Section 1

Living Things and the Environment

CALIFORNIA Standards Focus

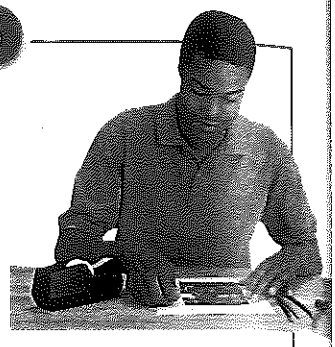
S 6.5.e Students know the number and types of organisms an ecosystem can support depends on the resources available and on abiotic factors, such as quantities of light and water, a range of temperatures, and soil composition.

- What needs are met by an organism's environment?
- What are the two parts of an organism's habitat with which it interacts?
- What are the levels of organization within an ecosystem?

Key Terms

- organism
- habitat
- biotic factor
- abiotic factor
- photosynthesis
- species
- population
- community
- ecosystem
- ecology

Lab zone Standards Warm-Up



What Does It Depend On?

1. Choose a magazine picture of a nature scene. Paste the picture onto a sheet of paper, leaving space all around the picture.
2. Locate everything in the picture that is alive. Use a colored pencil to draw a line from each living thing. If you know its name, write it on the line.
3. Using a different colored pencil, label each nonliving thing.

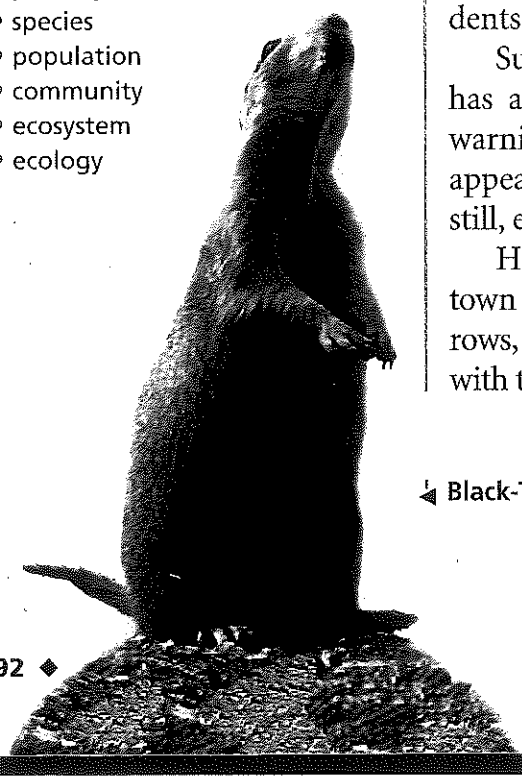
Think It Over

Inferring How do the living things in the picture depend on the nonliving things? Using a third color, draw lines connecting the living things to the nonliving things they need.

As the sun rises on a warm summer morning, the Nebraska town is already bustling with activity. Some residents are hard at work building homes for their families. They are working underground, where it is dark and cool. Other inhabitants are collecting seeds for breakfast. Some of the town's younger residents are at play, chasing each other through the grass.

Suddenly, an adult spots a threatening shadow—an enemy has appeared in the sky! The adult cries out several times, warning the others. Within moments, the town's residents disappear into their underground homes. The town is silent and still, except for a single hawk circling overhead.

Have you guessed what kind of town this is? It is a prairie dog town on the Nebraska plains. As these prairie dogs dug their burrows, searched for food, and hid from the hawk, they interacted with their environment, or surroundings.



Black-Tailed Prairie Dog

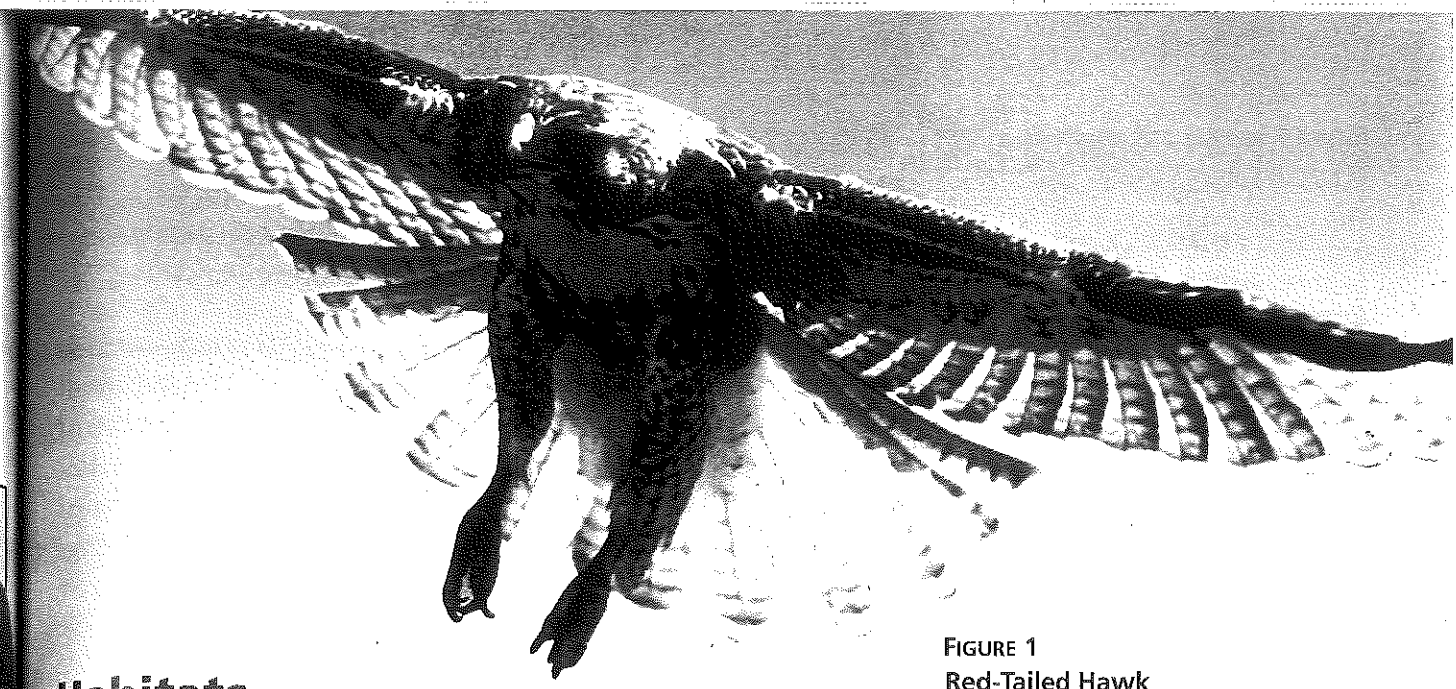


FIGURE 1
Red-Tailed Hawk
This red-tailed hawk obtains food, water, and shelter from its habitat. Prairie dogs are a source of food for red-tailed hawks.

Habitats

A prairie dog is one type of **organism,** or living thing. Different types of organisms must live in different types of environments. **An organism obtains food, water, shelter, and other things it needs to live, grow, and reproduce from its environment.** An environment that provides the things the organism needs to live, grow, and reproduce is called its **habitat.**

One area may contain many habitats. For example, in a forest, mushrooms grow in the damp soil, salamanders live on the forest floor, and woodpeckers build nests in tree trunks.

Organisms live in different habitats because they have different requirements for survival. A prairie dog obtains the food and shelter it needs from its habitat. It could not survive in a tropical rain forest or on the rocky ocean shore. Likewise, the prairie would not meet the needs of a spider monkey or hermit crab.

Reading Checkpoint Why do different organisms live in different habitats?

Biotic Factors

To meet its needs, a prairie dog must interact with more than just the other prairie dogs around it. **An organism interacts with both the living and nonliving parts of its habitat.** The living parts of a habitat are called **biotic factors** (by AHT ik). Biotic factors in the prairie dogs' habitat include the grass and plants that provide seeds and berries. The hawks, ferrets, badgers, and eagles that hunt the prairie dogs are also biotic factors. In addition, worms, fungi, and bacteria are biotic factors that live in the soil underneath the prairie grass.

Reading Checkpoint Name a biotic factor in your environment.

Lab zone Try This Activity

Observing a Habitat

1. With your teacher's permission, visit an area such as a schoolyard or park that contains habitats for a variety of organisms. **CAUTION:** *Avoid insect bites or contact with harmful plants that may cause allergic reactions.*
2. Select appropriate tools, such as binoculars or a hand lens. Use them to observe a particular organism and the biotic factors in its habitat.
3. Record your observations. To display your data, make a poster showing your organism and the biotic factors you identified.

Predicting How do you think the organism interacts with the habitat's biotic factors?

FIGURE 2
Abiotic Factors
The nonliving things in an organism's habitat are abiotic factors. **Applying Concepts** *Name three abiotic factors you interact with each day.*

▲ This orangutan is enjoying a drink of water.

▲ Sunlight enables this plant to make its own food.

▲ This banjo frog burrows in the soil to stay cool.

Abiotic Factors

Abiotic factors (ay by AHT ik) are the nonliving parts of an organism's habitat. They include water, sunlight, oxygen, temperature, and soil.

Water All living things require water to carry out their life processes. Water also makes up a large part of the bodies of most organisms. Your body, for example, is about 65 percent water. Plants and algae need water, along with sunlight and carbon dioxide, to make their own food in a process called **photosynthesis** (foh toh SIN thuh sis). Other living things depend on plants and algae for food.

Sunlight Because sunlight is needed for photosynthesis, it is an important abiotic factor for most living things. In places that do not receive sunlight, such as dark caves, plants and algae cannot grow. Because there are no plants or algae to provide food, few other organisms can live in such places.

Oxygen Most living things require oxygen to carry out their life processes. Oxygen is so important to the functioning of the human body that you can live only a few minutes without it. Organisms that live on land obtain oxygen from air, which is about 20 percent oxygen. Fish and other water organisms obtain oxygen that is dissolved in the water around them.

Temperature The typical range of temperatures in an area determines the types of organisms that can live there. For example, if you took a trip to a warm tropical island, you might see colorful orchid flowers and tiny lizards. These organisms could not survive on the frozen plains of Siberia.

Some animals alter their environments so they can survive very hot or very cold temperatures. Prairie dogs, for example, dig underground dens to find shelter from the hot summer sun and cold winter winds.

Soil Soil is a mixture of rock fragments, nutrients, air, water, and the decaying remains of living things. Soil in different areas consists of varying amounts of these materials. The composition of soil in an area influences the kinds of plants that can grow there. Many animals, such as the prairie dogs, use the soil itself as a home. Billions of microscopic organisms such as bacteria also live in the soil.

Reading Checkpoint **How do abiotic factors differ from biotic factors?**

Levels of Organization

Of course, organisms do not live all alone in their habitat. Instead, organisms live together in populations and communities, and with abiotic factors in their ecosystems.

Populations In 1900, travelers saw a prairie dog town in Texas that covered an area twice the size of the city of Dallas. The town contained more than 400 million prairie dogs! These prairie dogs were all members of one species, or single kind, of organism. A **species** (SPEE sheez) is a group of organisms that are physically similar and can mate with each other and produce offspring that can also mate and reproduce.

All the members of one species in a particular area are referred to as a **population.** The 400 million prairie dogs in the Texas town are one example of a population. All the pigeons in New York City make up a population, as do all the bees that live in a hive. In contrast, all the trees in a forest do not make up a population, because they do not all belong to the same species. There may be pines, maples, birches, and many other tree species in the forest.

Communities A particular area usually contains more than one species of organism. The prairie, for instance, includes prairie dogs, hawks, grasses, badgers, and snakes, along with many other organisms. All the different populations that live together in an area make up a **community.**

To be considered a community, the different populations must live close enough together to interact. One way the populations in a community may interact is by using the same resources, such as food and shelter. For example, the tunnels dug by prairie dogs also serve as homes for burrowing owls and black-footed ferrets. The prairie dogs share the grass with other animals. Meanwhile, prairie dogs themselves serve as food for many species.

Lab zone Try This Activity

With or Without Salt?

In this activity you will explore salt as an abiotic factor.

1. Label four 600-mL beakers A, B, C, and D. Fill each with 500 mL of room-temperature spring water.
2. Set beaker A aside. Add 2.5 grams of noniodized salt to beaker B, 7.5 grams of salt to beaker C, and 15 grams of salt to beaker D. Stir each beaker.
3. Add $\frac{1}{8}$ spoonful of brine shrimp eggs to each beaker.
4. Cover each beaker with a square of paper. Keep them away from direct light or heat. Wash your hands.
5. Observe the beakers daily for three days.

Drawing Conclusions In which beakers did the eggs hatch? What can you conclude about the amount of salt in the shrimps' natural habitat?

FIGURE 3
A Population
All these zebras make up a population.

Go Online
SCILINKS NSTA

For: Links on biotic and abiotic factors
Visit: www.SciLinks.org
Web Code: scn-0511

Ecosystems The community of organisms that live in a particular area, along with their nonliving surroundings, make up an **ecosystem.** A prairie is just one of the many different ecosystems found on Earth. Other ecosystems in which living things make their homes include mountain streams, deep oceans, and evergreen forests.

Figure 4 shows the levels of organization in an ecosystem. **The smallest level of organization is a single organism, which belongs to a population that includes other members of its species. The population belongs to a community of different species. The community and abiotic factors together form an ecosystem.**

Because the populations in an ecosystem interact with one another, any change affects all the different populations that live there. The study of how living things interact with each other and with their environment is called **ecology.** Ecologists are scientists who study ecology. As part of their work, ecologists study how organisms react to changes in their environment. An ecologist, for example, may look at how a fire affects a prairie ecosystem.

Reading Checkpoint **What is ecology?**

Section 1 Assessment

S 6.5.e; E-LA: Reading 6.1.0; Writing 6.2.0

Vocabulary Skill Use Related Words
Complete the sentence by using the correct form of *habitat* or *inhabit.* An organism must live in a _____ that meets its needs for survival.

Reviewing Key Concepts

1. a. **Listing** What basic needs are provided by an organism's habitat?
   b. **Predicting** What might happen to an organism if its habitat could not meet one of its needs?
2. a. **Defining** Define the terms *biotic factors* and *abiotic factors.*
   b. **Interpreting Illustrations** List all the biotic and abiotic factors in Figure 4.
   c. **Making Generalizations** Explain why water and sunlight are two abiotic factors that are important to most organisms.
3. a. **Sequencing** List these terms in order from the smallest level to the largest: *population, organism, ecosystem, community.*
   b. **Classifying** Would all the different kinds of organisms in a forest be considered a population or a community? Explain.
   c. **Relating Cause and Effect** How might a change in one population affect other populations in a community?

Writing in Science

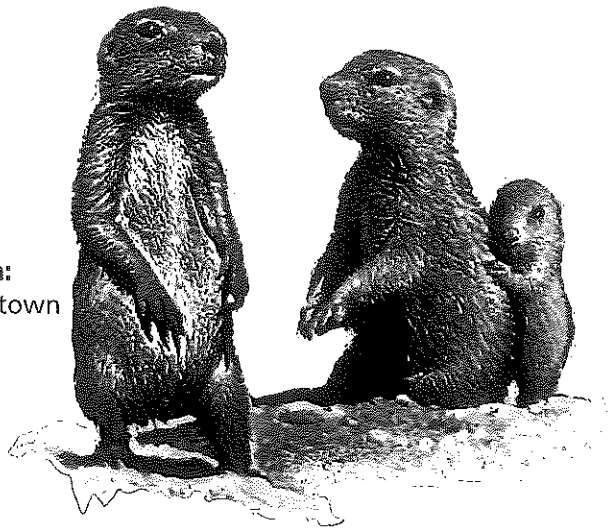
Descriptive Paragraph What habitat do you live in? Write a one-paragraph description of your habitat. Describe how you obtain the food, water, and shelter you need from your habitat. How does this habitat meet your needs in ways that another would not?

FIGURE 4

Ecological Organization

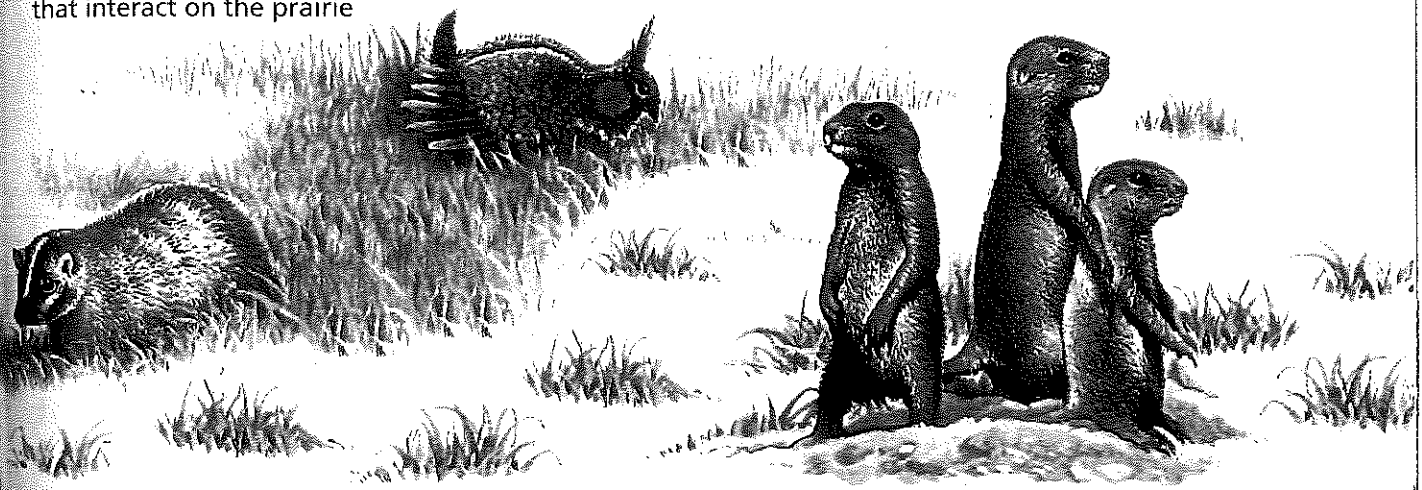
The smallest level of organization is the organism. The largest is the entire ecosystem.

Organism: Prairie dog

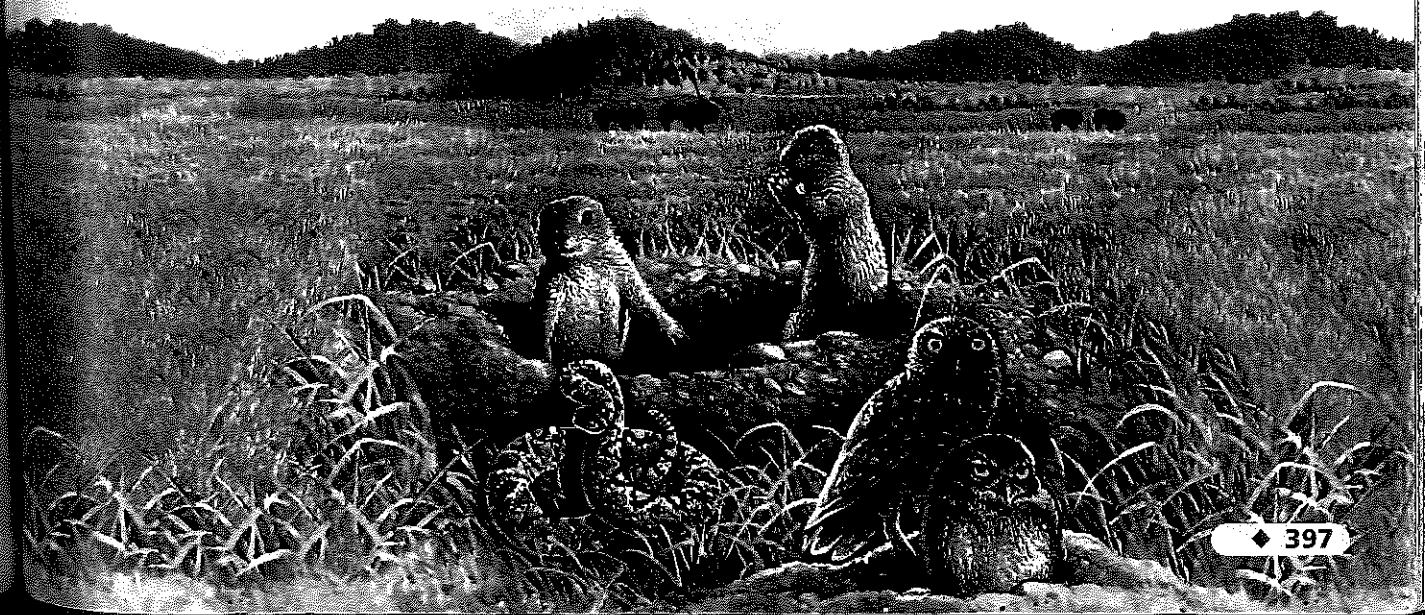


Population: Prairie dog town

Community: All the living things that interact on the prairie



Ecosystem: All the living and nonliving things that interact on the prairie



Section 2

Populations

CALIFORNIA Standards Focus

S 6.5.e Students know the number and types of organisms an ecosystem can support depends on the resources available and on abiotic factors, such as quantities of light and water, a range of temperatures, and soil composition.

- What causes populations to change in size?
- What factors limit population growth?

Key Terms

- birth rate
- death rate
- immigration
- emigration
- limiting factor
- carrying capacity

Lab zone Standards Warm-Up

How Can Population Size Change?

A population of 30 deer lives in a forest. In your notebook, calculate how the population size changes during the five years listed below.

1. In the first year, 10 deer are born and 5 die.
2. In the second year, 8 deer are born and none die.
3. In the third year, 7 deer are born and 2 die.
4. In the fourth year, 12 deer are born, 8 die, and 10 leave the forest.
5. In the fifth year, 6 deer are born, 10 die, and 12 leave the forest.
6. Make a graph of the changes in population size.

Think It Over

Interpreting Graphs Describe how the population size of the deer herd changed over time. Did the overall population size increase, stay the same, or decrease?

How would you like to be an ecologist today? Your assignment is to study the albatross population on an island. One question you might ask is how the size of the albatross population is changing. Is the number of albatrosses on the island increasing, decreasing, or remaining about the same? To answer this question, an ecologist must observe how the size of the albatross population changes over several years.

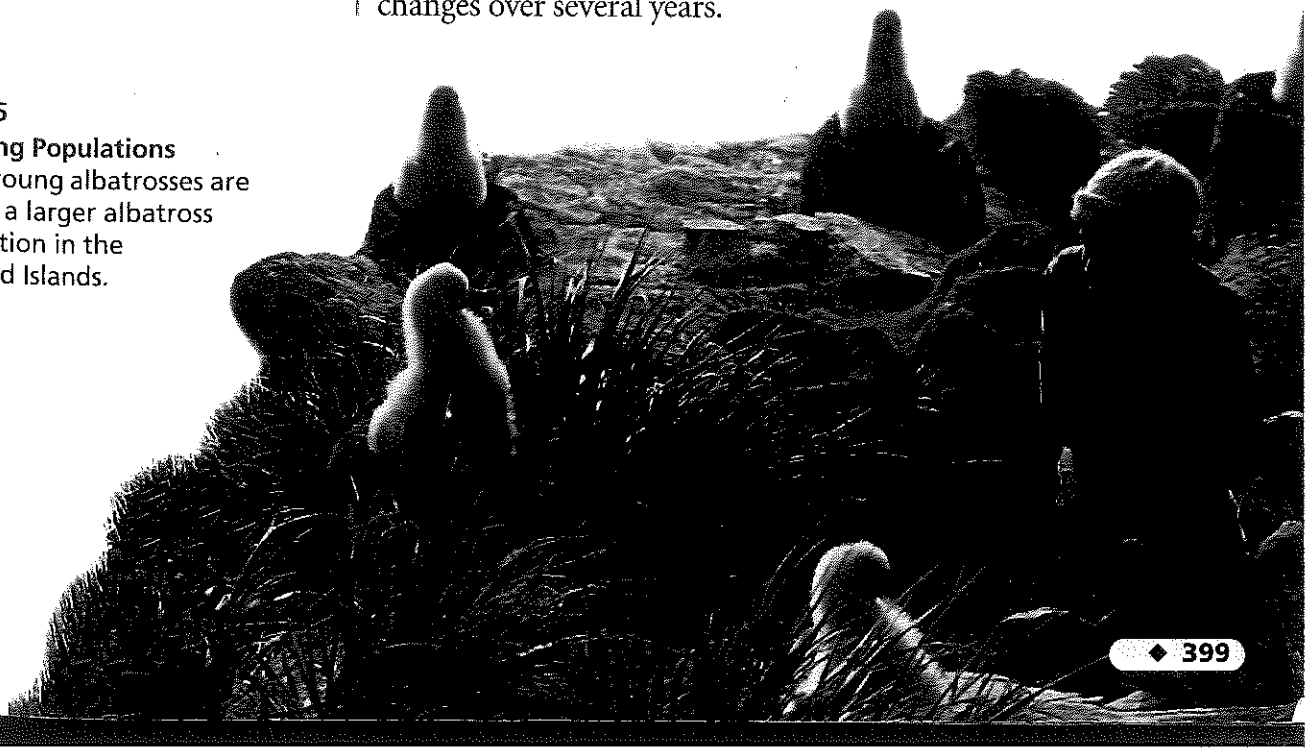


FIGURE 5
Studying Populations These young albatrosses are part of a larger albatross population in the Falkland Islands.

Changes in Population Size

The size of any population does not remain the same for very long. **Populations can change in size when new members join the population or when members leave the population.**

Births and Deaths The main way in which new individuals join a population is by being born into it. The **birth rate** of a population is the number of births in a population in a certain amount of time. For example, suppose that a population of 100 rabbits produces 600 young in a year. The birth rate in this population would be 600 young per year.

The main way that individuals leave a population is by dying. The **death rate** is the number of deaths in a population in a certain amount of time. If 400 rabbits die in a year in the population, the death rate would be 400 rabbits per year.

The Population Statement When the birth rate in a population is greater than the death rate, the population will generally increase. This can be written as a mathematical statement using the "is greater than" sign:

If birth rate > death rate, population size increases.

However, if the death rate in a population is greater than the birth rate, the population size will generally decrease. This can also be written as a mathematical statement:

If death rate > birth rate, population size decreases.

Immigration and Emigration The size of a population also can change when individuals move into or out of the population. **Immigration** (im ih GRAY shun) means moving into a population. **Emigration** (em ih GRAY shun) means leaving a population. For instance, if food is scarce, some members of an antelope herd may wander off in search of better grassland. If they become permanently separated from the original herd, they will no longer be part of that population.

Graphing Changes in Population Changes in a population's size can be displayed on a line graph. Figure 6 shows a graph of the changes in a rabbit population. The vertical axis shows the numbers of rabbits in the population, while the horizontal axis shows time. The graph shows the size of the population over a ten-year period.

Reading Checkpoint How does emigration affect population size?

Math Skills

Inequalities

The population statement is an example of an inequality. An inequality is a mathematical statement that compares two expressions. Two signs that represent inequalities are

< (is less than)

> (is greater than)

For example, an inequality comparing the fraction $\frac{1}{2}$ to the decimal 0.75 would be written

$$\frac{1}{2} < 0.75$$

Practice Problems Write an inequality comparing each pair of expressions below.

1. $5 \blacksquare -6$
2. $0.4 \blacksquare \frac{3}{5}$
3. $-2 - (-8) \blacksquare 7 - 1.5$

FIGURE 6
This line graph shows how the size of a rabbit population changed over a ten-year period. **Interpreting Graphs** *In what year did the rabbit population reach its highest point? What was the size of the population in that year?*

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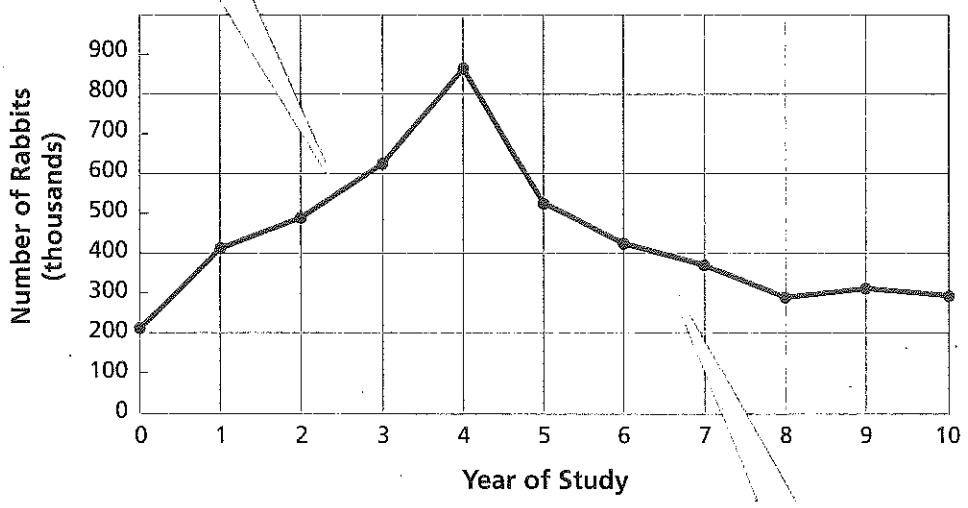
For: Changes in Population activity
Visit: PHSchool.com
Web Code: cep-5012

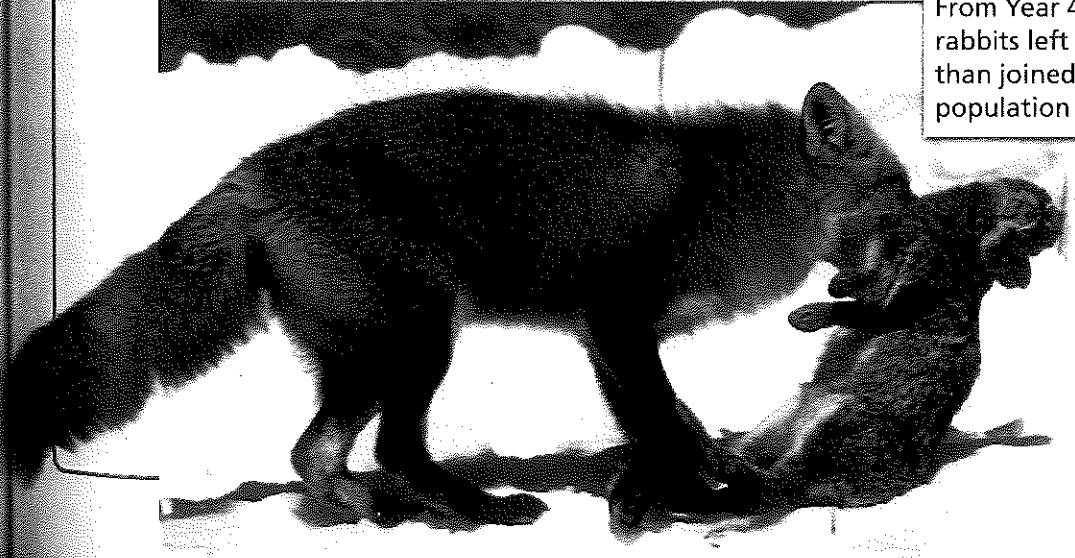
▼ Young rabbits in a nest

From Year 0 to Year 4, more rabbits joined the population than left it, so the population increased.

Changes in a Rabbit Population



From Year 4 to Year 8, more rabbits left the population than joined it, so the population decreased.



◀ Rabbit caught by a fox

Limiting Factors

When the living conditions in an area are good, a population will generally grow. But eventually some environmental factor will cause the population to stop growing. The number of organisms an ecosystem can support depends on the amount of resources available and on abiotic factors. A **limiting factor** is an environmental factor that causes a population to stop growing. **Some limiting factors for populations are food and water, space, light, soil composition, and weather conditions.**

Food and Water Organisms require food and water to survive. Since food and water are often in limited supply, they are often limiting factors. Suppose a giraffe must eat 10 kilograms of leaves each day to survive. The trees in an area can provide 100 kilograms of leaves a day while remaining healthy. Five giraffes could live easily in this area, since they would only require a total of 50 kilograms of food. But 15 giraffes could not all survive—there would not be enough food. No matter how much shelter, water, and other resources there were, the population would not grow much larger than 10 giraffes.

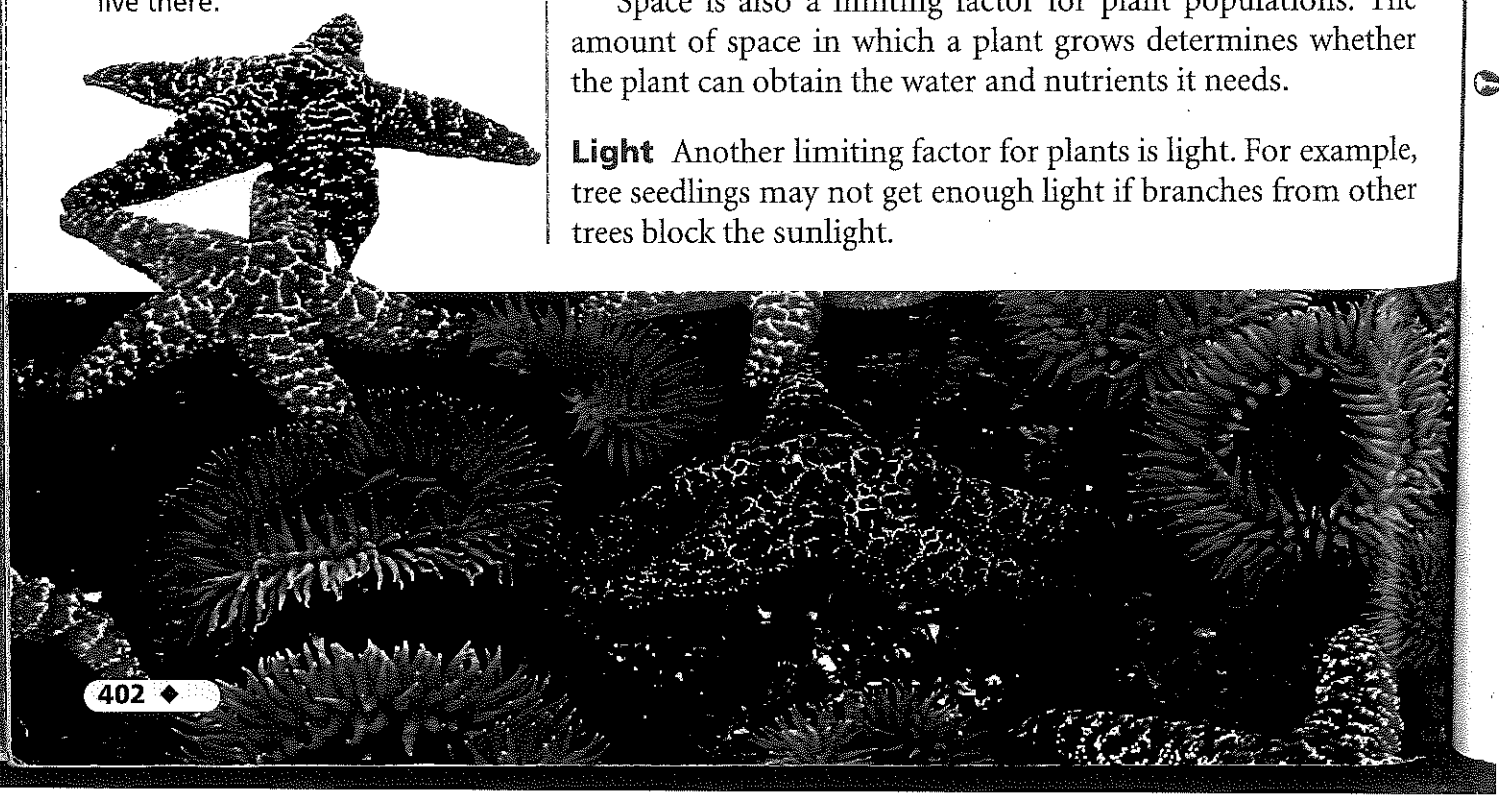
The largest population that an area can support is called its **carrying capacity.** The carrying capacity of this giraffe habitat would be 10 giraffes. A population usually stays near its carrying capacity because of the limiting factors in its habitat.

Space Space is also a limiting factor. For example, nesting space is a limiting factor for seabirds such as gannets. The rocky shores where gannets nest get very crowded. If a pair does not find space to nest, they will not be able to add to the population.

Space is also a limiting factor for plant populations. The amount of space in which a plant grows determines whether the plant can obtain the water and nutrients it needs.

Light Another limiting factor for plants is light. For example, tree seedlings may not get enough light if branches from other trees block the sunlight.

FIGURE 7
Space as a Limiting Factor
The amount of space available in this tidepool limits the number of sea stars and anemones that can live there.



Soil Composition The composition of the soil is also a limiting factor that affects plant growth. To support vigorous plant growth, soils must contain sufficient nitrogen and minerals, including phosphorus and potassium. The soil must also contain enough humus without excess acidity or alkalinity.

Weather Weather conditions can limit population growth. Many types of organisms require a particular range of temperatures and amount of rainfall to live and reproduce. For example, the saguaro cactus can withstand the heat and dryness of the Arizona desert. But the saguaro will not grow where winter temperatures fall much below freezing.

The number of organisms that an ecosystem can support varies from season to season. For example, more organisms thrive during temperate summers than can survive icy winters.

Unusual weather events can also affect population size. A cold snap in late spring can kill the young of many species of birds and mammals. A hurricane or flood can wash away nests and burrows.

Reading Checkpoint **How can unusual weather affect population size?**

FIGURE 8
Weather as a Limiting Factor A snowstorm can limit the size of an orange crop.
Applying Concepts *What other weather conditions can limit population growth?*

Section 2 Assessment

S 6.5.e, E-LA: Reading 6.1.0, Math: 6 NS 2.3

Vocabulary Skill Use Related Words Complete the sentence by using the correct form of *limit* and *limiting*. A _____ factor will stop the growth of an animal population because it may _____ food, water, or space for that population.

Reviewing Key Concepts

1. a. **Identifying** Name two ways organisms join a population and two ways organisms leave a population.
   b. **Calculating** Suppose a population of 100 mice has produced 600 young. If 200 mice have died, how many mice are in the population now? (Assume for this question that no mice have moved into or out of the population for other reasons.)
   c. **Drawing Conclusions** Suppose that you discovered that there were actually 750 mice in the population. How could you account for the difference?
2. a. **Reviewing** Name five limiting factors for populations.
   b. **Describing** Choose one of the limiting factors and describe how it limits population growth.
   c. **Inferring** How might the limiting factor you chose affect the pigeon population in your town?

Math Practice

3. **Inequalities** Complete the following inequality showing the relationship between carrying capacity and population size. Then explain why the inequality is true.

   If population size ■ carrying capacity, then population size will decrease.