The Human Population

CHAPTER 9

READING WARM-UP

Before you read this chapter, take a few minutes to answer the following questions in your ***EcoLog.***

1. In the United States, most parents have two or three children. Fifty years ago, many parents had six or more children. What might have caused this change?
2. What problems can occur if an area's human population grows very rapidly?

China has one of the largest populations in the world, with more than 1 billion people. However, China's population is projected to stop growing by the year 2050, mostly because Chinese families are having fewer children.

SECTION 1

Studying Human Populations

The human population of Earth grew faster in the 20th century than it ever has before. However, this rapid growth has led to environmental problems around the globe. Thus, we must try to understand and predict changes in human populations.

Demography is the study of populations, but most often refers to the study of human populations. Demographers study the historical size and makeup of the populations of countries to make comparisons and predictions. Demographers also study properties that affect population growth, such as economics and social structure. Countries with similar population trends are often grouped into two general categories. *Developed countries* have higher average incomes, slower population growth, diverse industrial economies, and stronger social support systems. *Developing countries* have lower average incomes, simple and agriculture-based economies, and rapid population growth.

Objectives

- Describe how the size and growth rate of the human population has changed in the last 200 years.
- Define four properties that scientists use to predict population sizes.
- Make predictions about population trends based on age structure.
- Describe the four stages of the demographic transition.
- Explain why different countries may be at different stages of the demographic transition.

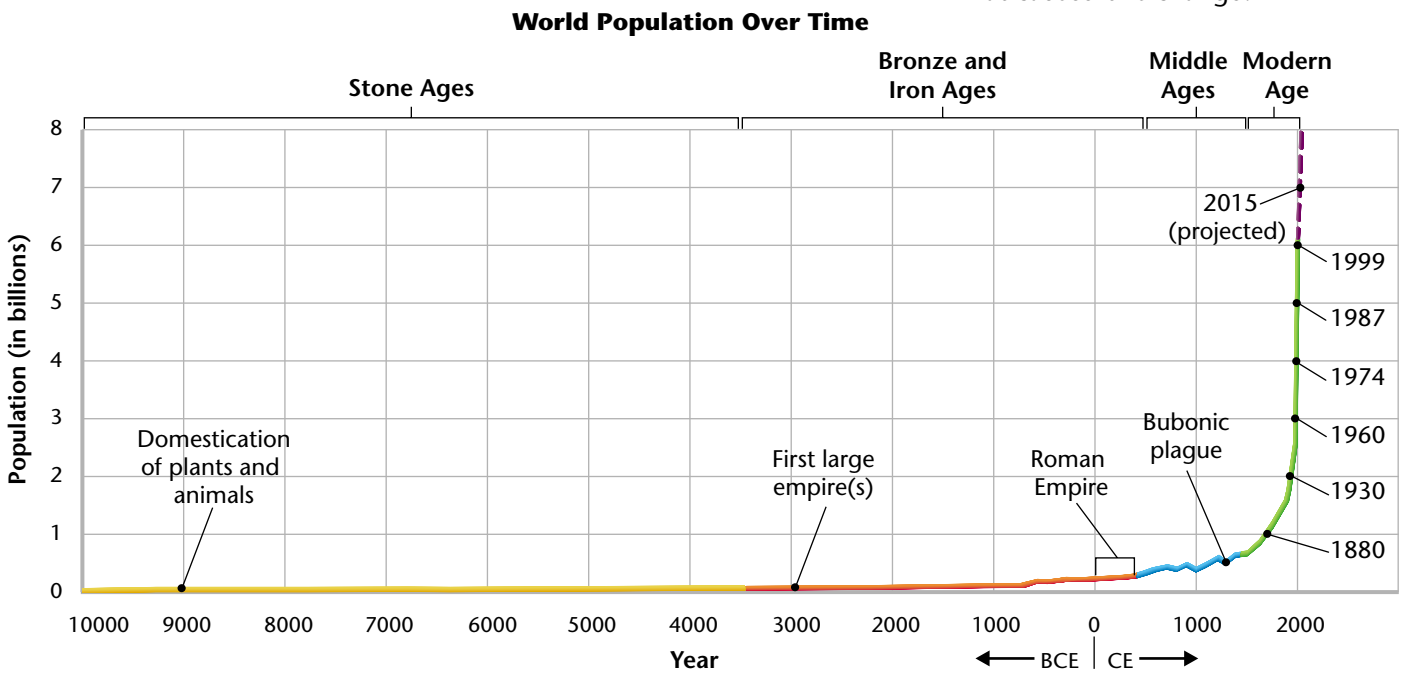
Key Terms

demography
age structure
survivorship
fertility rate
migration
life expectancy
demographic transition

The Human Population Over Time

After growing slowly for thousands of years, the human population grew rapidly in the 1800s, as shown in **Figure 1.** The human population underwent *exponential growth*, meaning that population growth rates increased during each decade. These increases were mostly due to increases in food production and improvements in hygiene that came with the industrial and scientific revolutions. However, it is unlikely that the Earth can sustain this growth for much longer.

Figure 1 ▶ After growing slowly for thousands of years, the human population grew rapidly in the 1800s. What caused this change?



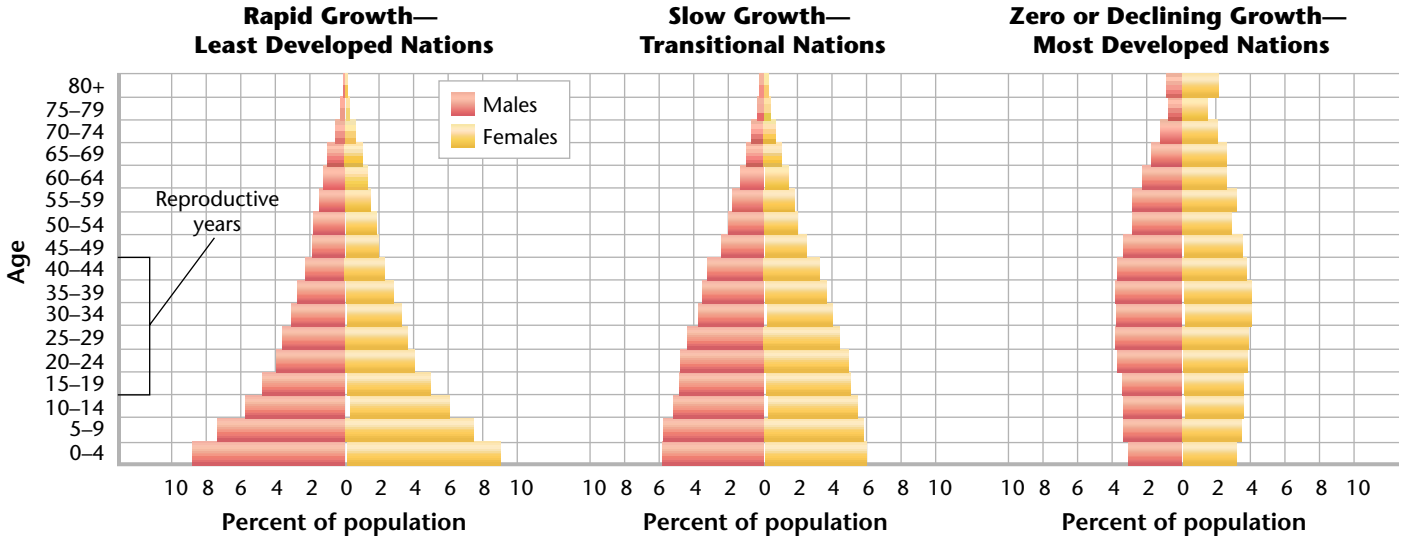


Figure 2 ▶ Age-Structure Diagrams These graphs have a typical shape for populations with different rates of growth. The number of males and females in each age group are shown as opposite-facing bars. People between 15 and 44 years of age are likely to produce children.

Forecasting Population Size

Will your community need more schools in the next 20 years, or will it need more retirement communities? Will people move in and create demand for more roads and utility services? Demographers look at many properties of populations to predict such changes. Population predictions are often inaccurate, however, because human behavior can change suddenly.

Age Structure Demographers can make many predictions based on **age structure**—the distribution of ages in a specific population at a certain time. For example, if a population has more young people than older people, the population size will likely increase as the young people grow up and have children. Age structure can be graphed in a *population pyramid*, a type of double-sided bar graph like those shown in **Figure 2.** The figure shows typical age structures for countries that have different rates of growth. Countries that have high rates of growth usually have more young people than older people. In contrast, countries that have slow growth or no growth usually have an even distribution of ages in the population. When parents are having fewer children, the population will have fewer young people.

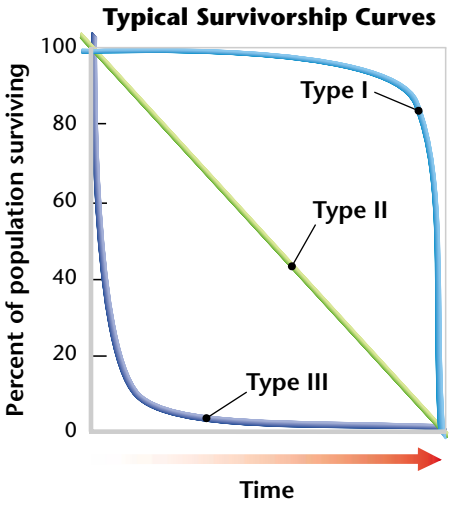


Figure 3 ▶ Survivorship curves show how much of the population survives to a given age. A Type I curve is seen in populations where most members survive to be very old. A Type III curve is seen in populations where many children die.

Survivorship Another way to predict population trends is to study survivorship. **Survivorship** is the percentage of members of a group that are likely to survive to any given age. To predict survivorship, a demographer studies a group of people born at the same time and notes when each member of the group dies. The results plotted on a graph might look like one of the types of *survivorship curves* in **Figure 3.** Wealthy developed countries such as Japan and Germany currently have a Type I survivorship curve because most people live to be very old. Type II populations have a similar death rate at all ages. Type III survivorship is the pattern in very poor human populations in which many children die. Both Type I and Type III survivorship may result in populations that remain the same size or grow slowly.

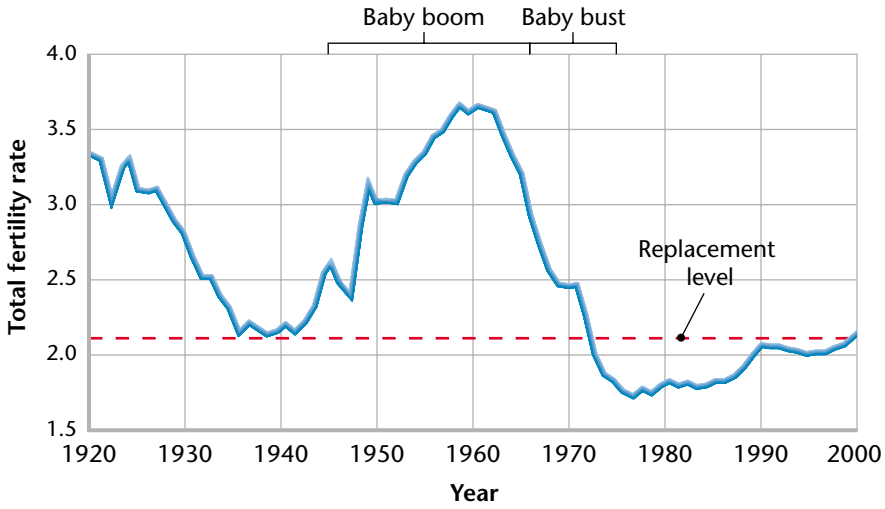


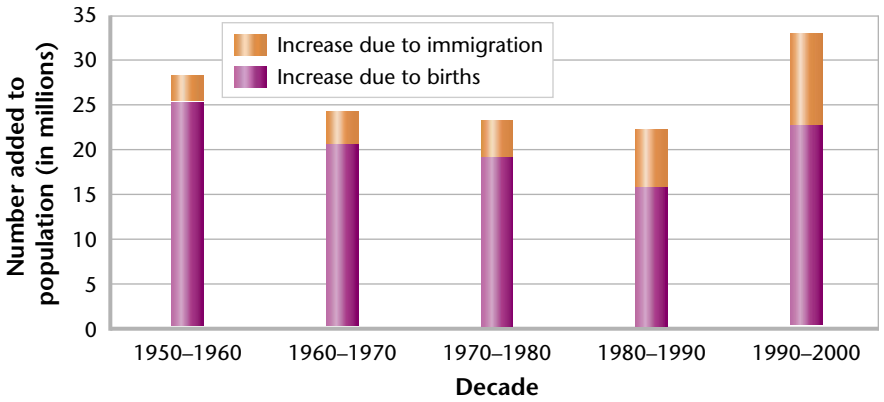
Figure 4 ▶ The total fertility rate in the United States went through many changes from 1900 to 2000. The *baby boom* was a period of high fertility rates, and the *baby bust* was a period of decreasing fertility.

Fertility Rates The number of babies born each year per 1,000 women in a population is called the **fertility rate.** Demographers also calculate the *total fertility rate*, or the average number of children a woman gives birth to in her lifetime.

A graph of historical total fertility rates for the United States is shown in **Figure 4.** In 1972, the total fertility rate dropped below replacement level for the first time in U.S. history. *Replacement level* is the average number of children each parent must have in order to "replace" themselves in the population. This number is about 2.1, or slightly more than 2, because not all children born will survive and reproduce.

Total fertility rates in the United States remained below replacement level for most of the 1990s. However, the population continued to grow, as shown in **Figure 5.** One reason for this growth was that the children of the baby boom grew up and had children.

Migration Another reason the population continued to grow was that immigration increased. The movement of individuals between areas is called **migration.** Movement into an area is *immigration* and movement out of an area is *emigration*. Migration between and within countries is a significant part of population change. The populations of many developed countries might be decreasing if not for immigration.



Source: U.S. Census Bureau.

Figure 5 ▶ The population of the United States has continued to grow in the last century because of births as well as immigration.

MATHPRACTICE

Extending the Equation for Population Change

The following equation is a simple way to calculate the change in a population over a period of time:

$$\textit{change in population} = (\textit{births} - \textit{deaths})$$

However, this equation does not account for changes due to migration. Rewrite the equation to include *immigration* and *emigration*.

Next, create an example word problem that would require the use of this new equation. Trade problems with a classmate, and try to solve the classmate's new word problem.

Figure 6 ▶ Today, people usually live longer because of improvements in healthcare, nutrition, and sanitation.

Declining Death Rates

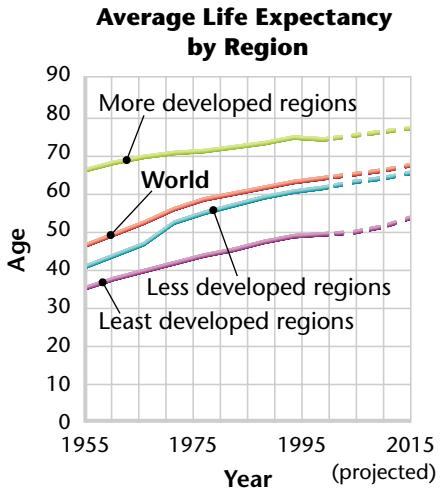
The dramatic increase in Earth's human population in the last 200 years has happened because death rates have declined more rapidly than birth rates. Death rates have declined mainly because more people now have access to adequate food, clean water, and safe sewage disposal. The discovery of vaccines in the 20th century also contributed to declining death rates, especially among infants and children. These factors are shown in **Figure 6.**

Life Expectancy The average number of years a person is likely to live is that person's **life expectancy.** Life expectancy is most affected by *infant mortality,* the death rate of infants less than a year old. In 1900, worldwide life expectancy was about 40 years and the infant mortality rate was very high. By 2000, the rate of infant mortality was less than one-third of the rate in 1900. The graph in **Figure 7** shows that average life expectancy has increased to more than 67 years worldwide. For people in many developed countries, life expectancy is almost 80 years.

Expensive medical care is not needed to prevent infant deaths. The infant mortality rate differs greatly among countries that have the same average income. Instead, infant health is more affected by the parents' access to education, food, fuel, and clean water. Even in poor areas, many people now know that babies simply need to be fed well and kept clean and warm. If these basic needs are met, most children will have a good chance of surviving.

Meanwhile, new threats to life expectancy arise as populations become denser. Contagious diseases such as AIDS and tuberculosis are a growing concern in a world where such diseases can spread quickly. Life expectancy in sub-Saharan Africa has been reduced in recent decades due to epidemics of AIDS.

Figure 7 ▶ Since 1900, average life expectancy has increased worldwide (red line), although it remains lower in less developed countries (blue and purple lines).



Source: UN Population Division.

The Demographic Transition

In most developed countries, populations have stopped growing. How can populations quadruple in a single century, then stop growing or even shrink in the next century? The **demographic transition** is a model that describes how these changes can occur. The model is based on observations of the history of many developed countries. The theory behind the demographic transition is that industrial development causes economic and social progress that then affects population growth rates. The graph in **Figure 8** compares expected trends in birth rates, death rates, and population sizes during each of the four stages of the transition.

Stages of the Transition In the first stage of the demographic transition, a society is in a preindustrial condition. The birth rate and the death rate are both at high levels and the population size is stable. Most of the world was in this condition until about 1700, when the scientific and industrial revolutions began.

In the second stage, a population explosion occurs. Death rates decline as hygiene, nutrition, and education improve. But birth rates remain high, so the population grows very fast. During this stage, the population could double in less than 30 years.

In the third stage of the demographic transition, population growth slows because the birth rate decreases. As the birth rate becomes close to the death rate, the population size stabilizes. However, the population is much larger than before the demographic transition. In most countries that have passed through the transition, the population quadrupled during the 20th century.

In the fourth stage, the birth rate drops below replacement level, so the size of the population begins to decrease. It has taken from one to three generations for the demographic transition to occur in most developed countries.

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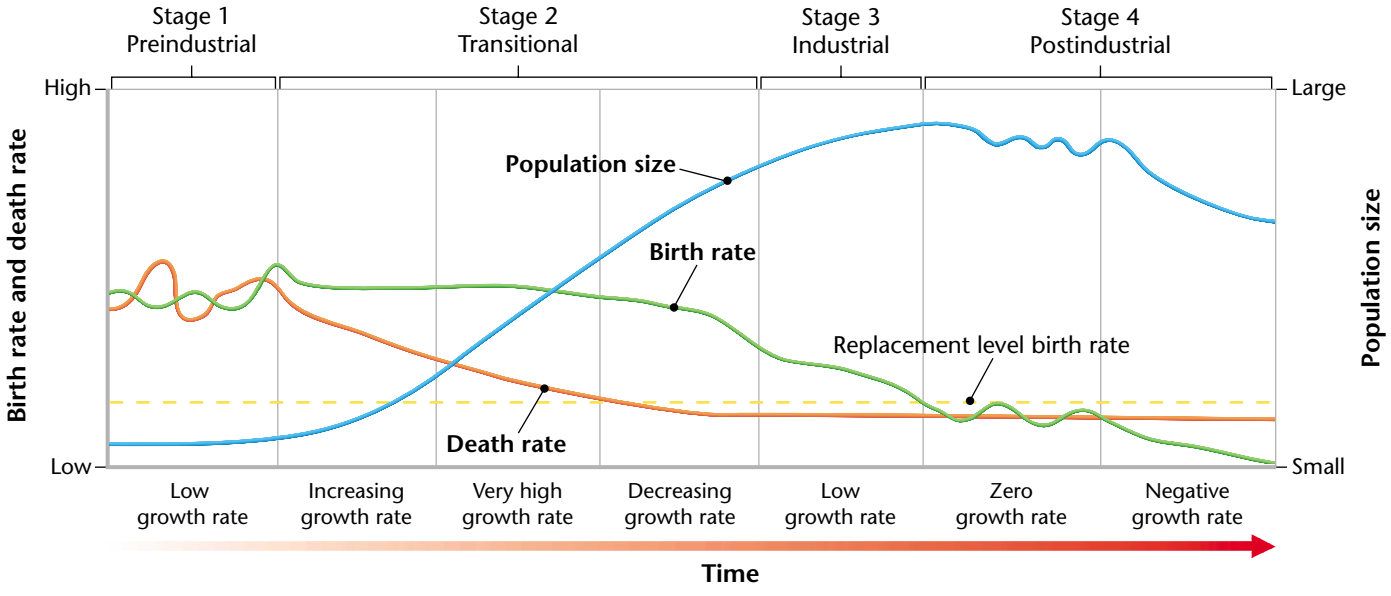
The Population Clock The Earth's human population is increasing by 2.4 people each second, which accounts for births and deaths. This means Earth gains over 200,000 people per day, or over 75 million per year.

Figure 8 ▶ The four stages of the demographic transition are shown here. Note the relative changes in birth rates, death rates, and population size. Do you think that all countries will fit this pattern?



Connection to Biology

Female Influence Females have the primary influence over reproductive rates in most species of animals, because they invest more energy in reproduction than males do. Females usually produce and lay eggs, carry the fetus, give birth, and care for the young offspring. The time and resources a female must invest in each successful offspring is usually greater than the energy a male must invest.

Women and Fertility The factors most clearly related to a decline in birth rates are increasing education and economic independence for women. In the demographic transition model, the lower death rate of the second stage is usually the result of increased levels of education. Educated women find that they do not need to bear as many children to ensure that some will survive. Also, the women may learn family planning techniques. They are able to contribute to their family's increasing prosperity while spending less energy bearing and caring for children. Some countries that want to reduce birth rates have placed a priority on the education of females, as shown in **Figure 9.**

Large families are valuable in communities in which children work or take care of older family members. But as countries modernize, parents are more likely to work away from home. If parents must pay for child care, children may become a financial burden rather than an asset. The elderly will not need the support of their children if pensions are available. All of these reasons contribute to lower birth rates. Today, the total fertility rate in developed countries is about 1.6 children per woman, while in developing countries, the rate is about 3.1 children per woman.

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Figure 9 ▶ These women in Bolivia are learning to read. Many countries include the education of women in development efforts.

SECTION 1 Review

1. **Describe** how the size and growth rate of the human population has changed in the last 200 years.
2. **Define** four properties that scientists use to predict population sizes.
3. **Explain** what we can predict about a population's likely growth rates based on its current age structure.
4. **Describe** the four stages of the demographic transition.

CRITICAL THINKING

5. **Analyzing Relationships** Read the description of life expectancy in this section. Explain why the oldest people in a population may be much older than the average life expectancy. READING SKILLS
6. **Evaluating Theories** Do you think that all countries will follow the pattern of the demographic transition? Explain your answer.