APES STUDY GUIDE: SPECIAL TEXT EXCERPT FROM "Living in the Environment" pages 123-129 HUMAN POPULATION AND ITS IMPACT

Read the text excerpt and answer the following prompts. Remember, many are old frqs and will provide invaluable practice with the style of question used on the May exam.

Section 6.1: How Do Environmental Scientists Think about Human Population Growth?

1. What is the world's population growth rate in recent years?
    i. How many people per year does this rate add to the global population?
    ii. In which regions of the world will most of this growth occur?

2. Identify the 3 most populous countries in the world today.

3. An important trend in population growth is the movement of people from rural to urban areas. According to the text excerpt, what percentage of the world's population now live in urbanized areas?

4. Examine figure 6-4 that lists some of the ways in which humans degrade the world's natural capital. Choose TWO from the list and describe, specifically, how these human activities are having a negative impact on Earth's biodiversity.

5. Define the terms **crude birth rate** and **crude death rate**.

6. How is population change calculated?

7. What is the replacement fertility rate of more economically developed countries? Less economically developed countries? *Think: why is the replacement fertility rate slightly higher for less economically developed countries?*

8. Explain why it is true that reaching replacement fertility rate for the world today would not stop population growth, at least in the short term.

9. If the global total fertility rate (TFR) were to drop to replacement rate of 2.1, how long would the world's population continue to grow before declining?

10. The TFR in the United States was 1.9 in 2012, below the global average of 2.4. Identify TWO reasons why the population of the US continues to grow.

11. Why do some analysts consider the US to be the world's most overpopulated country? How is the environmental impact of a country calculated?

12. Several factors affect birth and fertility rates. For EACH of the following causes, describe the effect on population growth rates. Discuss on each relationship

Cause (factor affecting TFR)	Effect on growth rate	Elaboration/discussion
Children used as part of labor force		
Cost of raising children		
Availability of public pension systems		
Infant mortality		
Urbanization		

13. What explanation does the text excerpt give for the rapid growth of the world's population over the past 100 years?

14. TWO important indicators of the health of a population are life expectancy and infant mortality rate. What 3 reasons are identified for high infant mortality rates?

6-1 How Do Environmental Scientists Think about Human Population Growth?

CONCEPT 6-1
The continuing rapid growth of the human population and its impacts on natural capital raise questions about how long the human population can keep growing.

Human Population Growth Shows Certain Trends

Estimates of what the global human population is likely to be in 2050 range from 7.8 billion to 10.8 billion people, with a medium projection of 9.6 billion people. For the year 2100, the projected population size ranges from 8 billion to 16 billion (Figure 6-1). These varying estimates depend on a variety of factors that we consider in more detail later in this chapter. However, *demographers*, or population experts, recognize three important growth trends.

First of all, in recent decades, the rate of population growth has slowed (Figure 6-2), but the world's population is still growing (Figure 6-1) at a rate of about 1.2%. This may not seem like much but in 2012 this growth added about 84 million people to the population—an average of more than 230,000 people each day, or almost 3 more people every second.

Second, demographers recognize that, geographically, human population growth is unevenly distributed and this pattern is expected to continue (Figure 6-3). About 2% of the 84 million new arrivals on the planet in 2012 were added to the world's more-developed coun-

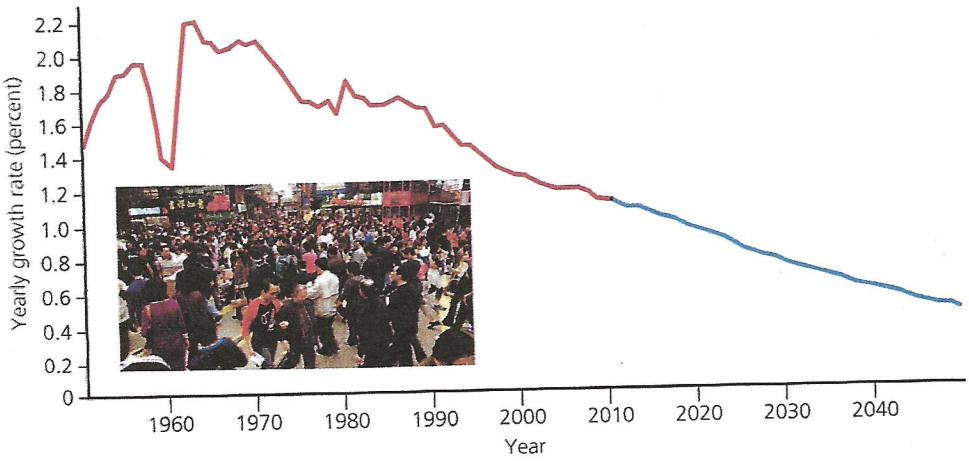
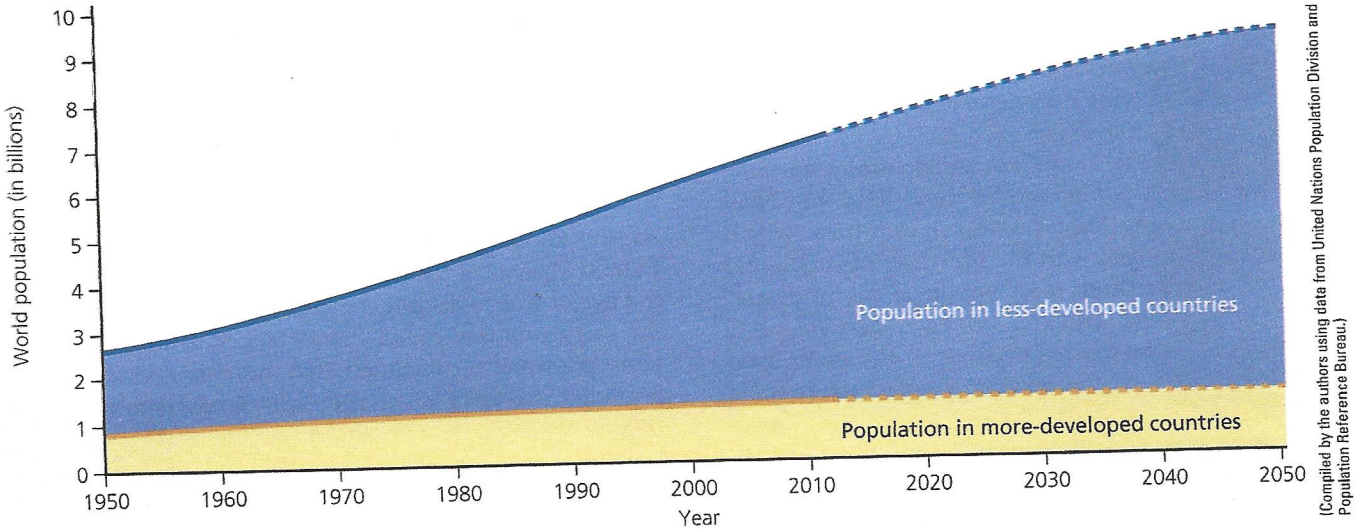


Figure 6-2 The annual growth *rate* of world population has generally dropped since the 1960s, but the population has continued to grow (Figure 6-1).

(Compiled by the authors using data from United Nations Population Division, U.S. Census Bureau, and Population Reference Bureau.)

Photo: JUSTIN GUARIGLIA/National Geographic Creative



(Compiled by the authors using data from United Nations Population Division and Population Reference Bureau.)

Figure 6-3 Most of the world's population growth between 1950 and 2012 took place in the world's less-developed countries. This gap has been projected to increase between 2012 and 2050.

SCIENCE FOCUS 6.1

HOW LONG CAN THE HUMAN POPULATION KEEP GROWING?

To survive and provide resources for growing numbers of people, humans have modified, cultivated, built on, and degraded a large and increasing portion of the earth's natural systems (Figure 6-A). As a result, our ecological footprints have spread across much of the globe (see Figure 1-12, p. 13) and are projected to expand significantly further by 2030. Some scientists estimate that by then, we would need the equivalent of two planet Earths to sustain the projected population of 9.6 billion people (see Figure 1-13, p. 14).

Scientific studies of the populations of other species tell us that *no population can continue growing indefinitely* (p. 113). How long can we continue to avoid the reality of the earth's carrying capacity for our species by sidestepping many of the factors that sooner or later limit the growth of any population?

The debate over this important question has been going on since 1798 when Thomas Malthus, a British economist, hypothesized that the human population tends to grow exponentially, while food supplies tend to increase more slowly at a linear rate. So far, Malthus has been proven wrong. Food production has grown at an exponential rate instead of at a linear rate because of genetic and other technological advances in industrialized food production.

Environmental scientists are reexamining arguments such as those of Malthus about possible limits to the growth of human populations and economies. One view is that we have exceeded some of those limits, with too many people collectively degrading the earth's life-support system (see Figure 3-B, p. 73). To some scientists and other analysts, the key problem is *overpopulation* because of the sheer number of people in less-developed countries (see Figure 1-14, top, p. 15), which have 82% of the world's population. To others, the key factor is *overconsumption* in affluent, more-developed countries because of their high rates of resource use per person (see Figure 1-14, bottom).

Another view of population growth is that, so far, technological advances have allowed us to overcome the environmental limits that all populations of other species face and that this has had the effect of increasing the earth's carrying capacity for our species. They point out that average life expectancy in most of the world has been steadily rising despite dire warnings from some environmental scientists that we are seriously degrading our life-support system.

Some of these analysts argue that because of our technological ingenuity, there are few, if any, limits to human population growth and resource use per person. They believe that we can continue ever-increasing economic growth and avoid serious damage to our life-support systems by making technological advances in areas such as food production and medicine, and by finding substitutes for resources that we are depleting. As a result, they see no need to slow the world's population growth.

Proponents of slowing and eventually stopping population growth point out that

tries, where population is growing exponentially at about 0.1% a year. The other 98% were added to the world's middle- and low-income, less-developed countries, where the population is growing exponentially, 14 times faster at about 1.4% a year, on average.

At least 95% of the 2.6 billion people projected to be added to the world's population between 2012 and 2050 will be born into the least-developed countries, which are not equipped to deal with the pressures of such rapid growth. The world's three most populous countries are, in order, China, India, and the United States. In 2012, more than one of every three persons on the earth lived in China (with 19% of the world's population) or India (with 18%).

A third important trend in human population growth is the movement of people from rural areas to cities. More than half of the world's people now live in *urban areas*, or cities (see chapter-opening photo) and their surrounding suburbs. The great majority of these urban dwellers live in less-developed countries where resources for dealing with rapidly growing populations are limited. (We cover this and other *urbanization trends* in Chapter 22.)

Human Population Growth Impacts Natural Capital

As the human population grows, so does the global total human ecological footprint (see Figure 1-13, p. 14), and the bigger this footprint, the higher the overall impact on the earth's natural capital. The 2005 Millennium Ecosystem Assessment concluded that human activities have degraded about 60% of the earth's ecosystem services (Figure 6-4).

This raises a question that many scientists are now studying: How many people can the earth support indefinitely (Concept 6-1)? Some analysts contend that we need to define the planet's **cultural carrying capacity**: the maximum number of people who could live in reason-

Figure 6-A **Natural capital degradation:** Fertile topsoil is an irreplaceable form of natural capital necessary for supplying the world's people with food. According to a joint survey by the UN Environment Programme (UNEP) and the World Resources Institute, topsoil is eroding faster than it forms on about 38% of the world's cropland, including this farmland in Iowa.

Lynn Betts/USDA Natural Resources Conservation Service

we are not providing the basic necessities for about 1.4 billion people—one of every five on the planet—who struggle to survive on the equivalent of about $1.25 per day. This raises a serious question: How will we meet the basic needs of the additional 2.6 billion people projected to be alive in 2050?

Proponents of slowing growth also warn of two potentially serious consequences that we could face if we do not sharply lower birth rates. First, death rates might increase because of declining health and environmental conditions and increasing social disruption in some areas, as is already happening in parts of Africa. A worst-case scenario for such a trend is a crash of the human population to a more sustainable level, perhaps as low as 2 billion. Second, resource use and degradation of normally renewable resources may intensify as more consumers increase their already large ecological footprints in more-developed countries and in rapidly developing countries such as China, India, and Brazil.

So far, advances in food production and health care have staved off widespread population declines. But there is extensive and growing evidence that we are steadily depleting and degrading much of the earth's irreplaceable natural capital (see Figure 1-3, p. 7) that supports us. We can get away with this for awhile, because the earth's life-support system is very complex and resilient, and because of built-in time delays between disturbances to the system and responses to them from within the system. But like unseen termites eating away the foundation of a house, at some point, such disturbances could reach a *tipping* or *breaking point* (see Figure 3-B, p. 73) beyond which there could be damaging and long-lasting change.

No one knows how close we are to environmental limits that, many scientists say, eventually will control the size of the human population. However, these scientists argue that human population growth is a vital scientific, political, economic, and ethical issue that we must confront.

Critical Thinking

How close do you think we are to the environmental limits of human population growth? Very close, moderately close, or far away? Explain.

able freedom and comfort indefinitely, without decreasing the ability of the earth to sustain future generations. (See the online Guest Essay by Garrett Hardin on this topic.) This issue has long been a topic of scientific and political debate (Science Focus 6.1).

Natural Capital Degradation

Altering Nature to Meet Our Needs

Reducing biodiversity

Increasing use of net primary productivity

Increasing genetic resistance in pest species and disease-causing bacteria

Eliminating many natural predators

Introducing harmful species into natural communities

Using some renewable resources faster than they can be replenished

Disrupting natural chemical cycling and energy flow

Relying mostly on polluting and climate-changing fossil fuels

Animated Figure 6-4 We humans have altered the natural systems that sustain our lives and economies in at least eight major ways to meet the increasing needs and wants of our growing population (Concept 6-1). ***Questions:*** In your daily living, do you think you contribute directly or indirectly to any of these harmful environmental impacts? Which ones? Explain.

CONCEPT 6-2A
Population size increases through births and immigration, and decreases through deaths and emigration.

CONCEPT 6-2B
The average number of children born to the women in a population *(total fertility rate)* is the key factor that determines population size.

The Human Population Can Grow, Decline, or Remain Fairly Stable

The basics of global population change are quite simple. If there are more births than deaths during a given period of time, the earth's population increases, and when the opposite is true, it decreases. When the number of births equals the number of deaths during a particular time period, population size does not change.

Instead of using the total numbers of births and deaths per year, demographers use the **crude birth rate** (the number of live births per 1,000 people in a population in a given year) and the **crude death rate** (the number of deaths per 1,000 people in a population in a given year).

Human populations grow or decline in particular countries, cities, or other areas through the interplay of three factors: *births (fertility), deaths (mortality),* and *migration.* We can calculate the **population change** of an area by subtracting the number of people leaving a population (through death and emigration) from the number entering it (through birth and immigration) during a specified period of time (usually 1 year) (Concept 6-2A):

$$\text{Population change} = (\text{Births} + \text{Immigration}) - (\text{Deaths} + \text{Emigration})$$

When births plus immigration exceed deaths plus emigration, a population grows; when the reverse is true, a population declines. (see Figure 18, p. S44, in Supplement 6 for a map showing various percentage rates of population growth in the world's countries in 2012.)

Women Are Having Fewer Babies but the World's Population Is Still Growing

Another measurement used in population studies is the **fertility rate**, a measure of how many children are born in a population over a set period of time. Here, we consider two types of fertility rates, the first being the **replacement-level fertility rate**: the average number of children that couples in a population must bear to replace themselves. It is slightly higher than two children per couple (2.1 in more-developed countries and as high as 2.5 in some less-developed countries), mostly because some children die before reaching their reproductive years. Any fertility rate above the replacement level will cause a population to grow.

If we were to reach the replacement-level fertility rate for the world, would it bring an immediate halt to population growth? No, because the number of *future* parents alive has grown dramatically. If all of today's couples were to have an average of 2.1 children, they would not be contributing to population growth. But if all of today's girl children were to grow up to have an average of 2.1 children as well, the world's population would continue to grow for 50 years or more (assuming death rates do not rise) because there are so many girls under age 15 who will be moving into their reproductive years.

The second type of fertility rate, and the key factor affecting human population growth and size, is the **total fertility rate (TFR)**: the average number of children born to the women in a population during their reproductive years (Concept 6-2B). Between 1955 and 2012, the average TFR for more-developed countries dropped from 2.8 to 1.6, and the average TFR for less-developed countries dropped from 6.2 to 2.6. The latter number is projected to continue dropping. If the global TFR, which was 2.4 in 2012, were to drop to 2.1, the world's population would continue to grow for about 50 years and then would level off and gradually decline.

Between 1955 and 2012, the global TFR dropped from 5 to 2.4. Those who support slowing the world's population growth view this as good news. However, to eventually halt population growth, the global TFR will have to drop to 2.1. (See Figure 19, p. S45, in Supplement 6 for a map showing how TFRs vary globally.)

CASE STUDY

The U.S. Population—Third-Largest and Growing

The population of the United States grew from 76 million in 1900 to 314 million by 2012, despite oscillations in the country's TFR and population growth rate (Figure 6-5). It took the country 139 years to reach a population of 100 million people, 52 years to add another 100 million (by 1967), and only 39 years to add the third 100 million (by 2006). During the period of high birth rates between 1946 and 1964, known as the *baby boom,* 79 million people were added to the U.S. population. At the peak of the baby boom in 1957, the average TFR was 3.7 children per woman. In 2012, and in most years since 1972, it has been at or below 2.1 children per woman (1.9 in 2012), compared to a global TFR of 2.4.

The drop in the TFR has slowed the rate of population growth in the United States. But the country's population is still growing faster than those of most other more-developed countries and it is not close to leveling off. According to the U.S. Census Bureau, about 2.3 mil-

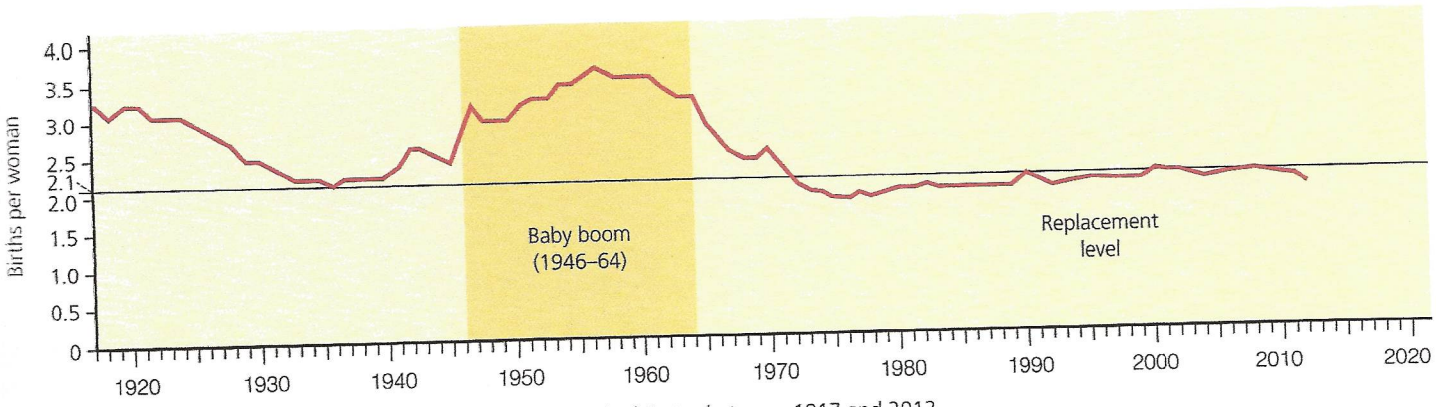
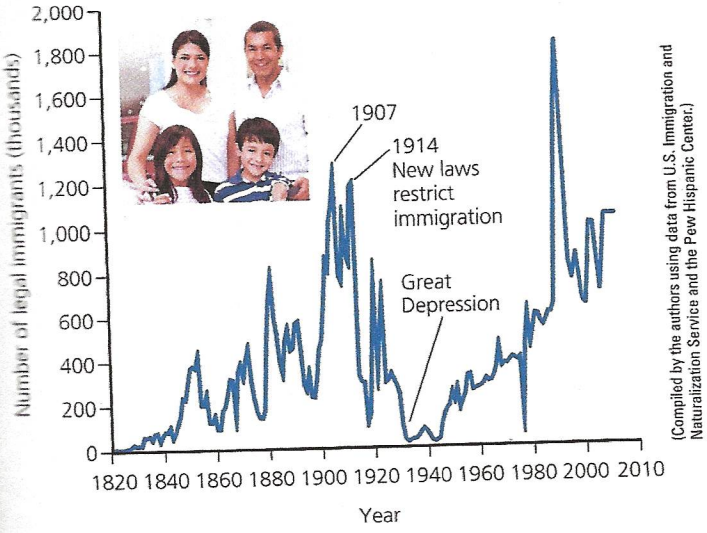


Figure 6-5 The graph shows the total fertility rates for the United States between 1917 and 2012. ***Question:*** The U.S. fertility rate has declined and remained at or below replacement levels since 1972. So why is the population of the United States still increasing?

(Compiled by the authors using data from Population Reference Bureau and U.S. Census Bureau.)

lion people were added to the U.S. population in 2012. About 1.6 million (70% of the total) were added because there were that many more births than deaths, and about 0.7 million (30% of the total) were immigrants.

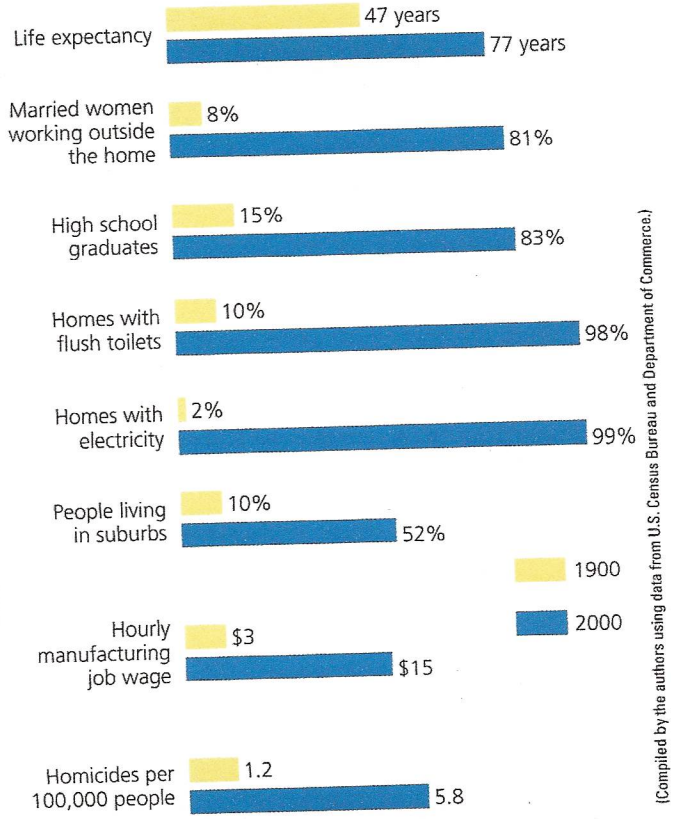
Immigration has become a political issue in the United States. The country was founded by immigrants and since 1820, it has admitted almost twice as many immigrants and refugees as all other countries combined. The number of legal immigrants (including refugees) has varied during different periods because of changes in immigration laws and rates of economic growth (Figure 6-6).



(Compiled by the authors using data from U.S. Immigration and Naturalization Service and the Pew Hispanic Center.)

Figure 6-6 Legal immigration to the United States, 1820–2006 (the last year for which data are available). The large increase in immigration since 1989 resulted mostly from the Immigration Reform and Control Act of 1986, which granted legal status to certain illegal immigrants who could show they had been living in the country before January 1, 1982.

In addition to the fourfold increase in population growth since 1900, some amazing changes in lifestyles took place in the United States during the 20th century (Figure 6-7), which led to Americans living longer. Along with this came dramatic increases in per capita resource use and a much larger total and per capita ecological footprint.



(Compiled by the authors using data from U.S. Census Bureau and Department of Commerce.)

Figure 6-7 Some major changes took place in the United States between 1900 and 2000. ***Question:*** Which two of these changes do you think had the biggest impacts on the U.S. ecological footprint?

causes of death in the United States were pneumonia, tuberculosis, and diarrhea (ailments that are seldom life-threatening now); 90% of U.S. doctors had no college education; one of five adults could not read or write; only 6% of Americans graduated from high school; the average U.S. worker earned a few hundred to a few thousand dollars per year; and there were only 9,000 cars in the country and only 232 kilometers (144 miles) of paved roads.

The U.S. Census Bureau projects that the U.S. population is likely to increase from 314 million in 2012 to 400 million by 2050—an addition of 86 million more Americans over four decades. Because of a high per-person rate of resource use and the resulting waste and pollution, each addition to the U.S. population has an enormous environmental impact (see the map in Figure 8, p. S33, in Supplement 6). Recall that the environmental impact of a population is obtained by multiplying the effects of three factors (see Figure 1-14, p. 15, bottom): population size, affluence (and resulting high rates of resource use per person), and technology. The United States has by far the world's largest total and per capita ecological footprint (see Figure 1-11, p. 13), mostly because of the size of its population multiplied by its very high rate of resource use per person. This explains why some analysts consider the United States to be the world's most overpopulated country.

CONSIDER THIS. . .

THINKING ABOUT The U.S. Population

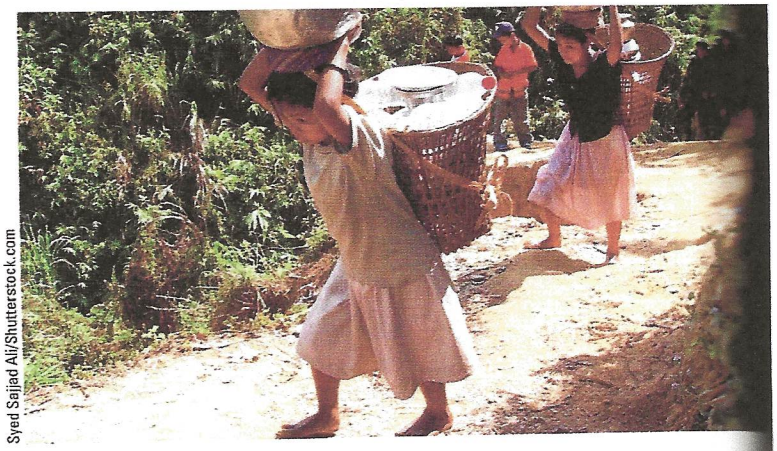
Considering this information, do you believe that the United States is the world's most overpopulated country? Explain.

Several Factors Affect Birth Rates and Fertility Rate

Many factors affect a country's average birth rate and TFR. One is the *importance of children as a part of the labor force*, especially in less-developed countries. This is a major part of why it makes sense for many poor couples in those countries to have a large number of children. They need help with hauling daily drinking water (Figure 6-8), gathering wood for heating and cooking, and tending crops and livestock.

Another economic factor is the *cost of raising and educating children*. Birth and fertility rates tend to be lower in more-developed countries, where raising children is much more costly because they do not enter the labor force until they are in their late teens or twenties. In the United States, it costs more than $235,000 to raise a middle-class child from birth to age 18. By contrast, many children in poor countries receive little education and instead have to work to help their families survive (Figure 6-9).

The *availability of, or lack of, private and public pension systems* can influence the decisions of some couples on how many children to have, especially the poor in less-developed countries. Pensions reduce a couple's need to have several children to help support them in old age.



Syed Saijad Ali/Shutterstock.com

Figure 6-8 These young girls in India are carrying water.

Also, there are more *infant deaths* in poorer countries, and over time, this has affected cultural norms related to family size in these countries. The more children a couple has, the more likely it is that at least a few will survive and grow to adulthood.

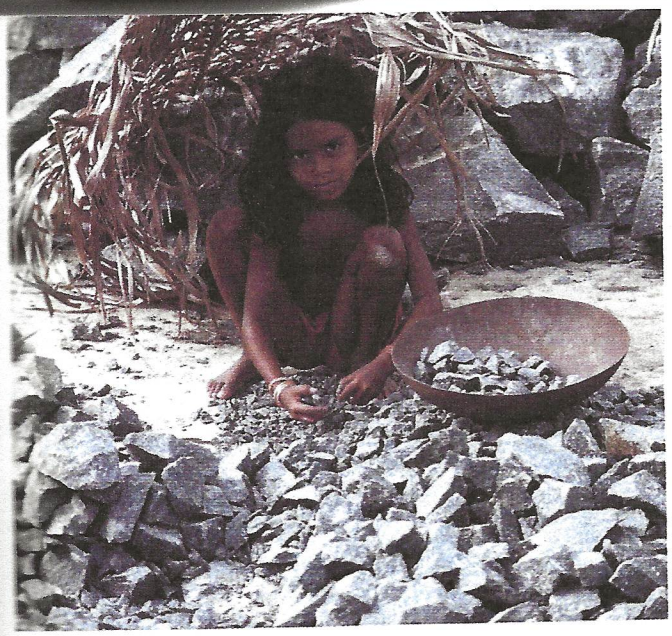
Urbanization plays a role in birth rate trends. People living in urban areas usually have better access to family planning services and tend to have fewer children than do those living in the rural areas of poorer countries.

Another important factor is the *educational and employment opportunities available for women*. Total fertility rates tend to be low when women have access to education and paid employment outside the home. In less-developed countries, a woman with no education typically has two more children than does a woman with a high school education. In most societies, better-educated women tend to marry later and have fewer children.

Average age at marriage (or, more precisely, the average age at which a woman has her first child) also plays a role. Women normally have fewer children when their average age at marriage is 25 or older.

Birth rates and TFRs are also affected by the *availability of legal abortions*. According to the World Health Organization and the Guttmacher Institute, each year, about 210 million women become pregnant and at least 42 million of them get abortions—about 22 million of them legal and the other 20 million illegal (and often unsafe). The *availability of reliable birth control methods* also allows women to control the number and spacing of the children they have.

Religious beliefs, traditions, and cultural norms also play a role. In some countries, these factors favor large families as many people strongly oppose abortion and some forms of birth control.



PRIIT VESILIND/National Geographic Creative

Figure 6-9 This young girl is breaking granite into gravel in the Kerala State of India.

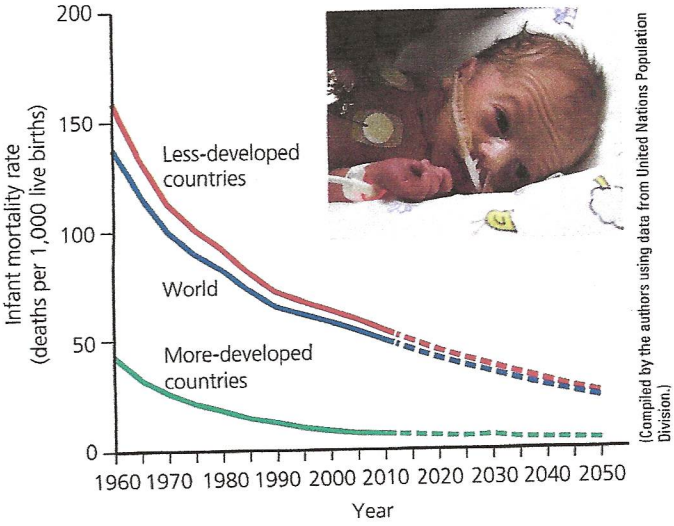


Figure 6-10 Infant mortality rates for the world's more-developed countries and less-developed countries, 1950–2012, with projections to 2050 based on medium population projections.

Photo: Gert Vrey/Shutterstock.com

CONSIDER THIS . . .

CONNECTIONS Preference for Male Children and Social Problems in China

In China, where families are strongly encouraged to have only one child, there is a strong preference for male children, partly because daughters are likely to marry and leave their parents. Some pregnant Chinese women use ultrasound to determine the gender of their fetuses and get an abortion if the child is female. As a result, baby boys are sometimes kidnapped and sold to families that want boys, and some young girls have been kidnapped and sold as brides for single men. The Chinese government estimates that by 2030, about 30 million Chinese men will not be able to find wives and if the economy slows, they might have poor job prospects. Sociologists say this is a recipe for social upheaval.

Several Factors Affect Death Rates

The rapid growth of the world's population over the past 100 years is not primarily the result of a rise in the birth rate. Instead, it has been caused largely by declining death rates, especially in less-developed countries. More people in some of these countries are living longer and fewer infants are dying because of increased food supplies, improvements in food distribution, better nutrition, medical advances such as immunizations and antibiotics, improved sanitation, and safer water supplies.

A useful indicator of the overall health of people in a country or region is **life expectancy**, which for any given year is the average number of years a person born in that year can be expected to live. Between 1955 and 2012, the average global life expectancy increased from 48 years to 70 years. In 2012, Japan had the world's longest life expectancy of 83 years. In the world's poorest countries, life expectancy is 55 years or less.

GOOD NEWS

Between 1900 and 2012, the average U.S. life expectancy increased from 47 years to 79 years. However, the United States ranks 32nd among nations in life expectancy, down from 5th in 1950. Research indicates that a key factor in this ranking is poor health, even though the United States leads the world in health-care costs per person.

Another important indicator of overall health in a population is its **infant mortality rate**, the number of babies out of every 1,000 born who die before their first birthday. It is viewed as one of the best measures of a society's quality of life because it reflects a country's general level of nutrition and health care. A high infant mortality rate usually indicates insufficient food *(undernutrition)*, poor nutrition *(malnutrition)*, and a high incidence of infectious disease. Infant mortality also affects the TFR. In areas with low infant mortality rates, women tend to have fewer children because fewer of their children die at an early age.

Infant mortality rates in most countries have declined dramatically since 1965 (Figure 6-10) but vary widely among different countries (see Figure 20, p. S45, Supplement 6). Even so, every year, more than 4 million infants (most of them in less-developed countries) die of *preventable* causes during their first year of life. This average of nearly 11,000 mostly unnecessary infant deaths per day is equivalent to 55 jet airliners, each loaded with 200 infants younger than age 1, crashing *every day* with no survivors—a tragedy rarely reported in the news.

In 1900 the U.S. infant mortality rate was 165. In 2012 it was 6.0. This sharp decline was a major factor in the marked increase in U.S. average life expectancy during this period. However, in 2012 the United States ranked 44th among all nations in terms of infant mortality rates for two main reasons: the generally inadequate health care for poor women during pregnancy, as well as for their babies after birth, and drug addiction among many pregnant women.