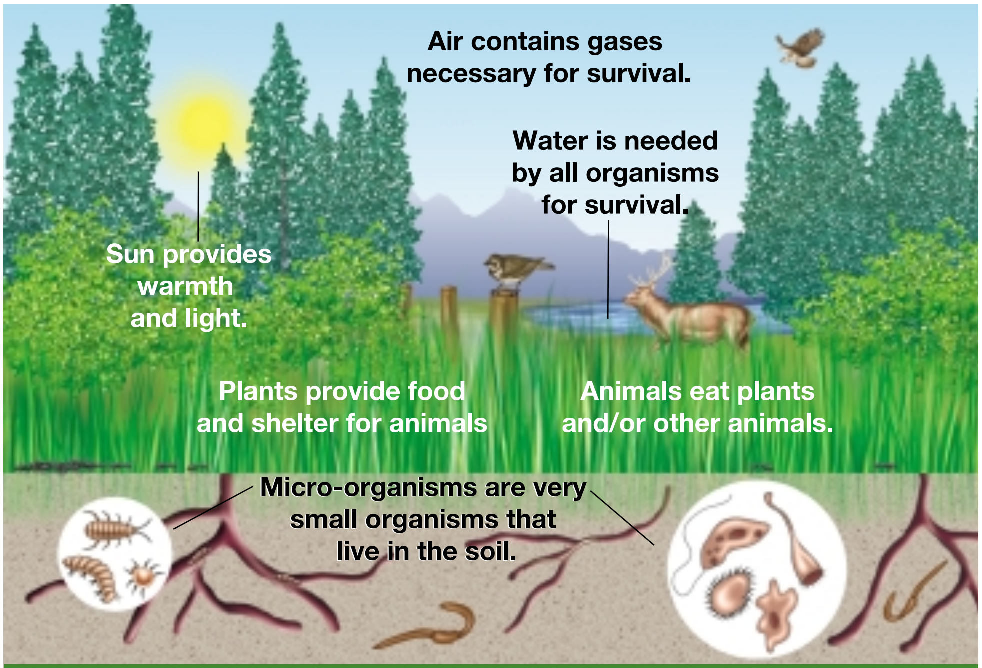
TOPIC 4 How Organisms Interact

As this lynx chases the hare, two living organisms are interacting in an environment. The lynx and the hare are two examples of the **biotic**, or living, parts of an ecosystem. All living organisms — including humans, bacteria, insects, and plants — are the biotic part of an ecosystem. The lynx and the hare are also interacting with the **abiotic**, or non-living, parts of their ecosystem. For example, if this photograph were taken in the summer, the hare's fur would be brown, not white. This is because the hare interacts, or responds, to the changing seasons (a non-living part of an environment) and it moults its fur as the seasons change. The abiotic parts of an ecosystem include the air, water, and soil.



Soil contains abiotic parts, such as minerals, and biotic parts, such as decaying bodies of dead organisms. Soil provides a home for many animals that live underground. Soil also provides minerals and other nutrients for plants.

Pause & Reflect

The swift fox occupies several niches. It eats small mammals, birds, insects, grasses, and berries and lives in dens dug into the ground. The presence of swift foxes affects the biotic and abiotic features of the southern prairie ecosystem in Alberta. What niche does your study animal occupy? Record your findings in your Science Log.

The Roles of Organisms in an Ecosystem

You, like all other members of human communities, play several different roles in your daily life. At school, you are a student. On the weekend, you might be a member of a sports team, or a volunteer at a food bank. Similarly, the organisms in a community of plants and animals play different roles, too. Each of these roles is known as a **niche**. One organism usually fills several niches.

Knowing an organism's niche can help explain why organisms act and interact as they do. To determine an organism's niche, you must look at what it eats, where it lives, and how it interacts with other organisms in its ecosystem.

Figure 1.28 What are the niches of the various organisms shown here?

Plants and algae are able to grow using energy from the Sun and nutrients present in the soil. They fill the niche called **producers** because they produce food energy for themselves. Producers make life possible for all other organisms on Earth.

All other organisms are called **consumers**, because their niche is to consume (eat) the food made by the producers. Consumers occur in all sizes and shapes and may also eat other consumers. For example, the coyote in the ecosystem above is a consumer, so it must find food to eat by hunting and foraging. It also fills different niches when it finds or builds shelter, and stays safe from other organisms.

Consumers can be divided into three different groups: herbivores, carnivores, and omnivores. **Herbivores** are animals that eat producers and fill the plant-eating niche. Cows, prairie dogs, deer, herring, and tadpoles are examples of this group of consumers. **Carnivores** are animals that eat other consumers, filling the meat-eating niche. Lynx, cod, minnows, and dragonflies are examples of carnivores. **Predators** are consumers that kill and eat other animals called **prey**. Red foxes and golden eagles are examples of predators. **Omnivores** are animals such as raccoons, skunks, and humans (that are not vegetarians) that eat both producers and consumers.

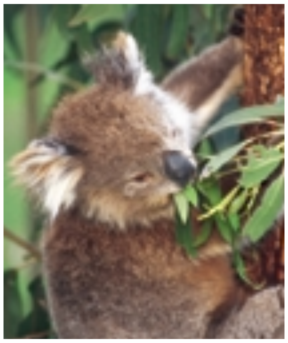


Figure 1.29 Although there are over 600 kinds of eucalyptus, koalas eat only the leaves of 35 kinds that grow in eastern Australia. Today, koala bears are endangered because eucalyptus forests were cut down to make room for farms and other developments.

INVESTIGATION 1-E

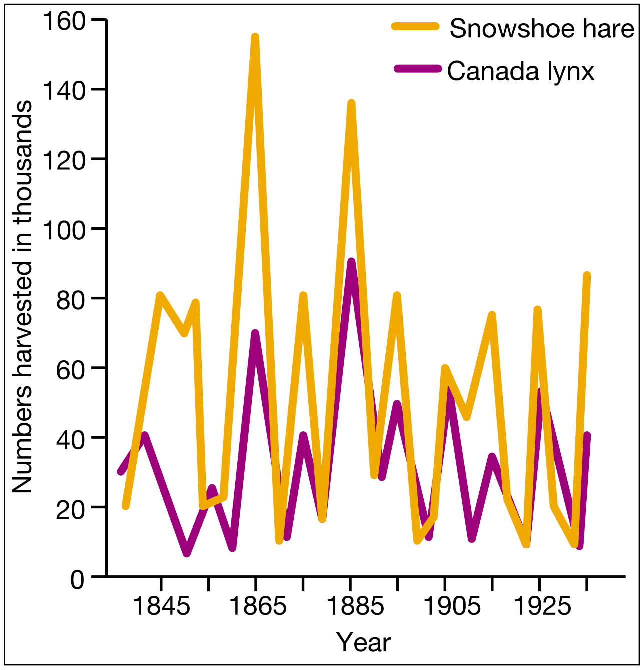
SKILLCHECK
- Initiating and Planning
- ✷ Performing and Recording
- ✷ Analyzing and Interpreting
- Communication and Teamwork

What Goes Up Must Come Down

Think About It

The niches of the Canada lynx and the snowshoe hare are linked together. The Canada lynx feeds mainly on snowshoe hares. Snowshoe hares eat plants. When there are lots of plants for snowshoe hares to eat, more of them survive and reproduce. This means that the lynxes that feed on snowshoe hares have more food. Therefore, more lynxes survive and reproduce.

However, after several years there are so many lynxes killing snowshoe hares that the hare population starts to decline. Then the lynxes do not have enough food, and *their* numbers decline. Plants are able to grow because there are fewer snowshoe hares around to eat them. As new generations of snowshoe hares are born, there is plenty of food for them. Since there are fewer lynxes to hunt them, the hare population begins to increase. There is more food for the lynxes, so *their* numbers increase, too. So this whole cycle, which lasts about ten years, begins again. The graph below shows how the numbers of lynxes and hares harvested by trappers changed over a period of 90 years.



What to Do

Use the data in the graph to answer the following questions.

(a) In 1845, approximately how many lynxes were harvested by trappers?

(b) In 1845, how many hares were harvested by trappers?

(c) How many of each were harvested in 1855?

(d) In 1865, two years before Canada's Confederation, how did the two populations compare? What led to this change in the relative numbers of the two populations? What food that affects both hares and lynxes does not appear on this graph?

Analyze

1. Use the graph to explain how changes in the lynx population appear to follow changes in the hare population.

2. How can prey be said to control a predator's population? How can predators be said to control a prey's population?

3. The data in the graph are incomplete after the year 1935. Based on the data in the rest of the graph, estimate the populations of harvested lynxes and hares in 1940. Hypothesize about what might happen with these populations in 1945.

4. The last few years shown in the graph are the years of the Great Depression (1929–1939), a time of mass unemployment. How might this unemployment have affected populations such as these?

Food Chains

Word CONNECT

The word "herbivore" comes from the Latin words *herba* (herb or plant) and *vorare* (to devour). Using this knowledge, write what you think the Latin words *carnis* and *omnis* mean.

Grass and other plants grow by using energy from the Sun and nutrients in the soil as sources of food. The energy of the Sun is then stored in plants. When an animal, such as a cow, eats a plant, it obtains the Sun's energy indirectly in a useful form. When a meat-eating animal eats a steak, some of the stored energy in the cow is passed on to the consumer.

A **food chain** is a model that shows how energy stored in food passes from organism to organism (see Figure 1.30).

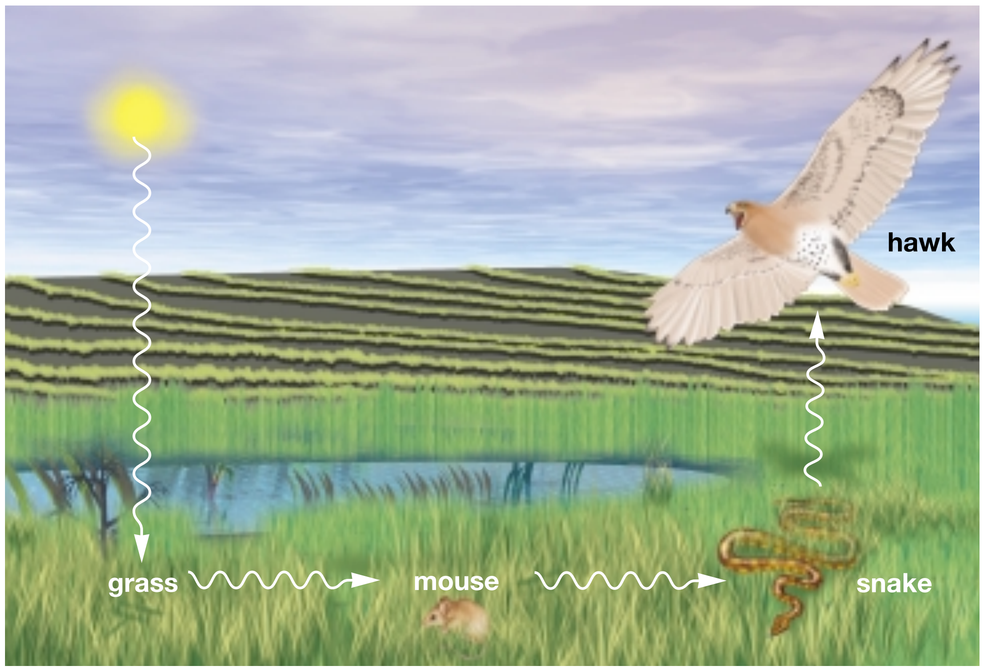


Figure 1.30 In this prairie slough food chain, arrows show the flow of energy through the chain. At the top of the food chain is the top carnivore. This organism eats other carnivores. For example, a hawk preys on smaller insect-eating birds. In some cases top carnivores may also feed on herbivores, for example, the lynx eats snowshoe hares, and the wolf eats moose.

STRETCH Your Mind

Approximately 10 percent of available food energy is passed to the next level of a food chain. If tuna fish are four steps up a food chain, what mass of phytoplankton (the producers in the ocean) would be required to provide a human with 126 g of tuna for a sandwich?

How does energy move through a food chain? At each step along the chain, energy is taken in by an organism and is used as fuel. As the organism uses the fuel, some energy is also released as heat. Some of the energy is stored in the organism's body tissues, while the energy that cannot be used passes out of the animal as waste. For example, when a grazing cow eats 2 kg of grass in one day, its mass does not increase 2 kg. Where does the mass of the grass go? Examine Figure 1.31.

Energy flow is the movement of energy, starting from the Sun, and passing from one organism to the next. In a food chain, as Figure 1.30 shows, very little energy that is stored in one organism is passed on to the next organism.

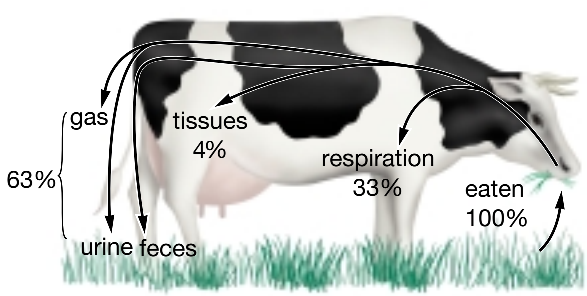


Figure 1.31 Most of the energy in grass eaten by a cow is not passed along the food chain. Only the 4 percent that goes to build and repair the cow's body tissues stays in the tissues. A little over 30 percent fuels the cow's normal activities such as breathing, mooing, and pumping blood through its body. Over 60 percent is passed out of its body as waste.

Food Webs

Food chains are rarely as simple as in Figure 1.30. Producers are usually eaten by many different consumers, and most consumers are eaten by more than one kind of predator. A mouse, for example, eats several kinds of plants and seeds. The mouse may be eaten by a hawk, a raccoon, or a snake. Figure 1.32 shows a typical **food web**. (network of interconnected food chains). Food webs can quickly become very large and complex.

Figure 1.32 Food webs are a combination of several food chains. They show the connections among the food chains.

Figure 1.33 A pyramid of numbers is a model of an ecosystem that represents the number of organisms consumed at each level. Producers always form the broad base.

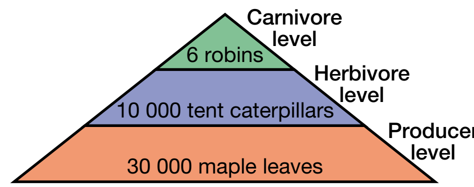


Figure 1.34 Each time a caterpillar eats a maple leaf, energy is lost and only a small amount is stored in its tissues. Thus, 10 000 caterpillars store only enough energy to feed six robins.

Pyramid of Numbers

Food chains and food webs show how food energy moves through an ecosystem, but not how many organisms are involved in the total energy transfer. In Figure 1.32, we do not know how many grasshoppers the snakes eat. We know only that snakes eat grasshoppers.

To solve this problem, ecologists build a **pyramid of numbers** (see Figure 1.33). It includes the same organisms as in a food chain, but the size of each level changes to show the number of organisms involved. There are always more animals being eaten than there are animals eating. There may be one hawk eating three woodpeckers, but not three hawks eating one woodpecker.

A pyramid of numbers does not indicate exactly *how much* energy is consumed. We can find this out by looking at how much each level of the pyramid weighs — how many kilograms of grasshoppers are needed to feed a kilogram of woodpeckers. **Biomass** is the total mass of all the organisms in an ecosystem. Just as each level in the pyramid of numbers has fewer organisms than the level below it, it also has less biomass. In any pyramid of numbers, the most biomass is in the base formed by the producers (see Figure 1.34).

Find Out ACTIVITY

What Was for Dinner?

Looking at an animal's scat (feces) or what an animal has in its stomach is one way to find out what niche it occupies! In this activity you will examine the contents of an owl pellet. Owl pellets are not scat, they are pellets of undigested food that are regurgitated by owls.

Safety Precautions

Wash your hands when you have completed this investigation.

Materials

owl pellet
paper towel
forceps or a fine probe
magnifying glass

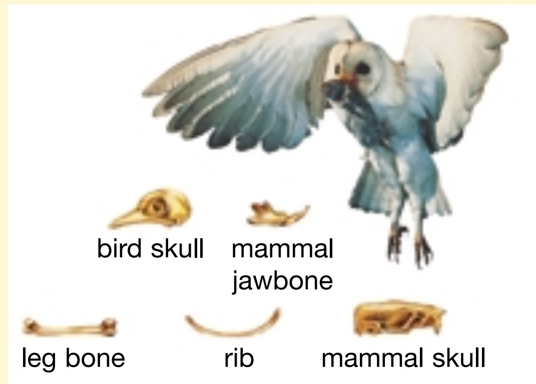
Procedure ✷ Performing and Recording

1. Place the owl pellet on a paper towel. Using forceps or a fine probe, carefully break the pellet apart, separating out all of the smaller pieces.

2. Describe each item you were able to separate out from the pellet. Be as specific as possible.

3. Identify as many of the items from the pellet as you can. Study the illustration of contents of a pellet shown here.

4. Clean up as your teacher directs, and wash your hands after this activity.



What Did You Find Out? ✷ Analyzing and Interpreting

1. How many different organisms were represented by the remains in the pellet? Explain your answer.

2. What is the niche of an owl in its ecosystem? (Where does it live, and what and where does it eat?)

3. Is the owl a producer or a consumer? Explain your answer.

STRETCH Your Mind

You may have seen a robin eat a worm, but have you ever seen a worm eat a robin? Try to explain how this might happen.

The Clean-Up Squads: Scavengers and Decomposers

Have you ever wondered why you seldom see a dead carcass in a natural environment? If dead organisms stayed whole, Earth would soon be covered in bodies! In every ecosystem, there must be "clean-up squads" that get rid of garbage and waste. These organisms break down dead material and waste. As the material breaks down, the nutrients that had been stored within it are released back into the ecosystem. They can then be taken in by other organisms and used for growth and other functions.

In a biological community, the clean-up squads are consumers called scavengers and decomposers. **Scavengers** are organisms that feed on dead or decaying plant or animal matter. Scavengers eat the dead material and break down the large carcasses into smaller pieces during digestion (see Figures 1.35A and B).

Decomposers are different from scavengers because they do not actually eat dead material. Instead, they grow on or in the dead or waste material, absorbing some of the nutrients into their own cells. The remaining nutrients recycle back into the ecosystem.


Figures 1.35A and **B** The magpie (above left) and the wolverine (above right) are common scavengers in Alberta. They eat dead and waste material, breaking it down into smaller parts and spreading the stored nutrients back into the ecosystem.

Have you ever found food covered in mould in the refrigerator? If so, you have witnessed decomposers at work. Many bacteria and fungi are decomposers. Although bacteria are micro-organisms (too small to see without a microscope), some fungi are quite large and visible (see Figure 1.36). In fact, you can see common fungi called mushrooms in any grocery store or vegetable market.

Decomposers play a key role in breaking down much of our kitchen waste. We can assist this process by composting lettuce leaves, apple cores, carrot peelings, and other kitchen wastes in a composter like the one shown in Figure 1.37. When we compost, we let nature's decomposers turn our kitchen wastes into rich soil we can use for fertilizing the garden. In the next investigation you will experiment with composters.

INTERNET CONNECT

www.mcgrawhill.ca/links/sciencefocus7

Find out more about decomposers by researching them on the Internet. Go to the above web site, click on **Web Links** to find out where to go next. Create a display of different decomposers and the ways in which they affect humans.

Figure 1.36 Bracket fungus digests the dead cells of tree bark.

Figure 1.37 Kitchen wastes can be composted in a backyard composter.

DidYouKnow?

The wreck of the *Titanic* could disappear completely from the ocean floor by 2030. Bacteria are removing the iron from its hull at a rate of one-tenth of a tonne a day.

Across Canada

Dr. Kevin Vessey

"Curiosity is probably the most important characteristic that leads someone into a career in science," says Dr. Kevin Vessey, a scientist from the University of Manitoba. Kevin grew up in Prince Edward Island. As a teenager, he enjoyed watching marine biology shows, such as "The Undersea World of Jacques Cousteau," on television. Kevin's curiosity inspired him to study biology at Dalhousie University in Halifax, Nova Scotia, and then at Queen's University in Kingston, Ontario.

Dr. Vessey is interested in the many types of good bacteria in soil that help plants grow. The most common type of helpful bacteria are called rhizobia. They convert nitrogen from the air into ammonium, the mineral form of nitrogen. Plants cannot use nitrogen in the air, but they can use this mineral form of nitrogen to make protein. Rhizobia live in tumourlike growths on the roots of plants. When rhizobia attach themselves to a plant, they "infect" it. Dr. Vessey studies the development of infection by rhizobia in peas and soybeans (legumes). He says that this process of "nitrogen fixation" is similar to plants having their own fertilizer factory in their roots!

The research Dr. Vessey is doing will help farmers use helpful bacteria and fewer pesticides. You might have a chance to hear Dr. Vessey if you listen to "The Science Quiz" portion of "Quirks and Quarks" on CBC radio. He has taken part in this show in the past and plans to contribute more science questions for curious minds in the future.

Find Out ACTIVITY

No Fishing Allowed

Bull trout are large fish that live in the rivers flowing from the eastern slopes of the Rocky Mountains down into the Prairies. Bull trout are part of a food chain that involves many other organisms. Recently, the bull trout have been disappearing from Alberta rivers and lakes. This affects different parts of the ecosystem.

Procedure — Performing and Recording; Analyzing and Interpreting

1. Use the library and the Internet to research bull trout in Alberta. Look for answers to these questions.
   - What other organisms are in the food chain? Where do the bull trout fit into the chain?
   - What has caused the reduction in the numbers of bull trout?
   - If the bull trout become extinct, what might happen to the food pyramid in which the bull trout are found?
2. Use a concept map to organize your findings. Write a brief report with the information that you found.

TOPIC 4 Review

1. Define the following terms in your own words, and give an example of each.
   (a) producer **(b)** omnivore
   (c) predator **(d)** decomposer
2. Use a Venn diagram to compare a pyramid of numbers and a food chain.
3. Explain why all of the energy in one level of a food pyramid is not available to other organisms in the pyramid.
4. Use arrows and words to draw three food chains you might find in the prairie ecosystem found on page 42. If you wish, you may add other prairie organisms not shown in the illustration.
5. **Thinking Critically** Choose and observe an ecosystem in your community (a local park, a ravine, or your own backyard). List the biotic and abiotic features. Indicate the niche occupied by each organism in your ecosystem.