CHAPTER 5

Interactions within Ecosystems

KEY QUESTION: How are all of the parts within an ecosystem connected?

Looking Ahead

- Organisms have different roles in ecosystems.
- Food chains and food webs show how energy from the Sun is passed from one organism to another in an ecosystem.
- The skills of scientific inquiry can be used to model and investigate food webs.
- Matter is constantly recycled in an ecosystem.
- Investigation skills can be used to examine the biotic and abiotic interactions in a composter.

VOCABULARY

photosynthesis	food chain
producer	food web
consumer	pyramid of numbers
herbivore	closed system
carnivore	cycle
scavenger	sustainable
omnivore	evaporation
detrivore	condensation
decomposer	precipitation

Rocks that Teach

Deep within a forest near Peterborough is the largest known collection of First Nations rock carvings in Canada. These carvings, known as "petroglyphs," were carved into limestone rock hundreds of years ago. There are several hundred petroglyphs depicting turtles, snakes, birds, and humans. The rock is a sacred place to the First Nations peoples and is known as "Kinomagewapkong," which means "the rocks that teach." The carvings show the history of the people who first settled this area and their sacred traditions. They also teach of the interactions between humans and the environment.

David Johnson, a council member of Curve Lake reserve, is an artist who has spent a great deal of time learning from the "rocks that teach." He now educates others about their significance. Johnson has learned that from a First Nations perspective, humans are an integral part of nature and cannot separate themselves from "Mother Earth." The Sun, soil, water, and air are sacred gifts to be cared for and treated with respect. All living beings have lessons to teach us and help humanity co-exist with nature.

Every component in an ecosystem has an important role to play and is affected by the other components in the ecosystem. This is why many First Nations communities believe in the saying "in every deliberation we must consider the impact of our decisions on the next seven generations." In other words, for every decision we make, we must think of how it will affect the world one hundred, or even two hundred, years from now.

Figure 1 The limestone petroglyphs northeast of Peterborough are generally believed to have been carved by the Algonquins between 900 and 1400 CE.

LINKING TO LITERACY

Making Connections

To gain deeper meaning from your reading, practise making connections between what you are reading and what you have read before, what you know about similar topics or elements in the world, and your own life experiences.

1. How do First Nations petroglyphs compare to Egyptian hieroglyphics? Consider composition, creation, and purpose.
2. Discuss the following with a partner: What did you already know about First Nations' beliefs? How does this text add to your knowledge about these people?
3. Examine the photo of the petroglyphs on this page. What do you see? What do you think it means? Write a short summary of your interpretation.

5.1 The Roles of Organisms in an Ecosystem

You, like all members of human communities, play several roles. At school you are a student, after school you may be on a sports team, at home you are part of a family. Organisms in a natural community also play different roles within their ecosystem. An organism's role within an ecosystem depends on how it obtains its food. Plants and animals obtain their food in very different ways, so they have very different roles in an ecosystem. The way in which an organism obtains food also affects its interactions with other organisms in the ecosystem.

Producers

Plants have the ability to make their own food through a process called **photosynthesis**. In photosynthesis, plants use energy that they absorb from the Sun, water that they absorb from the soil, and carbon dioxide that they absorb from the air to make food in the form of sugar (Figure 1). Because plants produce their own food through photosynthesis, they are known as producers. **Producers** are organisms that are able to make their own food using abiotic elements in the ecosystem. Plants use only some of the food they make to perform life processes. Any food that they do not use is stored in the form of starch.

photosynthesis: a process by which plants use water, carbon dioxide, and sunlight to produce sugars (food)

producer: an organism that makes its own food from non-living materials

LINKING TO LITERACY

Summarize Your Understanding

In your own words, summarize the process of photosynthesis. Refer to the diagram to support your understanding.

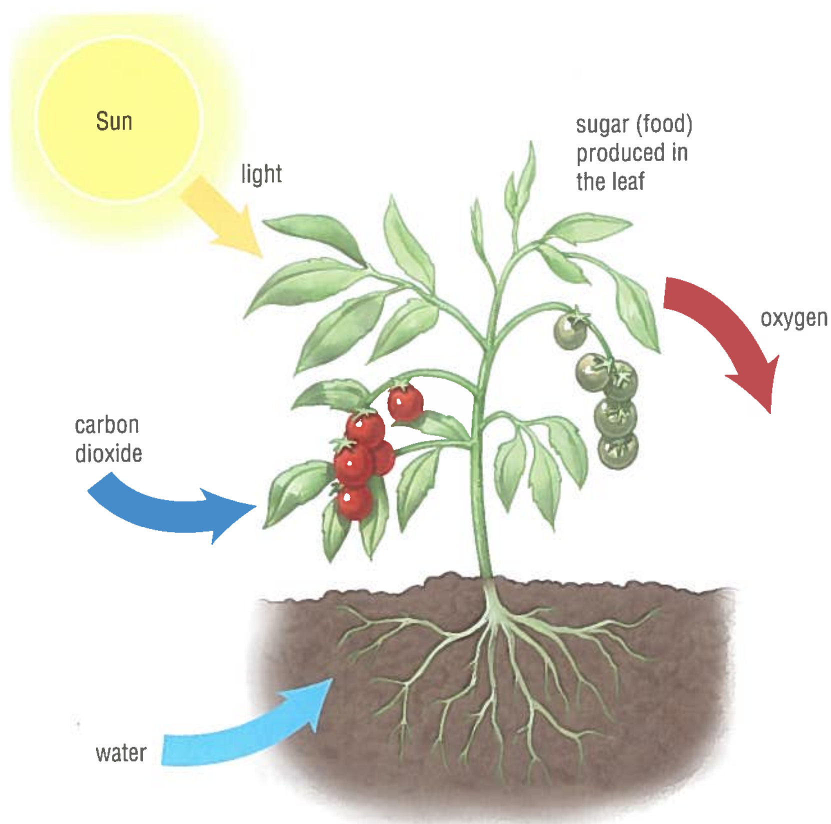

Figure 1 In photosynthesis, energy from the Sun, carbon dioxide, and water combine to produce sugars that the plant can use for food.

The process of photosynthesis can also be written as a word equation:

Sun's energy + water + carbon dioxide → food (sugar) + oxygen

Oxygen is another product of photosynthesis. Plants need oxygen to help perform life processes, but they produce more oxygen than they need. They release the excess oxygen into the air where it can be used by humans and other organisms.

To learn more about photosynthesis,
Go to Nelson Science

Consumers

Animals cannot make their own food. They must obtain their energy by eating, or consuming, other organisms. An organism that eats other organisms for energy is called a **consumer**. There are different types of consumers. Consumers that eat only plants are called **herbivores**. Deer (Figure 2(a)) and beavers are examples of herbivores.

Consumers that eat only animals are called **carnivores**. Ospreys (Figure 2(b)), wolves, and bass are all examples of carnivores. One group of carnivores, called **scavengers**, feed on already dead animals (they do not usually kill their own food). Coyotes and ravens are scavengers, but also occasionally prey on living things.

A consumer that eats both plants and animals is called an **omnivore**. For example, raccoons are omnivores because they eat fish and frogs but also seeds. Bears are omnivores because they eat fish as well as blueberries. Humans are generally omnivores (Figure 2(c)); they can eat chicken, sheep, and many other animals. Humans also eat different types of plant seeds (grains), which are ground up to make flour for use in breads, pastas, and many other foods. In addition, humans eat a wide variety of fruits and vegetables.

consumer: an organism that eats other living things for energy

herbivore: an organism that eats plants only

carnivore: an organism that eats other animals only

scavenger: an organism that eats already dead animals

omnivore: an organism that eats both plants and animals

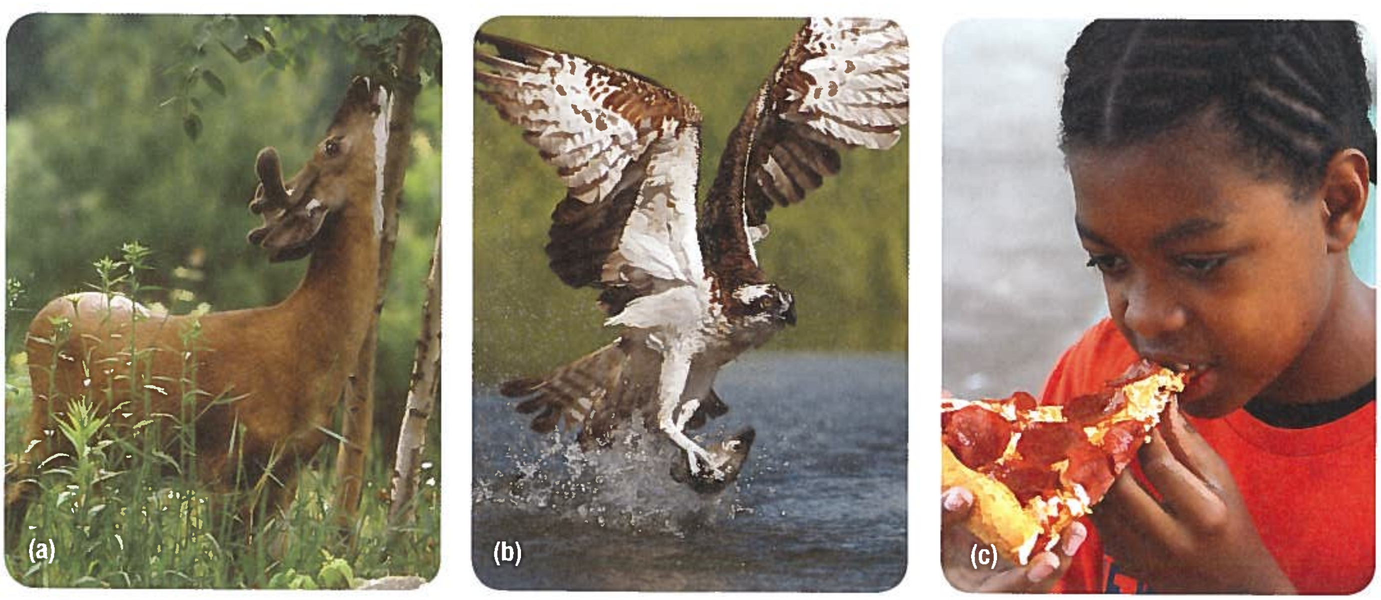

Figure 2 (a) Deer are herbivores. (b) Ospreys and other hawks are carnivores. (c) Although some humans eat only vegetable products, most are omnivores.

Detrivores and Decomposers

detrivore: an organism that feeds on large parts of decaying plant and animal matter and on waste material

Earth would soon be covered in dead organisms if there were not some way of disposing of all the dead plants and animals. **Detrivores** are organisms that obtain nutrients by feeding on large parts of decaying animals and plants, and on waste material. Earthworms, many types of beetles (Figure 3), and some sea birds are detrivores.

Figure 3 In addition to eating living plants, this darkling beetle feeds on decaying vegetation.

decomposer: an organism that consumes and breaks down dead organisms or waste matter into simple substances

Detrivores leave behind their own waste material and small pieces of decaying plant and animal matter. **Decomposers** feed on any remaining decayed matter and waste left behind by consumers and detrivores. Decomposers break these parts down into simpler substances. Bacteria and fungi, such as mould (Figure 4), are common decomposers.

LINKING TO LITERACY

Compare and Contrast

Create a six-column chart and at the top of each column, write one of the following title words: producer, herbivore, carnivore, omnivore, detrivore, decomposer. Below each title, describe how each of these organisms obtains food. Compare ways in which they are the same and different. Discuss your findings with a partner.

Figure 4 The mould on this bread is a decomposer.

CHECK YOUR LEARNING

1. Explain the differences between producers and consumers.
2. (a) What are the raw materials of photosynthesis?
   (b) What are the products of photosynthesis?
   (c) What happens to the products of photosynthesis?
3. What is the difference between detrivores and decomposers?
4. (a) What are the similarities between omnivores and carnivores?
   (b) What are the differences between omnivores and carnivores?
5. What role do scavengers play in ecosystems?

5.2 Food Chains and Food Webs

How did you get to school today? Did you walk, ride your bike, or take a bus (Figure 1)? Did you walk from class to class during the day? Did you write in your notebook today? All of these activities require energy. We obtain energy from the food we eat. But how did energy get into our food in the first place?

Figure 1 You obtain the energy you need to get to school from the food you eat.

The path energy takes in an ecosystem begins with the Sun. All plants grow by absorbing energy from the Sun and turning it into foods such as sugars and starches. The energy of the Sun is stored in the plant. When an animal such as a chicken eats grain (seeds of various grass plants), the energy stored in the plant is transferred from the starches in the grain to the chicken (Figure 2). When you eat chicken for dinner, some of the energy is passed on to you. So, energy starts from the Sun and passes from producers to consumers.

LINKING TO LITERACY

Before Reading: Using Text Features to Support Predicting

Before reading Section 5.2, take a few moments to scan the pages. Look at the following text features: title, subtitles, illustrations, photos, highlighted text, and captions. What information can you learn from scanning these features before you read? Make a prediction about the kind of information you will learn about as you read this section.

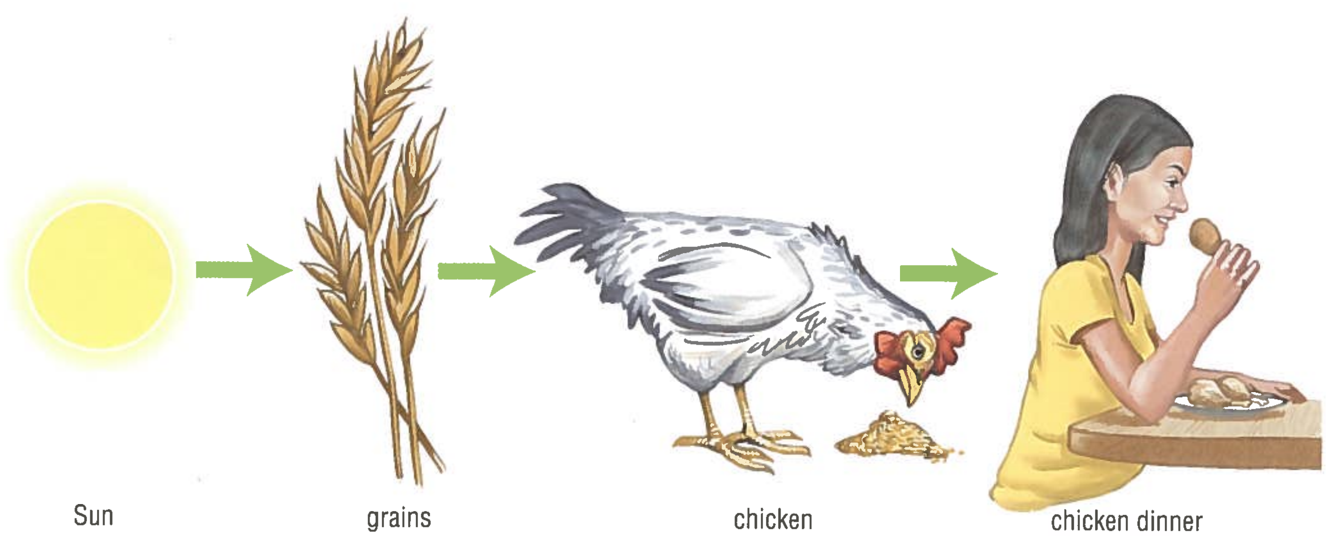

Figure 2 The energy from the Sun is stored by producers in the form of high-energy sugars and starches. When an organism consumes grain, some of the Sun's energy is passed on.

Food Chains

food chain: a sequence that shows how energy and nutrients are transferred from one organism to another in an ecosystem

A **food chain** is a model that shows how energy and nutrients flow from one organism to another in an ecosystem. Arrows show the direction of the energy and nutrient flow. The number of "links" in a food chain can vary, but the food chain always starts with a producer and ends with a consumer. A food chain can have just two components, a producer and a consumer (Figure 3(a)). Other food chains are more complicated (Figures 3(b) and (c)). A producer may be consumed by a herbivore (primary consumer), which is then eaten by a carnivore (secondary consumer). In some cases, another carnivore (tertiary consumer) eats the first carnivore.

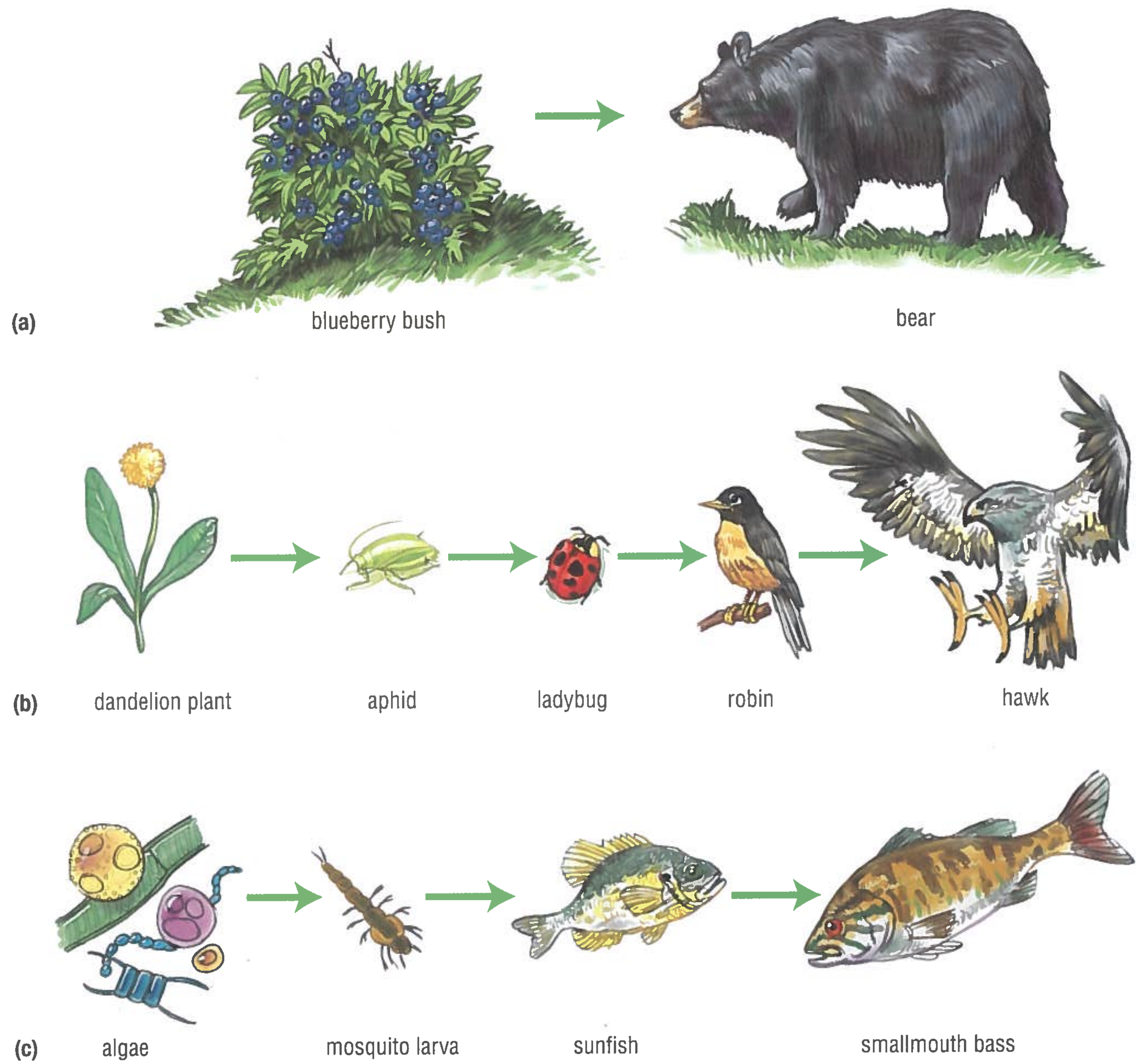

Figure 3 Three food chains: (a) a forest, (b) a school ground, (c) a small lake. The length of a food chain depends on the number of organisms. The flow of energy through a food chain is in one direction, from producers (on the far left) to consumers (to the right of the producer).

Food Webs

Food chains show one producer being eaten by one consumer and perhaps another consumer eating the first consumer. Food chains are not that simple in real ecosystems. Producers are usually eaten by many different consumers, and most consumers are eaten by more than one predator. For example, a squirrel eats several different types of seeds, fruits, and nuts. The squirrel may be eaten by a fox, a hawk, or a raccoon. The raccoon also feeds on frogs, clams, birds' eggs, and corn. The fox will also eat mice and grasshoppers; the hawk will also eat frogs, mice, and snakes. Most organisms are part of several food chains. A model that shows the connections between several different food chains is called a **food web** (Figure 4). A food web starts with the producers in the ecosystem and then branches off into interconnected food chains that show who eats whom in the ecosystem. Food webs can quickly become very complex.

food web: a model that shows how food chains in an ecosystem are connected

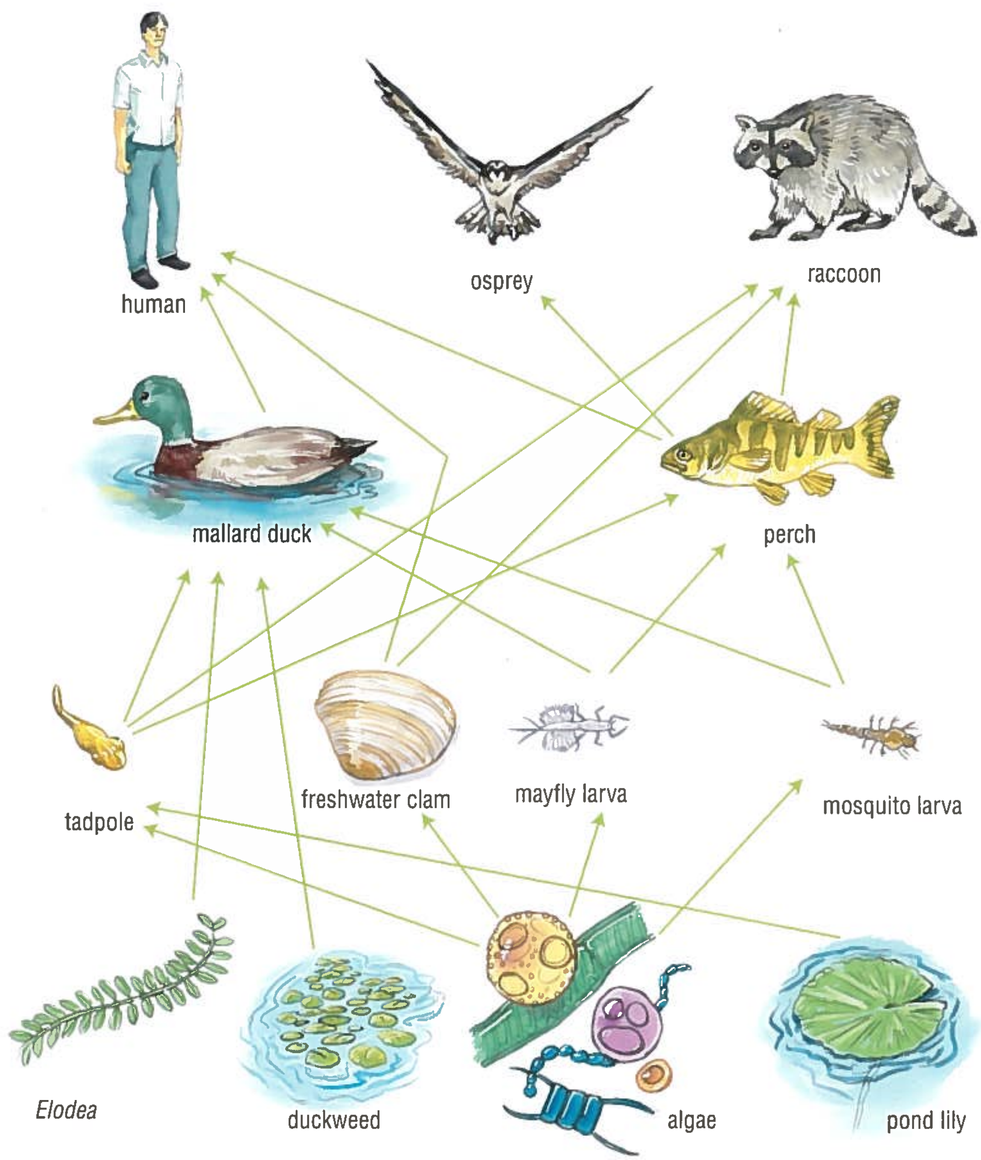

Figure 4 This food web shows the many feeding connections between the organisms that live in and around a small lake.

Changes in Food Chains and Food Webs

If one species is eliminated from a food chain or web, it affects the other species in that chain or web. For example, consider the simple food chain: clover → rabbit → fox. If rabbits are removed from the food chain, then the population of foxes in that ecosystem will decrease because they will have no food (Figure 5). If one species disappears from a food chain, organisms that eat that species may eat other species instead. This will also affect the food web that the food chain is part of. The foxes, for example, may begin to eat mice and insects instead. When any part of a food web changes, it affects the flow of energy throughout the web.

To learn more about food chains and food webs,
Go to Nelson Science

Figure 5 Foxes rely on rabbits as a source of food. If rabbits are not available to feed on, the population of foxes must find other organisms for food, or they will die.

Unit Task A food web shows how energy flows through an ecosystem. The food chains within a food web show the feeding relationships among species in a community. How will your knowledge of food chains and food webs help you with the Unit Task?

CHECK YOUR LEARNING

1. Create two food chains from the following list. Use Figure 4 to help you.
    - raccoon
    - mallard duck
    - mosquito larva
    - algae
    - *Elodea*
    - freshwater clam
    - human
    - duckweed
2. What is the role of producers in food chains and food webs?
3. (a) What are the similarities between food webs and food chains?
   (b) What are the differences between food webs and food chains?
4. In your own words, explain what may happen to a food web if one of the species of the web is removed.
5. What is the initial source of the energy in all food webs and food chains?

SCIENCE WORKS

Bridget Stutchbury—Renowned Ecologist

What do Canadian forests, South American rainforests, coffee, and songbirds have in common? Bridget Stutchbury (Figure 1), ecologist, author, and professor at York University, believes they have a lot in common. Everything is connected in ecosystems, and what humans do in one place can have a tremendous impact in other places. To illustrate this point, Professor Stutchbury and her students are currently studying the effects of habitat loss on forest songbirds. These songbirds spend the summer in Canadian forests and then migrate to South American rainforests in winter.

Figure 1 Dr. Stutchbury uses a variety of methods to study the effects of habitat loss on forest songbirds.

"I became a biologist by accident," says Stutchbury. "As a kid I loved the outdoors. My dad… always encouraged me to take science in high school and in university. My lucky break came in my third year at Queen's University, when I was hired by a professor to work on a project involving birds. I learned to catch birds, check their nests, and study their breeding behaviour. I was hooked for life!"

According to Stutchbury, ecology will play a huge role in our future. "Ecologists and environmental scientists are going to be needed more than ever to keep Earth's life-sustaining ecosystems functioning. Biology students need to understand ecology and the threats to our environment. As an ecologist at York University, I don't just explain the problems to people; I am figuring out solutions through my own research."

"Field biologists today need more than a good pair of binoculars and a notebook; my research involves DNA testing, physiological tests of health, and miniature tracking devices that allow us to follow birds on migration. All these projects have a common goal: find out why bird populations are declining."

Professor Stutchbury has some advice on how to help songbirds:

- Buy toilet paper (and other paper products) made from 100 % post-consumer waste. It does not make sense to destroy our forests on Earth to make toilet paper!
- Plant fruit trees, shrubs, or sunflowers in your backyard. During migration, these plants provide tired and hungry songbirds safe places to rest and eat.

What is the connection between coffee and birds? "Shade-grown" coffee is grown in the shade of tropical trees. Keeping these trees means that songbirds have a winter habitat. If you can convince your parents to buy shade-grown coffee, you will be helping Canadian songbirds!

To learn more about songbirds,
Go to Nelson Science

The Great Web of Life

What happens when a food web, or a part of a food web, is weakened? Think of a chain link fence. If one or two links are broken, the chain still works. However, as more links are removed, the entire fence becomes weaker until it can no longer do its job. The same relationship happens in an ecosystem. An ecosystem consists of many interactions among the various elements. If one of these elements is weakened or removed, the ecosystem changes, but can accommodate the loss. However, a major disruption will affect the entire system. In this activity, you will model what happens to food chains when changes occur.

SKILLS MENU

- [x] Questioning
- [ ] Hypothesizing
- [ ] Predicting
- [ ] Planning
- [ ] Controlling Variables
- [x] Performing
- [x] Observing
- [ ] Analyzing
- [ ] Evaluating
- [x] Communicating

Purpose

To investigate interactions within an ecosystem and to determine what happens when these interactions are weakened.

Equipment and Materials

- coloured cards
- tape or pins
- string or yarn


coloured cards


tape or pins


string or yarn

LINKING TO LITERACY

Understanding Text Patterns: Procedural Text

The text on this and the next page is a procedure, or a type of text that explains, step by step, how something is made or done. Procedures can include a purpose, equipment and materials, steps to the procedure, and analysis questions. Many procedures also include an extension where you are asked to think about other ways to apply what you have learned.

Knowing more about this text pattern will help you to better understand your reading and what you are asked to do when following a procedure.

Procedure

1. Each of the following will already be printed on a coloured card, with each colour representing different biotic and abiotic elements in a water ecosystem:
   - blue: sunlight, air, water, soil (abiotic elements)
   - green: algae, *Elodea*, duckweed, cattails, willow, pond lilies (producers)
   - yellow: tadpoles, mosquito larvae, beaver, snails, *Daphnia* (herbivores)
   - red: raccoon, black bear, clams, mallard duck (omnivores)
   - orange: loon, osprey, perch, sunfish, otter, bullfrog (carnivores)
   - brown: herring gull (scavengers), bacteria (decomposers)
2. Select one of the cards. Research or review the biotic or abiotic element on your card.
3. Attach the card to your shirt.
4. As a class, form a large circle. Make sure that the different coloured cards are dispersed throughout the circle. For example, all students with yellow cards should not be standing side by side.

5. The student with the "sunlight" card begins the next part of the activity by holding the end of the yarn. The student then names another card and states his or her connection to that card. For example, "I provide energy for duckweed to make its own food." The student then passes the ball of yarn to the student with the "duckweed" card, but keeps holding the end of the yarn.
6. That second student then names another card and states his or her card's connection to it. The second student passes the yarn while holding on to his or her piece of the yarn at the same time (Figure 1).

Figure 1 Step 6

7. Continue stating connections and passing the ball of yarn until each card has at least one connection to another card. There may be several connections to any one card. Make sure that you hold on to the yarn.
8. Once all the connections have been made, gently tug on the yarn you are holding. Count how many people in the circle feel the tug.
9. Repeat step 8 for each member of the circle.
10. Determine which component of the web seems least important. Remove it from the web by having the person with that card drop the yarn.
11. Repeat step 10 with the remaining elements. From time to time, tug on the yarn and note any difference in the sensation.

Analyze and Evaluate

(a) What happens as the web becomes less complex? Are changes more dramatic as the web has fewer elements? Explain.

(b) Which cards (species) had more impact on the web? Which had less impact?

(c) What do you think would happen if the water in this model ecosystem became badly polluted?

(d) Why are the scavengers and decomposers necessary in the food web?

Apply and Extend

(e) What do you think would happen if more cards (more species) were added to the circle?

(f) Is there anything that was left out of the circle that you might include? Explain why or why not.

(g) Come up with another creative way to model the interactions within an ecosystem. Try it out with your group.

(h) Describe in your own words what the term "interdependence" means.

5.4

Energy Flow in an Ecosystem

LINKING TO LITERACY

Summarize
Summarizing will help you check your understanding of the information in this section. Read the subsection "Energy Use within an Organism" on this and the following page. Before moving onto the next part of the section, stop and think about what you have read. Work with a partner to summarize, in your own words, how energy is used within an organism. Refer to Figure 1 to explain your thinking.

Food chains and food webs show how energy moves from one organism to another. They do not show how each organism uses the energy or how much is used. Different organisms need different amounts of energy. This can depend on what the energy is being used for. For example, we eat more food when we have been very active because we need energy. The energy comes from the food.

To understand how energy flows in an ecosystem, you need to know how each organism in a food chain uses the energy it obtains. You also need to understand how much energy passes between levels in the food chain or food web. In this section, you will learn how ecologists study energy flows within and between organisms.

Energy Use within an Organism

An organism obtains energy when it makes its own food or eats a plant or animal. Some of the energy fuels the organism's normal life functions and is used up and released as heat. Some of the energy is stored in the organism for growth, maintenance, and repair. Finally, some of the energy is not useable. Unused energy passes out of the organism as waste. Only the energy stored in the organism is available to the next organism in the food chain. Figure 1 shows the breakdown of energy. In general, only about 10 % of the energy that an organism eats is passed on to the next organism in the food chain.

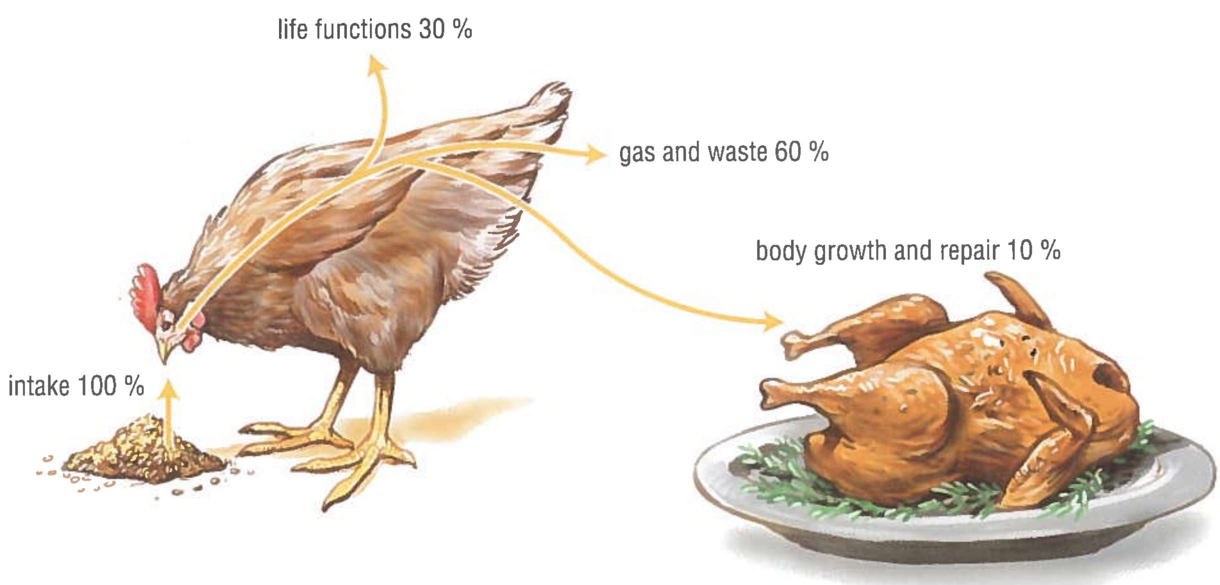

Figure 1 Only a small portion of the energy that the chicken receives from consuming the grain ends up on our plates.

At each level in a food chain or food web, the amount of available energy is much smaller than in the level below it. The amount of energy left for the top consumers in a food web is just a tiny portion of the energy that was in the producers. As a result, there are usually no more than four levels in a food chain or food web. There is not enough energy left to feed consumers at higher levels.

Pyramid of Numbers

An ecological pyramid shows the effects of energy loss at each level in a food chain. Ecologists use ecological pyramids to show this energy loss in a visual way. Each level in the pyramid represents a level in the food chain or food web. One way that ecologists measure the amount of energy available at different levels is by comparing the total mass of all organisms at each level. As you move higher in the food web, there is less mass and, therefore, less energy. The levels in the energy pyramid get smaller.

Another way to show the amount of energy available at each level of a food web is by constructing a pyramid of numbers. A **pyramid of numbers** shows the total number of organisms at each level of a food chain or food web (Figure 2). In a healthy ecosystem, there are usually more producers than consumers. The producers form a broad base, while the number of consumers at each level above gets smaller. This gives the diagram its "pyramid" shape. Each level of consumers above the producers has fewer individuals because there is less energy available. For example, in a lake ecosystem, hundreds of tadpoles need to eat thousands of duckweed plants to get enough energy to survive and grow. These tadpoles only provide enough energy to support one or two snapping turtles.

LINKING TO LITERACY

Summarize

Read the subsection called "Pyramid of Numbers." Before moving onto the next section, work with a partner to summarize how and why numbers are different from one level of the pyramid to the next. Refer to Figure 2 to help explain your thinking.

pyramid of numbers: a model that shows the number of individuals at each level in a food chain or food web

To learn more about pyramids used by ecologists, Go to Nelson Science

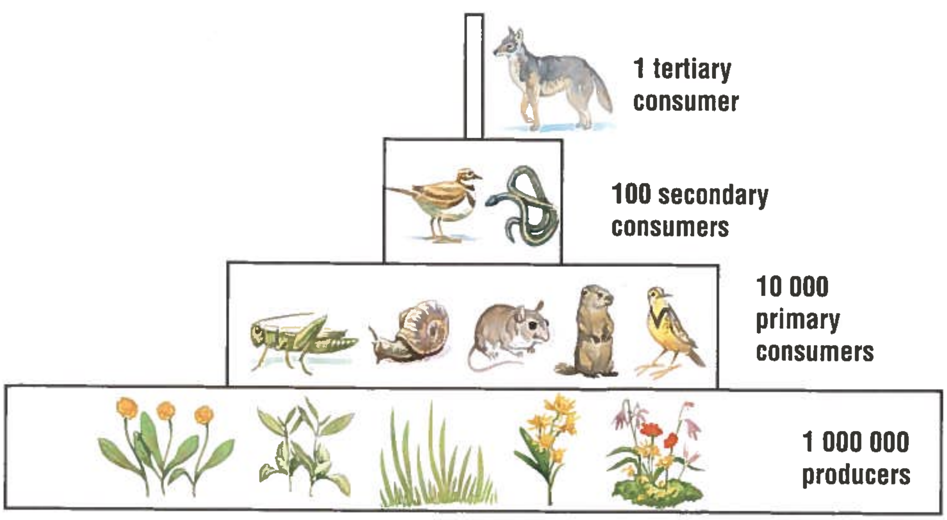

Figure 2 A pyramid of numbers for a grassland food web

TRY THIS: Dealing Out a Pyramid of Numbers

SKILLS MENU: **performing, observing, analyzing, evaluating**

SKILLS HANDBOOK 2.B.7.

A pyramid of numbers illustrates the number of different organisms at each level of a food chain or food web. In this activity, you will make your own pyramid of numbers using playing cards to represent organisms.

Equipment and Materials: playing cards; field guide (optional); paper; pencil

1. Write down the name of a plant or animal on a piece of paper. Do not show it to anyone.
2. As a class, collect all the papers and classify them as producers, primary consumers, secondary consumers, or tertiary consumers. Create a tally for each category. If you are unsure about which category an organism should be in, use a field guide to determine what that organism eats.
3. For each category, deal out the same number of playing cards as the tally number for that category. For example, if the tally showed four tertiary consumers, there should be four playing cards in that pile.
4. Use the four piles of cards to build a card tower. Use only the producer cards for the bottom level, only the primary consumer cards for the next level, only the secondary consumer cards for the next level, and the tertiary consumer cards for the top level.
5. If you cannot build a stable tower from the piles, start again using as many cards as you need to create a stable tower with four levels.
6. As you build, count the number of cards you use for each level. Record the numbers for each level in your notebook.

A. Were you able to create a card tower using the tally totals? Discuss the reasons why or why not.

B. In step 5, what adjustments had to be made to the numbers of cards at each level before a stable tower could be created?

C. If the cards in the card tower represent individual producers and consumers in a pyramid of numbers, what does the card tower tell you about the number of individuals at each level?

D. Does a card tower adequately represent the idea of a numbers pyramid? Explain why or why not.

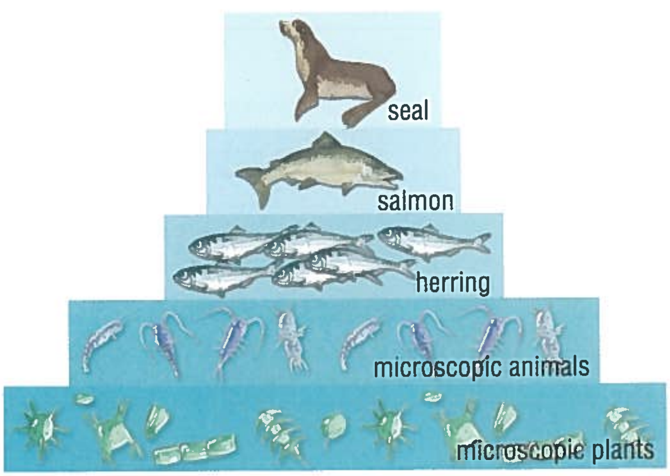

Figure 3 A pyramid with a wide base can support a stable population of consumers.

To maintain stable populations in an ecosystem, there must be a large number of producers to provide enough food energy for primary, secondary, and tertiary consumers. The wider the base of the pyramid, the more consumers can live in the ecosystem. Now, consider Figure 3. What do you think would happen if the microscopic plants level of the pyramid was only half the width it is in the diagram? What would happen to the microscopic animals level? Changes to the number of organisms at any level in the pyramid will affect the number of organisms at other levels.

CHECK YOUR LEARNING

1. A chicken eats some grain. In your own words, describe what happens to the energy in the food once the chicken eats it.
2. What is a pyramid of numbers? How does it relate to a food chain?
3. How is a pyramid of numbers different from an ecological pyramid?
4. (a) What happens to the total number of organisms at each level of a pyramid of numbers?
   (b) Explain in your own words why this occurs.
5. What type of organisms always occupy the first level of an ecological pyramid or a pyramid of numbers?

Matter Cycles

5.5

Food chains, food webs, and ecological pyramids show how energy moves in one direction in ecosystems. Matter also moves in ecosystems. What happens to matter—the leaves, roots, bones, hair, muscles, and every other part of an organism—in an ecosystem?

Earth is a closed system. A **closed system** is one in which no new matter can enter and no matter can leave. (On Earth, the only exception to this is when meteorites hit the surface of the planet.) The amounts of carbon, water, oxygen, hydrogen, and nitrogen on Earth are the same now as they were when dinosaurs were alive. However, organisms are continuously using these materials to stay alive. How do the amounts of matter on Earth remain the same over long periods of time? The answer is through recycling. Matter is taken up from the environment, used in life processes, and eventually returned to the environment where it can be used again. Ecologists call this repeating pattern a **cycle**.

closed system: a system in which the amount of matter remains constant over time

cycle: a pattern in nature that repeats over time

The Cleanup Squad

Detrivores and decomposers recycle in an ecosystem. They are essential to any ecosystem. As you have already learned, detrivores and decomposers eat the remains of dead plants and animals that scavengers and other consumers have left behind (Figure 1). Detrivores and decomposers also feed on animal wastes. Detrivores break up organic matter into smaller pieces. When decomposers feed, they break down these smaller pieces into simple substances such as minerals, nitrates, and phosphates. These substances are left in the soil as nutrients that plants can absorb. This is nature's way of recycling matter. Decomposers play a critical role in any ecosystem. They convert biotic elements, such as plant and animal matter, into abiotic elements, such as minerals. They allow matter to be recycled and reused by other organisms in the ecosystem.

LINKING TO LITERACY

Synthesizing Information

Synthesizing means to summarize what you read, reflect on your learning, and make connections with what you already know to form new opinions, apply your learning, or construct new ideas. Use the text on this and the next page to help you understand decomposers and detrivores.

Figure 1 (a) Scavengers like this turkey vulture feed on already dead animals and leave behind decaying matter. (b) Detrivores such as earthworms break down the organic matter into smaller pieces. (c) Decomposers like this fungus break down the remaining matter, releasing nutrients back into the ecosystem.

To learn more about composting,

Go to Nelson Science

A composter is a perfect example of matter being recycled. Food and plant wastes are put into a container. Earthworms and other detrivores break down large pieces of decaying matter into smaller pieces. Bacteria, fungi, and other decomposers then further break down these pieces into nutrient particles. The final product is compost. Gardeners mix nutrient-rich compost into the existing soil. Garden plants then use these nutrients to grow.

TRY THIS: Discovering Interactions in a Rotting Log

SKILLS MENU: **performing, observing, analyzing**

It generally takes 10 years for a rotting log (Figure 2) to break down completely into soil. In this activity, you will investigate the interactions in a rotting log that will cause it to decompose.

Equipment and Materials: rotting log; gloves; hand lens; forceps; water in a spray bottle; small shovel; plastic containers with lids; field guides (optional)

Figure 2 There are many hidden interactions happening within a rotting log.

1. Find a rotting log in your neighbourhood. It might be in a park or even on your school grounds.
2. Put on your gloves. Using the hand lens and forceps, carefully observe the log. Look for any signs of life. Use the spray bottle to keep the log moist. You may want to use field guides to identify what you see. Place any living things you find into plastic containers for temporary observation.
3. In your notebook, record any observations, along with any questions that arise from your investigation.
4. Return any organisms to where you found them on the log. Wash your hands when you are finished.

A. What evidence did you observe that indicates that the log is decomposing?

B. Is the rotting log an ecosystem? Use your evidence to explain.

Ecosystems Are Sustainable

Without scavengers, detrivores, and decomposers, Earth would be piled high with dead organisms. For example, the leaves that fall from trees would still be there in the spring, continuing to pile up year after year. With no new nutrients being added to the soil, plants would slowly starve and die. As a result, animals would also starve and die.

sustainable: something that can be maintained and used indefinitely

Healthy ecosystems are **sustainable**, which means that they can be maintained indefinitely. They can replenish resources by continuously recycling matter. For example, a bear catches a fish, eats most of it, and leaves the carcass to rot into the soil. The nutrients in the carcass are released by decomposers. Forest trees use these nutrients to grow and stay healthy. The healthy forest provides a home and food for the bear.

The Carbon Cycle

Carbon is found in many places on Earth. It is found in abiotic elements, such as coal, oil, and natural gas, and in the air as carbon dioxide. Carbon is also found in all living things.

Carbon has a predictable cycle (Figure 3). Plants use carbon dioxide in photosynthesis to produce sugars. When animals and other organisms break down these sugars to obtain energy, they produce water and carbon dioxide. Animals also release waste carbon dioxide when they exhale, or breathe out. When decomposers break down dead plants and animals, they too release carbon dioxide. All of the carbon dioxide released into the air by these processes is available to plants for photosynthesis. The cycle starts again.

LINKING TO LITERACY

Reading a Diagram
Diagrams help you understand what is written in the text. Figures 3 and 4 (on the next page) are described in words. As you read, move back and forth between the text and the diagram to help you understand the ideas.

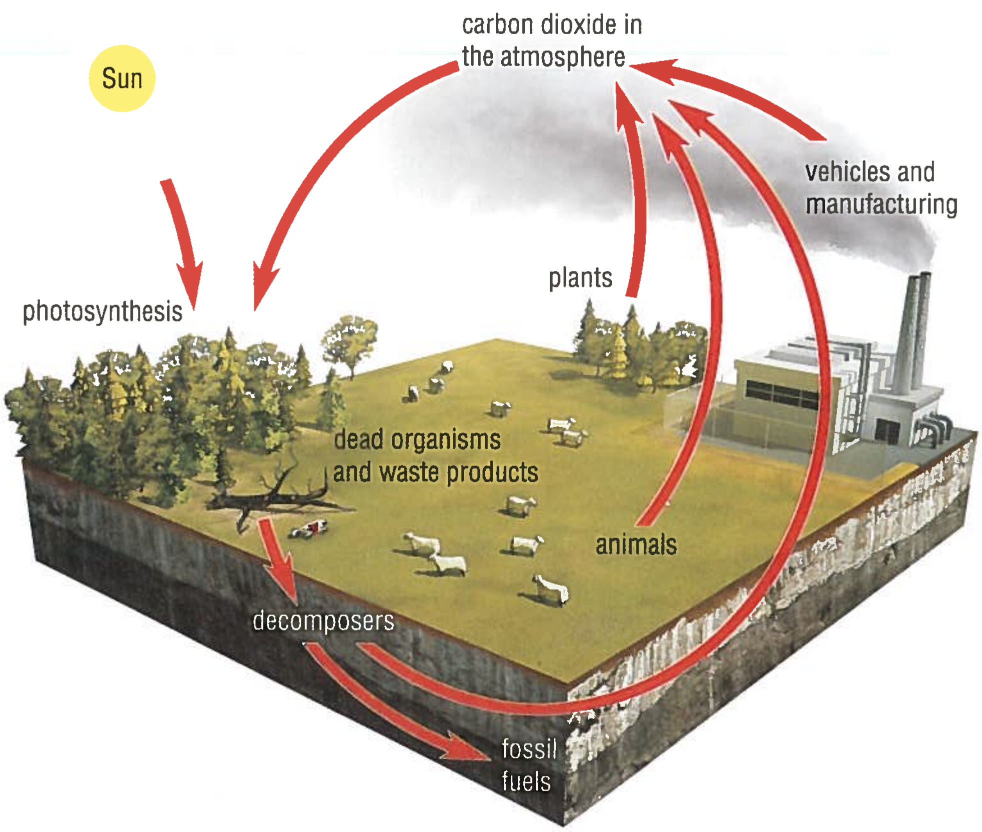

Figure 3 The carbon cycle

Carbon in dead plants that are buried in soil may not decompose completely. This organic matter remains underground for millions of years where it undergoes chemical changes to form fossil fuels such as coal, oil, and natural gas. When humans burn fossil fuels, most of the carbon quickly enters the atmosphere as carbon dioxide. Carbon dioxide is a gas that stays in Earth's atmosphere and absorbs the energy radiated by Earth and the Sun. This contributes to the warming of Earth's surface. Gases that trap energy in Earth's atmosphere are known as greenhouse gases. Earth would be a frozen world without greenhouse gases. However, humans have burned so much fossil fuel that there is about 30 % more carbon dioxide in the air today than there was 150 years ago.

All this extra carbon dioxide in the atmosphere has affected where organisms can live. Some locations are now too warm to meet the ideal temperature ranges of the organisms. These temperature changes have become a growing concern for society.

The Water Cycle

Water keeps all living things alive. Most living things are made largely of water. Water also moves in a cycle.

evaporation: the process in which a substance changes state from liquid to gas

condensation: the change in state of a substance from gas to liquid

precipitation: water in the liquid or solid state that falls to Earth

The water cycle begins with evaporation (Figure 4). **Evaporation** is the change in state of a substance from liquid to gas. As the Sun's energy warms up oceans, lakes, and rivers, some of the water evaporates to form water vapour. Large amounts of water vapour also escape from plant leaves. The water vapour rises in the atmosphere, contracting as it cools to form tiny water droplets. The change of state from a gas to a liquid is called **condensation**. The tiny water droplets that result from the condensation of water vapour form clouds. As more and more droplets condense, they fall back to Earth as rain or snow, also called **precipitation**. Precipitation can run off of the surface of Earth and into bodies of water. Precipitation may also seep into the ground and remain trapped there for years as groundwater. Groundwater also eventually seeps into large bodies of water. At any stage in the cycle, the water may evaporate back into the atmosphere. Nature recycles water so that it can be used again and again!

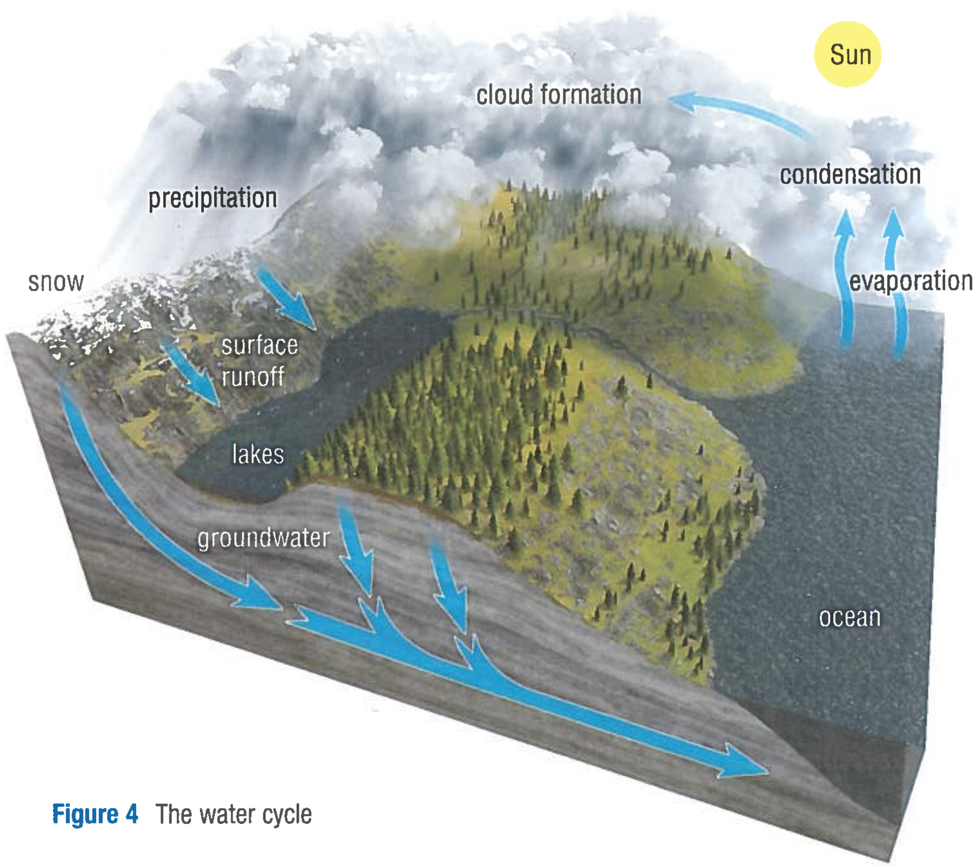

Figure 4 The water cycle

We all need clean fresh water to survive, but the supply of fresh water on Earth is limited. Agriculture and industry use large amounts of fresh water to irrigate crops and for industrial processes. Humans use water faster than it can be replenished by the water cycle because the demand has increased with the growth of the human population. Also, pollutants from agriculture, mine tailings, and other industrial processes can seep into local groundwater and make it unsafe to drink (Figure 5). We have to use water more carefully and protect it from pollution. This is the only way to ensure a supply of clean fresh drinking water in the future.

To learn more about the water cycle,
Go to Nelson Science

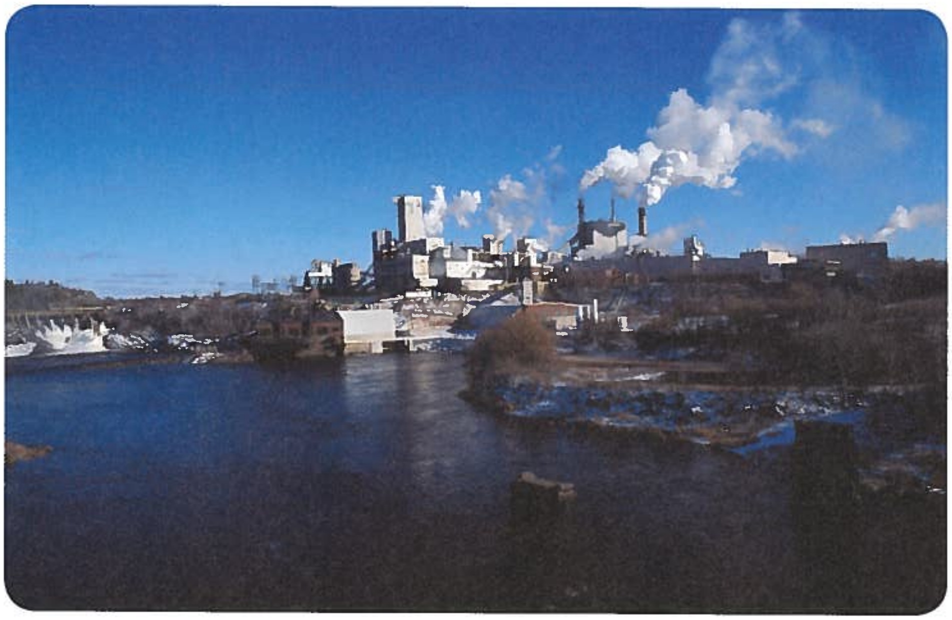

Figure 5 Smoke and steam are released from this paper mill near an Ontario lake. Pollutants that enter the water from industrial plants such as this are cycled through ecosystems and affect organisms.

In the same way that changes in food chains can affect an entire food web, changes to one of nature's cycles can affect other cycles. For example, Earth's temperature increases when more carbon enters the atmosphere. This can affect the water cycle. Higher temperatures affect precipitation patterns and the amount of water humans take from lakes and groundwater sources. It is important to think about the effects that different cycles in nature can have on each other.

Unit Task When you complete the Unit Task, think about whether your plan for naturalizing your area is sustainable.

CHECK YOUR LEARNING

1. What is a cycle?
2. Explain how detrivores and decomposers recycle matter.
3. What is meant by the statement "Ecosystems are sustainable"?
4. In your own words, describe the carbon cycle.
5. In your own words, describe the water cycle.
6. Describe some of the ways that the supply of fresh water on Earth is at risk.

Breaking Down the Waste Barrier

SKILLS MENU

- ☐ Questioning
- ■ Hypothesizing
- ■ Predicting
- ☐ Planning
- ■ Controlling Variables
- ■ Performing
- ■ Observing
- ■ Analyzing
- ■ Evaluating
- ■ Communicating

You create waste when you prepare a meal, such as vegetable peels or leftover chopped greens. Most kitchen waste can be composted. Decomposers in compost break down wastes so that the nutrients they contain can be released into the soil. What kinds of materials break down? Which do not? In this investigation, you will examine the processes of composting and observe decomposers at work.

Testable Question

What types of household materials decompose when buried in moist soil?

Hypothesis/Prediction

SKILLS HANDBOOK 2.B.3.

Read the Experimental Design and Procedure, and then formulate a hypothesis based on the Testable Question. Your hypothesis should include a prediction and reasons for your prediction.

Experimental Design

In this investigation, you will determine whether or not decomposition occurs (dependent variable) depending on the kinds of materials you choose to test (independent variable). The materials you choose will be the only things different in each container. All other materials and conditions used will be the same in each container; they will be controlled variables. You can then determine which materials decompose and which do not.

Equipment and Materials

- markers
- scissors
- rubber bands
- water in a spray bottle
- 6 bottoms of clear 2 L plastic bottles
- garden soil
- garden waste
- raw vegetable and fruit peels
- paper, aluminum foil, plastic wrap
- masking tape
- window screening


markers


scissors


rubber bands


water in a spray bottle


6 bottoms of clear 2 L plastic bottles


garden soil


garden waste


raw vegetable and fruit peels


paper, aluminum foil, plastic wrap


masking tape


window screening

Procedure

1. Place a 2 cm layer of garden soil at the bottom of each of the six bottles.
2. Add a 5 cm layer of garden waste on top of the soil layer in each of the six bottles.
3. Place a different vegetable or fruit scrap into each of the first three bottles. For example, place some banana peel into one, some potato peel into the next, and some orange peel into the third.
4. Place pieces of paper, aluminum foil, and plastic wrap into the remaining three bottles. Put only one type of material into each bottle.
5. Make sure that there are similar amounts of each material in each bottle.
6. Add garden soil to each bottle until half full. Label each bottle to indicate what materials it contains.
7. Add enough water to each bottle to make the mixture inside moist, but not wet. Cover the bottle opening with window screening and secure it with a rubber band.
8. Place the bottles in a warm location for one week. Use a spray bottle to moisten the contents of each bottle every couple of days.
9. After one week, remove the screening. Move the soil in each container aside so that you can view the materials. In your notebook, record any observations, including how the materials look and smell. Describe the degree of decomposition of each of the test materials.

Minimize the amount of time that the materials in the bottle are exposed to air. Do not breathe in too deeply when smelling the contents. Be sure to wash your hands after you observe your bottles.

10. Push the soil back over, moisten the contents of the bottles, and set aside for another week.
11. Repeat steps 8 to 10 for two more weeks.

Analyze and Evaluate

(a) Which materials decomposed? Which did not? Did your observations support your hypothesis?

(b) Answer the Testable Question.

(c) Of the materials that decomposed, which decomposed fastest? Which decomposed slowest?

(d) What may have enabled some of the materials to decompose?

(e) Why were both garden waste and soil added to the compost?

Apply and Extend

SKILLS HANDBOOK 2.B.2., 2.B.4.

(f) Consider the health of our environment. What should be done with those materials that did not break down easily?

(g) Design your own experiment to determine what effect, if any, temperature would have on the rate of decomposition. Make sure that your experiment is a fair test (your hypothesis should state whether you expect one variable, such as the rate of decomposition, to change when you alter another variable, such as temperature).

(h) Conduct research on vermicomposting and red wrigglers. What is the advantage of each? With permission from your teacher, set up a vermicomposter in your classroom to compost any vegetable and fruit waste you may have.

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CHAPTER 5

SUMMARY

Interactions within Ecosystems

BIG Ideas

- ☑ Ecosystems are made up of biotic (living) and abiotic (non-living) elements, which depend on each other to survive.
- ☑ Ecosystems are in a constant state of change. The changes may be caused by nature or by human intervention.
- ☑ Human activities have the potential to alter the environment. Humans must be aware of these impacts and try to control them.

Looking Back

Organisms have different roles in ecosystems.

- The role each organism plays is related to the way in which it obtains energy.
- Producers make their own food. Consumers must eat other organisms to obtain energy.
- Herbivores eat plants; carnivores eat animals; omnivores eat both plants and animals.
- Scavengers eat dead animals; detrivores and decomposers eat dead plants and animals and their wastes.

Food chains and food webs show how energy from the Sun is passed from one organism to another in an ecosystem.

- Food chains start with a producer and end with a consumer. Food chains show the feeding patterns of organisms in an ecosystem.
- Food webs show how the food chains in an ecosystem are interconnected. A food web may contain several food chains.
- Changing any part of a food chain or food web affects all the organisms in that chain or web.
- Energy is lost at each level in a food chain.
- Ecological pyramids are visual representations of the loss of energy at each level in a food chain. Number pyramids show the number of organisms at each level of a food chain or web.

The skills of scientific inquiry can be used to model and investigate food webs.

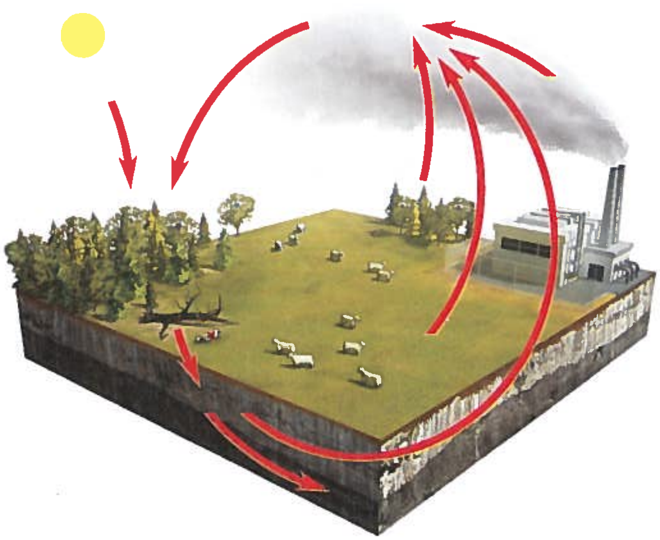
- A model food web can be used to investigate the interactions between the biotic and abiotic elements in an ecosystem.
- Changes in food webs can be observed by using a model ecosystem.

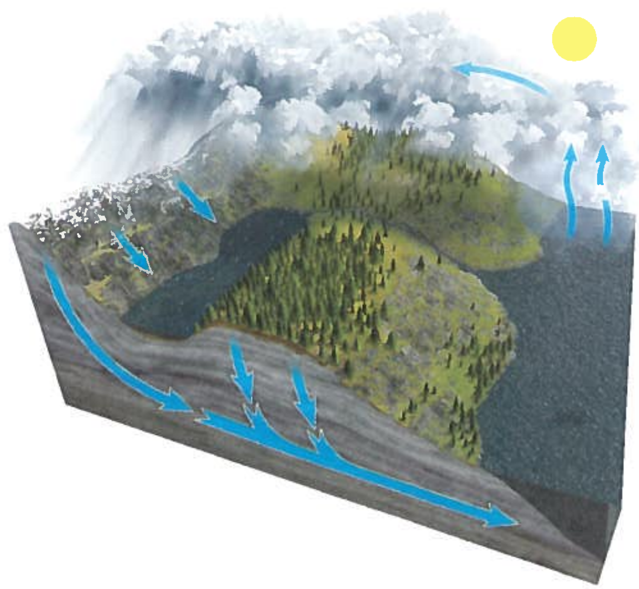
Matter is constantly recycled in an ecosystem.

- Carbon, water, and oxygen are recycled in ecosystems. Both detrivores and decomposers are critical to the recycling of matter.
- Detrivores break down decaying plant and animal matter into small pieces. Decomposers further break down the matter, releasing nutrients back into the environment for use by organisms.
- The continuous recycling of matter makes ecosystems sustainable.

VOCABULARY

photosynthesis, p. 122
producer, p. 122
consumer, p. 123
herbivore, p. 123
carnivore, p. 123
scavenger, p. 123
omnivore, p. 123
detrivore, p. 124
decomposer, p. 124
food chain, p. 126
food web, p. 127
pyramid of numbers, p. 133
closed system, p. 135
cycle, p. 135
sustainable, p. 136
evaporation, p. 138
condensation, p. 138
precipitation, p. 138





Investigation skills can be used to examine the biotic and abiotic interactions in a composter.

- Only certain types of matter decompose in a composter.
- Biotic elements help matter in a composter decompose.

CHAPTER 5 REVIEW

The following icons indicate the Achievement Chart categories: K/U Knowledge/Understanding, C Communication, T/I Thinking/Investigation, A Application

What Do You Remember?

1. What are the "ingredients" of photosynthesis? K/U
2. Create a food chain that has four organisms. K/U
3. What would happen to ecosystems if dead organisms did not decompose? K/U
4. Decomposers play an important role in which matter cycle? K/U
5. Give two examples of each of the following: producer, herbivore, carnivore, omnivore, scavenger, detrivore, and decomposer. Organize your answers in a table. K/U C
6. Explain the difference between a producer and a consumer. K/U
7. For each of the following, explain the difference between the two terms: K/U
   (a) food chain, food web
   (b) carnivore, scavenger
   (c) detrivore, decomposer
   (d) primary consumer, secondary consumer
8. If you found bald eagles, algae, mosquito larvae, and salmon within the same ecosystem, what role would each organism most likely play? K/U
9. Explain what is meant by "Energy flows and matter cycles." K/U
10. Explain why each level in a pyramid of numbers is smaller than the one below it. K/U
11. List four different roles organisms play within an ecosystem. Include examples. K/U
12. Why are long food chains less effective in transferring energy than short food chains? Explain your answer using a diagram of an energy pyramid. K/U
13. Based on Figure 1, use your own words to explain what is happening at each arrow. K/U

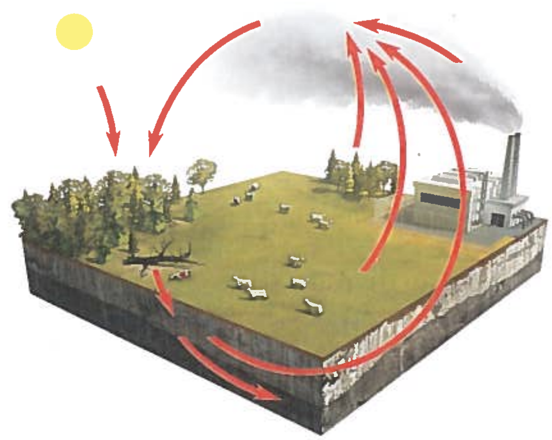


Figure 1

What Do You Understand?

14. Some people promote vegetarianism as a way of helping the environment.
    (a) Explain how vegetarianism can help the environment in terms of what you have learned in this chapter.
    (b) Do you agree or disagree that vegetarianism is a good way to help the environment? Explain. A
15. A rotting log is an ecosystem. Create a food web for a rotting log that may be found in your local area. A
16. Composting has become popular in urban communities. What are the benefits of putting kitchen wastes into a composter or green bin? A

Solve a Problem!

17. An average tree can remove about 9 kg of carbon dioxide per year from the air.
    (a) Why might tree-planting campaigns be useful in urban areas?
    (b) Suggest other ways to reduce the amount of carbon in the air. A

18. Read situations i, ii, iii, iv, and v.
    (a) Indicate whether the carbon cycle, water cycle, or both are affected in each situation.
    (b) Predict the changes that might happen in the carbon and water cycles if the situation actually occurred. T/I A
    i) An oil spill occurs.
    ii) Heavy rains wash pesticides and toxins on our roads down the sewers.
    iii) Carbon dioxide gas emissions into the air continue to increase.
    iv) No garden waste is placed into garden beds.
    v) There are no plants in a given area.
19. You have just consumed a ham and cheese sandwich and a glass of milk.
    (a) List all the organisms needed to produce your lunch.
    (b) Draw a food chain for each item, with you at the top. (Hint: break down each part of the lunch to create your chains. For example, create separate chains for bread, cheese, and so on.)
20. Trace the water cycle within your community. In your area, are there any human-made structures or mechanisms to deal with the water cycle? T/I A
21. Many communities are concerned about West Nile disease, which is spread by mosquitoes, and want to add chemical pesticides to the local pond to destroy all the mosquito larvae.
    (a) Create a typical food web for a pond. Include all the links that mosquito larvae may have in that ecosystem.
    (b) Use this drawing to explain how using pesticides affects the food web.
    (c) Provide some alternative ways to control the mosquito population. T/I A C
22. Gulls and raccoons are often looked down upon by humans because they eat garbage.
    (a) What is your view of the situation?
    (b) What might our beaches and cities be like if this did not occur?
    (c) What role do these animals play within an ecosystem that includes humans?
    (d) What can you do to help people live in greater harmony with wildlife in cities and towns? T/I A

Create and Evaluate!

23. You are a nature interpreter at a local park.
    (a) Create a poster for visitors to the park that shows what happens to dead material and illustrates how it helps promote sustainability in the ecosystem.
    (b) Have your classmates evaluate the effectiveness of your poster. Evaluate their suggestions and make any changes that you think will improve the poster. K/U C
24. Collect several pictures of Native artwork that focus on nature. Discuss your interpretation of these artworks with a partner. Create a visual display of what you believe the paintings show about ecosystems. A C

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Reflect on Your Learning

25. Has your understanding of human and nature interactions changed from the concepts introduced in this chapter? Explain why or why not.
26. Think back to the Key Question on the first page of the chapter.
    (a) In a brief paragraph, answer the Key Question. You may use diagrams.
    (b) Write one or two more questions about the topic of this unit that you would like to explore.