dam has been abandoned and breaks apart, the area gradually dries out. The forest is slowly restored by the process of secondary succession.

## What to Do

1. The diagrams below show the stages of secondary succession in a forest ecosystem that was flooded by a beaver pond. In your notebook, make a sketch of each stage. Add labels to identify parts of the ecosystem (for example, beaver pond, bog plants).
2. Describe what is happening during each stage. Refer to changes in
   (a) soil,
   (b) plants,
   (c) animals,
   (d) amount of sunlight.

A beaver dam creates a pond and drastically alters the forest ecosystem.

3. Look at panel C of the diagram below. Suppose you walked in a straight line from the edge of the river through the bog plants and shrubs to the forest trees. Describe how the changes in habitat along your walk represent different stages of succession.
4. Construct your own flow chart of images to illustrate the changes that occur during primary succession, starting with bare rock and ending with boreal forest. How do these changes compare with those that occur during secondary succession?



## Checking Concepts

1. Define the term *succession*.
2. Give one example of a natural event and one example of a human activity that is followed by secondary succession.
3. Make a flow chart to show the changes that occur during the process of secondary succession in a forest after a fire.
4. Why is lichen termed a "pioneer species"?
5. Name two examples of a climax community. Where might you find an example of each?
6. The diagram below shows stages of succession from bare rock to the establishment of a forest. Sketch the key features of this diagram in your notebook, and label the diagram to explain what is happening at each stage of succession.

## Understanding Key Ideas

7. What evidence would indicate that a shallow pond once existed in an area that is now a forest?
8. During a drive through some farmland you notice an old farm field overgrown with weeds and shrubs. Predict what the field will look like after several more years if it continues to be left undisturbed. Explain your prediction.
9. Use a specific example to explain how a community of plants and animals alters the environment to create new conditions that allow other species to live in the area.

### Pause and Reflect

Both natural events and human activities can destroy ecosystems. Does this mean that humans do not have to be concerned about their impacts on the environment? Give reasons to justify your answer.

# 3.2 The Impact of People on Ecosystems

Humans have a major impact on ecosystems because of our powerful technologies and large human population. The main impacts include loss of habitat, introduction of alien species, overharvesting of natural resources, and pollution. Decisions about conservation of natural areas depend on scientific evidence as well as economic, cultural, and other factors.

## Key Terms

acid rain
endangered
extinct
introduced species
monoculture
native species
natural resources
pollutants
renewable resources
sustainable
unsustainable

Imagine you are suspended by a hot air balloon above the place where you live. What do you see below you? There will be buildings and roads. Depending where you live, there may be trees, parks, playing fields, gardens, and perhaps a pond or river. Farther away, you may see fields, forests, bogs, mountains, tundra, the ocean, a mine, an airport, more buildings, golf courses, or factories.

Now imagine you are looking at the same area 50 years ago (Figure 3.5). How would it be different from the way it looks today? What might it have looked like 100 years ago?

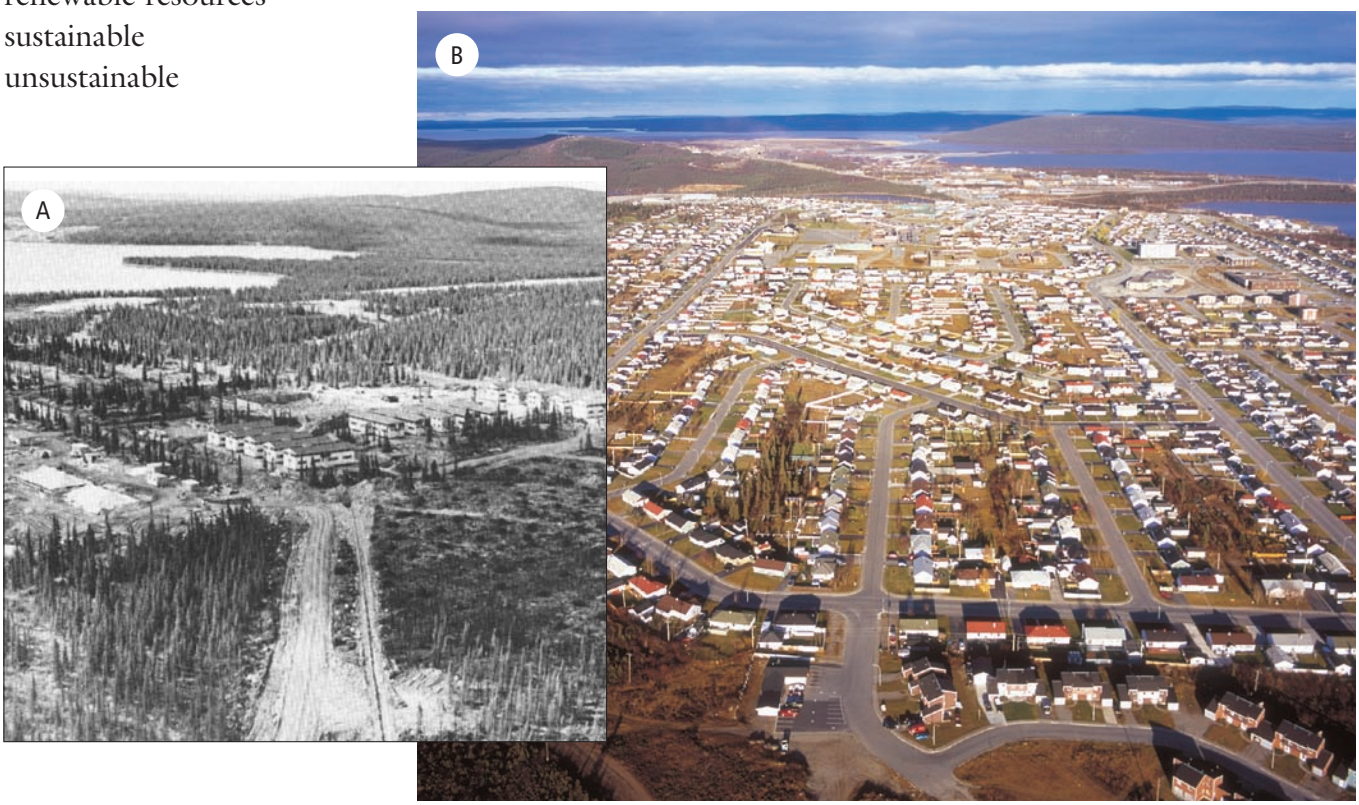



**Figure 3.5** The aerial view of Labrador City in 1962 (A) is barely recognizable as the same city forty years later (B).

# 3-2A Mapping Your Home

Find Out ACTIVITY

How much do you know about the natural world where you live? This activity gives you a chance to find out. Mapping is one tool that people use to record data about ecosystems. What would you include if you drew a map of the ecosystem around your home?

## Materials

- large sheet of paper
- coloured markers

## What to Do

1. Mark a dot at the centre of your sheet of paper to represent your home. Add a label to identify it.
2. Use the steps below to help you add details to the map. Details do not need to be to scale. Use different colours and labels for each feature. Don't worry if you are not able to answer all the questions. You can carry out research later to fill in more parts of the map.
   (a) Draw the nearest body of fresh water.
   (b) Show the source of your drinking water.
   (c) Add landforms such as mountains, rivers, or coastline.
   (d) Show where wastes from your community go. (Include household garbage and wastes that go down the drain.)
   (e) Sketch areas of vegetation. Include natural (for example, forest, bog) or human-made areas (for example, school field).
   (f) At the side of the map, sketch three plants that are natural to the area.
   (g) Sketch three wild animals that live in the area. Try to include one land animal, one bird, and one aquatic animal, if possible.
   (h) Indicate the direction in which the sun rises.
   (i) Show a natural area that is being conserved or protected from development.
   (j) Show a natural area that is being altered by human activities.
3. Share your map with your classmates. Discuss any questions that you had difficulty answering and add any new information to your map. If you still have unanswered questions, use the library or the Internet to research further. You can also ask your teacher or another adult to help with your research.

## What Did You Find Out?

1. How well do you think you understand the environment in which you live? Explain your answer.
2. What are some ways that you could increase your understanding of the environment in which you live?
3. How might your everyday activities affect the natural community around your home?
4. What are two ways that you could monitor plants or animals in your ecosystem?
5. What type of long-term study could ecologists do to learn more about your ecosystem?

## Changing Ecosystems

Like all species, humans depend on ecosystems for food, water, and places to live. Unlike other species, however, humans have developed technologies such as powered vehicles and machinery. Our technologies enable us to have a much greater impact on ecosystems than other species do (Figure 3.6).

**Figure 3.6** Human development can drastically alter the landscape in an area. This can have a dramatic impact on the local ecosystem.

The impact of a species is also related to its population size. In 1950, the total human population was about 2.6 billion. In 2007, the world population reached 6.6 billion people. The human population increases by over 200 000 people each day. Such large numbers of people, combined with our powerful technologies, has produced a growing demand for natural resources. **Natural resources** are materials and products found in nature that people use to meet their basic needs. Water, oil, metals, lumber, fish, and land for buildings and for growing crops are examples of natural resources.

One of the key differences between the world of today and the world of 50 years ago is that human activities now use greater areas of land. There are more cities and highways, more mines to obtain minerals and metals, and more dams built to produce hydro-electricity. Bogs have been drained and forests cut. Our garbage and wastes pollute more land and water. As human activities have spread, the areas occupied by natural ecosystems have shrunk.

In 1950, about one-third of the world population lived in towns and cities. The majority of people lived in rural areas. Today, more than half of all the people in the world live in cities. It is difficult for city-dwellers to make the connection between their lives in the city and the natural ecosystems on which they still depend (Figure 3.7).

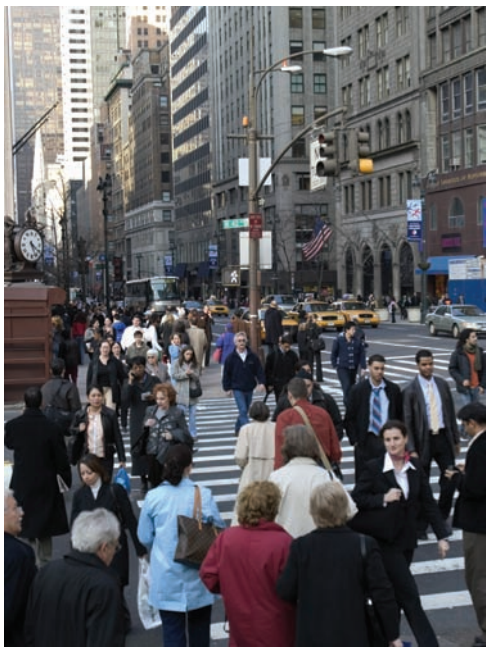


**Figure 3.7** City-dwellers often do not see the natural ecosystems on which they depend.

## Habitat Loss

Table 3.1 below lists some common human activities and the direct effects they have on land, water, and vegetation. Each activity also has indirect effects on ecosystems. For example, removing vegetation and soil removes food and shelter for many animals. Changes on land can alter the drainage of water, which affects ecosystems in rivers and lakes.

Wherever each of these activities is carried out, habitats for plants and animals are lost. What happens to water plants when a pond is drained? What do moose do when a forest is logged? The loss of habitats usually leads to the loss of many species from an area.

**Word Connect**

The range of organisms present in a community or ecosystem is known as biodiversity.

**Table 3.1 The Effects of Human Activities on Ecosystems**

| Activity | Physical Impact on Ecosystems |
|---|---|
| Construction of roads and buildings | Removes vegetation and paves over soil. May alter slope of land and divert rivers and streams. |
| Mining | Removes vegetation, soil, and rock. Alters slope of the land. May clog streams. |
| Dam building | Alters river course. Floods land. Creates lakes. |
| Logging | Removes vegetation. May clog streams and increase soil erosion. |
| Farming | Removes native vegetation. May drain wetlands and increase soil erosion. May divert water for irrigation and remove nutrients from soil. |
| Manufacturing and consumption of goods | Produces waste products and garbage that must be disposed of on land or in water. May produce air pollution. |
| Oil drilling, refining, and transportation | Construction of rigs, refineries, and pipelines damages vegetation, soil, and rock. |
| Outdoor recreation | Ski lifts, golf courses, all-terrain vehicles, speed boats, and other recreational activities can damage vegetation, soil, and waterways. |

## Endangered Species

Some plants and animals can live in a wide range of habitats. Coyotes, for example, can survive in grasslands, farmland, woodlands, and even on the outskirts of cities. Most species, however, cannot survive if their habitat is destroyed. The loss of habitat is the largest single cause of the decline in populations of wildlife.

**Figure 3.8** The adaptable coyote can survive in environments that humans have altered.

Today, many species in Canada and around the world are in danger of extinction. A species is **extinct** when there are no longer any living individuals of that species anywhere in the world. A species is said to be **endangered** when it has such a low population that it is nearly extinct. Endangered species can only be saved by very strict protection of their habitat or by collecting individuals and breeding them in a refuge such as a zoo or botanical garden.

Does it matter if species become extinct? On page 25 you learned that each species has a different niche in a community. When a species disappears, therefore, ecological processes are disrupted and the entire community is affected. Habitat loss is not the only reason that so many species are at risk of extinction. They are also threatened by the impacts of introduced species, overharvesting, and pollution.

### Did You Know?

Twenty species of animals and plants in Newfoundland and Labrador are endangered, threatened with extinction, or of special concern because they are sensitive to human activities and natural events.

## Impact of Introduced Species

Most wild species that you see today have lived in their environment since before humans settled the land. They are called **native species.** Some species, however, have spread beyond their natural range into new locations as a result of human activities. These are called **introduced species.** You might also hear introduced species referred to as alien species, exotic species, or non-native species.

Some species are introduced deliberately by humans. For example, early European settlers in Canada brought their farm animals, crops, garden plants, and pets from Europe. Other species arrive by accident, travelling on ships or planes with cargo. For example, pests like the Norway rat and disease organisms such as influenza and smallpox arrived in North America with the first European settlers. With the increase in global travel, introduced species continue to invade ecosystems around the world.

Some introduced species spread rapidly in their new homes. As their populations expand, they can displace or destroy native species, damage ecosystems, and cause harm to the economy or to human health. For example, purple loosestrife is a garden plant introduced to Canada from Europe. People brought it to Canada because its rich purple colour and pleasing shape make gardens look more attractive. Purple loosestrife grows especially well in wetland areas. It grows so well that native species, which normally develop at the next stage of succession around wetlands, cannot become established. As a result, purple loosestrife has now spread through wetland areas over much of North America. Over time, the loosestrife removes much of the water from wetland areas, making them unsuitable for the hundreds of species of plants and animals that depend on wetlands to survive.

Introduced species can also affect ecological processes. For example, Eurasian water milfoil is a water plant found in ponds and lakes in parts of Canada. It grows rapidly to form huge mats of vegetation. When the plants die and decay, large amounts of nutrients are added to the aquatic ecosystem, unbalancing the normal nutrient cycle (See Section 2.4).

**Figure 3.10** Dense mats of water milfoil cover the edges of a lake.

### Did You Know?

Almost half of the mammal species found on the island of Newfoundland are not native. For example, moose were first introduced from other parts of Canada in the late 1800s.

**Figure 3.9** Purple loosestrife is an introduced species that is difficult to control.

## Reading Check

1. Give three examples of natural resources.
2. What is the difference between an extinct species and an endangered species?
3. What is the difference between a native species and an introduced species?

## Impact of Overharvesting

If you catch some fish in a lake, eventually as the remaining fish in the population reproduce, they will replace those that you caught. If you cut down some trees in a forest, new trees will grow in their place. Living natural resources, such as fish and trees, are called **renewable resources** because they grow and reproduce in a fairly short time to replace those taken from the environment.

When resources are renewed as quickly as they are used, the harvest is **sustainable.** A resource that is harvested at a sustainable rate can be used year after year, indefinitely, without danger of disappearing.

Today, the growing human demand for resources has led to **unsustainable** rates of harvesting. This means that resources are used faster than they can be renewed. The result of unsustainable harvesting is a shrinking supply of resources.

### Atlantic Cod Fishery

For hundreds of years, fishing boats brought back rich harvests from the seas off the coast of Newfoundland and Labrador. By the 1990s, the seemingly limitless fish stocks had almost disappeared and the fishing industry of eastern Canada was closed (Figure 3.11). What happened?

- *New fishing technology* Starting in the 1950s, fishing nations built larger, faster fishing vessels. They used larger nets and could stay out in the ocean for longer periods by processing and freezing fish on board. They used underwater sonar and other detectors to scan the ocean for schools of fish.
- *More demand* A growing demand for protein caused fishing nations from around the world to join Canadians in the Atlantic. By the mid-1960s, 18 nations had fishing vessels on the Grand Banks.


**Figure 3.11** The reproductive rate of fish is no match for the human rate of catching them.

- *Lack of conservation* Some scientists have warned of the risks of overfishing in the past. In 1974, limits on the quantities of fish caught were set by international agreement. However, each fishing nation wanted the maximum amount of fish it could catch, and regulations were ignored.
- *Unsustainable harvesting* In 1977, Canada extended its control over Atlantic fishing to 322 km (200 miles) from shore. This regulation, still commonly known as the "200 mile limit", was meant to conserve fish stocks. However, Canadian fishing fleets increased their catch after fishing boats from other nations were limited. At the same time, foreign vessels started fishing on the Nose and Tail of the Grand Banks. These were important areas where many species of fish reproduced. The fish populations collapsed.

### Reading Check

1. Use examples to explain what is meant by "renewable resources."
2. What makes a renewable resource sustainable?
3. What conditions make the harvesting of a resource unsustainable?

## Impact of Pollution

Figure 3.12 shows vegetables growing in a field. This method of planting large areas with a single crop is called a **monoculture.** As well as producing food for humans, however, the field is a huge source of food for insects that eat vegetables. To protect their crops from insect pests, farmers spray the fields with pesticides. To increase the growth rate of their crops, farmers add fertilizer to the fields.

**Figure 3.12** Modern farming methods have many impacts on ecosystems, including pollution.

## Did You Know?

Waste oil dumped from ships kills over 300 000 seabirds annually off the coast of Newfoundland and Labrador alone.

**Figure 3.13** Oil from ships coats the feathers of seabirds. The birds drown or become poisoned when they try to clean themselves.

Added pesticides and fertilizers are two examples of pollutants. **Pollutants** are substances that cause harm to the air, soil, water, or living things. For example, pesticides pass from insect pests into food chains, where they may kill beneficial organisms such as birds or frogs. Fertilizers wash from farmers' fields into waterways, where they cause excessive growth of water plants.

Pollutants are produced by many human activities. Often, they are indirect waste products, such as the exhaust gases that come from vehicles and factory chimneys, or chemical wastes that leak into waterways from garbage dumps. Sometimes they are the result of accidents or deliberate dumping. For example, waste oil is often dumped into the ocean from ships.

Pollutants may have a direct impact on organisms, like the oil covering the seabird in Figure 3.13. Pollutants also have indirect impacts as they move through ecosystems. For example, burning fossil fuels produces waste gases that contain sulfur and nitrogen. These pollutants combine with water vapour in the atmosphere to produce acids. The acids fall from the atmosphere in precipitation as **acid rain.** Acid rain is a particular problem in Newfoundland and Labrador because much of the land is formed of granite rock, which lacks the ability to neutralize acid. Figure 3.14 shows the pH scale on which acidity is measured. A low pH can kill plants and animals on land and in aquatic ecosystems.

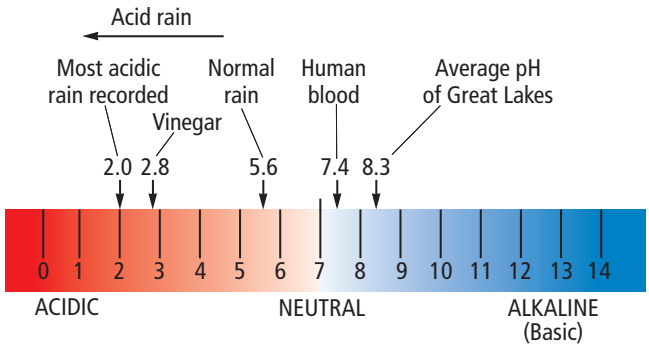



**Figure 3.14** The pH scale measures acidity. It ranges from 0 (very acidic) to 14 (very basic). A value of 7 is neutral.

## Reading Check

1. What can happen when people grow crops as a monoculture?
2. What are pollutants?
3. How is acid rain formed?

## 3-2B The Pros and Cons of Conservation

Think About It

From cod fisheries to forests, Canadians have been facing the problems of overharvesting natural resources. On one hand are the risks of over-harvesting, habitat destruction, and the loss of biodiversity. On the other hand are concerns for maintaining jobs, demand for resources, and other human needs.

### What to Do

Choose a local issue that involves the conservation of natural resources. For example, the construction of a highway may require trees to be cut. Wastes from a factory may pollute a pond or river. A mine may be planned in an area where rare plants are growing.

Research both sides of the issue.

### What Did You Find Out?

1. Decide which side you support, then write a letter to a government representative, create a poster, conduct a debate, or use another method to present and defend your position.

## 3-2C Checking the pH

Find Out ACTIVITY

How acidic is the rain where you live? In this activity, you will find out.

### Materials

- clean collecting jars with lids
- labels
- samples of rainwater
- samples of pond or river water
- sample of tap water
- pH indicator paper

### Safety

- Use caution when collecting samples from ponds or rivers.

### What to Do

1. As a class, collect several water samples from different sources and locations in your neighbourhood. These may include puddles, ditches, streams, ponds, lakes, and melted snow. Collect a sample of tap water. Label each sample.
2. Dip a piece of pH indicator paper into one sample. Observe the colour of the paper and compare it to a pH chart. Record the pH of the sample.
3. Repeat the procedure for every sample.
4. Clean your work area and wash your hands after this activity.

### What Did You Find Out?

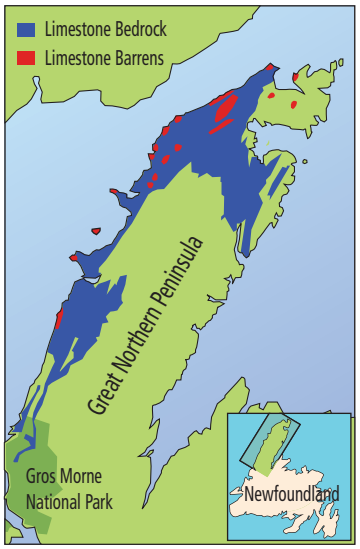
1. Were your neighbourhood water samples acidic, basic, or neutral?
2. Was your tap water sample acidic, basic, or neutral?
3. Based on your results, has the water in your local area been affected by acid precipitation? Explain why or why not.

# Science Watch

## Protecting the Limestone Barrens

It's hard to believe that part of the island of Newfoundland was once the floor of a shallow tropical sea. Yet, over 450 million years ago that's just what it was. Now known as the Limestone Barrens, this area was later lifted above sea level by moving tectonic plates. The limestone was formed from the layered shells of marine organisms that lived long ago.

The Limestone Barrens stretch 300 km along a narrow strip of land on the west coast of the Great Northern Peninsula. At first glance, this area looks harsh and uninviting. The Barrens are made up of gravel and limestone bedrock pummelled by strong winds and arctic-like temperatures. If you look more closely, though, you'll see that small plants manage to thrive there by anchoring themselves between the rocks and cracks in the limestone.




These calciphiles, or "calcium-loving" plants, don't have large exotic flowers or a lot of leaves, but some of them can't be found anywhere else on Earth. The Limestone Barrens make up only 1 percent of the island of Newfoundland, but they are home to 114 of the island's 271 rare plants. Two examples are Long's braya, which is an endangered species, and Fernald's braya, which could soon become an endangered species.

People used the Barrens to quarry limestone and extract gravel to help pave the Northern Peninsula highway. It was also used as a racetrack for all-terrain vehicles (ATVs), which tear up rare plants and compress the limestone gravel so that new plants can't grow in their place.

Although the rare plants were first described in the 1920s by botanist Merritt Lyndon Fernald (for whom the Fernald's braya is named) it wasn't until the 1990s that local residents realized just how special the Barrens are. Since then, conservation groups like the Limestone Barrens Habitat Stewardship Program (LBHSP) have formed to help protect this fragile habitat.

Group members put up signs on the Barrens to inform people about the unique plants. The members visit schools and community centres to talk about the Barrens. They also conduct field trips to encourage local residents to take pride in the extraordinary ecosystem they once took for granted.

### Questions

1. Why are calciphiles able to survive on the limestone gravel soil of the Limestone Barrens?
2. Do you think it is important to save unique places like the Limestone Barrens? Why or why not?

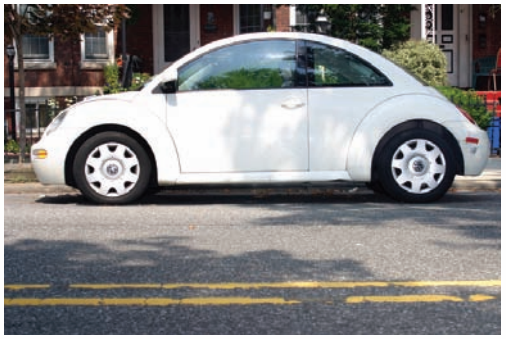
## Checking Concepts

1. Name two reasons why the human demand for natural resources has increased over the past 100 years.
2. Describe three human activities that have a physical impact on the landscape.
3. Name four factors that can lead to the extinction of species.
4. Why might the extinction of a species have an impact on an entire biological community?
5. What are introduced species?
6. Why are fish considered to be a renewable resource?
7. Use an example to explain what is meant by "unsustainable harvesting."
8. Describe two activities that produce pollutants.
9. Give two examples of natural disturbances and two of human disturbances to an ecosystem.

## Understanding Key Ideas

10. Humans use technology to meet their needs and their wants. The pictures below show three commonly used technologies. Is each essential to your survival? What resources does each use?

A



B

C

11. A plantation of trees is a monoculture. In your own words, explain the meaning of this statement.
12. Why is habitat loss the biggest single threat to the survival of many species?
13. A species of wildflower grows only near an area of wetland in Newfoundland and Labrador. Researchers discover that the population of this plant has declined since last year. A building project nearby has been draining parts of the wetland and filling other areas with dirt.
    (a) What connection might there be between the decline of the plant population and the human activities occurring in this area?
    (b) What could be done to stop or slow down the decline of the plant population?

### Pause and Reflect

Extinctions have occurred ever since there have been living things on Earth. Why should we be especially concerned about the extinction of species today?

# 3.3 Monitoring and Managing Ecosystems

Environmental monitoring is used to detect changes in ecosystems. Different methods of monitoring focus on physical, chemical, biological, and atmospheric changes. Information from monitoring can be used to help manage and protect ecosystems.

## Key Terms

baseline data
climate change
environmental impact assessment
environmental monitoring
long-term monitoring
permanent plot

How would you know if an ecosystem has been disturbed and is in need of protection? Some types of damage are obvious. For instance, an outbreak of spruce budworm can kill trees over a large area of forest in just a few years. Other changes happen slowly and are not obvious. Habitats may be disturbed and species may begin to disappear before people are aware of what is happening. One way to detect such changes is by **environmental monitoring** (Figure 3.15). This refers to checking and measuring different parts of the environment at regular intervals.


**Figure 3.15** Examples of environmental monitoring.
A. Physical monitoring tracks changes in the landscape over time. For example, satellite maps show how fast forests are shrinking, and deserts are growing.
B. Atmospheric monitoring measures changes in air and water temperatures and weather patterns, such as hurricanes and droughts.
C. Chemical monitoring tracks changes in the levels of chemical pollutants in the air, water, and soil.
D. Biological monitoring tracks changes in the distribution and population size of organisms.

Figure 3.15 shows four basic types of environmental monitoring. Each measures different parts of the environment and uses different techniques. Together, they indicate how well ecosystems are functioning and how they are changing over time. Monitoring also helps track the responses of ecosystems to human activities and natural events such as volcanic eruptions.

## Long-Term Monitoring

Suppose you count a population of 67 moose in a provincial park one year. The next year you count 37 moose. Is this data enough to tell you about the health of the moose population? Not really. You have learned how some populations of organisms may change naturally from year to year. In order to discover if the environment is changing in a significant way, it is necessary to carry out **long-term monitoring** over a period of many years.

To carry out long-term monitoring, researchers often use volunteers, such as the students shown in Figure 3.16, to help them collect data. In addition, groups of bird watchers across Canada carry out counts of the different species of birds they observe in their area each year. Some local groups have been collecting bird population data for over 30 years!

In 2007, the National Audubon Society used information gathered in this way to warn people that 20 of the most common birds living in North America had radically declined in numbers over the past 40 years. For example, observers counted about 31 million bobwhite quail in 1967. In 2007, there were only about 5.5 million.

**Figure 3.16** Student volunteers help to collect data that is vital in monitoring the health of a population or an ecosystem.

### Did You Know?

Bacteria have been found to live in water temperatures of 90°C and in water as acidic as vinegar.

### internet connect

Are you interested in volunteering to be part of a monitoring program in your area? You can find out what's available by starting your search at **www.discoveringscience.ca.**

## Methods of Monitoring

The environment is complex and ever-changing. Because of this, the methods of collecting data for long-term monitoring must be consistent. For example, if you want to learn if the climate is changing, you must measure temperature, wind speed, precipitation, and other factors with exactly the same instruments, in the same places, at the same time each day or week or other interval (Figure 3.17). If you do not do this, you cannot easily determine whether changes in data are due to changes in the environment or changes in your methods!

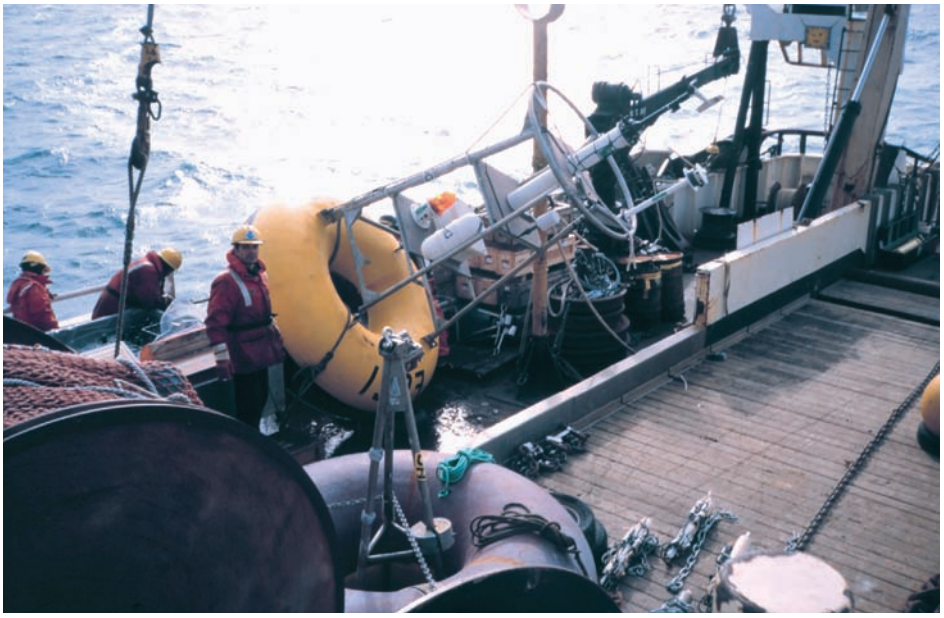


**Figure 3.17** Once this weather buoy is deployed and is anchored in the ocean, it will collect data about the atmosphere and ocean. Data from this buoy, as well as others, are transmitted to a central location where they are analyzed and interpreted by computers.

**Baseline data** are measurements that form a starting point from which later changes can be monitored. For instance, scientists might count the average number of trees per hectare in a forest that they are studying. Suppose there is a forest fire. Scientists can use their baseline data, together with the size of the area burned, to estimate the number of trees that were destroyed. They can also use the baseline data to measure whether the number of trees growing after a fire is greater, less, or the same as before the fire.

**Permanent plots** are sample areas of a habitat that scientists monitor year after year. For example, it is not practical to monitor millions of hectares of an area such as a grassland. Instead, researchers mark off a few one-hectare plots in different locations. They can study these plots in detail over a long period of time. It is likely that any changes that are observed in the sample plots are also taking place over the grassland as a whole.

Grasses, trees, and other plants stay in one place, but most animals move. Some species migrate over hundreds or thousands of kilometres during different seasons. To study changes in animal populations, scientists may carry out annual surveys. The bird count described on page 87 is an example of an annual survey.

Methods of counting animals depend on the size and habits of the species. For instance, aerial photographs may be used to make graphs such as the one in Figure 3.18. Data from people who hunt or fish are sometimes used to monitor changes in numbers of some species. Many animals can be fitted with tags, leg bands, or radio collars. They are then tracked using equipment such as that shown in Figure 3.19, and the data are mapped to indicate how far the animals move. This data helps scientists decide where habitats might need conserving.

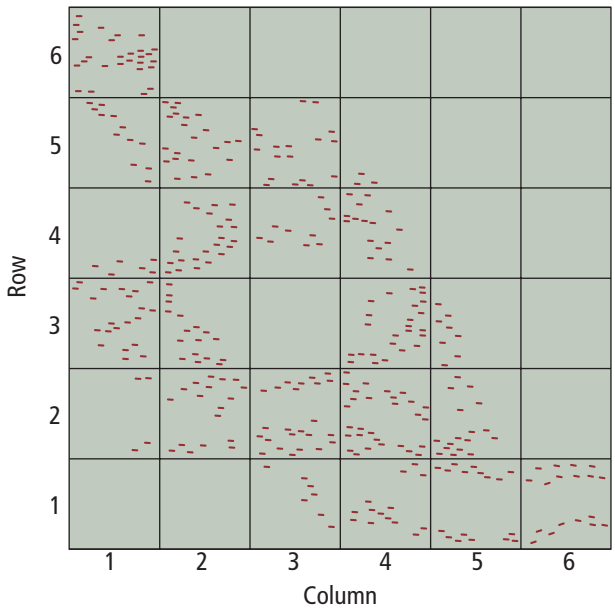



**Figure 3.18** This graph was drawn using data from aerial photographs of caribou in Nunavut. The total area of the graph represents 1 km$^2$ on the ground, and each marking represents one caribou.

**Figure 3.19** This researcher is holding an antenna to detect radio signals transmitted from an animal with a radio collar.

## Reading Check

1. Name four basic types of environmental monitoring.
2. Give an example of baseline data.
3. Why is long-term monitoring needed to detect significant changes in the environment?
4. Name a method commonly used to monitor the size of animal populations.

## Managing Ecosystems

Suppose you are managing a forest that contains moose. Is the moose population too high or too low? How can you manage the numbers of moose? When moose were first introduced to the island of Newfoundland, they spread rapidly. After wolves became extinct on the island in the 1920s, there were no natural predators to control the moose population. Moose hunting was established in 1935. Since then, more than three quarters of a million moose have been harvested by hunters in Newfoundland and Labrador.

A high moose population is a benefit to hunters. It also draws tourists who like to see and photograph these wild animals. But moose are not a benefit to foresters, bird watchers, or unwary drivers. Moose on the island of Newfoundland have altered natural plant communities by overgrazing. They damage young trees, reducing future timber crops. They remove shrubs that shelter nesting songbirds. They are also involved in costly collisions with cars every year (Figure 3.20). Managing forest resources must balance all these different factors.

**Figure 3.20** Moose are a novel sight for tourists, but they are dangerous to motorists. They can also cause damage to vegetation and bird habitats.

## Prevention is Better Than Cure

Whether the threat to an ecosystem comes from animals, plants, pollution, or development, it is easier to prevent harm before it occurs than it is to control damage later. For example, there are laws that protect habitats and rare species. There are also laws that restrict development in certain areas, ban the import of alien species, and ban the use of some toxic chemicals.

Many individuals and organizations in Canada carry out education programs and activities that help conserve natural ecosystems. These groups include The Conservation Corps, World Wildlife Fund, Canadian Parks and Wilderness Committee, and the David Suzuki Foundation.

## Predicting Changes to Ecosystems

One goal of environmental monitoring is to measure changes in ecosystems. These measurements also allow us to predict how ecosystems could change in the future. One of the best known examples of prediction concerns **climate change.** Scientists have warned that Earth is undergoing major shifts in climate, based on their long-term monitoring of changes in atmospheric gases, air and ocean temperatures, melting of glaciers, and other data. Analyzing these trends, they predict that one result will be warmer average temperatures over much of the planet.

The ability to predict changes to ecosystems is important for planning future developments. For example, if a company wants to blast rock and cut trees to make a level area to build a shopping mall, what effect will this have on surrounding habitats? Scientists can make reasonable predictions about the impact using studies of the environment as it exists now and data from similar environments that have already been changed.

A report that outlines how an activity will affect the environment is called an **environmental impact assessment.** Developers and governments use these reports to plan how to minimize harm to an ecosystem. If the predicted changes are too destructive, local citizens, conservation organizations, and governments may argue that the proposed activity should not be allowed.

### Reading Check

1. Why did the moose population on the island of Newfoundland increase so much after the animals were introduced onto the island?
2. Name two groups that help to conserve natural ecosystems in Canada.
3. Give a reason why it is important to be able to predict changes to ecosystems.
4. What is an environmental impact assessment?

### Did You Know?

Canada had its first known case of infection by the West Nile virus in Ontario in 2002. The virus can be transmitted to humans by mosquitoes after they feed on the blood of a bird infected with the virus. The disease organism was once restricted to parts of Africa, but is now able to survive in Canada due to milder winters.

### internet connect

In what ways is climate change linked to the health of people and other organisms in Canada? Start your research at **www.discoveringscience.ca.**

# 3-3A Modelling an Environmental Impact Assessment

Think About It

The ways in which people use land and water can have far-reaching effects. How many resources should be used for human needs and how many for wildlife? Decisions should be made using social, economic, and ecological factors.

## What to Do

1. As a class, identify a local project that involves a conflict over land use, or create a scenario that you can use for this activity. Agree on four to six roles that you will use to discuss the project and its impacts. Half of the roles will support the project and half will oppose it. For example, the project may be to open a mine near a fishing lake. Supporters might include unemployed miners, local businesses, and companies that use minerals from the mine. Opponents might include local fishermen, the Minister of Tourism, and residents concerned about water quality.
2. Form groups so that each group represents one role. You do not have to agree with the point of view of your group's role, but you must present it fairly.
3. Use your library, the Internet, and other sources to research the issue. Focus on questions that you may be asked in your group's role. For example:
   - What economic benefits will the project bring?
   - What impacts will it have on the soil, vegetation and water?
4. When you have collected information that answers your questions, prepare a presentation for the Environmental Impact Assessment Board. This role will be played by your teacher. Use charts, tables, or graphs to display data where possible.
5. Present your case to the class, allowing time for questions.
6. Based on the information presented, draft a report that recommends whether the project should be approved, abandoned, or modified. This outcome should be a joint decision by the class.

## What Did You Find Out?

1. Give an example of how your studies of ecosystems helped you to research and present your arguments.
2. Were there important questions or issues not covered by this process? If so, what were they?
3. Describe an advantage and a disadvantage of the process you modelled in this activity.

## Checking Concepts

1. How does long-term monitoring help people to conserve natural ecosystems?
2. What are four types of ecosystem monitoring? Give an example of something that would be measured for each type.
3. (a) What is meant by baseline data?
   (b) Why is it useful?
4. Give an example of a monitoring program that uses volunteers. Why are volunteers important in such programs?
5. Give an example of something that can be measured by an annual survey. What method could be used to collect the data?

## Understanding Key Ideas

6. What is the goal of an environmental impact assessment?
7. Explain what baseline data you would collect to determine whether acid rain was a growing problem in your area.

## Pause and Reflect

Some time within the next 50 to 100 years, we can expect to see humans landing on, exploring, and even living on the planet Mars. One goal of many scientists who dream of living on other planets is to make these planets able to support human life and the life of other organisms we want or need for survival. The process of making a world able to support human life is called terraforming. Terraforming would change the abiotic conditions of Mars. For instance, it would increase the amount of oxygen in its atmosphere. It would also change the climate of the planet.

(a) Do you think that an environmental impact study of another planet, such as Mars, is necessary before humans start to terraform the planet? Give reasons for your answer.

(b) Assume that Mars is shown to have absolutely no life of any kind, now or in the past. Would that change your answer to part (a)? Why or why not?

(c) Assume that Mars is shown to have a few populations of bacteria and other microscopic organisms that live on the planet now. Does that change your answer to part (a)? Why or why not?

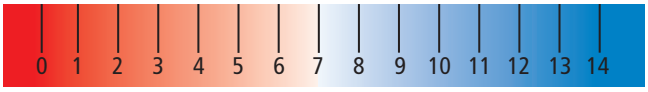
## Prepare Your Own Summary

In this chapter, you investigated how natural events and human activities cause changes in ecosystems. Create your own summary of key ideas from this chapter. You may include graphic organizers or illustrations with your notes. (See Science Skill 9 for help with using graphic organizers.) Use the following headings to organize your notes:

1. The Process of Succession
2. Examples of Human Activities
3. Impacts of Human Activities
4. Monitoring and Managing Ecosystems

## Checking Concepts

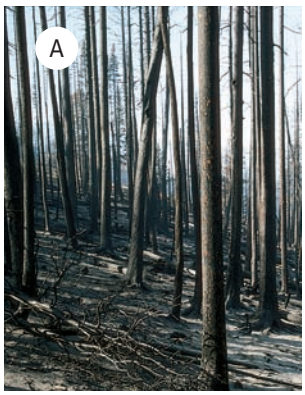
1. Three of the following terms are answers to the three questions below: primary succession, secondary succession, pioneer species, endangered species, introduced species.
   (a) What is the term used to describe the re-growth of an area of forest that has been flooded by a beaver pond?
   (b) The first organisms that live in an area that has been damaged are referred to as this.
   (c) What is the name given to species of organisms that have spread to a new location as a result of human activities?
2. Name three examples of natural resources.
3. Name three examples of pollutants.
4. Describe three causes that led to the overharvesting of cod on the Grand Banks.
5. Are the following statements true or false? If the statement is false, rewrite it to make it a true statement.
   (a) Sustainable rates of harvesting occur when resources are being used faster than they can be renewed.
   (b) If an ecosystem is not disturbed, it eventually produces a climax community.
   (c) A field of potatoes is an example of a monoculture.
   (d) A pine tree is an example of a pioneer species.
   (e) Atmospheric monitoring measures changes in air and water temperatures and weather patterns, such as hurricanes and droughts.
6. Use an example to show how an introduced species might affect an ecosystem.
7. The diagram below shows the pH scale.

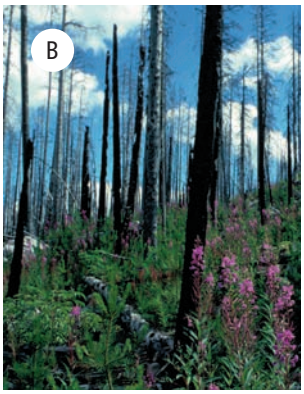



Imagine that you are analyzing a sample of water that you have collected from a storm drain in your neighbourhood.
   (a) If the water sample is acidic, would you expect its pH to be higher than 7 or lower than 7?
   (b) If the water sample has a pH of 7, what does this tell you?
   (c) Which is more acidic: a pH of 5 or a pH of 2?
   (d) Which is more basic: a pH of 11 or a pH of 9?
   (e) What is the pH of normal rainwater?

## Understanding Key Ideas

**8.** Examine the two photographs.
(a) Which happened first: the events shown in Photo A or the events shown in Photo B?
(b) Describe the process that is occurring in Photo B.
(c) Imagine that you take a photo of this same area 20 years from now. Briefly describe or sketch what you predict you would see.




**9.** A family cultivated part of their lawn and turned it into a vegetable garden. The family then moved away. The house remained empty, and nobody looked after the garden. Ten years later, the family came back to visit their old property. The lawn looked similar, but it was much weedier. They were surprised, though, to see wildflowers, shrubs, and small bushes growing in their deserted garden. Explain why this is an example of succession.

**10.** Why is it important to monitor ecosystems over a long period of time?

**11.** Why is it important that the methods used to monitor ecosystems are consistent?

**12.** Name an endangered species in Newfoundland and Labrador. Why is it endangered?

**13.** Give one example of a natural event and one of a human activity that can cause a change in a lake ecosystem.

**14.** Draw a flow chart to illustrate the process of secondary succession.

**15.** Give an example to demonstrate how long-term monitoring can help scientists predict future changes in the environment.

**16.** Imagine you are a biologist, and the company you work for assesses the impact of development projects. There is a plan to build a new luxury resort on the shore of a large bay. Builders need to know what environmental impact the project will have on particular ecosystems. Your job is to estimate the number of organisms in these different ecosystems. How could you sample:
(a) the number of insects in a large tree
(b) the number of whales in a large bay off the coast
(c) the number of fish in a small lake

### Pause and Reflect

Should people simply leave all natural ecosystems exactly as they are, or is it acceptable to make changes to ecosystems? What kinds of changes could be acceptable, and under what circumstances would they be acceptable? Use these questions as the basis for a letter to the editor of a school or local newspaper.

# Unit Summary

## 1 An ecosystem is all the living and non-living things in a particular place.

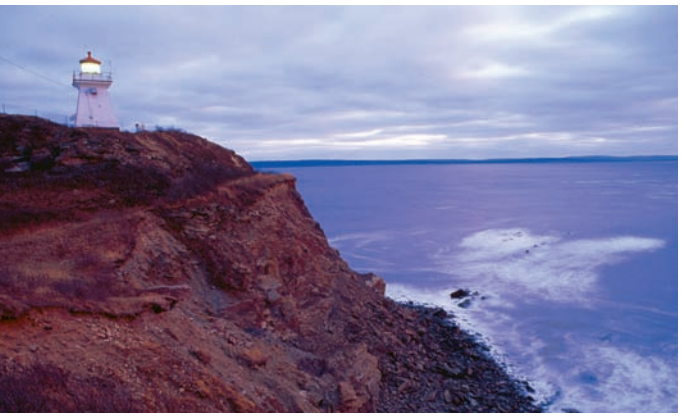
- All ecosystems include biotic (living) and abiotic (non-living) things. (1.1)
- Ecosystems such as oceans and deserts may cover huge areas. Other ecosystems are quite small—such as a rock pool or a rotting log. (1.1)
- Abiotic parts of an environment include such things as temperature, light, air, water, soil, and climate. (1.2)
- Each type of organism is adapted to a particular set of abiotic conditions. (1.2)
- Individual members of the same species living together in the same area at the same time form a population. (1.3)
- Populations of different species interact in communities. (1.3)

## 2 Living and non-living things interact in ecosystems.

- Symbiotic relationships include parasitism, mutualism, and commensalism. (2.1)
- Feeding relationships can affect the population size of the organisms that are eaten and of the organisms that eat them. (2.1)
- Animals obtain their food from the biotic environment by consuming other organisms. They are called consumers. (2.2)
- Plants produce their food from the abiotic environment by the process of photosynthesis. They are called producers. (2.2)
- Waste and dead matter are a source of food for scavengers and decomposers. (2.2)
- Energy from sunlight is transferred through ecosystems in food chains and food webs. Energy is lost at each step in a food chain. (2.3)
- Nutrients are continuously recycled through the biotic and abiotic environment. (2.4)

## 3 Natural events and human activities cause changes in ecosystems.

- Ecosystems may be disturbed by natural events such as storms and floods and by human activities such as logging and fishing. (3.1)
- An area of bare rock can gradually change over centuries into a complex community of species by the process of succession. (3.1)
- Humans have a major impact on ecosystems because of our powerful technologies and large human population. (3.2)
- The main impacts include loss of habitat, introduction of alien species, over-harvesting of natural resources, and pollution. (3.2)
- Environmental monitoring is used to detect changes in ecosystems. (3.3)
- Information from monitoring can be used to help manage and protect ecosystems. (3.3)



## Key Terms

- abiotic
- adaptation
- biotic
- community
- ecosystem
- habitat
- individual
- niche
- organism
- population
- range of tolerance
- species

## Key Terms

- carnivores
- commensalism
- consumers
- decomposers
- energy pyramid
- fermentation
- food chains
- food webs
- herbivore
- host
- mutualism
- nutrients
- nutrient cycles
- omnivores
- parasites
- parasitism
- producers
- scavengers
- symbiosis
- symbiotic

## Key Terms

- acid rain
- baseline data
- climate change
- climax community
- endangered
- environmental impact assessment
- environmental monitoring
- extinct
- introduced species
- long-term monitoring
- monoculture
- native species
- natural resources
- permanent plot
- pioneer species
- pollutants
- primary succession
- renewable resources
- secondary succession
- succession
- sustainable
- unsustainable

# Making a Garbage-Reduction Diary

Many companies monitor the waste they produce. If they can reduce or eliminate wastes, not only do they help the environment, but they also save money. With family members, classmates, or others, measure how much garbage is produced at home, at school, or at a workplace.

## Problem

How can you keep track of all the garbage produced during a week?

## Criteria

- Collect data to measure the amounts of garbage produced in your chosen location.
- Determine how to measure and record each type of waste, such as glass, paper, food, and plastic.

## Procedure

### Part 1 Brainstorming Ideas

1. Create a garbage-reduction diary to record your data for one week. You will need to track the types and quantities of garbage produced by each person in the location for every day.
2. Place your garbage-reduction diary on a bulletin board, refrigerator, or other place where all participants in your project can easily use it.
3. Discuss the procedure for measuring and recording garbage production with each person in your project team. Each of them should record every item discarded.
4. Each day for a week, have all participants record in the diary every item they throw out as garbage. For example, if you throw away a magazine on the first day, record it as one item of paper waste on Day 1. If another person in the project throws away a newspaper on the same day, they will also record it as one item of paper waste, making a total of 2 for that day.

## Report Out

1. At the end of the week, total the data and present it in the form of a clear chart. The chart should indicate the totals of each type of waste and also the totals of all the waste produced by each participant during the week.
2. Compare how much waste was thrown away in different categories. For example, how much paper was thrown out compared with plastic waste? Did some individuals produce more garbage than others?
3. List five ways you could have reduced the garbage that was produced during the week. Use your project to plan ways of reducing garbage, for example by composting organic waste and recycling paper, plastic, glass, and tin. Share your plan with other participants and put it into action for the future.

# Saving Endangered Spaces

The biggest threat to the survival of wild animals and plants is loss of habitat. Governments must often balance the need for wilderness areas and parks against industrial development. Yet, few people consider that unspoiled natural ecosystems are an important natural resource that contribute to the health of society and the economy, just as fisheries, mines, and pulp and paper mills do.

## Background

In the province of Newfoundland and Labrador, only about 4 percent of the land is protected from industrial development. This means that most of the forests can be logged and most of the other land can be developed for mining, highways, construction, agriculture, dam-building, and other land activities.

As natural ecosystems are altered by humans, there are fewer and fewer places for wild species to survive. If human impacts on the environment continue, many of these species will disappear. Provincial, national, and international organizations help promote research and education on environmental conservation. A key step is convincing governments and private landowners to protect shrinking habitats from destruction.

The Bay du Nord Wilderness Reserve is the largest protected river ecosystem in the province of Newfoundland and Labrador.

The Burnt Cape cinquefoil is one of more than 300 plant species that grows in Burnt Cape Ecological Reserve near the tip of the Great Northern Peninsula. About 30 of these species are considered rare.

## Find Out More

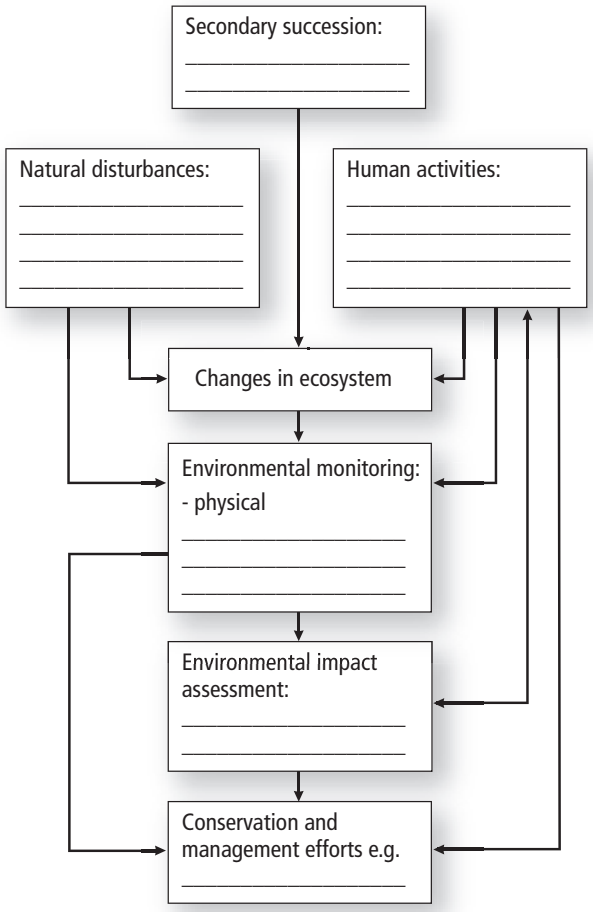
Choose an area in the province that is home to rare or endangered species of animals or plants. Find out if this area is protected or if it is threatened by human activities. Contact conservation groups and write to government departments responsible for managing the land and resources. Use the Internet to research news about development plans for the area. You can start your search at **www.discoveringscience.ca.**

## Report Out

Create a poster, brochure, or electronic presentation to inform people about the endangered ecosystem you chose to research. Include details of rare species that live there and the recent history of development or protection in the area. Organize a volunteer activity in your school to support a conservation group that is working to help save the area from development.

## Visualizing Key Ideas

1. Copy the following concept map about ecosystems into your notebook. Complete it by filling in the empty spaces.




## Using Key Terms

2. Create a quiz by writing a list of ten questions which can be answered using terms chosen from the list below. Create an answer key linking each term to the correct question.
   - ecosystem
   - abiotic
   - species
   - niche
   - symbiotic
   - producers
   - biotic
   - environmental impact assessment
   - climax community
   - decomposers
   - food chain
   - nutrient cycles
   - succession
   - pioneer species
   - extinct
   - introduced species
   - unsustainable
   - pollutants

## Checking Concepts

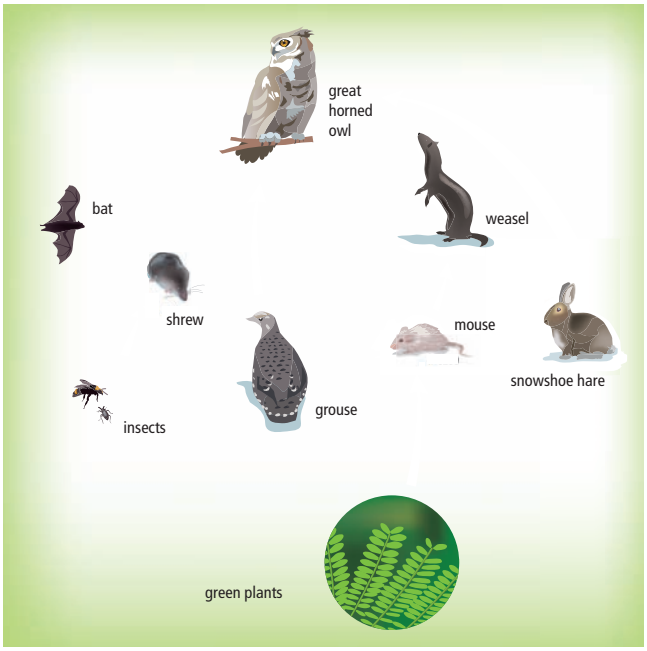
### 1

3. Choose an organism and explain how it interacts with sunlight, air, water, and soil in its environment.
4. Describe an interaction between two abiotic parts of the environment.
5. Draw a diagram to show the relationships between individuals, populations, communities, and ecosystems.
6. Name three types of ecosystems that can be found in Newfoundland and Labrador. List two plants and two animals that live in each ecosystem.
7. Explain the connection between the terms "range of tolerance" and "tree line."

### 2

8. Why do all consumers depend on producers for food?
9. (a) Why are scavengers and decomposers important in ecosystems?
   (b) How do they differ?
10. Why is a food web better than a food chain for describing the relationships among organisms in an ecosystem?

11. Draw as many food chains as you can using the organisms shown below.




12. Make a sketch to explain what is meant by a pyramid of energy.
13. Write a paragraph telling the story of a nutrient as it passes through a cycle. Start with a nutrient in a dead leaf that falls from a tree and end when the nutrient becomes part of another plant.

## 3

14. Explain what succession is, and use an example to support your explanation.
15. Describe three human activities that alter ecosystems. How might each activity threaten the survival of a species?
16. Use an example to explain the relationship between the terms "overharvesting" and "sustainable resource."
17. A farmer notices that shrubs and small trees are starting to grow in a pasture that was once used for grazing cattle. The farmer has not put cattle there for two years. Explain why the pasture has changed.
18. What sort of data is gathered using a permanent plot? Why is this useful?
19. A development is planned in an area that includes the habitat of a rare species of plant. What process can be used to help predict the impact of the development on the plant?

## Understanding Key Ideas

20. In your own words, describe what is meant by the term "ecosystem." Give an example.
21. List three non-living parts of the environment.
22. Give an example of
    (a) mutualism,
    (b) parasitism,
    (c) commensalism.
23. Describe the role of each of the following in an ecosystem: spider, hawk, corn, mouse.
24. What might happen in a forest ecosystem if all the carnivores were removed?
25. What are two reasons that might cause a species to become threatened with extinction?
26. What natural factors can control the population size of a species?
27. How can introduced species affect populations of native species?
28. Describe one way you could help to protect a species from extinction.
29. What impacts does a monoculture have on an ecosystem?
30. Name four parts of the environment that can be measured for long-term monitoring.
31. Why does food "go bad"? Describe four methods of preserving food.
32. What condition is necessary to allow a renewable resource to be harvested indefinitely?

## Thinking Critically

**33.** An avalanche removes all the plants and animals from a large area on the side of a mountain, leaving only a bare strip of mud and rock. Predict how this disturbed area might change over the next few years. Explain your prediction.

**34.** Imagine you are a real estate agent describing an area of recently-burned forest to a group of forest-living animals and plants. How will you persuade them that this might be an excellent place for them to make their home in a few years from now?

**35.** List your three favourite foods. Explain how each food provides you with energy from the sun.

**36.** Use an example to explain how forestry, farming, or fishing has affected the population of a native species in Newfoundland and Labrador.

**37.** What action could you take to increase the biodiversity of an ecosystem near where you live?

**38.** A plant nursery wants to import a fast-growing plant from Europe to sell to gardeners on the island of Newfoundland. Explain why this is not a good idea.

**39.** Imagine you are shipwrecked on a small island with only a few hens and a large bag of grain saved from the ship's cargo. There is no other food available for you or the hens. To survive as long as possible, what should you do?
(a) Eat the grain, and then eat the hens.
(b) Eat the hens, and then eat the grain.
Explain your choice.

**40.** Why should people not release exotic pets such as fish, snakes, or spiders into the wild?

**41.** (a) How are the meals you eat today different from the meals that your grandparents ate?
(b) What impacts might this difference have on ecosystems?

**42.** You may have seen a robin eating a worm. Using your knowledge of nutrient cycles, explain how a worm might eat a robin.

**43.** The bird in the photo is a harlequin duck. These shy and uncommon birds spend the winter along the rocky coasts of Newfoundland and Labrador but fly north to the Arctic in summer. Scientists studying this bird have put a red band on its leg to record where and when it was caught. How does this band help researchers learn more about the habitat and needs of this species?

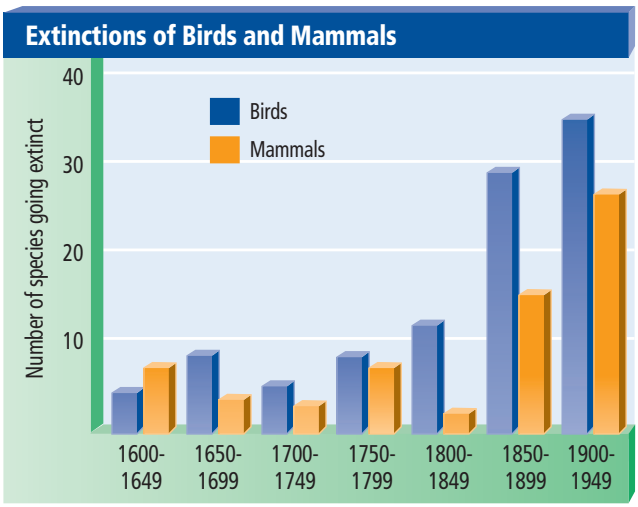
**44.** Why should people who live in a large city be concerned about changes that happen in a forest or lake in a part of the province far from where they live?

## Developing Skills

**45.** How is a species of organism different from an individual organism? Explain your thinking.

**46.** As a class, discuss how you could make a model of an ecosystem. What would you include in your model? Why?

**47.** The graph shows extinction rates for species of birds and mammals around the world since 1600. Use this graph to answer the following questions.




(a) In what interval did most extinctions of mammalian species occur?
(b) Approximately how many species of birds became extinct in the interval 1650–1699?
(c) Approximately how many species of birds became extinct in the interval 1900–1949?
(d) Based on this data, predict how many species of mammals became extinct in the period 1959–1999.

**48.** Choose a species that lives near your home and describe how you would monitor long-term changes in its population size.

**49.** Create a plan to illustrate a way in which you could increase the biodiversity of a habitat in your neighbourhood.

**50.** Draw diagrams to show
(a) how energy moves through ecosystems
(b) how nutrients are cycled.

**51.** Imagine that you are an ecologist. A group of people in your community wants to introduce an organism into the local ecosystem that will get rid of the mosquito population. Identify the mosquito's place in the food chain and explain to the group why introducing a new organism would not be a good idea.

**52.** Think of (and observe if possible) an ecosystem near your home. Make a chart or diagram to show abiotic-biotic interactions in the ecosystem.

**53.** Consider the ecosystem you observed in question 52. Predict what would happen if each of the following major changes occurred:
(a) The rain becomes acidic.
(b) A hydro line is built through the area.
(c) Chemical fertilizers are used in a neighbouring area.
(d) One species in the ecosystem (e.g., earthworms) is attacked by a parasite and its numbers are severely reduced.

**54.** Think about each of the following pairs of organisms, and name the type of symbiotic relationship the partners might have. Indicate what the gains and/or losses might be for each partner:
(a) a flowering plant and an insect
(b) a cat and a flea
(c) a nectar-eating bat and a flowering cactus
(d) a bird and a water buffalo

## Pause and Reflect

"The landscape is not just a supply depot. It is also the home in which we must live." What does this statement mean? Should people consider the entire planet as our home?