15.1

KEY CONCEPT

Populations have many characteristics.

VOCABULARY

population dynamics p. 527

carrying capacity p. 528

population size p. 530

population density p. 531

BEFORE, you learned

- Species change over time
- Evolution is a process of change
- A habitat is an area that provides organisms with resources

NOW, you will learn

- About stages in population dynamics
- About variables that define a population
- About changes that affect populations

THINK ABOUT

How fast can a population grow?

How big can a population grow? Suppose you started with a pair of fruit flies. That single pair can produce 200 eggs. In three weeks, each pair from that batch could produce 200 flies of its own—producing up to 20,000 flies. Assume all eggs hatch—an event highly unlikely in the real world. After three weeks, 2 million fruit flies would be buzzing around the area. After just 17 generations, given ideal conditions (for the fruit fly, that is), the mass of fruit flies would exceed the mass of planet Earth.

CHOOSE YOUR OWN STRATEGY

Begin taking notes on the three stages of populations. Use a strategy from an earlier chapter or one that you already know.

Populations go through three stages.

Look closely at the fruit flies above. As a group of the same species living together in a particular area, they represent a population. The particular area in which a scientist studies a population may be as large as a mountain range or as small as a puddle. Scientists study how populations of organisms change as they interact with each other and the environment. Over time, the number of individuals in a population changes by increasing or decreasing. **Population dynamics** is the study of why populations change and what causes them to change. In this chapter you will learn about some of the important observations scientists have made about populations.

CHECK YOUR READING What is population dynamics?

One species of iguana may have several populations living on different islands. As a result, these iguana populations don't interact with each other. Yet there may be other populations of iguanas living on the islands made up of a different species.
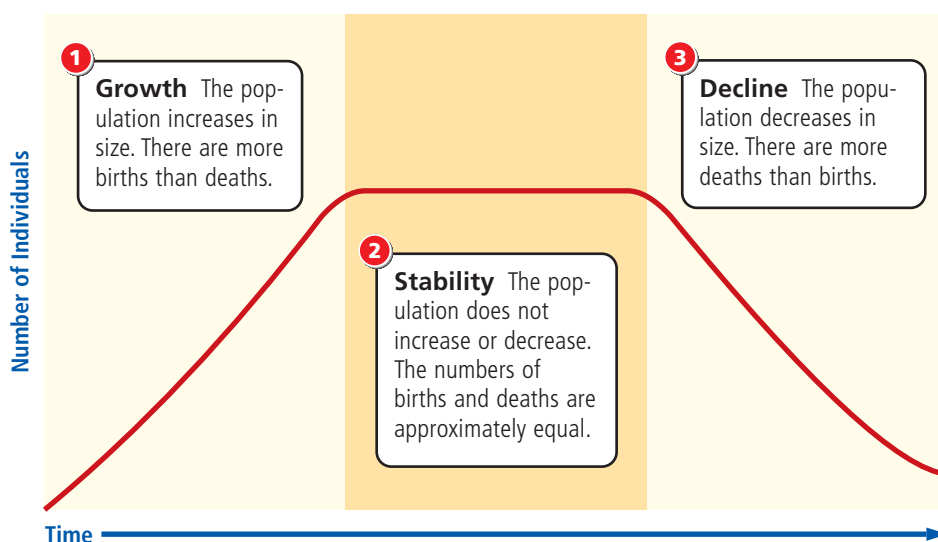
Growth, Stability, and Decline

As different as populations may be—whether cacti, finches, dragonflies, or iguanas—all populations go through the same three stages of change: growth, stability, and decline.

All living things need resources such as water, energy, and living space. Populations get their resources from the environment. However, the area a population occupies can support only so many individuals. **Carrying capacity** is the maximum number of individuals an ecosystem can support.

When a habitat contains enough resources to meet the needs of a population, the population grows rapidly. This growth stage of a population tends to be brief. On a graph, it looks like a sharp rise. The growth stage is followed by a period of stability, when the size of a population remains constant. For most populations, the stability stage is the longest stage of a population's existence. The stability stage is often followed by a decline in population size.

Population Change

The graph shows three stages of population change.

1 Growth The population increases in size. There are more births than deaths.

3 Decline The population decreases in size. There are more deaths than births.

2 Stability The population does not increase or decrease. The numbers of births and deaths are approximately equal.

Number of Individuals

Time

READING VISUALS   How is the number of individuals changing over time?

During the growth stage, populations can increase according to two general patterns. One pattern is <mark>rapid growth</mark>, which increases at a greater and greater rate. Another pattern is <mark>gradual growth,</mark> which increases at a fairly steady rate. The two graphs below show the two different types of growth.

Population Growth

The graphs show two patterns of population growth.

Rapid Growth

Number of individuals

Time

Gradual Growth

Number of individuals

Time
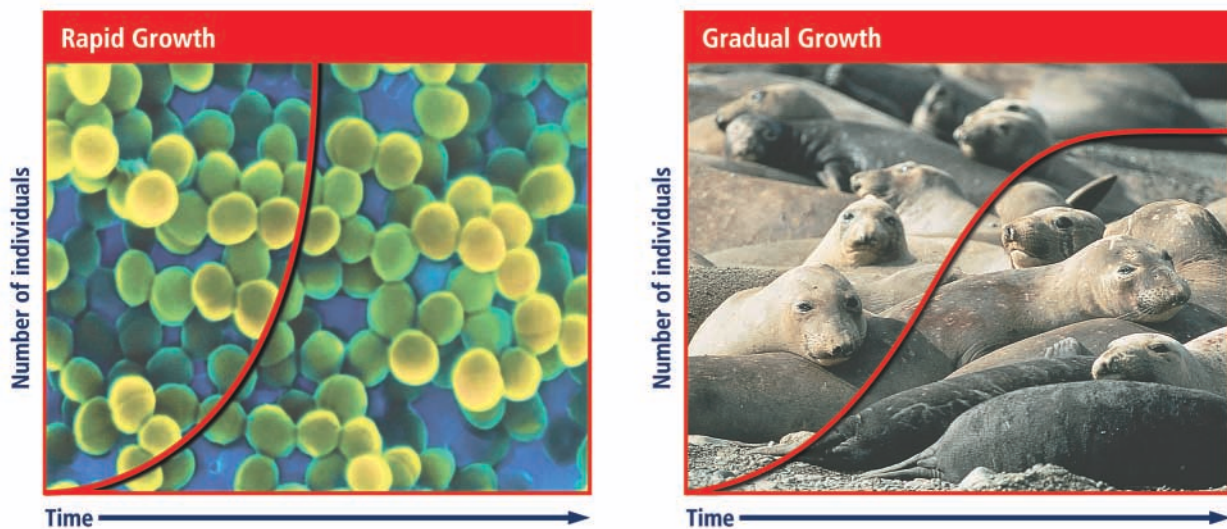
Darwin's Observations of Population Growth

In Chapter 14 you read about the observations and conclusions made by the naturalist Charles Darwin. In his book *On the Origin of Species* Darwin included important observations about population growth.

- All populations are able to grow rapidly.
- Populations tend to remain constant in size.
- There are limits to natural resources.
- Within a given population there is genetic variation.

▼ REMINDER
A species that is no longer living is considered extinct.

Darwin recognized that organisms in most species have the ability to produce more than two surviving offspring. He knew that if there were no limits to growth, then populations would grow rapidly. However, Darwin also observed that in the real world there are natural limits to growth, so populations tend to stabilize. In order for a species to continue, individuals must be replaced as they die. This means that, on average, one member of a population must produce one surviving offspring. If the birth rate doesn't match the death rate, a population can decline until it becomes extinct.

Four characteristics define a population.

When scientists think about population dynamics, they consider four major characteristics. These characteristics include population size, population density, population spacing, and age structure.

Population Size

Population size is the number of individuals in a population at a given time. Even when the population size appears to be stable over time, changes can occur from year to year or from place to place. Population size varies from one habitat to another. It also varies within a single habitat.

An area where the summers are hot and the winters are cold is a good place to observe how population size might change at different times of year. For example, the population sizes of many insects change within a year. Mosquitoes that are all around you on warm summer evenings are nowhere in sight when the temperatures fall below freezing.

The size of plant populations can also change during the year. In the spring and summer you can see flowering plants across the deserts, woods, and mountains of North America. However, by fall and early winter, when there is less rainfall and temperatures drop, many of these plants die. Below is a picture of a southwestern desert in full bloom. During the springtime months of March through May, many deserts in the United States experience a change. There is a period of rapid growth as a variety of wildflowers begins to bloom.

When there is little rainfall, a desert seems empty. After a rain, there is a brief time when plants bloom.

The availability of resources, such as water, increases plant growth. By summer the change in season brings higher temperatures and less rainfall. As a result, desert wildflowers experience a rapid decline in their population size.

CHECK YOUR READING   What are two factors that affect population size?

Population Density

Population density is a measure of the number of individuals in a certain space at a particular time. Population density is related to population size. If a population's size increases and all of the individuals remain in the same area, then population density increases, too. There are more individuals living in the same amount of space. If the size of a population in a particular area decreases, density also decreases. Some species, such as bumblebees or mice, live in populations with high densities. Other species, such as blue herons or wolves, live in populations with low densities.

CHECK YOUR READING   What is the difference between low density and high density?

Population Density

Density can change over time and over the entire area of the population.

Low Density

Herons are usually found alone or in pairs in marshy areas. Herons are an example of a low-density population.

High Density

Bees in a beehive are an example of a high-density population—many individuals are packed into a small area.

READING VISUALS   COMPARE How does the number of herons in an area compare with the number of bees?

The distribution of a population across a large geographic area is its range. Within that range, population density may vary. For example, there may be more grasshoppers in the middle of a prairie than there are at the edges. The population density tends to be higher where more resources are available. Habitats located in the middle of a population range tend to have a greater population density than habitats located at the edges.

CHECK YOUR READING   How might population density vary within a range?

Population Spacing

Take a look around you as you walk through a local park. You might notice many flowers growing in open, sunny spots but few beneath the shade of large trees. The pattern in which the flowers grow is an example of population spacing. Scientists have observed three distinct patterns of spacing: clumped, uniform, and random.

In clumped spacing, individuals form small groups within a habitat. Animals like elephants clump because of their social nature. Clumping can also result from the way resources are distributed throughout a habitat. Salamanders that prefer moist, rotten logs may be clumped where logs have fallen in their habitat.

Population Spacing

Population spacing describes how individuals arrange themselves within a population.

Clumped

Individuals that clump themselves often gather around resources.

Uniform

Individuals that are uniformly arranged often compete for resources.

Random

Random patterns are rare and occur without regard to other individuals.

READING VISUALS   Compare and contrast the way populations are spaced.

Some individuals live at a distance from each other. These individuals are uniformly spaced. Many plants that grow too close together become evenly spaced as individuals die out. Uniform spacing can protect saguaro cacti from competing for important resources in the desert. Individuals that aren't uniform or clumped space themselves randomly. Dandelions, for instance, grow no matter where other dandelions are growing.

Age Structure

Scientists divide a population into three groups based on age.

- postreproductive: organisms can no longer reproduce
- reproductive: organisms capable of reproduction
- prereproductive: organisms not yet able to reproduce

The age structure of a population affects how much it can grow. On the graph below, the postreproductive age range for humans is over 45, reproductive is 14 to 44 years of age, and prereproductive is 0 to 14.
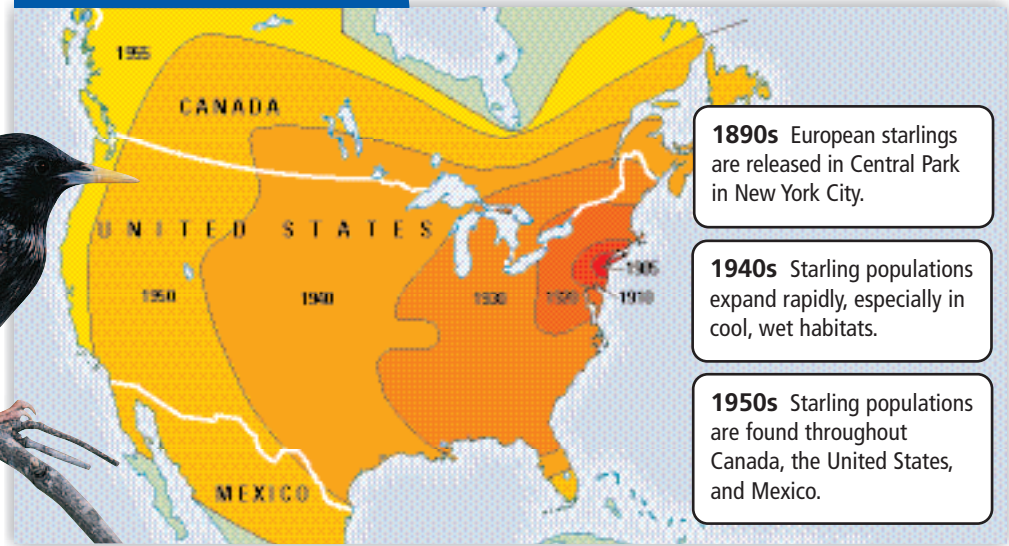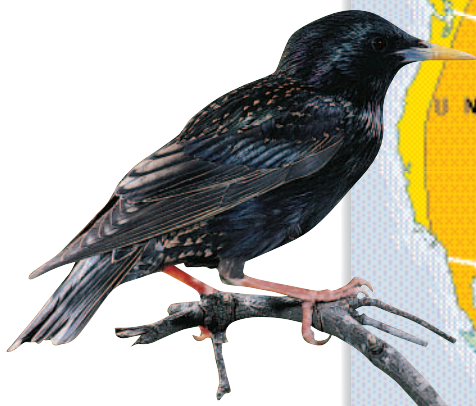
Age Structure

Population of Canada (millions)
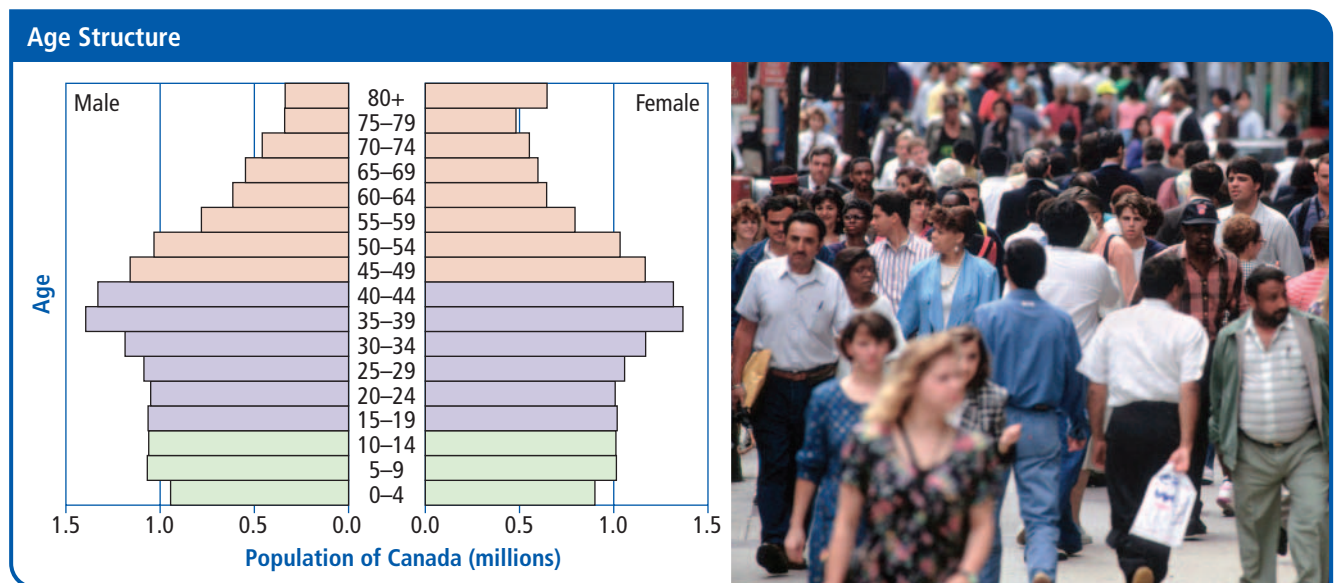
Scientists can predict population change.

Scientists use these four factors—size, density, spacing, and age structure—to describe a population and to predict how it might change over time. Sometimes a population changes when a particular factor changes.

A population can change in response to its surroundings. Suppose a population of frogs is living in a pond where the water becomes saltier. Only those frogs that can survive in an environment with more salt will survive. Thus the population size of frogs will probably decrease as a result of the changing conditions. By looking at population size, scientists can predict how changes affect the population.

Starling Population

1890s European starlings are released in Central Park in New York City.

1940s Starling populations expand rapidly, especially in cool, wet habitats.

1950s Starling populations are found throughout Canada, the United States, and Mexico.

Scientists can also predict change by looking at the distribution of population. The story of the European starling provides a dramatic example of how the movement of organisms into or out of an area affects a population.

In 1890, the first starlings were introduced to the United States in New York City's Central Park. Their numbers went from 60 individuals to about 200 million in just over 100 years as they expanded on the North American continent. The population of starlings rose as starlings moved into new habitats that had the resources they needed.

Today large populations of starlings can still be found across the North American continent. Even within a given habitat, the population can vary. In Central Park, for example, you can find starlings in clumps, uniformly spaced, or randomly spaced.

VISUALIZATION
CLASSZONE.COM

Watch how a change in the environment can affect a population.

15.1 Review

KEY CONCEPTS

1. Describe the three stages of population growth.
2. Make a chart showing the four factors that affect population dynamics and an example of each.
3. Give an example of how a shift in age distribution can affect population growth.

CRITICAL THINKING

4. **Apply** Choose a population in your neighborhood. Describe its population spacing. Is it clumped, uniformly spaced, or randomly spaced?
5. **Compare/Contrast** How is population size related to population density? Your answer should mention area.

CHALLENGE

6. **Predict** Explain how a heavy thunderstorm might affect the population density of birds living in the area.