2.2 Ecological Roles and Relationships

We can look at an ecosystem as a complex network of interactions. Within an ecosystem, all organisms need to carry out basic essential life functions such as growth, movement, repair, and reproduction. In order to perform these functions, organisms must take in food, water, and other nutrients. **Nutrients** are the elements and compounds that organisms must have in order to live and grow. Nutrients include water, oxygen, vitamins, and minerals, as well as the foods we eat that provide fats, proteins, and carbohydrates. Some organisms, like plants, can make their own food, while other organisms need to consume food in order to live.

LEARNING TIP

Active readers interact with the text. As you read Section 2.2 go back and forth between the words in bold and the photographs. Ask yourself, "How can I figure out the meanings of unfamiliar terms from cues in the text and illustrations?"

Producers

The **producers** or **autotrophs** (Figure 1) are organisms that make their own food, usually using energy from the Sun in a process called photosynthesis. You will learn more about this process in Chapter 4. Producers are also an important food source for other organisms.

Almost all plants can photosynthesize, and on land they are the most important type of producer. In aquatic environments, producer organisms called algae photosynthesize as well. Algae include some plant-like protists (single-celled, eukaryotic organisms), single and multicellular plants, and some photosynthetic bacteria. Microscopic algae are called **phytoplankton**.

Some producers are not photosynthetic and can live on the ocean floor or deep within caves, in the total absence of light. Instead of using the energy of the Sun, they use the thermal and chemical energy of Earth's interior in a process called chemosynthesis.

Figure 1 Producers come in all shapes and sizes, including (a) *spirogyra* algae, (b) purple lupins, and (c) deciduous trees. What they share in common is the ability to make food from inorganic materials and a source of energy, such as the Sun.

Consumers

To learn more about the role of organisms in an ecosystem, watch the animation found at **www.science.nelson.com**

Organisms that consume other organisms or biotic waste in order to survive are called **consumers** or **heterotrophs**. Consumers ingest other organisms and break down the chemical bonds within those organisms to obtain energy and carbon. You will learn more about this process in Chapter 4.

Consumers that eat producers are called **herbivores** or **primary consumers.** Herbivores include insects and animals, such as caterpillars and elk, that eat plants (Figure 2). In aquatic environments, herbivores include microscopic **zooplankton** that eat phytoplankton. Consumers that eat other consumers are called **carnivores**, such as those shown in Figure 3. Some organisms called **omnivores** eat both producers and other consumers (Figure 4). Humans are omnivores, as are grizzly bears that eat a variety of foods including salmon and insects as well as fruits and berries.

(a)

(b)

Figure 2 (a) The elk and (b) caterpillar are both herbivores. Both rely on producers as food.

(a)

(b)

Figure 3 (a) The killer whale and (b) praying mantis are both carnivores. They eat other consumers in order to gain the energy they need to survive.

(a)

(b)

Figure 4 (a) Grizzly bears and (b) humans are both omnivores. They eat producers as well as other consumers.

Detrivores are consumer organisms that feed on the waste material in an ecosystem, including the bodies of other organisms that have recently died, plant debris, and animal feces (Figure 5). **Decomposers** are a special type of consumer that breaks down the complex molecules found in dead organisms and waste matter into simpler molecules. Decomposers like bacteria and fungi cause the decay of material. Decomposer organisms like bacteria are nature's recyclers. They make the nutrients contained in waste and dead matter available to producers once again through a process called **biodegradation** (Figure 6). In areas where decomposers are abundant, rich fertile soil exists. Ecosystems with few decomposers have very little decay, and as a result the soil tends to be thin and low in nutrients.

(a)

(b)

Figure 5 Organisms such as (a) earthworms and (b) hagfish that feed on the waste and remains of other organisms are called detrivores.

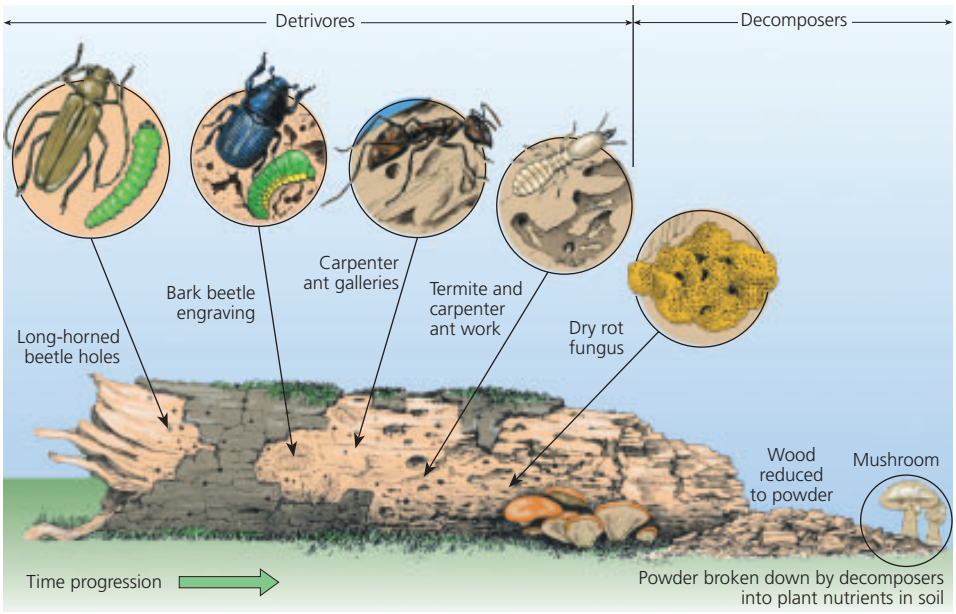

Figure 6 Decomposers such as fungi and bacteria, as well as detrivores like insects and other scavengers, form a complex community within a log. Eventually they break the log down, releasing the nutrients into the soil.

TRY THIS: Leaf Debris

Skills Focus: conducting, recording, communicating, questioning, observing, predicting

In this activity, you will explore leaf litter for signs of decomposers and the work that they do.

Materials: fallen rotting leaves; hand lens or dissecting microscope

Some people have reactions to airborne microbes in decomposing material. Use caution if you have allergies or asthma.

1. Collect some fallen leaves that have been on the ground for some time.
2. Observe the leaves under a hand lens or dissecting microscope. Look for any signs of decomposers.

A. What characteristics help you to identify a decomposer?

B. What kind of organism is mould? What role do moulds play in a forest ecosystem?

C. What other organisms can you find in your sample? What roles do they play in a forest ecosystem?

D. What do you think will eventually happen to the material contained in the leaves?

E. Select two abiotic factors and predict how they will affect the process occurring in the rotting leaves.

Figure 7 Not all predators are fast, with sharp claws and teeth. This sea star is a predator.

Predators

Predation occurs when a consumer captures and eats another organism, such as when a **predator** like a mountain lion captures, kills, and eats a **prey** animal such as a deer. It is common to think of predators as fast-moving carnivores, but the term more broadly refers to any consumer in an ecosystem. Organisms as varied as sea stars, centipedes, rabbits, and tigers are all predators (Figure 7).

At first glance it might seem that a predator simply reduces the population of prey in a community. However, there tends to be a cyclic rise and fall in both populations called the **predator–prey cycle** (Figure 8). The cycle begins when the prey population decreases as the predators eat the prey. Then, the predator population decreases as available prey run out. The cycle continues as the decreased number of predators allows more prey to survive, and the prey population rebounds. The predator population then increases because it now has an abundant food supply. The predators reduce the prey population and the cycle begins again. A distinct characteristic of this cycle is the time lag of the predator population. This refers to the delay as the predator population responds to the changes in the prey population.

The cycle in actual populations, such as the Canadian lynx and the snowshoe hare (Figure 9), is much more complex than the simple predator–prey cycle predicts and only slightly resembles the simplified model shown in Figure 8. However, the model remains useful to understand the cycling of the two interrelated populations. 2B *Investigation*

In natural populations there are several other environmental factors at work and effectively two predator–prey cycles. Remember! Herbivores are predators as well and have a predator–prey relationship with the plants they eat. Both populations are interacting with the prey they consume.

2B *Investigation*

Predator–Prey Simulation

To perform this investigation, turn to page 44.

In this investigation, you will simulate the interactions between a predator and a prey species.

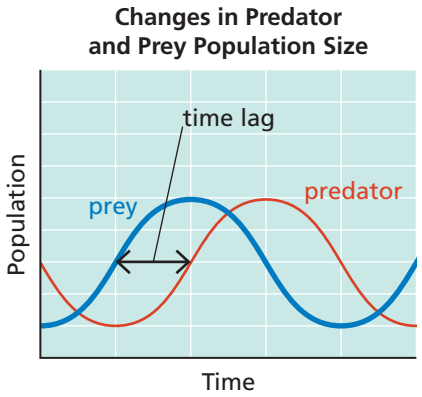

Figure 8 The predator–prey model describes the cycling of the predator and prey populations.

Figure 9 The interaction between the snowshoe hare and the Canadian lynx is one of the best known illustrations of the predator–prey cycle.

2.2 CHECK YOUR Understanding

1. Compare the following terms. Give both similarities and differences.
   (a) producer and consumer
   (b) omnivore and carnivore
   (c) carnivore and herbivore
2. The word "autotroph" literally means "self-feeder." Why is this term appropriate in reference to producers?
3. The word "heterotroph" literally means "other-feeder." Why is this term appropriate in reference to consumers?
4. How does a consumer differ from a decomposer?
5. What role do decomposers fill in an ecosystem?
6. List five producers and five consumers that live near your home.
7. Compare a herbivore, a carnivore, and a detrivore. Indicate both similarities and differences.
8. In your own words, define "nutrient."
9. Which of the following classifications is most appropriate for bread mould and mushrooms?
   A. producers
   B. herbivores
   C. carnivores
   D. decomposers
10. Often farmers will plough the remains of their crops into the soil. Explain why this is a better option than taking them away to burn.
11. Which of the following terms refers to organisms that are able to cause biodegradation?
   A. herbivores
   B. omnivores
   C. carnivores
   D. decomposers
12. The word "omnivore" is from two Latin words: *omne* meaning "all" or "everything" and *vorare* meaning "to devour." What characteristic of omnivores makes this an appropriate name for them? In what ways is the name misleading?
13. The interaction between the snowshoe hare and the Canadian lynx has been documented for over 100 years.
   (a) In what ways is the predator–prey cycle shown in Figure 10 similar to the idealized model shown in Figure 8?
   (b) In what ways is it different?
   (c) Suggest factors that may be responsible for any difference you see.

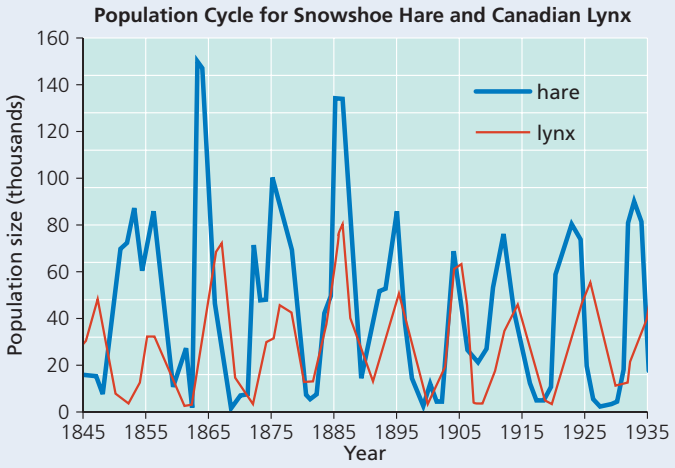

Figure 10

14. Create a six-column table with the following headings: producer, herbivore, carnivore, omnivore, decomposer, detrivore. Insert examples of each type of organism in the proper column.
15. Draw the predator–prey cycle shown in Figure 8 into your notebook. Describe what happens to cause each direction change on the graph. Clearly label the time lag.