

Chapter 3

Interactions of Living Things

What lives in a pond? The plants, fish, reptiles, birds, and even microscopic organisms in a pond interact in many ways, creating a natural balance. A fisherman from Maryland made an alarming discovery in 2002. He caught a northern snakehead fish, which is native only to Asia and Africa. It may have been dumped in the pond by someone who imported the species from China. This torpedo-shaped fish can grow to a length of one meter. A female can lay over 100,000 eggs each year. It can breathe air and travel on land, so it has been nicknamed the walking fish. The walking fish eats other fish. There is nothing that eats the walking fish. What affects might this fish have on the pond? In the previous chapter, you studied individual living things. In this chapter, you will see how different organisms interact in living systems.



Key Questions

1. *What do living things need for survival?*
2. *Why are American biologists worried about the European green crab?*
3. *How is energy transferred between organisms?*



3.1 Variables in Habitats

Living things are found on or near Earth's surface where the conditions for life are the best. Earth's life-supporting layer of land, water, and air is known as the *biosphere* (Figure 3.1). Within this layer there are millions of species of living things and millions more that have yet to be classified by scientists. In this section, you will learn about the systems of the biosphere.

Ecosystems and habitats

Living systems As you have learned, an individual organism is made up of many smaller systems that work together. Each system has a *structure* (its parts) and a *function* (what it does). This is true for cells, tissues, organs, organ systems, and the entire organism. For example, your heart is a system made of muscle (its structure) that allows it to pump blood throughout your entire body (its function).

Ecosystems A higher level of organization is called an ecosystem. An **ecosystem** is made up of a group of living things and their physical surroundings. An ecosystem can be as big as the entire biosphere, or as small as a drop of water containing one-celled organisms. The living and nonliving things in an ecosystem function together—kind of like a single organism.

Habitats A **habitat** is a place where a particular type of organism lives. A dolphin's habitat is the ocean. A goldfish in a fishbowl has a much smaller habitat (Figure 3.2). There are land habitats, freshwater habitats, and saltwater habitats. Each type of habitat has a set of physical variables such as the amount of sunlight, temperature, and amount of moisture. An organism lives in a habitat where the range of variables is suitable for keeping it alive. For example, a dolphin wouldn't survive very long in your habitat.



Figure 3.1: The biosphere is Earth's life-supporting layer.

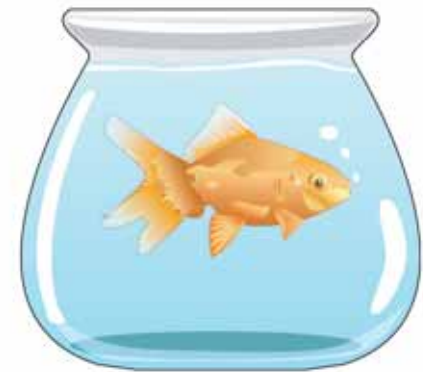
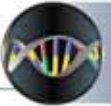
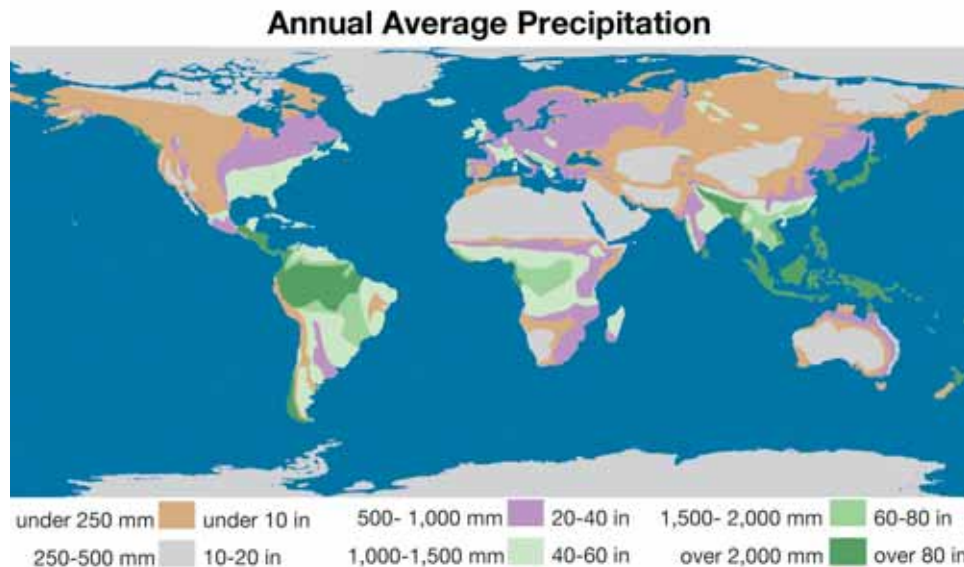


Figure 3.2: What is the habitat of this goldfish?



Land habitats

- Land variables** Many variables affect life on land. Five important ones are *temperature, precipitation, sunlight, type of soil, and oxygen.*
- Temperature** Most living things can survive in temperatures above freezing and below 70°C. Extreme temperatures limit the number and kinds of organisms that can survive. Tropical rainforests have moderate temperatures and support more species of animals and plants than any other land habitat. Polar regions are very cold and do not support as many species. The polar bear is adapted to live in the cold temperatures of the Arctic (Figure 3.3).
- Precipitation** Living things need water to survive. The amount of precipitation (rain or snow) determines the kinds of living things that can survive in a land habitat. The amount of precipitation on Earth is not evenly distributed. Some parts of Earth's surface are very dry, while others are very wet. The map below shows the average precipitation that falls on different parts of Earth each year.



VOCABULARY

(from previous page)

ecosystem - a group of living things and their physical surroundings.

habitat - a place where an organism lives.



Figure 3.3: *The polar bear lives in the Arctic. It has dense fur and a thick layer of fat to keep it warm.*

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Describe your habitat. What is the range of temperatures? How much precipitation does it receive each year? How much sunlight? What type of soil is present? What is your altitude? List the types of organisms that live in your habitat.

Sunlight Sunlight provides the energy for living things to grow and survive. Plants capture the energy from sunlight and store it in the form of molecules. Animals get their energy by eating plants or by eating other animals that eat plants. The amount of sunlight determines the amount of energy available in an ecosystem. Some plants, like ferns, can survive with very little sunlight. A cactus needs a lot of sunlight to grow (Figure 3.4).

Type of soil *Soil* is a mixture of decayed plant and animal parts and very small rock particles (Figure 3.5). It provides an anchor for plants that have roots. It also holds water and nutrients to help plants grow. The type of soil varies in different land habitats. *Sand* does not hold water very well and contains few nutrients. *Clay* has smaller particles than sand and holds water. The best soils for growing plants contain a mixture of particle sizes and some decayed matter. Soil is a habitat for many organisms such as bacteria and worms. In fact, a cup of soil contains billions of living bacteria!

Oxygen Most organisms need oxygen to live. The air you breathe is about 21% oxygen. The amount of oxygen in the air varies depending on altitude. Habitats at higher altitudes, like mountain tops, have less oxygen than habitats at lower altitudes. People who live at high altitudes have adapted to breathing less oxygen. If you live at a low altitude and visit a higher altitude, you may notice that you are short of breath. If you spend enough time there though, your body will adapt.

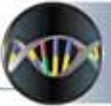
Air habitats Some organisms spend much of their time in the air. However, most occasionally return to land. Organisms that spend time in the air are affected by the same variables as those that live on land. Can you name some organisms that spend much of their time in the air?



Figure 3.4: *Ferns can survive with very little sunlight. A cactus needs a lot of sunlight to grow.*



Figure 3.5: *Soil is a mixture of decayed matter and rock particles.*



Freshwater habitats

Distribution of water on Earth Water covers 71% of Earth's surface. The oceans contain just about all of the water available to living things. About 2.5% of Earth's water is frozen at the poles or is deep underground. Less than 0.01% of Earth's water is found in freshwater habitats such as rivers, streams, lakes, and ponds (Figure 3.6).

Variables in freshwater habitats Variables that affect life on land also affect life in fresh water. These include temperature, precipitation, sunlight, type of soil on surrounding land, and oxygen. The chemical content of the water is very important in determining which types of life can survive there.

pH *pH* is a measure of chemicals called *acids* and *bases* in water. *pH* ranges from 0 to 14. Pure water is *pH* 7 (neutral). Lower *pH* values indicate the presence of acids. Most aquatic plants and animals function best when *pH* is between 6 and 8. Most fish have trouble reproducing when the *pH* is too acidic (Figure 3.7).

Dissolved oxygen The oxygen available to living things in water is called *dissolved oxygen*. Fish “breathe” by passing water over their gills to extract the dissolved oxygen. A good amount of dissolved oxygen for most aquatic life is about 9 parts per million. The amount of dissolved oxygen in freshwater varies with temperature and movement. Cooler waters hold more oxygen than warmer waters. Fast-moving streams contain more oxygen than standing waters like ponds.

Nitrates and phosphates *Nitrates* and *phosphates* are important nutrients for living things. They are often used as fertilizers for land crops. Runoff from rain washes these chemicals into bodies of water. Too many nitrates and phosphates cause large growths of water plants. As the water plants die, they are eaten by bacteria in the water that use dissolved oxygen. This process lowers the amount of dissolved oxygen available to other organisms.

Water source	Percent of total water
Oceans	97.24%
Icecaps, Glaciers	2.14%
Ground water	0.61%
Fresh water lakes	0.009%
Inland sea	0.008%
Soil moisture	0.005%
Atmosphere	0.001%
Rivers	0.0001%

Figure 3.6: *The distribution of Earth's water.*

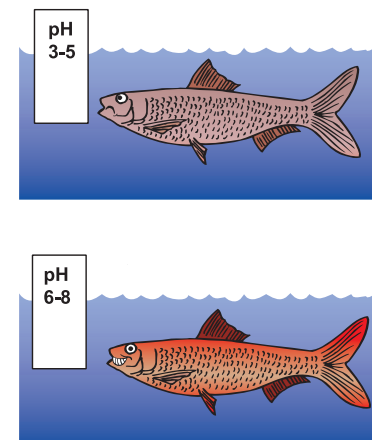
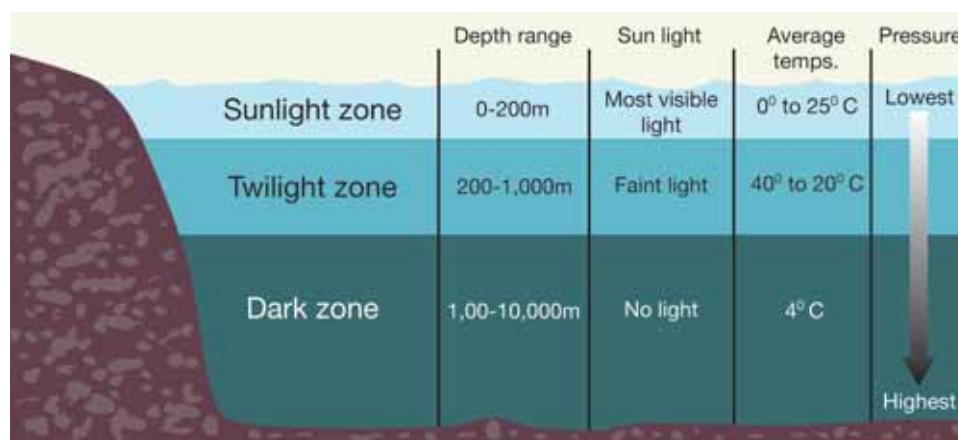


Figure 3.7: *Most fish can survive within the 6 to 8 *pH* range.*

The oceans

Chemicals in ocean water The salty oceans are the most stable of Earth's habitats. The salt content of the oceans has remained stable for 600 million years! The chemicals that the dissolved salts are made of include sodium, chloride, sulfate, magnesium, calcium, and potassium (Figure 3.8). The concentration of salts in the ocean is 35 parts per thousand (ppt). This means that there are 35 grams of salts dissolved in every liter of seawater.

Oceans are divided into zones Scientists divide the ocean into layers called *zones*. Zones extend from the surface to the bottom of the deepest trenches. As you go deeper, temperature and light decrease, and pressure increases.



Life in the zones Most life in the oceans is concentrated in zones where light can penetrate. In most places, light does not reach deeper than 200 meters. Plants that use sunlight to make food cannot live beyond this depth. Life is difficult for organisms in the deep zones. They must overcome lack of light, low temperatures, and extremely high pressures. Some organisms are able to produce their own light so they can find food and locate others of their same species (Figure 3.9).

Chemical	Concentration (ppt)
chloride	19.3
sodium	10.8
sulfate	2.7
magnesium	1.3
calcium	0.4
potassium	0.4
bicarbonate	0.1

Figure 3.8: The main chemicals dissolved in ocean water.



Figure 3.9: These deep-sea fish can produce their own light.



Pollutants

What is a pollutant? Human activities affect ecosystems in both positive and negative ways. One negative effect is pollution. A **pollutant** is a variable that causes harm to an organism. The harmfulness of a pollutant is often determined by three things:

1. Its ability to cause harm to a living thing;
2. Its concentration per unit of air, water, or soil (usually measured in ppt or ppm); and
3. How long it stays in the air, water, or soil.

Sulfur dioxide is an example of a pollutant Sulfur dioxide is a good example of a pollutant (Figure 3.10). In high concentrations in the air, it can make breathing difficult even for healthy people. It may increase the incidence of asthma, bronchitis, and other respiratory problems. It also reacts with water in the atmosphere to make acid rain. Natural areas like forests and lakes can be harmed by acid rain if they are downwind from a city or industrial area. Acid rain can kill trees and lower the pH of lakes and ponds, harming the life forms there.

Sources of pollutants Pollutants enter ecosystems naturally and through human activities. For example, volcanic eruptions are a natural source of sulfur dioxide. Coal-burning power plants are a human source of this pollutant.

Mercury is an example of a pollutant Mercury is another toxic substance that occurs naturally in the environment. It is released into the atmosphere from Earth's crust and oceans. Human activities like industry also cause the release of mercury into the atmosphere. Mercury is deposited from both sources on land and in water. It is taken in by different organisms and builds up in their tissues. When concentrations of mercury get high enough, an organism can get sick and even die.

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pollutant - a variable that causes harm to an organism.

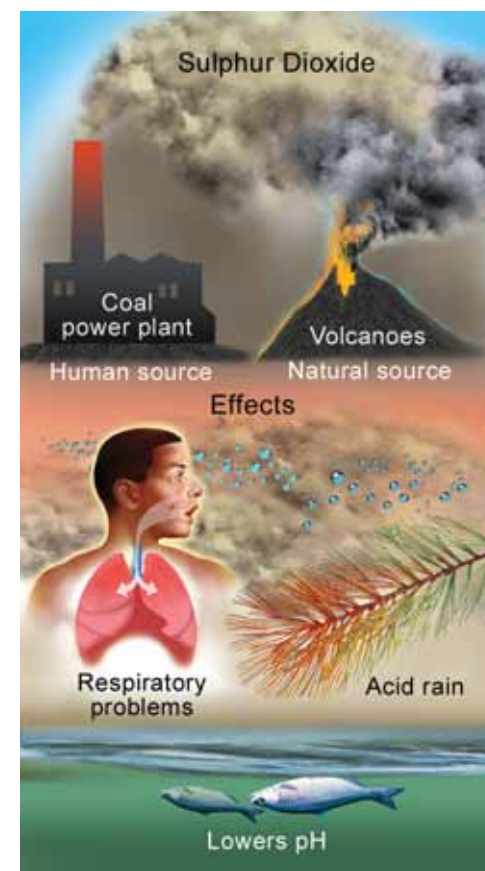


Figure 3.10: Sulfur dioxide is a good example of a pollutant.

3.1 Section Review

1. Explain the difference between an ecosystem and a habitat. Give two examples of each.
2. Describe the habitat of the organism in the picture to the right. List three physical variables of the habitat.
3. List and describe the physical variables of land habitats.
4. Sand is a type of soil best described as:
 - a. mostly decayed matter with tiny rock particles.
 - b. large rock particles and very little decayed matter.
 - c. very small rock particles that hold water well.
 - d. found only on beaches.
5. Carlos wants to set up a freshwater fish tank.
 - a. List the variables he should consider when setting up his tank.
 - b. Explain how Carlos could keep a good level of dissolved oxygen in his tank.
 - c. Why should Carlos test for pH?
6. Hatchetfish live in very deep parts of the ocean. What challenges must they overcome to survive in this environment?
7. What three factors determine if something is a pollutant?
8. Nitrates and phosphates are important chemicals to living things. Explain why these chemicals can also be pollutants.



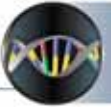
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Certain populations have specific names like a herd of cows or a pride of lions. These terms are referred to as *collective nouns*.

Write a short story about populations of organisms. Your story should include at least five different collective nouns.

SOLVE IT!

In a typical food pyramid of a community, about 65% of the organisms are producers. 20% are primary consumers, 10% are secondary consumers, and only 5% are top consumers. Imagine that your class is a community that is split into these groups. First, count how many students are in your class. Then, use the information above to determine what percent of the students would be producers, primary consumers, secondary consumers, and top consumers.



3.2 Populations and Communities

Individual living things can be grouped into higher levels of organization. Organisms of the same species are grouped into *populations*. Populations of different species are grouped into *communities*. Different communities form *ecosystems*, which as a whole, make up the *biosphere* (Figure 3.11). In this section, you will learn about populations and communities, and how organisms interact with each other in these systems.

Interactions create balance

Organisms interact in an area Organisms living together in an area interact in many ways. Their interactions create a natural balance. Sometimes a species that doesn't belong finds its way into a new area. This can upset the interactions that create the natural balance.

The European green crab The European green crab is a native of the coasts of Europe and Northern Africa (Figure 3.12). Recently, green crabs have been found in California. Scientists think they may have arrived in a cargo ship carrying seawater from another region.

Cause for concern The arrival of the green crab is cause for concern. These small crabs could change any ecosystem they enter. In the 1950s, they were blamed for the destruction of soft-shell clam populations in Maine. Because they can survive a wide range of temperatures, green crabs have the potential to spread up and down the West Coast of the U.S.

How might green crabs affect others? Green crabs eat many types of organisms including clams, mussels, and the young of other crab species. Studies have shown that the green crab is much quicker and a better predator than most other crabs. How might the presence of green crabs affect other types of organisms? To come up with a good hypothesis, you need to learn more about populations and communities.

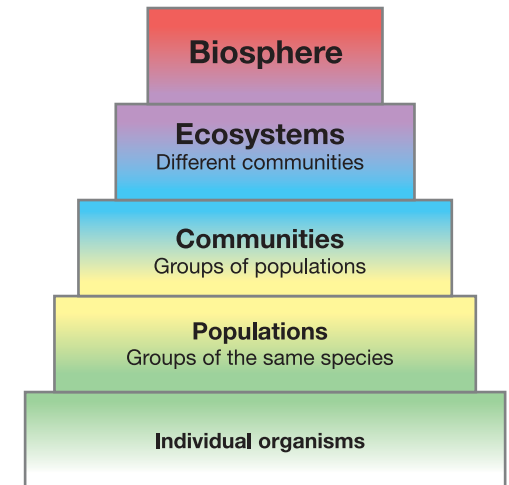


Figure 3.11: Levels of organization of living things on Earth.

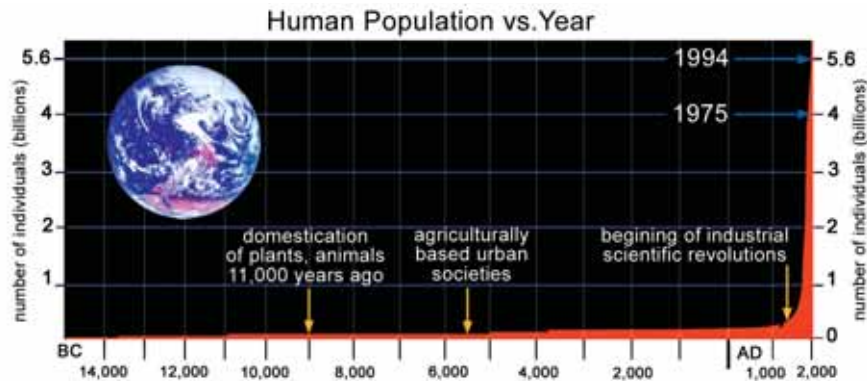


Figure 3.12: The European green crab.

Populations

What is a population? A **population** is a group of individuals of the same species living in a given area. A population of clover plants in a tray consists of the total number of plants in that tray. A population of clover plants in a field consists of the total number of plants in that field (Figure 3.12).

Growth rate Populations change as old members die and new members are born. In nature, populations often stay about the same size from year to year. Other times, populations grow or decline very fast. The change in size of a population over time is called its **growth rate**. Growth rates can be positive, negative, or neutral. The graph below shows the growth rate of the human population. What can you tell about human population growth from this graph?



Limits to population growth In order to grow, a population needs energy, nutrients, and space. Energy and nutrients both come from food. Therefore, population growth is limited by the amount of food available. Population growth is also limited by space. Different organisms require different amounts of space in which to live. If any of these variables are too limited, a population will not continue to grow.

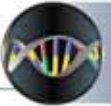


Figure 3.13: *Two different populations of clover plants.*

VOCABULARY

population - a group of individuals of the same species living in a given area.

growth rate - the change in size of a population over time.



Types of interactions

Communities A species' population growth also depends on the other organisms with which it interacts. A **community** is made up of all of the organisms that interact in a given area. On land, forests and prairies are examples of communities. In the ocean, bays and reefs are examples. A community can also be very small—like the organisms living in an aquarium (Figure 3.14).

Predator-prey relationships Most interactions between species in a community involve food. Organisms that hunt and feed on other organisms are called *predators*. Those that are eaten are called *prey*. The green crab is a predator that eats clams and mussels, its prey. Predator-prey relationships help keep population growth in balance. Introducing a new species to a community, like the green crab, can upset this balance.

Competition Often, organisms of the same or different species vie for the same food supply. This type of interaction is called **competition**. When introduced into a new community, the green crab competes with native species of crabs for food. If the green crab is more successful, it can cause negative population growth for other crab species.

Types of symbiosis There are many cases where two species live together for long periods of time. This type of interaction is called **symbiosis**. In symbiosis, one member always benefits from the interaction. In *commensalism*, the other member is unaffected. In *mutualism*, the other member is helped. In *parasitism*, the other member is harmed. For example, a species of barnacle is a parasite of the green crab in its native community (Europe and North Africa). The barnacles weaken some of the crabs and prevent them from reproducing. This helps keep the green crab's population in balance.



Figure 3.14: The organisms in an aquarium are a community.

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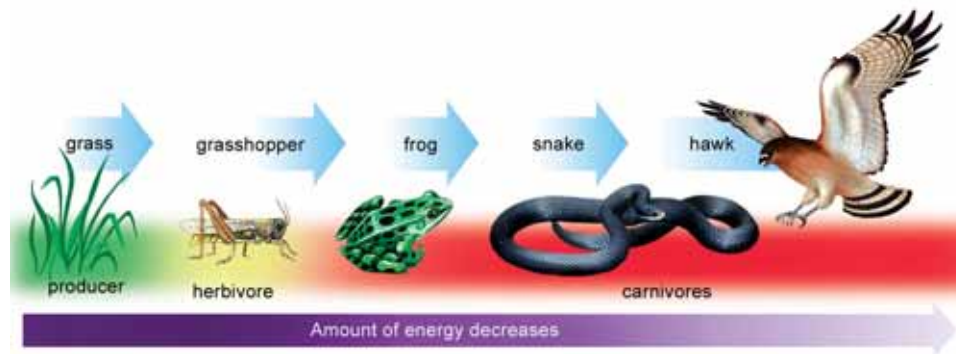
community - all of the organisms that interact in a given area.

competition - when organisms in a community vie for the same food supply.

symbiosis - an interaction where two species live together for a long time.

Food chains

Food chains A **food chain** shows how each organism in a community gets its food. Some animals eat plants and some animals eat other animals. Plants and some protists are called *producers* because they store energy from the Sun. Animals that eat plants are called *herbivores*. Animals that eat other animals are called *carnivores*. A simple food chain links a producer, a herbivore, and one or more carnivores.



Energy and food chains Arrows in the food chain above show how energy is passed from one link to another. In any community, there are always more producers than herbivores or carnivores. When a herbivore eats a plant, only a fraction of the plant's energy becomes part of the herbivore's body. The rest is lost as waste or used for movement. Also, when a carnivore eats another animal, only a portion of that energy becomes part of the carnivore's body. This means that organisms along a food chain pass on less energy than they get from the food they eat. Therefore, the amount of energy decreases as you move up a food chain.

Organisms along a food chain pass on less energy than they get from the food they eat.

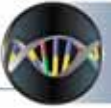
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food chain - shows how each organism in a community gets its food.

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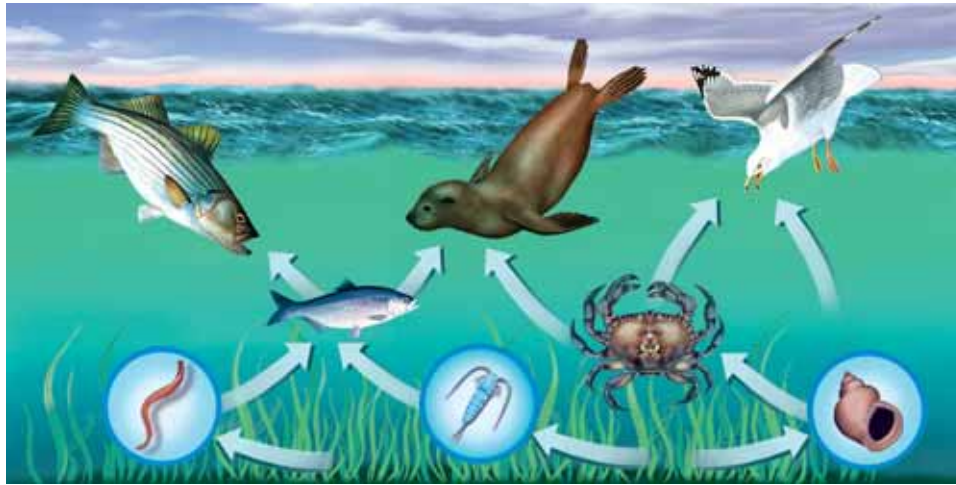
Visit a local park or pond

1. Write down a list of producers, herbivores, and carnivores that live there.
2. Make several food chains using these organisms. Draw arrows to show the direction of energy flow.
3. Be creative! Use photos or drawings of the organisms in your food chains.



Food pyramids You can show a food chain as a pyramid (Figure 3.15). The pyramid shows that a large number of living things at the base is needed to support a few at the top. There cannot be too many links in any food chain because the animals at the end of the chain (or at the top of the pyramid) would not get enough energy to stay alive.

Food webs Most animals are part of more than one food chain. They eat more than one kind of food to get enough energy and nutrients. You can connect many food chains to form a *food web*.



Organisms in a food chain are interrelated A change in the size of one population in a food chain affects other populations. This maintains the balance of different populations in a community. If a snail population becomes too large, there won't be enough food to go around. Many snails will starve and die. Fewer snails means more time for seagrass to reproduce and grow. Fewer snails also means less food for their predators. Once there are fewer predators, the snail population increases again (Figure 3.16). Introducing a new species, like the green crab, into a food chain can upset the balance. The green crab reproduces quickly and eats just about anything, animal or plant. Can you see why the presence of the European green crab is cause for alarm?



Figure 3.15: A food chain can also be shown as a pyramid.

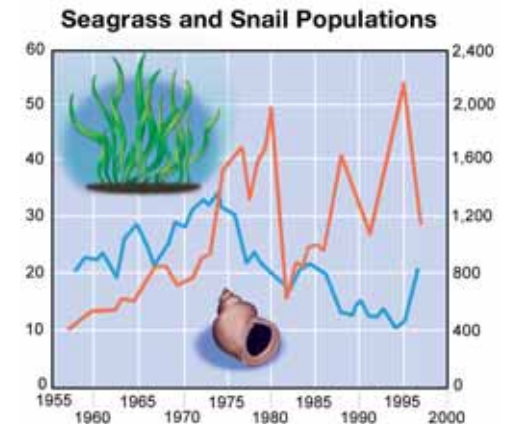
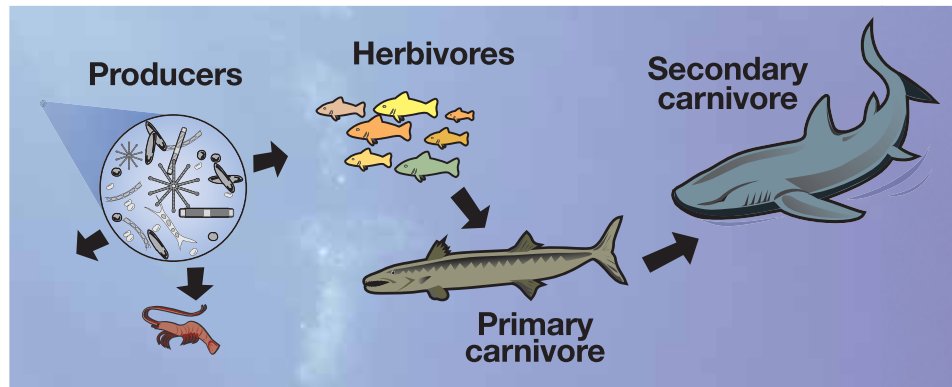


Figure 3.16: A change in size of one population affects the other populations.

Toxins in the food chain

What are toxins? Human activities create toxic pollutants (*toxins*). Toxins eventually end up in lakes and oceans (Figure 3.17). High concentrations of toxins can impact populations. They can cause slowed growth, decreased reproduction, and even death. When these substances enter lakes and oceans, they spread out and become less concentrated. Food chains concentrate some toxic pollutants, like mercury, into the tissues of animals. To understand how this happens, let's look at a marine food chain.



Concentration of toxins Toxins are concentrated at each link in a food chain. As producers store energy, they absorb molecules of toxins from the water. Next, herbivores eat large numbers of producers. Toxins like mercury dissolve in fat, not water. They are stored in the fatty tissues of herbivores and are not passed out of their bodies.

Toxins can be passed on to offspring When carnivores eat many herbivores, they accumulate even higher levels of toxins in their tissues. *Secondary carnivores*, who prey on other carnivores, can accumulate dangerous levels of toxic pollutants. These toxins can sometimes be passed on to their young. Figure 3.18 shows how the amount of a toxic pollutant can multiply as it travels up the food chain.

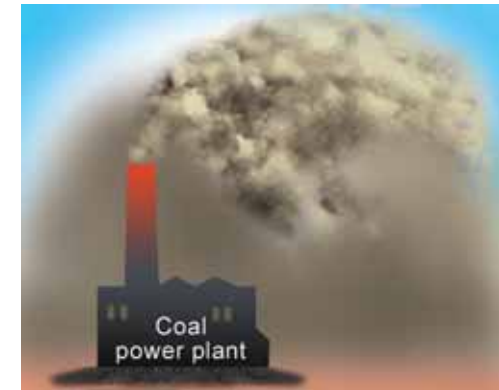


Figure 3.17: Some power plants send mercury into the air. This eventually falls to Earth with the rain and ends up in lakes and oceans.

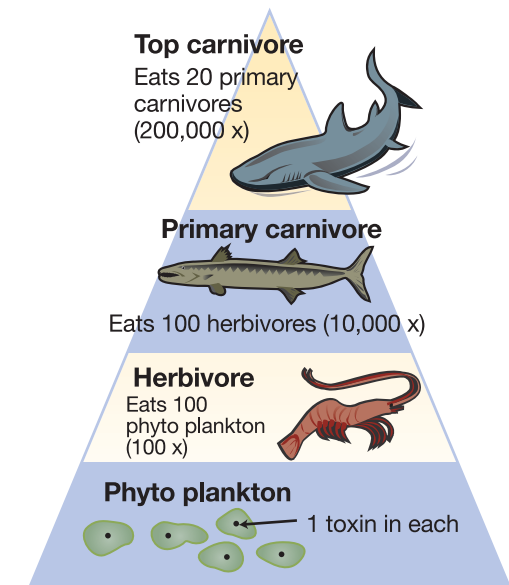
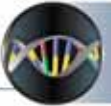
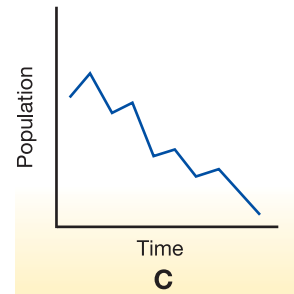
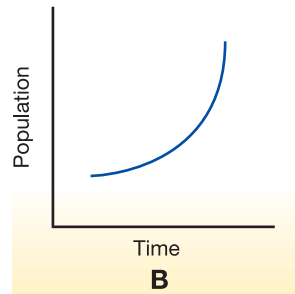
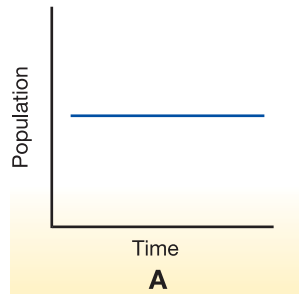


Figure 3.18: The pyramid shows how toxins are concentrated at each link in a food chain.



3.2 Section Review

1. What is a population? Give three examples of populations.
2. What three things does a population need to grow?
3. Which graph shows negative population growth?



4. What is the difference between a population and a community? Give two examples of communities.
5. A *remora* is a small fish that follows sharks around and eats their scraps. The shark does not benefit from the remora. This is an example of:
 - a. competition
 - b. predator-prey
 - c. parasitism
 - d. commensalism
6. Cans of tuna often carry warning labels. They state that pregnant women should limit the amount of tuna they eat each month.
 - a. Explain why tuna could contain dangerous toxins.
 - b. Draw a food chain showing how toxins could concentrate in the tissues of a tuna.

CHALLENGE

Find three real-life examples of each of the following interactions:

1. Competition
2. Predator-prey
3. Commensalism
4. Parasitism
5. Mutualism

Use encyclopedias and/or the Internet as resources.

SOLVE IT!

An ecologist studied the presence of a toxic chemical in a lake. She found that the water had one molecule of the toxin for every one billion molecules of water, or one part per billion (1 ppb). The algae had one part per million (1 ppm) of the toxin. Small animals, called zooplankton, had 10 ppm. Small fish had 100 ppm. Large fish had 1,000 ppm. How do you explain the increase in this toxin to 1,000 ppm for large fish? Use a drawing to help support your answer.



Yellow Star Thistle

Chances are, you have seen this stuff, maybe in a scene from a movie or a travel photograph of the Golden State. It blankets over 15 million acres of California wildland and pasture, roadsides and vacant lots, with thick patches of brilliant golden-yellow flowers that stand three to five feet tall. From the safe distance of a car or camera, yellow star thistle probably seemed like a beautiful wildflower brightening the landscape.

If, on the other hand, you were unlucky enough to wipe out on a mountain bike and land in one of these patches, you have discovered that yellow star thistle has a sinister side: spiky five-centimeter spines sticking out in every direction.

The painful jabs these spines inflict are not soon forgotten. And the plant is even crueler to horses. When they eat large amounts of this thistle, their lips and tongues become stiff and swollen, so that eating and drinking are difficult. Eventually it causes brain damage and death.

A costly problem

Yellow star thistle is painful in other ways, too. Ranchers despise this plant because their livestock don't like to eat it. (What creature would want to eat something that can poke it in the eye?) It grows so thick that it crowds out grazing grasses, rendering expensive ranch land useless for pasture.

Even worse, this plant has an amazing ability to suck water out of the soil. It has a long central taproot that can extend more than a meter. Over the course of its growing season, one thistle plant takes as much water out of the soil as does a mature oak tree. A report quoted by the University of

California Weed Research and Information Center states that these thistles may cost the state from \$16 million to \$56 million in water conservation annually.

How did it get here?

Yellow star thistle is native to Europe. The thistle's seeds have been found in California adobe bricks dating to the mid-1800s. Scientists believe the plant was brought from Spain to Chile in the 1600s, then from Chile to California in the 1800s, when farmers imported alfalfa seed that had some yellow star thistle seed mixed in.

Each yellow star thistle seedhead produces about 35 to 80 seeds. On their own, few seeds move more than two feet from the parent plant. It is human activity that is mainly responsible for spreading the seeds: they stick to the tractors that mow

roadside areas; construction equipment spreads them across new housing developments; sheep and cattle carry them in their coats to new grazing areas. Some seeds are still spread the way they were when they first came to California 200 years ago: among contaminated alfalfa seed.

Peggy Greb, USDA Agricultural Research Service,
www.forestryimages.org



What can be done?

It's not easy to get rid of yellow star thistle. You cannot burn the plants out because their seeds survive unharmed in the soil. Herbicides work, but they are too expensive to be used against a weed problem this large.

Scientists are studying insects from Greece and a fungus from Turkey, hoping that some of the plant's natural enemies could be imported to get it under control in California. But first they have to make sure these animals and plants wouldn't instead attack native California plants or crops.



In the meantime, further spread of the yellow star thistle can be prevented by cleaning trucks, tractors, and livestock to remove seeds before moving them to uninfested areas.

The Weed Research and Information Center helps ranchers and conservationists create management plans tailored to a specific area. Often, a combination of chemical, biological, and mechanical methods (like mowing) is used. Different methods are effective during different parts of the plant's life cycle. Used together, they could in a few years make a big dent in the yellow star thistle population.

The long view ...

Evolutionary biologists remind us it is useful to take a step back from the current problems of such pesky invaders. While yellow star thistle has certainly been no friend to ranchers, horses, or mountain bike riders, its long-term impact on California's ecosystems may not be disastrous.

Dr. Dov Sax of the University of California-Santa Barbara's Department of Ecology, Evolution, and Marine Biology cautions that it is easy to label invaders as "bad" and native plants as "good." In reality, many species that are now considered native were once invaders themselves.

The fossil record shows that over the course of Earth's history, massive shifts have occurred in the plants and animals that inhabit California. Invasions and extinctions have been caused by asteroid impacts, movement of land masses, rise and fall of sea levels, and glacial cycles. While painful in the short term, over the long term these events did not permanently reduce the total number of plant and animal species or cause long-lasting ecological damage. Perhaps a thousand years from now, the current wave of invasions will be seen as another interesting population shift that changed, but did not destroy, the California ecosystem.

Questions:

1. Name two ways that yellow star thistle costs Californians money.
2. Some clever Californians have found a way to make money from yellow star thistle. Use an Internet search engine to see if you can discover which agricultural enterprise uses this plant to benefit.
3. Look up the term "biodiversity" in an encyclopedia. Write a paragraph that defines biodiversity and give three reasons it is important to our planet.



CHAPTER ACTIVITY

Analyzing Population Growth

The human population is growing. Currently there are over 6 billion people on Earth. Table 3.1 below gives estimates of the human population over the past 2000 years. From the table, you can tell that the population has risen. A graph of the data is a better tool for analyzing the data. Using graph paper, make a graph of the data in Table 3.1.

Table 3.1: Human population (in billions)

Year	Population	Year	Population	Year	Population
0	0.30	1850	1.26	1950	2.52
1000	0.31	1900	1.65	1960	3.02
1250	0.40	1910	1.75	1970	3.70
1500	0.50	1920	1.86	1980	4.44
1750	0.79	1930	2.07	1990	5.27
1800	0.98	1940	2.30	2000	6.06

Applying your knowledge

- Based on the graph that you created, describe what has been happening to the global population over the last 200 years. How much did world's population change in the last 40 years?
- Graphs can be used to make predictions. Use your graph to predict the global population in the years 2040 and 2080 if the pattern you observe on this graph continues.

The number of individuals a given area can support is called the *carrying capacity*. When a species of organisms comes into a new area for the first time there are lots of resources available. The size of that population increases rapidly. Use the graph titled Carrying Capacity (right) to answer questions c through f.



- During what time period did the population increase rapidly for the organism?
- Eventually resources like space and food become limited. If there are more organisms in an area than the resources can support, some organisms will die off. During what time periods did this occur on the graph?
- Eventually, populations adjust to available resources and become more stable. What part of the graph indicates a stable population?
- Compare your graph of the human population to the graph above. Are there any similar features found in both graphs? What does this say about the human population?

Chapter 3 Assessment

Vocabulary

Select the correct term to complete the sentences.

ecosystem	population	competition
food chain	growth rate	symbiosis
pollutants	community	habitat

Section 3.1

1. ____ can enter an ecosystem because of natural causes or human activities.
2. An organism must live in a certain ____ that suits its particular needs.
3. An ____ includes the living and non-living things functioning together.

Section 3.2

4. There are three types of ____: parasitism, mutualism, and commensalism.
5. A ____ always starts with a producer storing energy from the sun.
6. A group of organisms of the same species living together in a certain place is a ____.
7. Predator-prey relationships, competition, and symbiosis are the three types of interactions among organisms in a ____.
8. How populations increase or decrease in numbers over time is called the ____.
9. Organisms in the same community may be in ____ for food, water, or living space.

Concepts

Section 3.1

1. Name a habitat where you predict that there are species that have yet to be classified by scientists. Give an explanation for your prediction.
2. Which is not a variable that affects organisms that live on land?
 - a. sunlight
 - b. oxygen
 - c. temperature
 - d. pH
3. List and describe the three variables of freshwater habitats that are different than variables that affect land habitats.
4. Why is most life in the ocean concentrated near the surface? Discuss sunlight, temperature, and pressure in your answer.

Section 3.2

5. Put these terms in order from smallest to largest level of organization: organ system, biosphere, tissue, organism, ecosystem, population, community, organ, cell.
6. Which of the following limit population growth?
 - a. space
 - b. nutrients
 - c. food
 - d. all of the above
7. The amount of energy _____ as you move further up a food chain.
 - a. increases
 - b. decreases
 - c. remains the same

8. Identify the following examples as: predator-prey relationship, competition, or symbiosis.
- Purple loosestrife, *Lythrum salicaria*, an invasive introduced plant species, needs the same wetland habitat as a native plant, cattails, *Typha spp.* Purple loosestrife is a fast growing plant that forms dense mats and can produce as many as 2.7 million seeds per flower.
 - The barnacle, *Sacculina carcini*, bores into the tissue of the European green crab, *Carcinus maenas*, to form an egg sac. This egg sac, which makes the crabs sterile, also turns the crab into an egg production facility for the barnacle.
 - The California sea lion, *Zalophus californianus*, is the fastest aquatic carnivore, swimming at speeds up to 25 mph. Sea lions feed on squid, octopus, abalone, and as many as fifty different species of fish. *Opalescent squid*, *Loligo opalescens*, can change color and patterns very quickly as it swims to camouflage.
9. A food ____ can also be shown as a food _____. Many food chains connected make up a food _____.
- web, pyramid, chain
 - chain, web, pyramid
 - pyramid, web, chain
 - chain, pyramid, web
10. Identify what type of symbiosis is being described below. List the organisms involved in the relationship. Next to each organism, indicate if it is helped or hurt. Use a + sign if the organism is helped, a - sign if the organism is harmed, and a 0 to show that it is neither helped nor harmed.

- A lichen is an organism made up of a green alga and a fungus that is often found on the surface of rocks or trees. The alga supplies the fungus with sugar by performing photosynthesis. The fungus protects the alga from intense sunlight and extreme temperatures by providing shelter.
- Desert night lizards, *Xantusia vigilis*, are very secretive reptiles that feed, reproduce, and live most of their lives under cover. Desert night lizards are usually found under dead leaves or dead branches of the Joshua Tree, *Yucca brevifolia*. Cover allows desert night lizards to hide from their predators like larger lizards, snakes, and predatory birds.
- Pacific mistletoe, *Phoradendron villosum*, is a unique type of plant that has no roots, but does have chlorophyll like other plants. It lives in the crowns of oak trees, *Quercus spp.*, in order to get the nutrients that other plants would get using their roots. By living in the tops of the oak trees, the Pacific mistletoe is also sure to get enough sunlight for photosynthesis. The oak tree loses nutrients and sunlight to the Pacific mistletoe plant.

Math and Writing Skills

Section 3.1

- Invent your own creature that is adapted to life in the deep ocean. Be sure to include adaptations to deal with the challenges of no sunlight, cold temperatures, and extreme pressure.
- Describe ways that you as an individual can help stop pollution in the environment.