

Succession and Change in Ecosystems

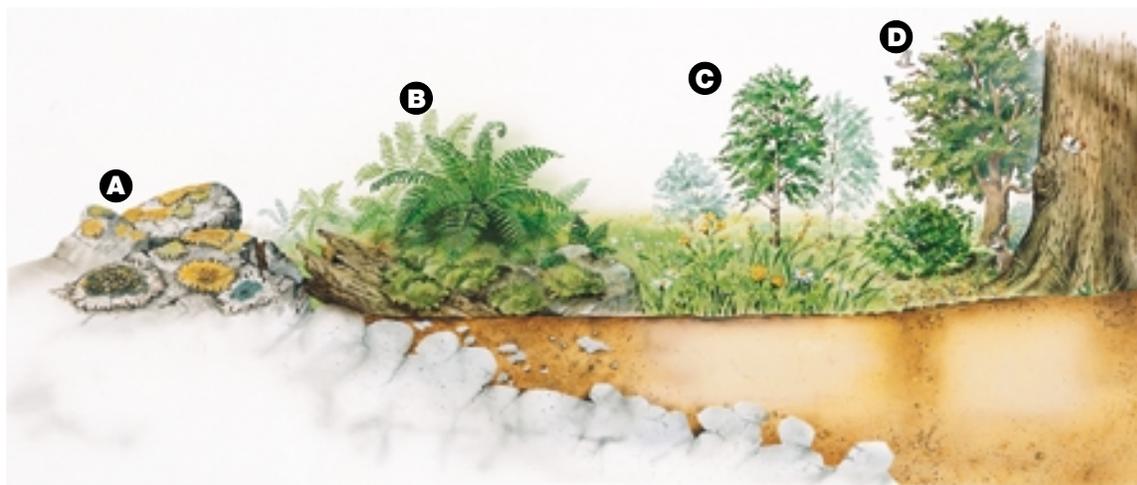
DidYouKnow?

The shallowest of the Great Lakes, Lake Erie, is being filled in by the process of succession. Plants are slowly growing out from the shoreline and the conditions along the shore are changing. These new conditions are changing what used to be open water and turning it into land!

Have you ever noticed grasses or plants growing in a vacant lot near your home? If you wait long enough, bushes and trees will grow, and animals will make their homes in the lot. How does this process happen?

Changes are constantly occurring in an ecosystem. Some changes are rapid. For example, a landslide might completely destroy an existing ecosystem. Other changes are slow. For instance, seeds carried by wind or water might take root in a vacant lot or in sidewalk cracks and result in a new population of plants. If conditions are good for growth, the new plants might become established and even replace plants that were already growing.

The gradual process by which some species replace other species in an ecosystem is called **succession**. In the process of succession, organisms that are present at one stage alter the environment in some way. This change makes it possible for some other species to move in.



A Lichens produce acids that help to break down the rock. The broken-down rock and the decomposing bodies of dead lichens contribute to soil formation.

B The resulting soil is poor and thin. However, mosses and ferns grow and slowly replace the lichens.

C The soil layer thickens, which means it can hold more water. Plants that need more soil and moisture, such as grasses and flowering weeds, take root and grow. They attract insects, such as bees and butterflies.

D Since the soil is now thicker and richer, bushes and trees take root. They provide shelter and food for birds, mammals, and other organisms, which now start moving in.

Figure 1.47 Succession is a long, slow process in which a stable natural ecosystem gradually develops over time.

Primary succession is the gradual growth of organisms in an area that was previously bare, such as rock. For example, lichens, mosses, and ferns will first appear on bare rock. As they become established and grow, they change the conditions of the area. (Lichens, for instance, may use chemicals in their tissue to slowly etch away the rock. This creates tiny depressions in the rock where soil and seeds from other plants can gather and eventually grow.) These new conditions allow other plants and animals to grow and survive. Succession can be a very slow process, taking hundreds, even thousands, of years.

Secondary Succession

The gradual growth of organisms in an area that previously had a number of organisms is known as **secondary succession**. The regeneration of a burned forest area is an example of secondary succession. Figure 1.48 shows the process of secondary succession in a burned forest. Wildflowers and other plants that grow best in strong sunlight are among the first to spring up. Blueberry bushes also thrive in these conditions, because they are adapted to grow in soil containing ash. Like blueberry bushes, a number of tree species actually grow better in soil that has been burned.



Figure 1.48A Forest fires often burn off the foliage but leave the tree trunks standing.

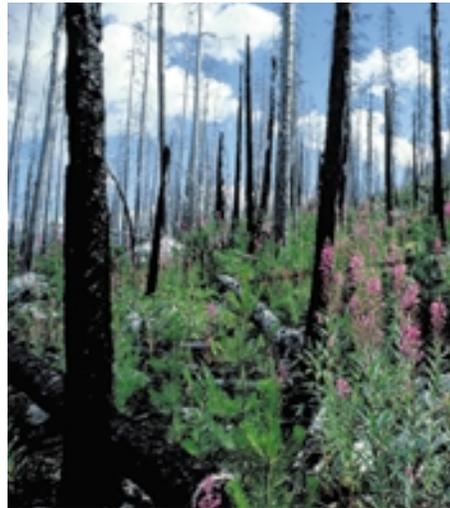


Figure 1.48B These wildflowers are thriving in soil that has been burned by fire.

DidYouKnow?

The cones from jack pine and lodgepole pine trees lie closed for years on the forest floor until the heat of a fire pops them open and releases the seeds that will grow into new trees. These types of cones are called serotinous cones.

Nothing Succeeds Like Succession

Succession can take place in any kind of area, large or small, in a short period of time or over many years. For instance, weeds grow quickly in an untended patch of soil, but trees take many years to grow back in an area cleared by forest fire or logging.

Question

How does succession take place in an ecosystem?

Hypothesis

Make a hypothesis about how succession takes place in an ecosystem.

Safety Precautions



Materials

2 L clear plastic soda bottle with the top cut off or large-mouth jar
potting soil
water

a small aquatic plant (maybe from an aquarium supply store)
wild birdseed

Procedure



- 1 Put soil in the bottom of the container, to a depth of 5 cm.
 - (a) Fill the container with water, to a depth of 7.5 cm, thus covering the soil.
 - (b) Place the container, uncovered, on a window sill, and allow the contents to settle overnight.



- 2 The next day, plant an aquatic plant in the container. Although the water will evaporate over time, do *not* add more water to the container.
- 3 Once a week, add 3 or 4 seeds from the wild bird seed mix to the container. **Predict** what will happen in the container. **Observe** and **record** your observations.



- (a) Continue adding seeds weekly, even though the water evaporates. **Predict** what will happen in the container. **Observe** and **record** what happens to these seeds.
- (b) After a few weeks, gradually start to add water again, as you would when watering a plant. Continue to **record** your observations.



Analyze

1. Keep a careful record of your observations. Describe what is occurring in your container.
2. Describe your observations during step 3. Were your predictions supported by your observations? Explain.
3. What was the significance of not adding water to your ecosystem? What happened to the aquatic plant?

Conclude and Apply

4. Compare your ecosystem at the beginning of this investigation with your ecosystem at the end. How did they differ?
5. To what extent does this investigation demonstrate succession?
6. Using your knowledge of succession, describe what you would expect to happen

if a fire burned through a forest, destroying most of the mature trees and vegetation.

Extend Your Skills

7. **Design Your Own** Design an experiment to determine what effects different environmental factors would have on your successional ecosystem. Remember to plan how you will measure the environmental variable that you will be measuring. Make sure that your experiment is a fair test, and have your teacher approve your procedure before you carry out your experiment. (Hint: Your hypothesis should state what effect changing one variable will have on another variable. For example, you might change an environmental condition of your choice in order to observe its effect on new plant growth.)

Changes Caused by Human Activity

Humans affect the environments around them in many different ways. Human technologies, such as those used in forestry and agriculture, can change the environment around us. The spread of urban areas, highways, and parking lots, can also change the environment.

Changing an ecosystem sometimes results in unexpected environmental changes. For example, in order to produce more food, vast tracts of previously forested land have been cleared. The land is used to grow oats, barley, potatoes, beans, and other crops. One unexpected result of clearing this land has been a reduction in the numbers of some bird species, such as small warblers and vireos. How did clearing land lead to the decline of these songbirds? You might be surprised that the culprit is the brown-headed cowbird, shown in Figure 1.49. The brown-headed cowbird adapts easily to change, so it spreads into areas that have been altered. The cowbird lays its eggs in the nests of other species of birds, such as warblers and vireos. When the cowbird chicks hatch, they loudly demand food. Cowbird chicks also grow quickly, often squeezing the smaller warbler and vireo chicks out of the nest. As a result, the warblers and vireos do not reproduce as successfully as they would without the cowbirds.



Figure 1.49 Brown-headed cowbirds have spread across Canada.

Pause & Reflect

Think of the animals and plants that you see in the environment in your community. Are some better able to live in disturbed environments? Sketch two organisms that are able to live in disturbed environments in your Science Log.

Some Species Adapt Better Than Others

The natural habitat of brown-headed cowbirds is the grassland biome of the Canadian Prairies. Since brown-headed cowbirds are adapted to living in open country, they quickly spread into newly cleared farmland. Brown-headed cowbirds have been quick to take advantage of the newly cleared habitat found east of the prairie grassland, across central Canada, and in the Atlantic provinces. The smaller birds that naturally occur in these areas are being forced into other habitats. They are not

adapted to these new habitats, so they are not surviving as well as they did in their natural habitat.

You may have heard of coyotes being seen occasionally within cities (see Figure 1.50), but have you ever heard of a wolf being sighted inside city limits? Although both of these animals occupy similar environments, the coyote is better able to adapt to living in habitats altered by humans.



Figure 1.50 The coyote lives in the wild, but it will adapt to life in built-up areas if food is scarce.

Pest Control



Figure 1.51 Adult insects and late stage nymphs are responsible for most of the lygus bug damage to crops. The lygus bug is also known as the tarnished plant bug.

In Topic 5 you learned about the use of pesticides, such as DDT, to kill pests. Pests that affect human health and crops are a major problem. However, one possible consequence of using pesticides is that beneficial organisms living in the same environment as the pests could also be harmed. This can happen because many pesticides kill more than just the pest. For example, the lygus bug in Figure 1.51 is a pest that feeds on alfalfa and canola plants and causes severe damage to these crops. However, pesticides that are sprayed to kill lygus bugs also kill bees.

Another downside to using pesticides is that they can also harm the beneficial insects that normally prey on the pests. This can result in the populations of pests actually increasing because there are fewer organisms to prey on them!

Biological Control

Another way to control insect pests is to use their natural enemies. This method, called **biological control**, can be very effective and limits or eliminates the need for pesticides. For example, leafy spurge is a weed that was accidentally introduced into Canada in the late 1800s (see Figure 1.52). Leafy spurge grows faster than naturally occurring pasture grasses. Cattle will not eat leafy spurge, so land that is infested with this weed cannot carry livestock. The black dot spurge beetle is a small beetle that feeds on leafy spurge (see Figure 1.53). The beetle was introduced into Alberta in 1983, and has been very successful in controlling the spread of leafy spurge. Desirable plants, such as pasture and rangeland grasses, are returning to the areas where leafy spurge used to grow.

Although biological control can work very well, there can be risks. Whenever a new organism that is not native to the area is introduced to an ecosystem, there is always a risk that it will cause harm.



Figure 1.52 Leafy spurge

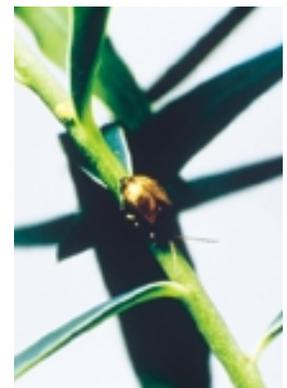


Figure 1.53 The black dot spurge beetle naturally controls the pest, leafy spurge. Natural control limits or eliminates the need for chemical controls such as pesticides.

The Good, the Bad, and the Buggy

Find Out **ACTIVITY**



Ladybird beetles are often sold at gardening and landscape stores to help control pests such as these aphids. There are many other insects that are used as biological controls to control pests in gardens and in agricultural fields in Alberta. In this activity you will investigate some of these insects.

Materials

reference materials

materials of your choice for a presentation

Procedure

- Performing and Recording
- Analyzing and Interpreting

- Using the Internet or other reference sources, gather information on an insect

or plant pest in Alberta that is being controlled using biological methods. You could also contact a local gardening store for assistance.

- Organize the information you collected using a graphic organizer of your choice.
- Present your research findings to your class using a presentation style of your choice. For example, you could prepare a web tutorial, or give a talk using visual aids such as pictures, sketches, or maps.

What Did You Find Out?

- How are biological methods being used to control an insect or plant pest?
- How would this pest be controlled if biological controls were not used?

Skill

FOCUS

For more information about using Technology in Science, turn to Skill Focus 9.

INTERNET CONNECT

www.mcgrawhill.ca/links/sciencefocus7

For information on the use of biological control in Alberta, go to the above web site. Click on **Web Links** to find out where to go next.

Use this information to help you complete the Find Out Activity above.

Introduced Species

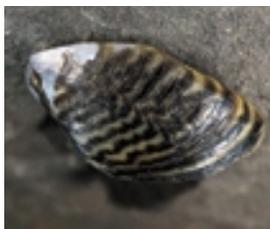


Figure 1.54 With no natural predators in the Great Lakes, the zebra mussel thrives.

Today, purposely introducing a new species, such as the black dot spurge beetle, into an ecosystem is done only after extensive scientific tests show the new organism will do more good than harm. However, many species are accidentally introduced to an environment where they are not naturally found. These are called exotic or **introduced species**. Exotic species occur naturally in another part of the world, and are controlled by predators and other natural controls there. Exotic species have a large impact on the environment into which they are introduced. If they are able to survive and reproduce better than naturally occurring species, they become invasive and can take over a particular ecosystem.

For example, zebra mussels (see Figure 1.54) were introduced by accident to the Great Lakes. The larvae of this mussel were discharged from ships. With no natural predators in the Great Lakes, the mussel was able to survive and thrive. Now it is a serious problem. It clogs water pipes and deprives animals that naturally occur there of space and food.

Historically, people purposely, but innocently, introduced many species, not realizing the problems that could result. In 1890 a group of people released 140 European starlings in Central Park in New York City. They wanted to introduce every species of bird mentioned in the plays of William Shakespeare into North America. Today, starlings have spread across North America and in many cases have taken the food or niche occupied by naturally occurring birds (see Figure 1.55). Today there are over 4 million starlings in the city of Vancouver alone!

The plant in Figure 1.58 is an introduced species that does not belong in North America. Imagine, only three seeds of scotch broom were planted on Vancouver Island in 1850, but today this plant is widespread. It has taken over the ecosystem of many native plants in British Columbia. Purple loosestrife, another plant that is not originally found in North America, is sometimes called the “beautiful killer” because it is deadly to other naturally occurring species. Purple loosestrife quickly takes over wetland areas and colonizes the habitat of native plant species (see Figures 1.56 and 1.57). As well, the animals that depend on these plants are forced to move to other areas if they are to survive.

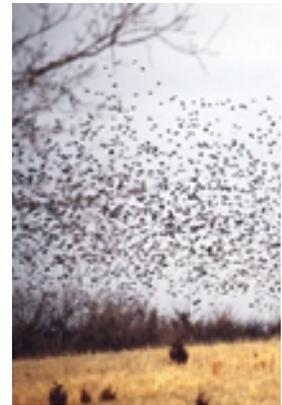


Figure 1.55 Many species that we eat have been introduced (apples, corn, oysters, to name a few). Unlike invasive species such as starlings, they remain under control.

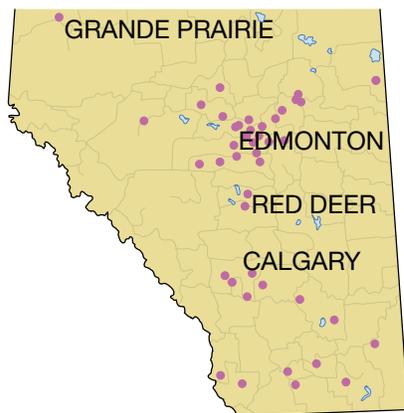


Figure 1.56 Reported garden plantings of purple loosestrife in Alberta, 1999.

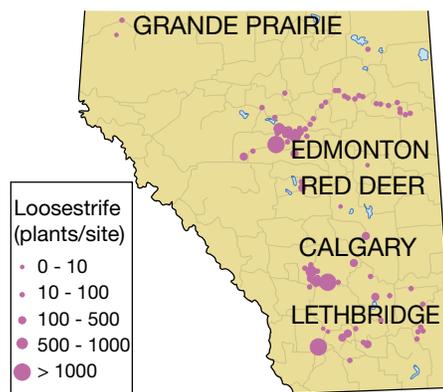


Figure 1.57 Reported infestations from escaped purple loosestrife in Alberta, 1999.



Figure 1.58 The introduced species, Scotch broom now growing over most of southern Vancouver Island, started with just three seeds.

DidYouKnow?

Scientists estimate that 90 percent of all living things that have ever lived are extinct. Extinction is the natural end of all species. Today, the speed at which living things are becoming extinct is increasing rapidly, largely because of human activities. Normally it takes millions of years for a species to disappear. It is estimated that a 100 years ago, about one species a year became extinct. Now, at least one species a day is lost.

Species in Danger

Many different species in Alberta and across Canada are in danger of extinction. If an organism becomes **extinct**, it no longer exists anywhere in the world. The loss of an organism's home, or habitat loss, is now the main reason why so many species are threatened with extinction. Humans have cleared land across Canada to build homes, cities, and roads, and to access natural resources and grow food. This has resulted in the loss of natural habitat for many different species. When an organism can no longer meet its needs in one habitat, it will move to a new habitat. Unfortunately, there is not enough habitat for all of the organisms that need a place to live.

Habitat loss is not the only cause of species extinction, however. Some biologists think that the problem of introduced species is so serious that it will one day replace habitat loss as the main cause of extinction. Plant and animal species can also be "overused." For example, passenger pigeons were hunted to extinction and, as you saw in Topic 4, bull trout are endangered as a result of overfishing. Pollution and changes in climate can also result in loss of species.

In Canada many species have become extinct. The great auk, sea mink, Dawson's caribou, and blue walleye all used to live in Canada and are now extinct. As well, there is a long list of species that are endangered. They include the eastern cougar, bowhead whale, right whale, burrowing owl, grizzly bear, and sea otter. The whooping crane and piping plover are two bird species that are endangered in Alberta (Figures 1.59A and B).



Is extinction forever? Perhaps not. Scientists are using DNA from the preserved bone of a woolly mammoth to see if an elephant — the woolly mammoth's closest living relative — could successfully give birth to a woolly mammoth.



Figure 1.59A The whooping crane is an endangered species in Alberta.



Figure 1.59B The piping plover is an endangered species in Alberta.



Figure 1.59C The grizzly bear is an endangered species in Alberta.

Endangered Animal for a Day



What would it be like to be an animal threatened with extinction? Step into the “shoes” of an endangered animal in this activity.

Materials

- 10 blue plastic chips per student
- 10 red plastic chips per student
- masking tape
- a large bucket of water
- small drinking cups

Procedure

- ✦ Performing and Recording
- ✦ Communication and Teamwork

1. Your teacher will divide all of the class except for three students into three equal-sized groups. Animals A can eat only red plastic chips. Animals B can eat only blue plastic chips. Animals C can eat either colour of plastic chip. The three remaining students are predators.
2. Mark off the boundary of the ecosystem (e.g., gymnasium, or an area half the size of a soccer field). Spread the plastic chips randomly throughout the playing area.
3. Use the masking tape to tape the thumbs of the Animals A and B to their second finger.



4. Give each animal a small drinking cup, which should be kept at the home base (starting place). Allow Animals A and B into the playing area for 3 min. They may pick up one plastic chip at a time and carry it back to the place where they started. During the 3 min that Animals A and B are in the playing area, they must have one cup of water and must rest at their home

base for 30 s. Students can choose when they drink and when they rest. The predators can catch Animals A and B by tagging them. The predators also must drink one cup of water and rest for 30 s.

5. After 3 min, count how many plastic chips each animal has collected. How many animals did each predator catch? Replace all of the plastic chips in the playing area.
6. For the next 3 min, allow Animals C into the playing area as well. They may also pick up one plastic chip at a time, but can gather either colour of chip. They also must gather one cup of water and rest for 30 s. The predators *cannot* catch Animals C.



7. After 3 min count how many plastic chips each animal has collected. How many animals did each predator catch? Replace all of the plastic chips in the playing area.
8. Repeat the game in an area half the size.

What Did You Find Out? ✦ Analyzing and Interpreting

1. Animal C was an exotic species. Explain how it affected the other animals in the ecosystem.
2. How did loss of habitat affect the animals in the ecosystem?
3. Which animal survived best in the smaller habitat, the native species (Animals A and B), or the introduced species (Animals C)? Explain why this happened.

- ☀ Initiating and Planning
- ☀ Performing and Recording
- ☀ Analyzing and Interpreting
- ☀ Communication and Teamwork

Keep Them Safe

The swift fox, burrowing owl, and the western blue flag (a plant) are all species at risk in Alberta. What can be done to help prevent them from becoming extinct?



Challenge

Devise a recovery plan to help keep a species at risk in Alberta from going extinct. Your plan should include a way to raise public awareness about the species and the risks it is facing.

Materials

research materials

materials for presentation, such as art materials, camera, video camera, computer

Design Specifications

- A. Your plan must state the main threats to your species and suggest ways that these threats can be reduced or eliminated.
- B. Develop a strategy to promote awareness of your species. You can use any method of communication you like, (posters, radio, or television programs, skits, interviews, or a presentation with visual aids).

- C. If there is a recovery plan already in place for this species, describe the project and how people can support the project.
- D. Explain how scientific knowledge is being used, or can be used, to help the recovery of this species.

Plan and Construct

- A. With your group, develop a strategy for gathering information.
- B. Develop a strategy for recording and organizing your information.
- C. Develop a strategy for making the public aware of what they can do to help this species.
- D. Complete your presentation.

Evaluate

1. Explain why this species is endangered.
2. How is science being used to help this species recover?
3. How can the general public help this species recover?

Extend Your Skills

1.  Create a class computer database to compile all of the data for the species that your class researched.
2. Contrast and compare the different risk categories, threats, and recovery plans for the different species studied in your class. Why do some species have a better chance for recovery than others?

How Can You Help?

In the last investigation you learned about some of the ways that scientific research is helping endangered species and threatened species to recover. However, many recovery programs depend on the work and support from the general public, who are not necessarily scientists. Operation Burrowing Owl is one such program. Burrowing owls nest deep in abandoned burrows of ground squirrels (also called gophers) and badgers (see Figure 1.60). Since most burrowing owls nest on private land, land-owners are key players in the owls' conservation and recovery. In the Operation Burrowing Owl program, landowners voluntarily agree to help the burrowing owls by protecting their habitat and by not spraying chemicals near their burrows.

In the next Topic you will explore other methods that scientists use to observe and monitor changes in ecosystems. As well, you will learn how you can participate in assessing our impacts on these ecosystems.



Figure 1.60 Burrowing owls nest in abandoned burrows in the ground.



Figure 1.61 Landowners help burrowing owls by protecting their habitat.

Word CONNECT

What is the difference between a threatened species and an endangered species? Research this question, and write your answer in your Science Log. Include some examples.

Off the Wall

A scientist on the island of Mauritius recently observed that the few *Calvaria* trees that remained on the island were all about 300 years old. He wondered why no new trees were growing. He knew that the dodo bird had become extinct about 300 years before, and he hypothesized that the two events were connected. Historical research showed that dodo birds ate *Calvaria* seeds, and that the seeds grew only after they had passed through a dodo's digestive system. Now scientists are experimenting with turkeys as a replacement for the dodo birds, hoping to ensure that the *Calvaria* tree does not become extinct.

TOPIC 6 Review

1. In nature, succession occurs naturally and slowly. Humans, however, sometimes make drastic changes that affect how succession works in an ecosystem. Explain, using either purple loosestrife or zebra mussels as an example.
2. Should humans simply leave all natural ecosystems exactly as they are, or is it acceptable to make changes? What kinds of changes are acceptable? Use these questions as the basis for a report, essay, article, or letter to a newspaper editor.
3. Imagine that you are a forester and have the option of using pesticides or biological control on an insect pest in the forest. Your employer does not want to use biological control because it costs more than using pesticides. What would you say to convince your boss that biological control is worth a try?
4. List four factors that can lead to the extinction of a species.

Environmental Monitoring

When you are feeling sick, your temperature is periodically taken as a way of monitoring your health. Scientists also monitor ecosystems and the organisms that live there. **Ecosystem monitoring** (also called environmental monitoring) is a way to check the condition of an ecosystem by comparing the results of investigations done at different times. Monitoring helps scientists understand the impacts of disturbances and changes in the environment in order to try to reverse or reduce them. Both the biotic and abiotic parts of an ecosystem can be monitored. For instance, scientists might monitor temperature over a long period of time, or they might count the number of birds or butterflies in an area once a month. Figures 1.62 A, B, C, and D show some of the different types of ecosystem monitoring that can be done.



Figure 1.62A Physical monitoring uses satellites to track the changes in landscape over time. For example, satellite maps can show the changes to the land that occur due to construction of cities or deforestation.



Figure 1.62B Environmental monitoring tracks changes in climate, temperature, and weather patterns.



Figure 1.62C Chemical monitoring assesses the quality of air, soil, and water.



Figure 1.62D Biological monitoring tracks the changes in organisms or populations of organisms.

Volunteers are often an important part of monitoring programs. Across Canada hundreds of people, including many students like you, are helping scientists monitor organisms and ecosystems. For example, the Canadian Wildlife Federation sponsors a moth and butterfly survey program. This information is used to monitor habitat loss and ecosystem health. The Canadian Nature Federation monitors ladybird beetles to determine how introduced species of ladybird beetles are affecting native populations of beetles.



Figure 1.63 Students from Alberta schools participate in a River Watch program. The students monitor water quality and observe wildlife and human activities on the river.

When Do We Monitor?

Environmental monitoring can begin after a disturbance has occurred. For example, after an earthquake or other large disturbance, scientists may monitor succession of plants and animals on the disturbed landscape. In one such study, scientists studied the area around Mount St. Helens in Washington after a volcanic eruption in 1980 (see Figure 1.64). These scientists were interested to see how quickly spiders would inhabit the disturbed environment. They found that several species of spiders were blown by the wind for over 50 km to Mount St. Helens where they recolonized the site.

Environmental monitoring can also begin before a disturbance occurs, for example, before an area of land is cleared. Studies can tell us which organisms are living in the area, and other important information about the ecosystem. If we combine what we know about ecosystems with the results from other monitoring studies in similar areas, we may be able to predict what will happen to those organisms over time.

A key part of making environmental decisions is trying to balance human needs with the needs of other organisms in the ecosystem. Initial investigations give us scientific data about what lives in the environment. Continuous monitoring enables us to identify the changes in that environment over time.

Long-Term Monitoring Programs

Amphibians, including frogs, toads, and salamanders, are common in Alberta and throughout much of the world. Amphibians are very sensitive to environmental change, however. If there is too much change, amphibians will not be able to survive. This makes amphibians a good **indicator species** to help us monitor the overall health of our environment. Pesticides, acid rain, loss of habitat, and the introduction of non-native species can all affect amphibians.

Scientists from all over the world have started to notice a decline in the numbers of amphibians and an increase in the number of amphibians found with deformities, such as the frog in Figure 1.65. In general, we know very little about most species of amphibians, so it is hard to understand why amphibian numbers are declining. This is changing, however, as amphibian monitoring programs are being established throughout the world.



Figure 1.64 The area around Mount St. Helens has provided useful information to scientists about recovery in a disturbed environment.



Figure 1.65 Frogs are considered to be indicator species, alerting us to environmental problems.

INTERNET CONNECT

www.mcgrawhill.ca/links/sciencefocus7

From counting butterflies, to identifying birds, to measuring water quality, there are several environmental monitoring programs in Canada in which you can participate. To find out how, go to the above web site. Click on **Web Links** to find out where to go next. Find a monitoring project that interests you and see how you can become involved.



Figure 1.66 These people are counting amphibians as part of the Amphibian Monitoring Program in Alberta.

Since the populations of amphibians naturally fluctuate from year to year, it is important to monitor populations over time. To study amphibian health and overall populations, a worldwide task force, made up of scientists and volunteers, has been created to monitor amphibian populations (see Figure 1.66). These people count the numbers of different amphibians in their region, which shows the status of amphibians in one local region. They also record any deformities they see in the animals. The results from the local studies are sent to one central location. This combined information helps answer larger questions, such as whether or not amphibian populations are really declining worldwide.

Studies such as these are done over time with the same sites monitored year after year. Populations of organisms fluctuate from year to year depending on many different factors. For example, think back to the lynx and the snowshoe hare populations shown on page 41. These populations varied in size over a cycle of approximately ten years. Monitoring an ecosystem over time gives a clearer picture of what is really happening.

INTERNET CONNECT

www.mcgrawhill.ca/links/sciencefocus7

To learn more about amphibian monitoring, go to the above web site. Click on **Web Links** to find out where to go next. Choose one amphibian and write a mini-report about its status. Report your findings to your classmates.

DidYouKnow?

Natural climate changes can be major and long term. For example, about 18 000 years ago, large parts of Earth, including all of what is now Canada, were covered with a thick layer of ice. The climate was much colder than today's climate. By about 8000 years ago, the climate was warmer than our climate today, and major global warming had melted the ice all over Canada and high into the Arctic. Archaeologists have discovered the remains of tropical plants and animals in what is now the Arctic!

Across Canada



Briony Penn

Who says individuals can't make a difference? Briony Penn is proof that this just isn't so. Briony is a naturalist who lives in British Columbia and enjoys observing frogs and other amphibians. In the mid-1980s, she was living on the outskirts of Holyrood Park in Scotland. Holyrood Park is owned by the Royal Family. It is a semi-wild area inhabited by lots of wildlife, including a population of toads. Briony noticed that a massacre occurred each March. The male toads would migrate from the park to a pond area. There they would call to the females who would eventually join them to breed. In order to get to the pond, the toads had to cross a busy road. They crossed in large numbers at night, and many were killed by passing traffic. Realizing that there was a simple solution, Briony wrote to Queen Elizabeth II. She asked that the road be closed for the few days when the toads would be crossing to and from the pond. The Queen obliged, and the toad population of Holyrood Park has made its annual migration safely ever since. Briony is now back in her home on Salt Spring Island. Like other naturalists on the Gulf Islands, she has made maps of amphibian crossings so that motorists can take special care during breeding season. The photograph shows Briony with one of her frog and rough-skinned newt-crossing maps.

What's the Change?

Think About It

Monitoring the numbers and whereabouts of organisms provides information about the health of the ecosystem in which they live. What type of amphibians are found in Alberta and where are they found?

Materials

field guide to amphibians paper
map of Alberta pencil

What to Do

Table 1.1: Results from 1997 and 1998 Volunteer Amphibian Surveys

Species	Number of observations 1997	Number of individuals 1997	Number of observations 1998	Number of individuals 1998
Tiger salamander	37	299	26	45
Long-toed salamander	5	170	6	69
Plains spadefoot	4	33	17	440
Great Plains toad	6	57	6	63
Boreal toad	41	649	60	661
Canadian toad	33	183	10	64
Boreal chorus frog	354	15 213	292	6 105
Wood frog	351	8 978	310	3 210
Spotted frog	8	117	10	115
Northern leopard frog	11	405	20	4 120
Total records	850	26 104	757	14 892
Number of participants	107		144	

Table 1.2: Numbers of Amphibians Captured at Five Alberta Sites in 1998

Study site	LTSA	TISA	BCFR	WOFR	CSFR	NLFR	BOTO	CATO	TOTAL
Beaverhill Lake	0	1	17	182	0	0	0	0	200
Cypress Hills	0	31	2	0	0	5	0	0	38
Kananaskis	186	0	0	61	7	0	33	0	287
Lesser Slave Lake	0	0	5	33	0	0	23	1	62
Meanook	0	0	4	277	0	0	343	0	624
Total	186	32	28	553	7	5	399	1	1 211

- 1 Use the field guide to look at pictures of each of the amphibian species.
- 2 Use the data in Table 1.1 to make a bar graph comparing the number of individuals observed in 1997 and 1998.
- 3 Locate the general area of the study sites from Table 1.2.
- 4 Use the data in Table 1.2 to make a bar graph comparing the numbers of individuals found at five different sites in Alberta.

Analyze

1. Use the tables and your graphs to answer the following questions:
 - (a) What are the two most common amphibians in Alberta?
 - (b) Which species has the largest/smallest distribution throughout Alberta?
 - (c) How can the data collected in Table 1.1 and Table 1.2 add to the understanding of amphibians over the long term?

LTSA – Long-toed salamander
TISA – Tiger salamander
BCFR – Boreal chorus frog
WOFR – Wood frog
CSFR – Columbia spotted frog
NLFR – Northern leopard frog
BOTO – Boreal toad
CATO – Canadian toad

Skill FOCUS

For tips on making bar graphs, turn to Skill Focus 10.

 Initiating and Planning

 Performing and Recording

 Analyzing and Interpreting

 Communication and Teamwork

Monitor Your Local Amphibians!



Think About It

There are 10 species of amphibians in Alberta. What do you need to know to effectively gather information on amphibians?

How Can Science Help?

Long-term monitoring distinguishes the difference between natural fluctuations in populations and changes that may be caused by pollution, habitat loss, or other factors.

Safety Precautions



- Conduct this investigation only under the supervision of your teacher.
- Never follow amphibians into the water.
- Do not handle amphibians if you have insect repellent or lotion on your hands.

Materials

paper
pencil

Apparatus

field guide to amphibians
small dip net
ice cream or plastic bucket with lid perforated with air holes
clipboard
thermometer
tape of frog calls (optional)
tape recorder and batteries (optional)

Rules For Observing Amphibians

- Handle each amphibian no longer than necessary, and limit the number of people who handle them.
- Make sure your hands are damp.
- Use only small nets to capture amphibians.
- Keep the amphibians cool and moist while you observe them.
- Return all amphibians to the place where they were caught.
- Wash your hands after handling amphibians.

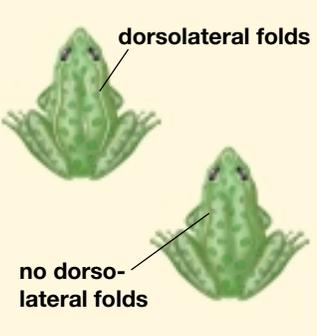
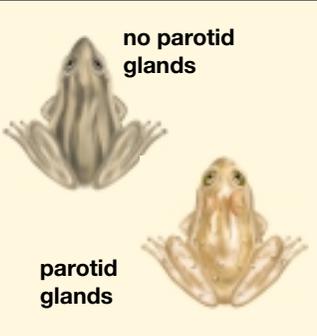
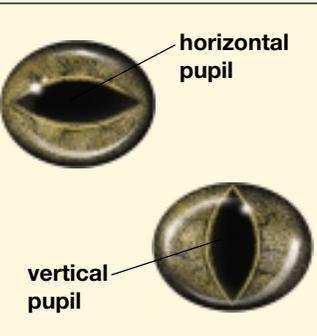
Procedure



- Using a field guide, the information from the Think & Link Investigation and the Internet Connect on the previous two pages, determine which species of amphibian would likely be found in your area and its breeding season.
- Find a suitable area for studying amphibians near your school.
- Review the amphibian key on the next page.
- Create a data sheet to record: the date, the time of observation, the species observed, the number of individuals observed, whether the species was actually seen, or just heard, and any presence of eggs. Provide space for sketches on your data sheet.
- Visit the study site and complete your data sheet.
- At the study site, sketch a map of the habitat in which the amphibian was found. Draw in major geological features, rivers, lakes, roads, and how the land is used around the wetland.

Identification Key for Alberta Amphibians

To use the key, start at number one and choose option A or B, whichever best describes the amphibian you are trying to identify. Proceed to the next number as indicated until you reach a species name. Use photographs or illustrations in a field guide to confirm your identification.

	Go to	
1. (a) Body covered with scales (b) Body does not have scales	This is a reptile 2	
2. (a) Hind legs same length as front legs and are not modified for hopping; long tail (b) Hind legs much longer than front legs, and are muscular and modified for hopping; no tail	3 4	
Salamanders		
3. (a) Irregular yellowish stripe (may be broken) down back; fourth toe on hind foot noticeably longer than other toes (b) Back and sides striped or spotted; fourth toe about the same length as others	Long-toed salamander Tiger salamander	
Frogs and Toads		
4. (a) Ridges (dorsolateral folds) present on back (b) No ridges (dorsolateral folds) present on back	5 7	
5. (a) Green or brown, with light-coloured ridges on back and dark spots with light border (b) Ridges on back; small and not light coloured	Northern leopard frog 6	
6. (a) Dark eye mask; back smooth; no red on belly (b) No eye mask; small warts on back; red colour on belly	Wood frog Spotted frog	
7. (a) Skin fairly smooth and poison (parotid) glands absent (b) Skin very warty and poison (parotid) glands present	8 9	
8. (a) Large, squat body; single black knob or "spade" on hind feet; vertical pupil (b) Small, slender body; no knob on hind feet; horizontal pupil	Plains spadefoot Boreal chorus frog	
9. (a) No raised ridge between eyes (b) Raised ridge between eyes	Western toad 10	
10. (a) Raised ridge between eyes parallel or joined behind eyes to form one raised ridge; spotted belly (b) Raised ridge starts at snout and spreads out behind eyes; belly unspotted	Canadian toad Great plains toad	

Analyze

- Use the procedures in this investigation to develop a long-term monitoring plan for your study area.
- What other information should you gather besides the species and numbers of amphibians present in your study area to make your long-term study most useful?
- What is the health of the amphibian habitat in your study area? Develop a plan for creating, maintaining, and/or protecting this habitat.

Looking Ahead

Municipalities that have implemented Blue Box programs have done so only after a lot of research and planning. Research the Internet and other sources to discover the planning stages involved in implementing the Blue Box program in your community, or another community in Alberta. Use the information you gather in your end-of-unit debate.

Baseline Data

In Topic 6 you learned about the effects of introduced species such as purple loosestrife. Many changes happen in an ecosystem after a natural event such as a flood, or a human-caused event such as the introduction of an exotic species. To determine the types of changes, it is important to know what the habitat was like before the disturbance occurred. To do this, scientists gather **baseline data**. Baseline data gives scientists a starting point to compare changes in the environment. Scientists often use **permanent plots**, or study areas, to monitor change. For example, one scientist is interested in seeing if global warming changes the plants growing in the forest. He has established several large permanent plots throughout North America. This researcher and his assistants visit the plots every few years or so to monitor changes in the forest. Ideally, several researchers will continue this study for many years to come. The researcher in Figure 1.67A is studying the plants in a permanent study plot. Other studies, such as bird surveys, are done at the same time and at the same place each year. The researcher in Figure 1.67B catches birds as they migrate between their wintering grounds and their summer breeding grounds. They place bands on the birds' legs with information on where and when the birds were captured.

Baseline data can also be used to predict changes in the environment. For example, if someone wants to drain a wetland to put in a shopping mall, scientists can refer to studies from that area, or from a similar area, to predict the effects. This also means that a plan could be developed to minimize the impacts or perhaps — if the changes are determined to be too serious — the development could be stopped. A report that outlines how an activity will affect the environment is called an **Environmental Impact Assessment**.

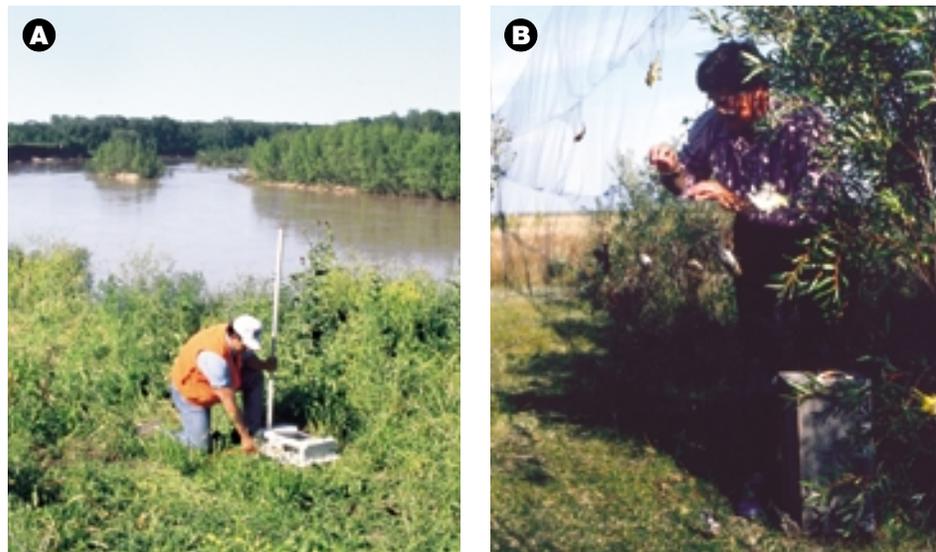


Figure 1.67A & B Studying plants in a permanent plot and examining migrating birds are two ways to obtain baseline data.

Common Alberta Organisms

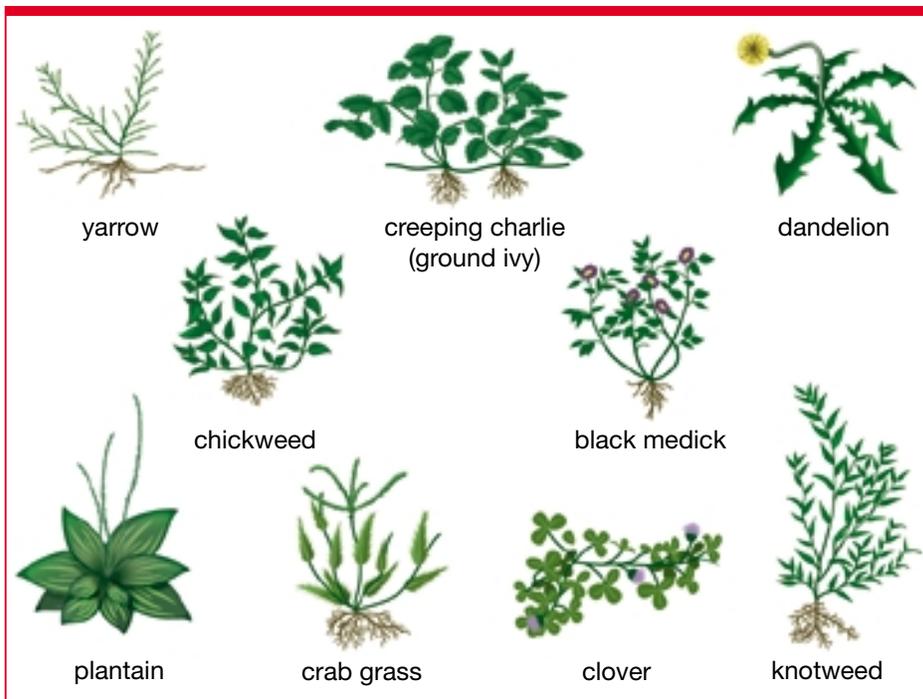
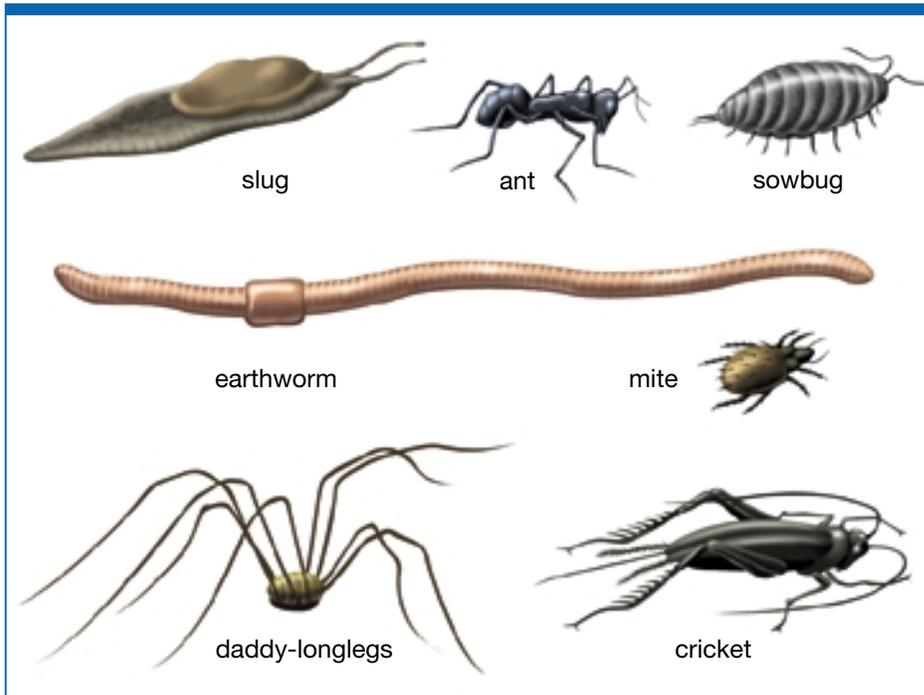


Figure 1.68 Scientists gather baseline data about habitats in order to learn about the effects of various environmental changes. The organisms shown here are common in Alberta. You can refer to them to help you identify the organisms you examine as you gather your own baseline data in the following investigation.

 Initiating and Planning

 Performing and Recording

 Analyzing and Interpreting

Communication and Teamwork

Comparing Ecosystems

Gather your own baseline data by comparing a disturbed habitat with an undisturbed habitat in your community. Different habitats have different characteristics, which affect the organisms that live within them. You will determine what organisms live in these habitats, describe them, and explain any differences you find. Choose a disturbed area, such as a section of lawn or school playing field, and a nearby natural area such as a forest.

Question

What kinds of organisms can be found living in two different habitats in your community?

Hypothesis

Form a hypothesis comparing the types of organisms found in a disturbed and a natural ecosystem.

Safety Precautions



Apparatus

4 metre sticks or 4 wooden pegs per group

several jars with caps that have holes in them

magnifying glass

clipboard

field guides

Materials

duct tape string

paper for sketching notebook

Procedure

- 1 Make an observation sheet by drawing a chart on a piece of paper. One column should list the names of plant and animal species you are likely to encounter. Leave several rows blank for species you cannot

immediately identify. Add an additional column with a separate heading for every area (called a quadrat) you sample (quadrat 1, quadrat 2, etc.).

- 2 Based on the biotic and abiotic characteristics of your two habitats, **predict** the types of organisms you will find. For example, if one of your habitats has a lot of trees, you may find birds in the area that you will not see on an open field.

- 3 Make a 1m² quadrat using the metre sticks or pegs and string as shown here. Choose a suitable location for your study. Toss your pencil at random into the habitat. Place a corner of your quadrat where it lands.

(a) **Count** all of each kind of organism within your quadrat. Count a plant on the boundary line only if more than half of it lies within the quadrat.

(b) On your observation sheet, **record** the total of each kind of organism.

- 4 Repeat step 2 for two more quadrat samples.



- 5 Average the totals for your quadrat samples to get the average number of each organism per square metre. Multiply the average number of each organism per square metre by your estimate of the number of square metres in the total ecosystem area. This will give you an estimate of the total population of each organism in the ecosystems. An example is given in the sample calculation.

6 If you find a plant you cannot name, make a sketch of it. Include an outline of the leaf. (This will help you to identify it later.) Use the illustration of common lawn plants on page 75. Use a letter code, such as B, to identify the unknown specimen.

7 If you find an insect or other animal you do not know, put one specimen in a jar, close the lid, and quickly make a simple sketch. (Be sure to check the number of legs and wings to help you identify it later.) Once you have completed your sketch, release the organism. Give your unknown specimen a number code, such as 2, for identification.

8 Repeat the experiment in the second ecosystem.

Name of species	Quadrat					Average # individuals per square metre	Total ecosystem area	Estimated total population
	1	2	3	4	5			

Sample calculation:

The number of blue beetles counted in five quadrat (1 m²) samples is 13, 15, 16, 14, 13.

Total number of blue beetles in five quadrats = 71.

$$\begin{aligned} \text{Average} &= \frac{\text{total number of blue beetles}}{\text{total area of quadrats}} \\ &= \frac{71 \text{ blue beetles}}{5 \text{ quadrants} \times 1 \text{ m}^2} \\ &= 14.2 \text{ blue beetles/m}^2 \end{aligned}$$

$$\begin{aligned} \text{Total ecosystem area} &= \text{length} \times \text{width of ecosystem} \\ &= 50 \text{ m} \times 20 \text{ m} \\ &= 1000 \text{ m}^2 \end{aligned}$$

Estimated total population of blue beetles in the ecosystem

$$\begin{aligned} &= \frac{14.2 \text{ blue beetles}}{\text{m}^2} \times 1000 \text{ m}^2 \\ &= 14\,200 \text{ blue beetles} \end{aligned}$$

Skill

FOCUS

For tips on scientific drawing, turn to Skill Focus 11.

Analyze

1. Try to identify your unknown organisms by matching them with pictures and descriptions in plant, insect, and animal books.
2. If possible, replace the number codes or letter codes on your observation sheets with the names of the specimens you have identified.
3. Complete your calculations to determine the numbers of different organisms in each habitat. As a class, create a chart comparing the different organisms present in the different habitats.

Conclude and Apply

4. What different biotic factors were present in your two habitats?
5. What different abiotic factors (non-living things) were present in your different habitats?
6. Your predictions were based only on the appearance of your habitats. Were your predictions supported by your observations? Explain.

Extend Your Knowledge

7. What other factors might affect the organisms living in your habitats?

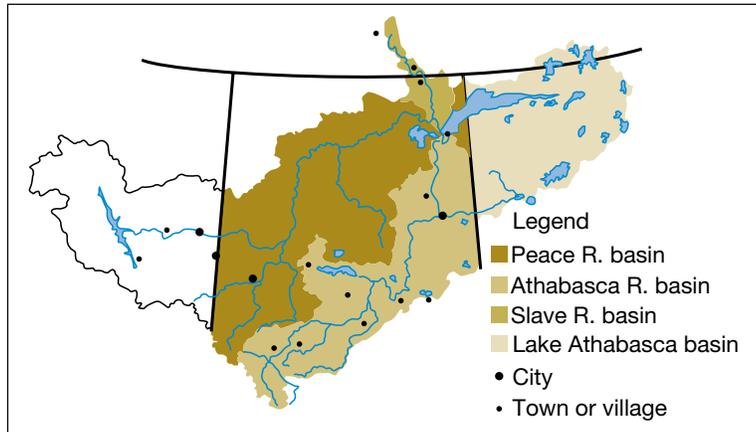


Figure 1.69 The Northern River Basins Study monitors and assesses the impact of development over a broad area.

Using Science in Real Ecosystems

The Northern River Basins region, made up of the Peace, Athabasca, and Slave River basins, covers a vast territory. Many Aboriginal people living in the Northern Basins region depend upon the land for food, clothing, medicines, and other natural resources. Their lifestyle is threatened by the economic development of the area's

natural resources. To monitor and assess the impact of development in the area, a huge scientific project, called the Northern River Basins Study, began in 1991. Its goal was to learn how developments in the area were affecting the ecosystems.

Over 150 scientific studies looked at many aspects of the environment in this region. The results of the research were combined with traditional Aboriginal knowledge about the Northern Basins Region. This resulted in a large body of information about the relationships between the air, land, water, organisms, and the people living in this region. The impact of human developments was considered as well.

When the information was analyzed, results showed that industries being developed in the area were affecting the health of the ecosystems, often negatively. Fish living downstream from pulp mills were smaller and healthier than fish living away from pulp mills. Industrial waste also affected the amount of oxygen present in the water. Lower oxygen levels in the water killed many of the small organisms that normally lived there. As a result, fish, such as mountain white fish and bull trout which eat these small organisms, also began to die.

By understanding how ecosystems work and by learning to monitor ecosystem health, we can all work toward restoring and maintaining a healthy environment.

Pause & Reflect

You have just sampled several different quadrats in areas that were chosen by randomly throwing your pencil. Explain why you sampled more than one area. What reasons can you think of for choosing the areas by chance? Write your answers in your Science Log.



Figure 1.70 Aboriginal cultures have extensive knowledge about the ecosystems in which they live, since many generations have lived on the same land.

TOPIC 7 Review

1. Explain how long-term monitoring can be used to help protect natural ecosystems.
2. What are the four types of ecosystem monitoring? Give an example of something that would be measured or monitored for each type.
3. Describe a Canadian monitoring program that volunteers (including you!) could become involved in.
4. Explain what is meant by baseline data.

If you need to check an item, Topic numbers are provided in brackets throughout.

Key Terms

succession

primary succession

secondary succession

biological control

introduced species

extinct

ecosystem monitoring

indicator species

baseline data

permanent plots

environmental impact assessment

Reviewing Key Terms

- Write a sentence to describe the relationship among the terms in each group.
 - introduced species and extinction (6)
 - primary succession and secondary succession (6)
 - biological control and introduced species (6)
 - baseline data and ecosystem monitoring (7)
- Explain the process of succession. (6)
- Why are amphibians good indicator species? (7)
- Name two ways that you can become involved in environmental monitoring. (7)
- Name two endangered species in Alberta. Describe the recovery plan for one of these species. (6)
- Explain why it is important to carry out long-term, rather than short-term, monitoring. (7)
- Imagine an alien has landed on Earth and has found a coloured pencil, a ballpoint pen, a felt pen, and a regular pencil. Write an identification key to help the alien identify these objects. (Refer back to page 73 for an example of an identification key.) (7)
- Give two examples of natural disturbances and two examples of human-induced disturbances. (7)
- Species have been going extinct for as long as there have been living things on Earth. If this is so, why are scientists so concerned about endangered species today? (6)

Understanding Key Concepts

- Explain why people should *not* release exotic pets, such as snakes, hedgehogs, or tarantulas, into the wild if they decide they do not want to keep them any longer. (6)
- Label this diagram with explanations of what is happening in each stage of succession. (6)





As more and more land in Canada is used for human activities, we can see the increasing impact of such development on the well-being of local wildlife and also on humans. Bernadette Tenning is a biologist who specializes in assessing the negative effects that new development can have on the environment, and helping people take steps to safeguard against them.

Q. How long have you been assessing the effects of new development?

A. I've been doing environmental assessments since 1998. That's when I graduated from university. Because of my First Nations descent, I've always been interested in biology and concerned about the environment, so after I had my children, I went back to university to study human geography and biology.

Q. What sort of assessment do you do?

A. I do a few different types. For example, I did an assessment for a timber company that was applying for a licence to operate in a northern community. They wanted me to assess the situation and show, in their application, that they had considered environmental factors and were taking steps to protect the ecosystem from damage.

Q. What did your assessment show?

A. I explained that the company proposed cutting the trees in winter when the ground was frozen. By doing this, the soil was less likely to erode away. (Soil erosion would decrease plant growth and negatively affect the animals that depend on those plants.) The company also

planned to avoid areas where there were plants and animals that were easily disturbed or harmed, and areas that are traditional First Nations hunting grounds.

Q. Are all of your assessments done for companies that are proposing developments?

A. No. One of the first assessments I ever did was for a First Nations lobby group concerned about a hog-processing plant proposed for their area. They wanted someone to assess the existing water quality and predict what sort of environmental impact the proposed plant would have.

Q. So were you looking strictly at water?

A. I was looking at the water as an indicator of environmental impact, but I had to consider the ecosystem of the whole area. Everything in an area is affected by the quality of the water. In this case, the quality of the water was already poor. The hog processor reported a high level of bacteria called *E. coli* in the water. Hog waste leads to high levels of bacteria. The processor believed, however, that additional waste from the hogs would not increase the amount of *E. coli* in the water beyond the level that was acceptable by

government standards. I was concerned that the water had not been tested for parasites such as *Giardia*. Compared with *E. coli*, this parasite can infect other organisms at much lower levels. Disease could spread to local wildlife. Then deer or mice could potentially spread sickness to livestock and humans.

Q. If the hog plant had not yet been built, why was the quality of water already so poor?

A. There was a lot of existing development, such as construction and agriculture, in the area. When development takes place and waste materials are not disposed of properly, the natural balance of the ecosystem can be thrown out of whack. My biggest concern was that waste from the hogs could add to the imbalance if it were not disposed of properly. This might result in a positive feedback loop — something every biologist fears.

Q. What is a positive feedback loop?

A. It's a situation in which a chain of events changes an ecosystem in a way that cannot be reversed. For example, in the proposed hog plant situation, hog waste released into the water would add large amounts of substances

with nitrogen. Nitrogen acts like a fertilizer in water and causes an increase in algae growth. As the algae grow, they take oxygen from the organisms that were in the water before they were. Fish populations begin to die from lack of oxygen, which affects birds, otters, bears — anything that depends on the fish for food.

Q. And you can't return the populations of fish and their predators to the way they once were, right?

A. Not easily. Once this situation happens, you usually lose the variety of organisms that used to grow in the environment. You end up with just a few organisms that adapt well to the new conditions. The algae begin to take over the water source. Gradually, the solid growth of algae can fill in the lake or river until it becomes a marsh and eventually dries up completely. Fortunately, the public is becoming more aware of these issues and more vocal in their demands for good-quality water. If enough people ask the right questions, more developers will become environmentally responsible.

EXPLORING Further

In the spring of 2000, the drinking water in Walkerton, Ontario, became contaminated with *E. coli* bacteria. Many people became ill and several died. These bacteria normally live in the intestines of people and other warm-blooded animals. They also occur in water systems in low numbers. However, the population of *E. coli* can

increase if raw sewage from cities or farms enters the water. Conduct some research to find out what is done to monitor the levels of *E. coli* in drinking water. What measures must be taken to ensure that this type of tragedy never occurs again? Work with a partner and present your findings along with a series of recommendations.

An *Issue* to Analyze

A DEBATE

Beyond the Curb: Is Recycling Really Reducing Garbage?



In this Unit you have learned about how humans affect the environment, often without even realizing it. For instance, our garbage goes to landfills. Landfills can contribute waste gases (called greenhouse gases) to the atmosphere and can add toxins to ground water and run-off. Presently, landfills and garbage dumps are being filled faster than ever. The main way that you can help to reduce waste in landfills by following the 3 Rs: reduce, reuse, and recycle.

Assume that you are following the 3 Rs to the best of your ability — you are confident that you separate and sort all the recyclable items in your garbage. How can you be sure that other people are as committed as you are, so that, together, you can make a difference in the garbage crisis?

Rising municipal taxes have caused some people to complain about the cost of the Blue Box program. These people argue that recycling is not helping the environment, but instead it is using up a lot of time, energy, and money. They would prefer to see the Blue Box program eliminated.

Resolution

Be it resolved that recycling programs, such as the Blue Box program, have not been effective in reducing the impact of garbage on the environment.

What to Do

- 1 Read the In Favour and Against points listed on the next page, and think about other points that could be made in favour of and against the resolution.
- 2 Four students will debate the resolution. Two students will speak in support of the resolution and two will speak against it. **Note:** No matter what view you actually hold, you must try your best to convince the jury, or debate listeners, of the point your side is defending.

- 3 To aid the two teams, two other students will work with them to help gather background information. This is needed to put forward a strong case for the point that each side is defending.
- 4 The rest of the class will act as the jury in hearing the debate. In preparation for the debate, they should do their own research in order to understand the science and technology behind the issues raised.
- 5 Your teacher will provide you with the proper debating procedures to follow.

In Favour

- Garbage is only one of many environmental concerns we face today. The rising level of energy consumption is perhaps of greater concern. The full recycling process uses a great amount of energy — much more than is required simply to dump garbage at a landfill.
- The quality of products made from recycled materials is generally lower than the quality of products made from new materials. In addition, most plastics and paper can be recycled only once, or maybe twice, before the product quality is so low that the products are unusable.
- Many people are still unwilling to make the effort required to recycle properly. The end result is that landfills are still overflowing with both recyclable and non-recyclable garbage.
- Recycling costs money and unless companies can make a profit by manufacturing products from recycled materials, they cannot afford to do it. Consumers pay for the cost of recycling by paying more for products made with recycled materials. Some consumers are unwilling to do this.

Against

- Recycling programs have made people much more aware of the garbage they produce.
- Much less energy is needed to recycle some materials than to process them from raw materials because of refined processing technologies.

- Although early technologies for cleaning, purifying, and reusing recycled materials were very limited, present technologies have allowed a wide range of plastics and papers to be added to the list of recyclable materials.
- Many resources are non-renewable and limited in quantity. If they are not recycled, they end up in dumps and landfills where they are inaccessible. It is important to continue recycling before our resources become depleted.



Analyze

1. Which team won the debate, based on a class vote?
2. Did the winning team produce better research or make a better presentation? Explain.
3. Did you find any studies or any other reliable information that contradicts the arguments that were presented? If so, explain.
4. Did your initial viewpoint change as a result of the points presented in the debate? Explain why or why not.

Extension

5. One proposal to motivate people to recycle more, and to do so more efficiently, is to charge individuals and businesses for each bag of garbage that is picked up. What do you think? Prepare arguments in favour of and against this idea to help you determine whether this proposal might, in fact, work.

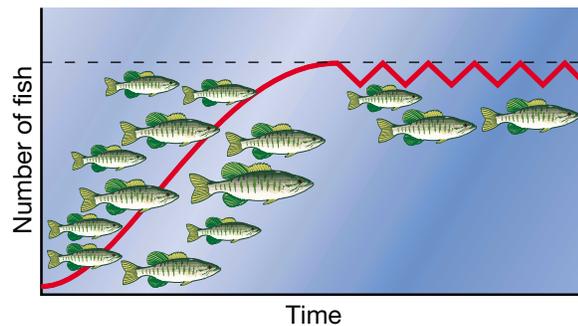
1 Review

Unit at a Glance

- Ecology is the study of the relationship between living organisms and their environment.
 - The basic needs of living things include food, a suitable habitat, water, and appropriate gases (oxygen, carbon dioxide).
 - Organisms adapt to “fit” their environment.
 - An adaptation is an inherited characteristic that helps an organism survive and reproduce in its environment.
 - Ecosystems include biotic and abiotic components.
 - Organisms interact with one another and some are interdependent on one another.
 - Humans’ needs and wants result in impacts on natural environments.
 - The impacts of human activities are not always easy to predict.
 - People’s interactions with the environment have changed over time.
 - We have used our understanding of science and technology to assess how we affect the environment, and how the impacts can be reduced.
 - Organisms fill several niches within an ecosystem.
 - Impacts in the environment can be a result of natural disturbance or they can be caused by human actions.
 - Energy, carbon, and water cycle through ecosystems.
 - The effect of pollutants can be magnified as they move through food chains.
 - Succession is the gradual process by which some species replace other species in an ecosystem.
 - Human impacts on the environment are often unexpected (e.g., the effects of exotic species).
 - Species can become endangered because of habitat loss, introduced species, pollution and/or overharvesting.
- Environmental monitoring is a way to check the condition of an ecosystem by comparing the results of investigations done over time.
 - Environmental impact assessments are used to predict impacts on the environment based on an understanding of scientific concepts and technology.

Understanding Key Concepts

1. Think of five different ecosystems that might be found in an area such as a national park. List the biotic and abiotic factors each ecosystem might contain. (Hint: Remember that ecosystems can be large, like a forest, or small, like a rotting log, as long as they include all of the biotic and abiotic factors present.)



2. Look at this illustration. The dashed line at the top of the graph indicates that above that line there will not be enough food to support any more fish. What do you think will happen to the number of fish if the present level of food remains available?
3. (a) Why are quadrats used to carry out ecosystem studies?
(b) How would you use a quadrat to estimate population sizes? Why is the result only an estimate and not an exact figure?
4. Choose an organism and describe at least one adaptation it possesses that helps it survive in its environment.

5. Choose an organism and explain how it interacts with sunlight, air, water, and soil. Give two examples of living things that interact.
6. Describe three human activities that can endanger a species.



7. In your notebook use words, arrows, and sketches to show the food web in this diagram. Name two herbivores, two producers, and two carnivores.
8. 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 for a visit. Their lawn looked similar, though much weedier. They were surprised, however, to see wildflowers, shrubs, and small trees growing in their deserted garden. Explain why this is an example of succession.
9. What is the carbon cycle? What role do each of the following play in it?
 - (a) fossil fuels burning
 - (b) forests burning
 - (c) animals respiring
 - (d) plants carrying out the process of photosynthesis

10. Explain how the extinction of various species results in a less diverse ecosystem. How can this lead to the extinction of even more species?
11. (a) Give two examples of how organisms interact with one another.
(b) Give two examples of organisms that are dependent on one another.
12. Make a chart, poster, or other representation to summarize how human activities can affect ecosystems.
13. Explain the methods that can be used to observe and monitor changes in ecosystems.
14. Based on your knowledge of cycles, explain the slogan “Have you thanked a plant today?”

Developing Skills

15. Think of (and observe if possible) an ecosystem near your home. Make a chart or diagram to show abiotic-biotic interactions in an ecosystem.
16. (a) Give two or more examples of how plants are adapted for interactions with abiotic factors in their environment.
(b) Choose one plant in the ecosystem you studied in question 15, and explain how it is adapted to its environment.
17. Imagine that you are teaching the topic of adaptation to a class of younger students. Devise two questions you could ask to assess the students’ understanding of an adaptation.
18. As a class, think about how you might create a model of an ecosystem. What would you include in your ecosystem? Why?
19. Design a poster that describes and defines an ecological footprint. Use an example that compares the ecological footprint of two activities (e.g., eating food grown in your garden and eating food imported from Europe).

20. Look at the graph in question 2. Design an experiment to investigate what will happen to the number of fish if more food were available. (Alternatively, select a different variable to investigate what you think would affect the number of fish.)
21. How have farming and forestry affected brown-headed cowbird populations in Canada? Give your answer in the form of a numbered list of steps, a labelled diagram, or a flowchart.
22. Design an activity that would increase the diversity of species where you live. What role might be played by a bird feeder or herbs growing in pots? What are some advantages of species diversity?
23. Design a poster, game, or model to explain bioaccumulation.

Problem Solving/Applying

24. Do you have a fish, hamster, or other living creature in your classroom or school? Observe it and write some notes about its original (wild) habitat based on visible adaptations. (For example, what kind of teeth does it have? What kind of feet does it have? Can it run quickly?)
25. Why do humans use running shoes, winter boots, snowshoes, skis, or flippers? Explain why these are not biological adaptations.
26. 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.
27. A sailor survived a shipwreck. She managed to save several hens and a bag of grain from the cargo. She is now on an island far from land, in an area where there are no other people. It may be months before she is rescued. To survive as long as possible, what should she do?
- Feed the grain to the hens, and eat the eggs they lay.
 - Eat the grain, and then eat the hens.
 - Eat the hens, and then eat the grain.
- Explain why you think the option you chose is best. If you do not agree with any of the options listed above, what other solution would you propose?
28. Imagine that you are a water particle. Trace a possible path that you might take as you move through one complete water cycle. Begin the cycle as a snowflake falling in winter.
29. You are a researcher working on methods of controlling insect pests. Identify some concerns you might have relating to preserving ecosystems. As well, what are some concerns relating to economic activities, such as forestry and farming?

Critical Thinking

30. 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:
- the number of insects in a large tree
 - the number of whales in a large bay off the coast
 - the number of fish in a small lake
 - the number of groundhogs living in a local golf course

31. 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 whale and a barnacle living on the whale's back
- (c) a dog and a flea
- (d) a nectar-eating bat and a flowering cactus
- (e) a bird and a water buffalo

32. Think about a food chain that includes grass → field mice → snakes → owls. Describe what would happen if many mice died as a result of disease. What would happen to the owls? What would happen to the snakes? What would be the probable results in the ecosystem?

33. Why do most humans have more food choices than many animals do? On your own or in a group, brainstorm answers to this question.

34. Consider the ecosystem you observed in question 15. Predict what would happen if each of the following major changes occurred:

- (a) People began to use chemical fertilizers.
- (b) The rain becomes acidic.
- (c) A hydro line is built through the area.
- (d) The area is hit by a severe hailstorm.
- (e) The butterflies do not appear one spring.
- (f) The earthworms are attacked by a parasite, and their numbers are severely reduced.
- (g) An oil spill occurs.

35. Think again about the changes you considered in question 34. What roles might people play to reduce or reverse the impact on the ecosystem?

36. What are the benefits and problems relating to the 3 Rs: reduce, reuse, and recycle?

37. Use the balance scale below to explain the concept of balance as it relates to ideas and issues in this unit.



38. Identify three examples of human impacts on the ecosystem. Is there a link between these impacts and people's needs and wants?

Pause & Reflect

1. In a number of cases, humans have introduced different organisms, or deliberately changed an ecosystem in other ways. To what extent can we or should we change natural ecosystems? What are some advantages and disadvantages of changing ecosystems?
2. Identify a specific issue raised by this unit. Explain why it is important to you. Plan and carry out positive actions by which you personally improve a situation related to the issue.
3. Now that you have completed this unit, go back to the Focussing Questions on page 4. Write answers to these questions in your Science Log.