

Populations

As You Read

What You'll Learn

- **Identify** methods for estimating population sizes.
- **Explain** how competition limits population growth.
- **List** factors that influence changes in population size.

Vocabulary

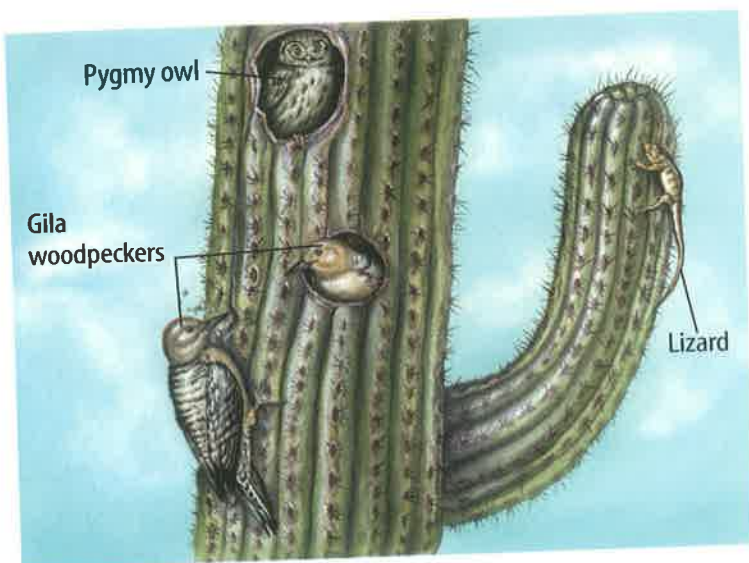
limiting factor
carrying capacity

Why It's Important

Competition caused by population growth affects many organisms, including humans.

Figure 5

Gila woodpeckers make nesting holes in the saguaro cactus. Many animals compete for the shelter these holes provide.



Competition

Some pet shops sell lizards, snakes, and other reptiles. Crickets are raised as a food supply for pet reptiles. In the wild, crickets come out at night and feed on plant material. During the day, they hide in dark areas, beneath leaves or under buildings. Pet shop workers who raise crickets make sure that the insects have plenty of food, water, and hiding places. As the cricket population grows, the workers increase the crickets' food supply and the number of hiding places. To avoid crowding, some of the crickets could be moved into larger containers.

Food and Space Organisms living in the wild do not always have enough food or living space. The Gila woodpecker, shown in **Figure 5**, lives in the Sonoran Desert of Arizona and Mexico. This bird makes its nest in a hole that it drills in a saguaro (suh GWAR oh) cactus. If an area has too many Gila woodpeckers or too few saguaros, the woodpeckers must compete with each other for nesting spots. Competition occurs when two or more organisms seek the same resource at the same time.

Growth Limits Competition limits population size. If the amount of available nesting space is limited, some woodpeckers will not be able to raise young. Gila woodpeckers eat cactus fruit, berries, and insects. If food becomes scarce, some woodpeckers might not survive to reproduce. Competition for food, living space, or other resources can prevent population growth.

In nature, the most intense competition is usually among individuals of the same species, because they need the same kinds of food and shelter. Competition also takes place among individuals of different species. For example, after a Gila woodpecker has abandoned its nesting hole, owls, flycatchers, snakes, and lizards compete for the shelter of the empty hole.

Population Size

Ecologists often need to measure the size of a population. This information can indicate whether or not a population is healthy and growing. Population counts can help identify populations that could be in danger of disappearing.

Some populations are easy to measure. If you were raising crickets, you could measure the size of your cricket population simply by counting all the crickets in the container. What if you wanted to compare the cricket populations in two different containers? You would calculate the number of crickets per square meter (m^2) of your container. The size of a population that occupies a specific area is called population density. **Figure 6** shows human population density in different places in the world.

 **Reading Check** *What is population density?*

Measuring Populations Counting crickets can be tricky. They look alike, move a lot, and hide. The same cricket could be counted more than once, and others could be completely missed. Ecologists have similar problems when measuring wildlife populations. One of the methods they use is called trap-mark-release. Suppose you want to count wild rabbits. Rabbits live underground and come out at dawn and dusk to eat. Ecologists set traps that capture rabbits without injuring them. Each captured rabbit is marked and released. Later, another sample of rabbits is captured. Some of these rabbits will have marks, but many will not. By comparing the number of marked and unmarked rabbits in the second sample, ecologists can estimate the population size.

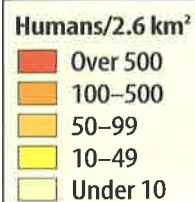
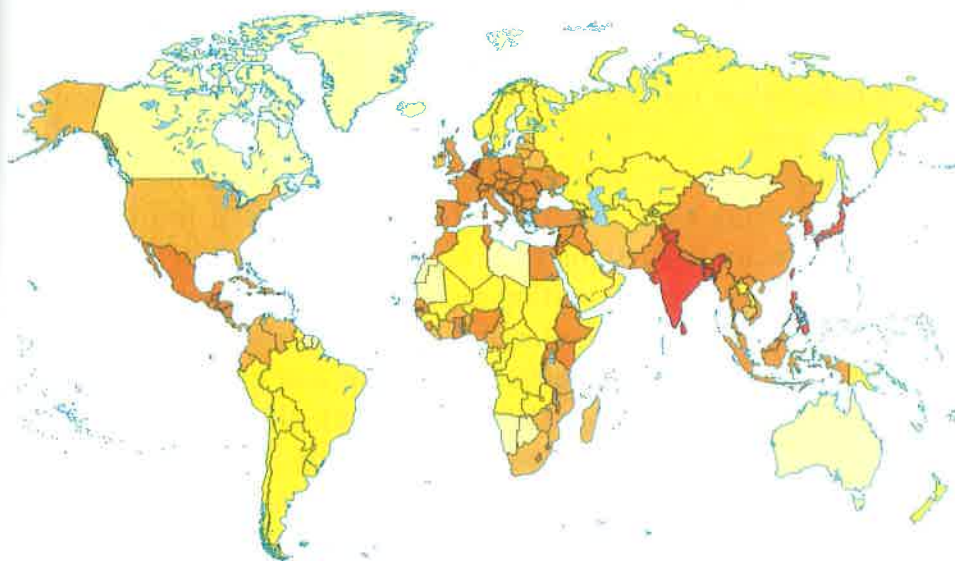


Figure 6
This map shows human population density. Which countries have the highest population density?

TRY AT HOME Mini LAB

Observing Seedling Competition

Procedure

1. Fill two plant pots with moist potting soil.
2. Plant radish seeds in one pot, following the spacing instructions on the seed packet. Label this pot "Recommended Spacing."
3. Plant radish seeds in the second pot, spaced half the recommended distance apart. Label this pot "Densely Populated." Wash your hands.
4. Keep the soil moist. When the seeds sprout, move them to a well-lit area.
5. Measure the height of the seedlings every two days for two weeks. Record the data in your **Science Journal**.

Analysis

1. Which plants grew faster?
2. Which plants looked healthiest after two weeks?
3. How did competition influence the plants?

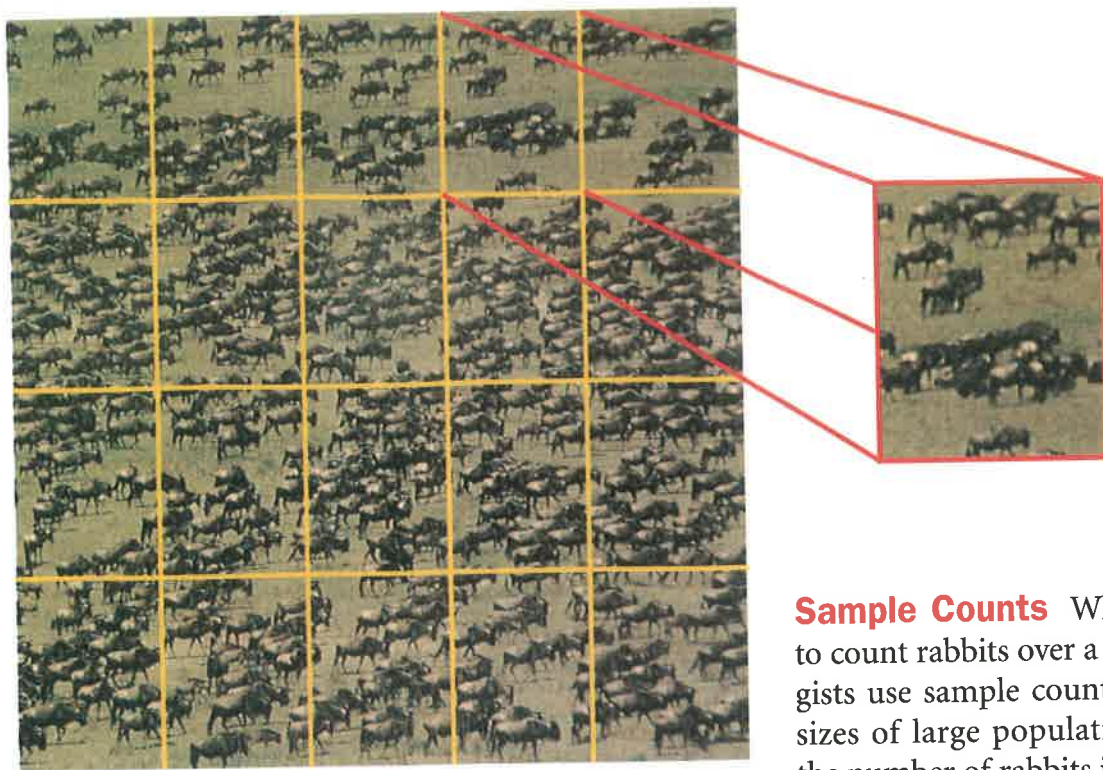


Figure 7
Ecologists can estimate population size by making a sample count. Wildebeests graze on the grassy plains of Africa. How could you use the enlarged square to estimate the number of wildebeests in the entire photograph?

Sample Counts What if you wanted to count rabbits over a large area? Ecologists use sample counts to estimate the sizes of large populations. To estimate the number of rabbits in a 100-acre area,

for example, you could count the rabbits in one acre and multiply by 100 to estimate the population size. **Figure 7** shows another approach to sample counting.

Limiting Factors One grass plant can produce hundreds of seeds. Imagine those seeds drifting onto a vacant field. Many of the seeds sprout and grow into grass plants that produce hundreds more seeds. Soon the field is covered with grass. Can this grass population keep growing forever? Suppose the seeds of wildflowers or trees drift onto the field. If those seeds sprout, trees and flowers would compete with grasses for sunlight, soil, and water. Even if the grasses did not have to compete with other plants, they might eventually use up all the space in the field. When no more living space is available, the population cannot grow.

In any ecosystem, the availability of food, water, living space, mates, nesting sites, and other resources is often limited. A **limiting factor** is anything that restricts the number of individuals in a population. Limiting factors include living and non-living features of the ecosystem.

A limiting factor can affect more than one population in a community. Suppose a lack of rain limits plant growth in a meadow. Fewer plants produce fewer seeds. For seed-eating mice, this reduction in the food supply could become a limiting factor. A smaller mouse population could, in turn, become a limiting factor for the hawks and owls that feed on mice.

Carrying Capacity A population of robins lives in a grove of trees in a park. Over several years, the number of robins increases and nesting space becomes scarce. Nesting space is a limiting factor that prevents the robin population from getting any larger. This ecosystem has reached its carrying capacity for robins. **Carrying capacity** is the largest number of individuals of one species that an ecosystem can support over time. If a population begins to exceed the environment's carrying capacity, some individuals will not have enough resources. They could die or be forced to move elsewhere, like the deer shown in **Figure 8**.



Figure 8
These deer might have moved into a residential area because a nearby forest's carrying capacity for deer has been reached.

Reading Check

How are limiting factors related to carrying capacity?

Problem-Solving Activity

Do you have too many crickets?

You've decided to raise crickets to sell to pet stores. A friend says you should not allow the cricket population density to go over 210 crickets/m². Use what you've learned in this section to measure the population density in your cricket tanks.

Identifying the Problem

The table on the right lists the areas and populations of your three cricket tanks. How can you determine if too many crickets are in one tank? If a tank contains too many crickets, what could you do? Explain why too many crickets in a tank might be a problem.

Cricket Population		
Tank	Area (m ²)	Number of Crickets
1	0.80	200
2	0.80	150
3	1.5	315

Solving the Problem

- Do any of the tanks contain too many crickets? Could you make the population density of the three tanks equal by moving crickets from one tank to another? If so, which tank would you move crickets into?
- The population density of wild crickets living in a field is 2.4 crickets/m². If the field has an area of 250 m², what is the approximate size of the cricket population? Why would the population density of crickets in a field be lower than the population density of crickets in a tank?

SCIENCE Online



Data Update For an online update of recent data on human birthrates and death rates around the world, visit the Glencoe Science Web site at **science.glencoe.com** and select the appropriate chapter.

Biotic Potential What would happen if no limiting factors restricted the growth of a population? Think about a population that has an unlimited supply of food, water, and living space. The climate is favorable. Population growth is not limited by diseases, predators, or competition with other species. Under ideal conditions like these, the population would continue to grow.

The highest rate of reproduction under ideal conditions is a population's biotic potential. The larger the number of offspring that are produced by parent organisms, the higher the biotic potential of the species will be. Compare an avocado tree to a tangerine tree. Assume that each tree produces the same number of fruits. Each avocado fruit contains one large seed. Each tangerine fruit contains a dozen seeds or more. Because the tangerine tree produces more seeds per fruit, it has a higher biotic potential than the avocado tree.

Changes in Populations

Birthrates and death rates also influence the size of a population and its rate of growth. A population gets larger when the number of individuals born is greater than the number of individuals that die. When the number of deaths is greater than the

number of births, populations get smaller. Take the squirrels living in New York City's Central Park as an example. In one year, if 900 squirrels are born and 800 die, the population increases by 100. If 400 squirrels are born and 500 die, the population decreases by 100.

The same is true for human populations. **Table 1** shows birthrates, death rates, and population changes for several countries around the world. In countries with faster population growth, birthrates are much higher than death rates. In countries with slower population growth, birthrates are only slightly higher than death rates. In Germany, where the population is getting smaller, the birthrate is lower than the death rate.

Table 1 Population Growth

	Birthrate*	Death Rate*	Population Increase (percent)
Rapid-Growth Countries			
Jordan	38.8	5.5	3.3
Uganda	50.8	21.8	2.9
Zimbabwe	34.3	9.4	5.2
Slow-Growth Countries			
Germany	9.4	10.8	-1.5
Sweden	10.8	10.6	0.1
United States	14.8	8.8	0.6

*Number per 1,000 people



Figure 9

The mangrove seeds sprout while they are still attached to the parent tree. Some sprouted seeds drop into the mud below the parent tree and continue to grow. Others drop into the water and can be carried away by tides and ocean currents. When they wash ashore, they might start a new population of mangroves or add to an existing mangrove population.

Moving Around Most animals can move easily from place to place, and these movements can affect population size. For example, a male mountain sheep might wander many miles in search of a mate. After he finds a mate, their offspring might establish a completely new population of mountain sheep far from the male's original population.

Many bird species move from one place to another during their annual migrations. During the summer, populations of Baltimore orioles are found throughout eastern North America. During the winter, these populations disappear because the birds migrate to Central America. They spend the winter there, where the climate is mild and food supplies are plentiful. When summer approaches, the orioles migrate back to North America.

Even plants and microscopic organisms can move from place to place, carried by wind, water, or animals. The tiny spores of mushrooms, mosses, and ferns float through the air. The seeds of dandelions, maple trees, and other plants have feathery or winglike growths that allow them to be carried by wind. Spine-covered seeds hitch rides by clinging to animal fur or people's clothing. Many kinds of seeds can be transported by river and ocean currents. Mangrove trees growing along Florida's Gulf Coast, shown in **Figure 9**, provide an example of how water moves seeds.

Mini LAB

Comparing Biotic Potential



Procedure

1. Remove all the seeds from a whole fruit. Do not put fruit or seeds in your mouth.
2. Count the total number of seeds in the fruit. Wash your hands, then record these data in your Science Journal.
3. Compare your seed totals with those of classmates who examined other types of fruit.

Analysis

1. Which type of fruit had the most seeds? Which had the fewest seeds?
2. What is an advantage of producing many seeds? Can you think of a possible disadvantage?
3. To estimate the total number of seeds produced by a tomato plant, what would you need to know?

Exponential Growth

Imagine what might happen if a pair of coyotes moves into a valley where no other coyotes live. Food and water are abundant, and there are plenty of areas where female coyotes can build dens for their young. This population grows quickly in a pattern called exponential growth. Exponential growth means that the larger a population becomes, the faster it grows.

After several years, the population becomes so large that the coyotes begin to compete for food and den sites. Population growth slows, and the number of coyotes remains fairly constant and reaches equilibrium. This ecosystem has reached its carrying capacity for coyotes. A graph that describes each stage in this pattern of population growth is shown in **Figure 10**. As you can see in **Figure 11**, Earth's human population shows exponential growth. In the year 2000, Earth's human population exceeded 6 billion. By the year 2050, it is estimated that Earth's human population could reach 10 billion.

Increase in Human Population

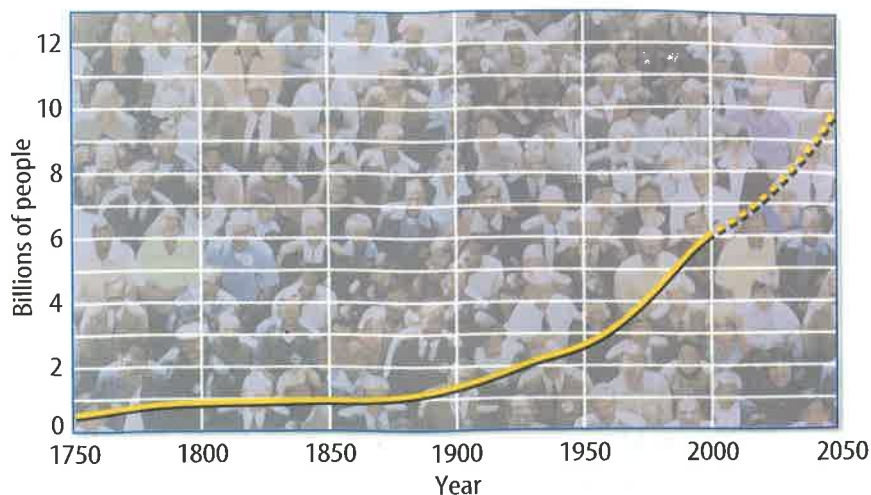


Figure 11

The size of the human population is increasing by about 1.6 percent per year. What factors affect human population growth?

Section

2

Assessment

1. How can an ecologist predict the size of a population without counting every organism in the population?
2. Why does competition between individuals of the same species tend to be greater than competition between individuals of different species?
3. How do birthrates and death rates influence the size of a population?
4. How does carrying capacity influence the number of organisms in an ecosystem?
5. **Think Critically** Why does the supply of food and water in an ecosystem usually affect population size more than other limiting factors?

Skill Builder Activities

6. **Making and Using Tables** Construct a table using the following data on changes in the size of a deer population in Arizona. In 1910 there were 6 deer; in 1915, 36 deer; in 1920, 143 deer; in 1925, 86 deer; and in 1935, 26 deer. Propose a hypothesis to explain what might have caused these changes. **For more help, refer to the Science Skill Handbook.**
7. **Solving One-Step Equations** A vacant lot that measures 12 m \times 12 m contains 46 dandelion plants, 212 grass plants, and 14 bindweed plants. What is the population density, per square meter, of each species? **For more help, refer to the Math Skill Handbook.**