Biology

A Guide to the Natural World

Chapter 34 • Lecture Outline

An Interactive Living World 1: Populations in Ecology

Fifth Edition

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34.1 The Study of Ecology

The Study of Ecology

- Ecology is the study of the interactions living things have with each other and with their environment.

An Ecologist on the Job

Figure 34.1

Scales of Life

- There are five scales of life that concern ecology:
  - physiology
  - populations
  - communities
  - ecosystems
  - the biosphere

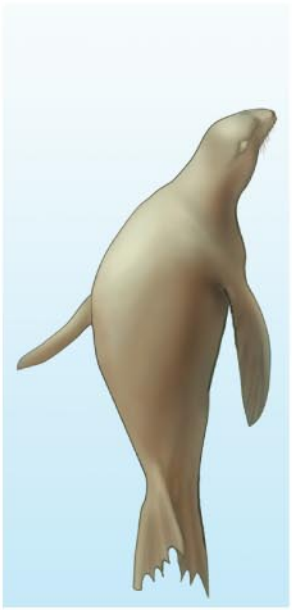
Scales of Life

- A population is all the members of a single species that live together in a specified geographical area.
- A community is all the members of all species that live in a single area.

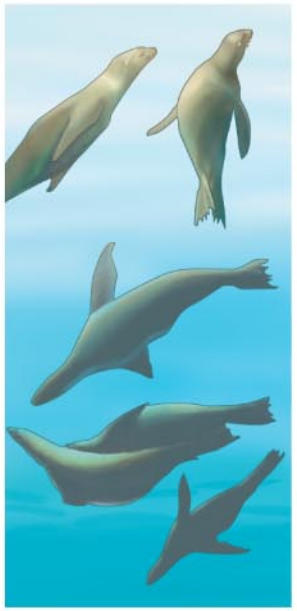
Scales of Life

- An ecosystem is a community and all the nonliving elements that interact with it.
- The biosphere is the interactive collection of all the Earth's ecosystems.

Scales of Life



organism (sea lion)



population (colony)

community (giant kelp forest)

ecosystem (Southern California coast)

biosphere (Earth)

Figure 34.2

34.2 Populations: Size and Dynamics

Populations

- To understand populations, ecologists count the number of individuals in it.
- Various techniques are used to estimate the size of populations whose members can't be counted directly.

Arithmetic and Exponential Growth

- An arithmetical increase occurs when, over a given interval of time, an unvarying number of new units is added to a population.

Arithmetic and Exponential Growth

- An exponential increase occurs when the number of new units added to a population is proportional to the number of units that exists.

Arithmetic and Exponential Growth

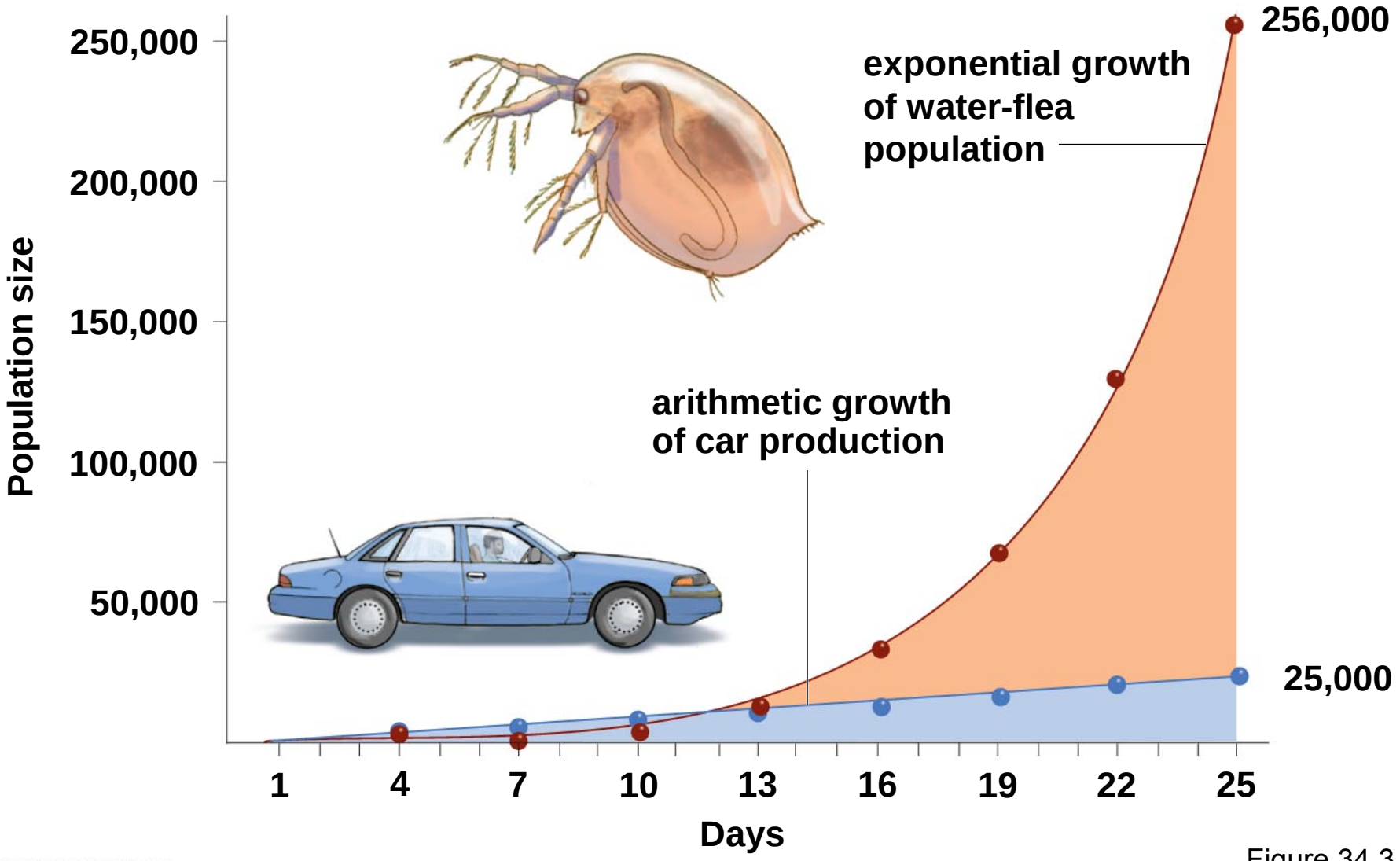


Figure 34.3

Arithmetic and Exponential Growth

- The rapid growth that sometimes characterizes living populations is referred to as exponential growth or as the J-shaped growth curve.

Arithmetic and Exponential Growth

- Populations that initially grow, but whose growth later levels out, have experienced logistic growth, sometimes referred to as the S-shaped growth curve.

Models of Growth for Natural Populations

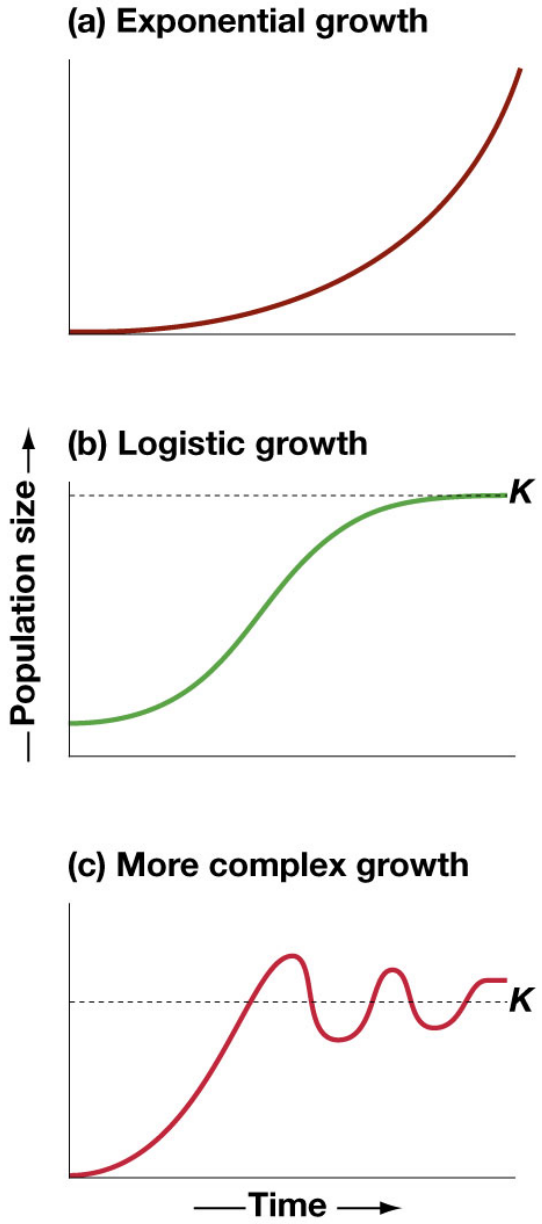


Figure 34.4

Environmental Resistance

- The size of living populations is kept in check by **environmental resistance**, defined as all the forces of the environment that act to limit population growth.

Calculating Exponential Growth

- Exponential growth in living populations can be calculated by subtracting a population's death rate from its birth rate, which yields the population's growth rate.
- Denoted as *r,* this rate is also known as the population's intrinsic rate of increase.

Intrinsic Rate of Increase (r)

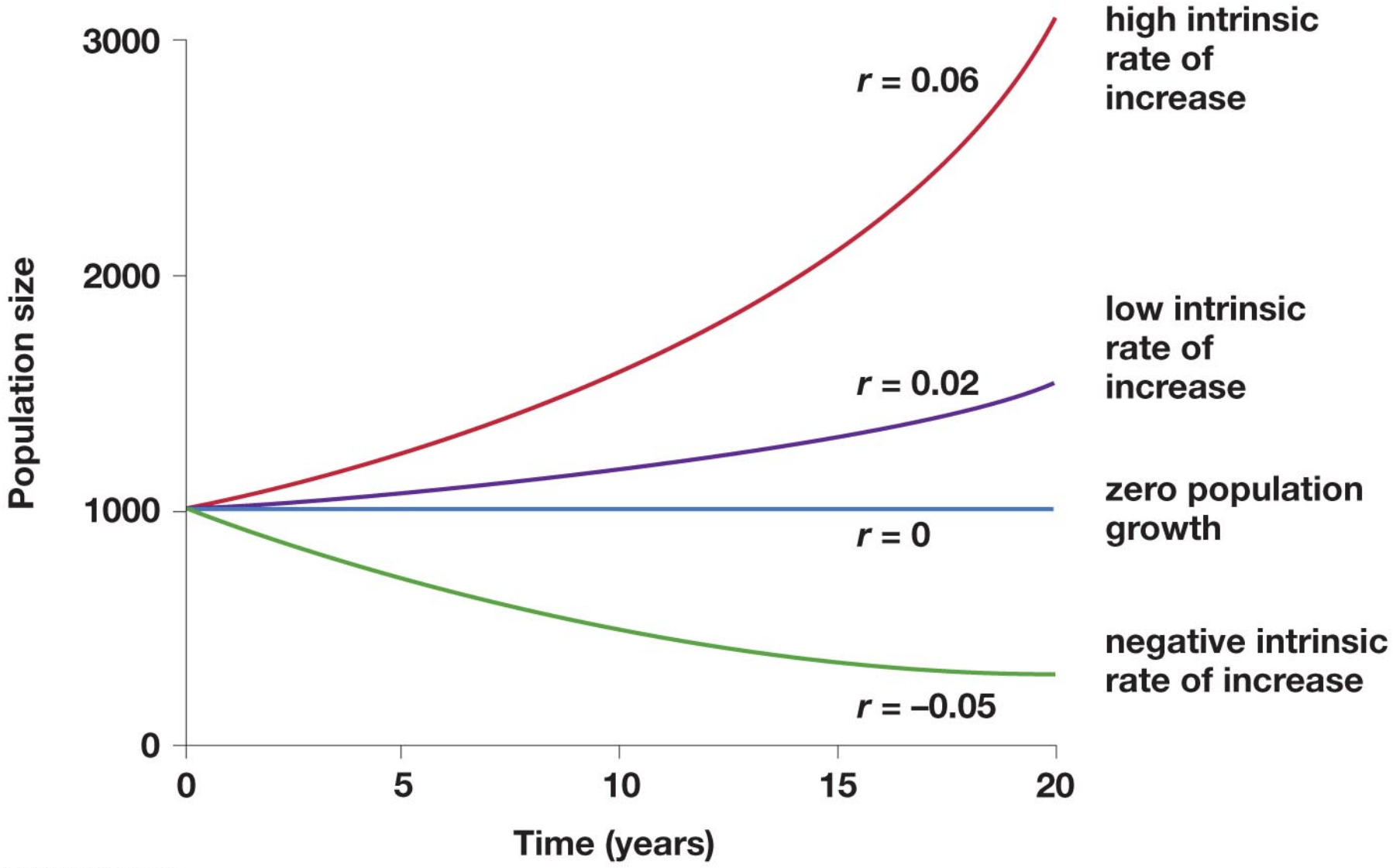


Figure 34.5

How Long Between Generations?

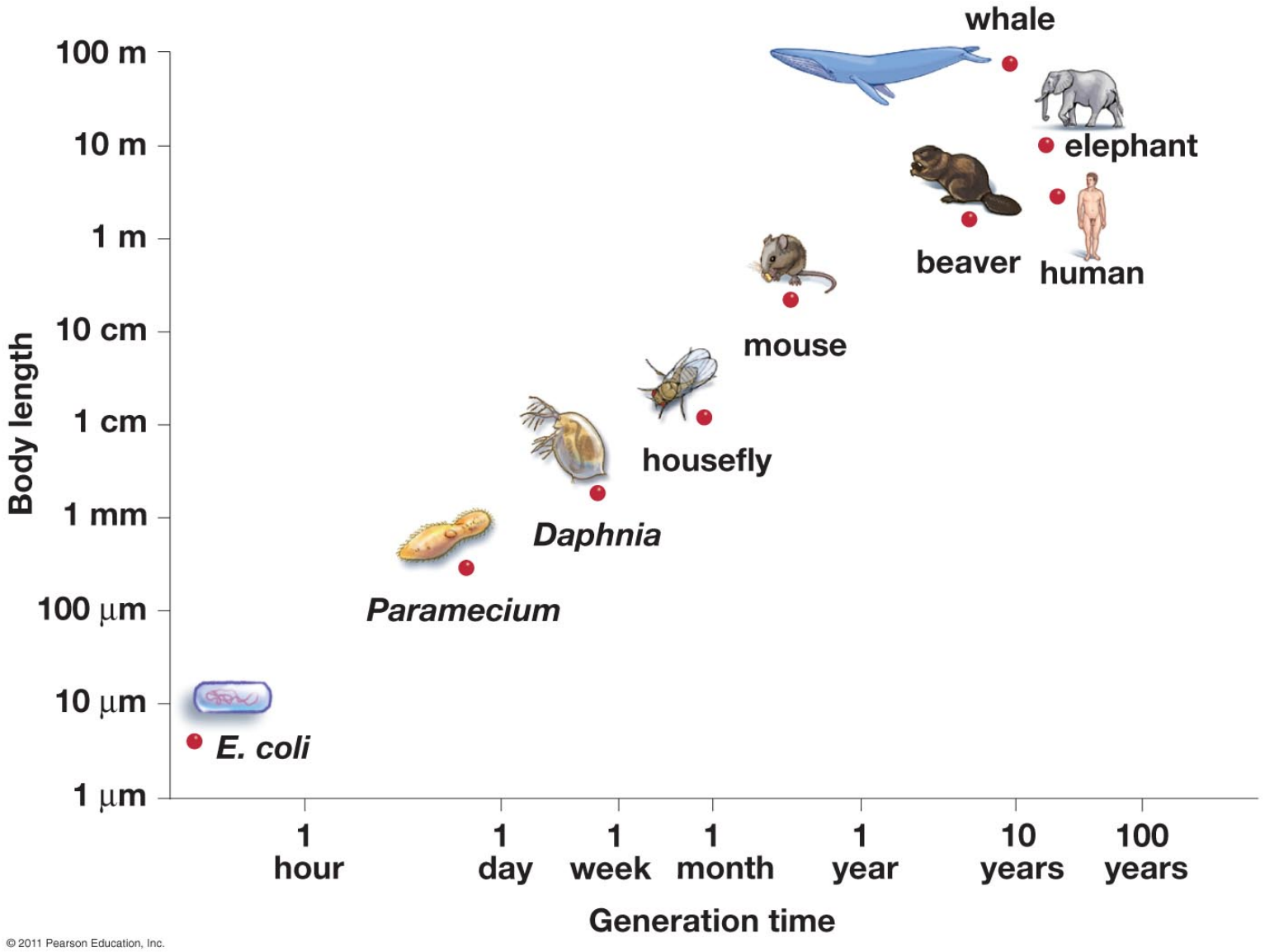


Figure 34.6

Carrying Capacity (K)

- Carrying capacity, denoted as K, is the maximum population density of a given species that can be sustained within a defined geographical area over an extended period of time.

34.3 r-*Selected and* K-*Selected Species*

Reproductive Strategies

- Different species have different characteristics that affect the number of fertile offspring they bear.

K-Selected Species

- Some species are said to be *K*-selected, or equilibrium, species.
- These species tend to be physically large, to experience their environment as relatively stable, and to lavish a good deal of attention on relatively few offspring.

K-Selected Species

- The pressures on *K*-selected species tend to be density dependent, meaning that as a population's density goes up, factors that limit the population's growth assert themselves ever more strongly.

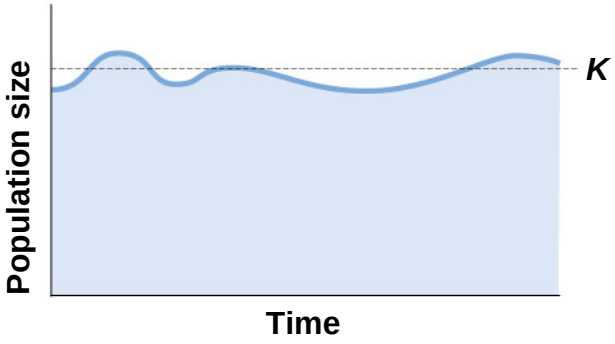
r-Selected Species

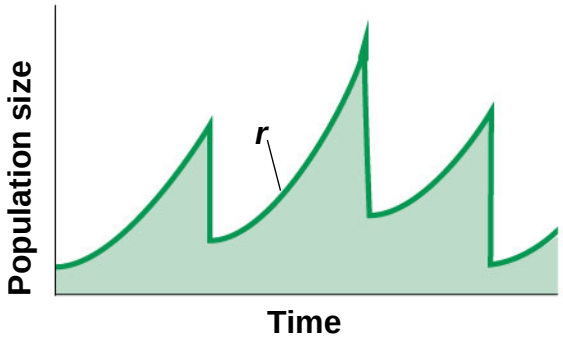
- Other species are said to be *r*-selected or opportunist species.
- These species tend to be physically small, to experience their environment as relatively unstable, and to give little or no attention to the numerous offspring they produce.

r-Selected Species

- The pressures on *r*-selected species tend to be density independent, meaning pressures that are unrelated to the population's density.

K-selected equilibrium species ⟷ **r-selected opportunist species**





Population size:
- limited by carrying capacity *(K)*
- density dependent
- relatively stable

Organisms:
- larger, long lived
- produce fewer offspring
- provide greater care for offspring

Population size:
- limited by reproductive rate (*r*)
- density independent
- relatively unstable

Organisms:
- smaller, short lived
- produce many offspring
- provide no care for offspring

Figure 34.7

Survivorship Curves

- Survivorship curves describe how soon species members tend to die within the species' life span.

Survivorship Curves

- There are three idealized types of survivorship curves:
  - Late loss (type I)
  - Constant loss (type II)
  - Early loss (type III)

Survivorship Curves

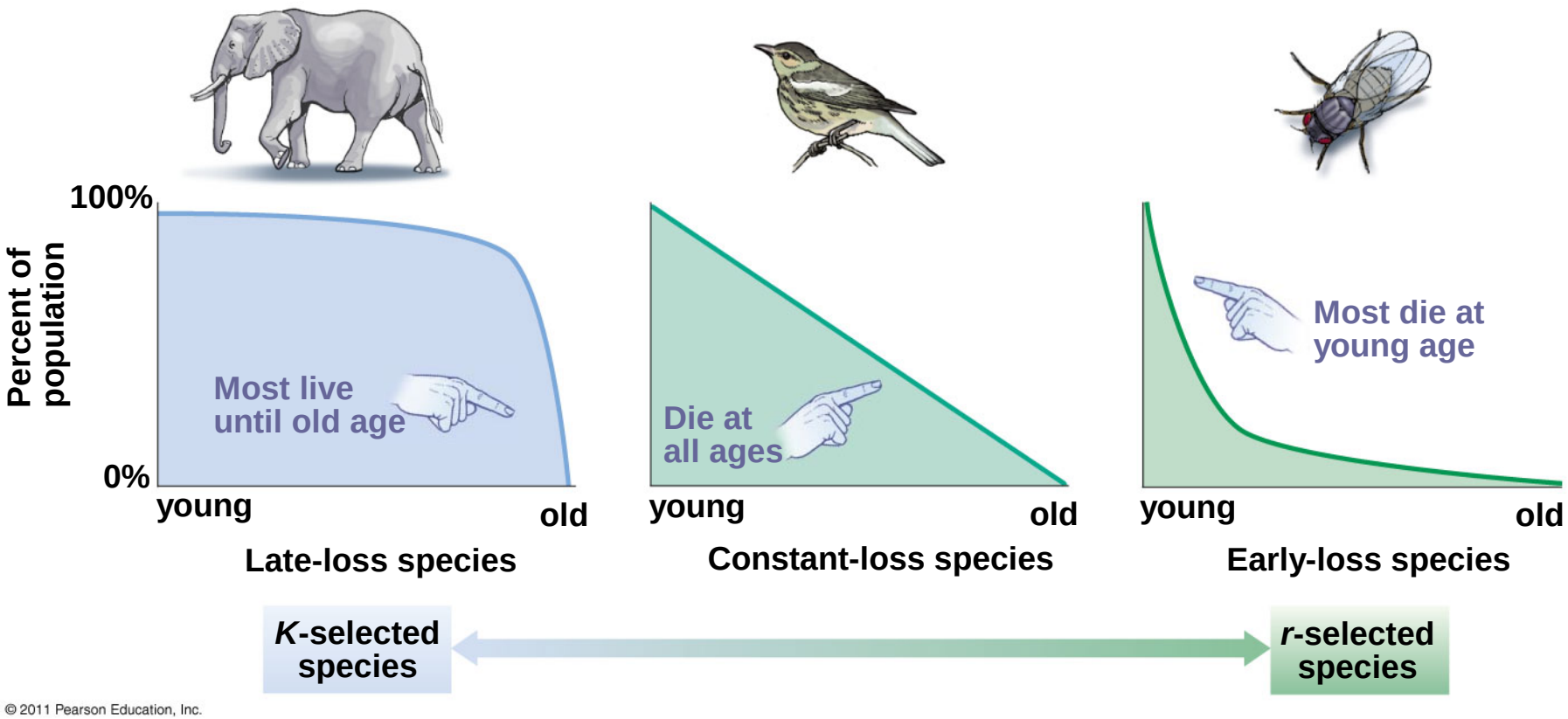


Figure 34.8

34.4 Thinking About Human Populations

Life Tables

- Survivorship curves are created from life tables, which set forth the probabilities of a member of a species being alive after given intervals of time.

Table 34.1

A Life Table for the United States

At age	Number still living	Average remaining lifetime, in years
10	99,129	68.5
20	98,709	58.8
30	97,776	49.3
40	96,517	39.9
50	93,735	30.9
60	88,038	22.5
70	76,191	15.1
80	53,925	9.1
90	22,219	5.0
100	2,510	2.6

Taking a hypothetical group of 100,000 persons born in the United States in 2004, the table shows the number likely to still be living at the ages indicated and the average remaining lifetime for persons at each age. The numbers are averaged for men and women, a choice that masks significant differences between the sexes in older age cohorts. Of 100,000 women born in 2004, for example, about 61,000 are likely to be alive at age 80, whereas for men the figure is about 46,000.

Source: National Center for Health Statistics

Population Pyramids

- An important step in calculating the future growth of human populations is to learn what proportion of the population is at or under reproductive age.

Population Pyramids

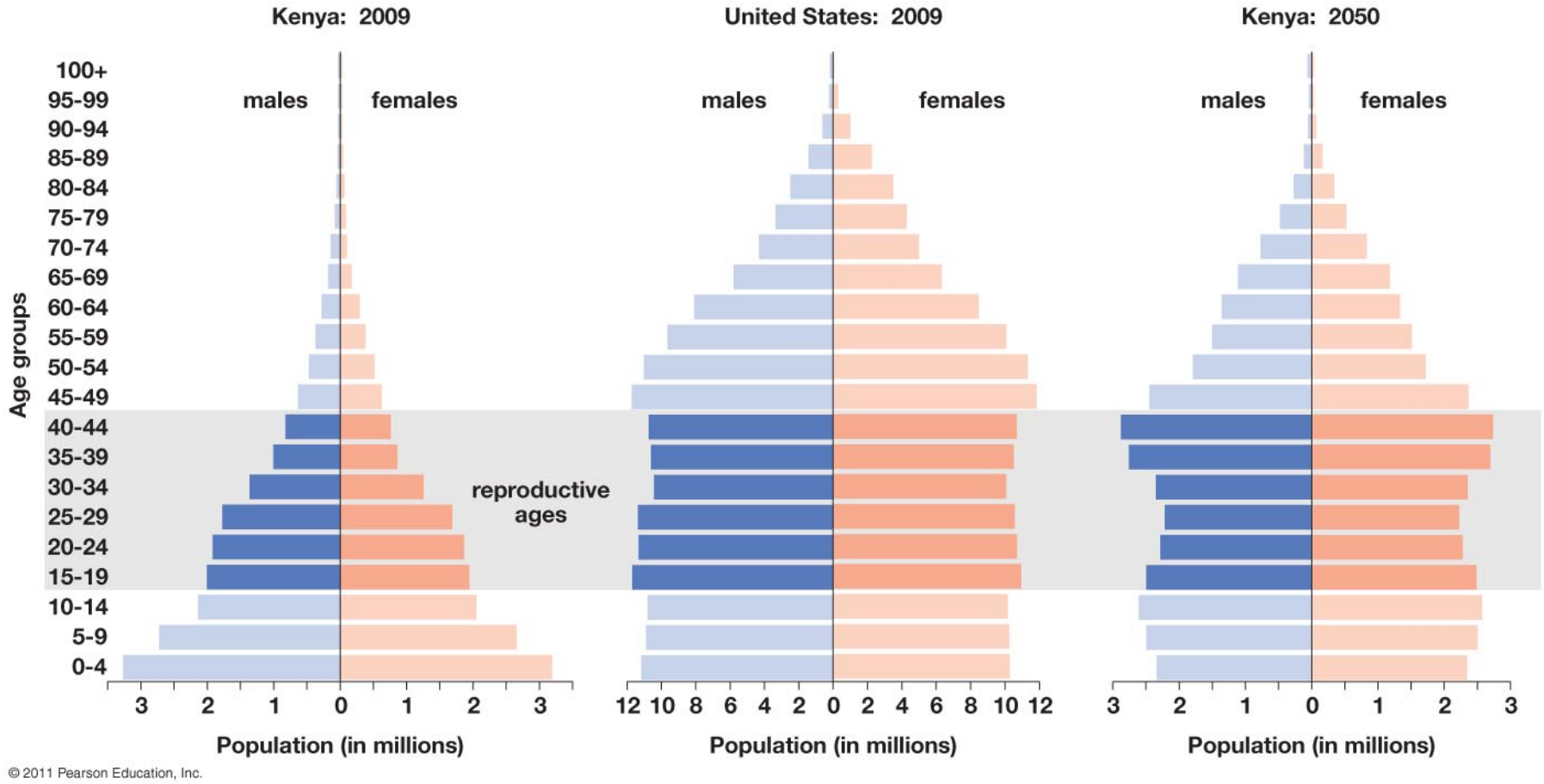


Figure 34.9

Human Population Increase

- The world's population is now growing at a much slower rate than in the past due to a decrease in the total fertility rate.

Human Population Increase

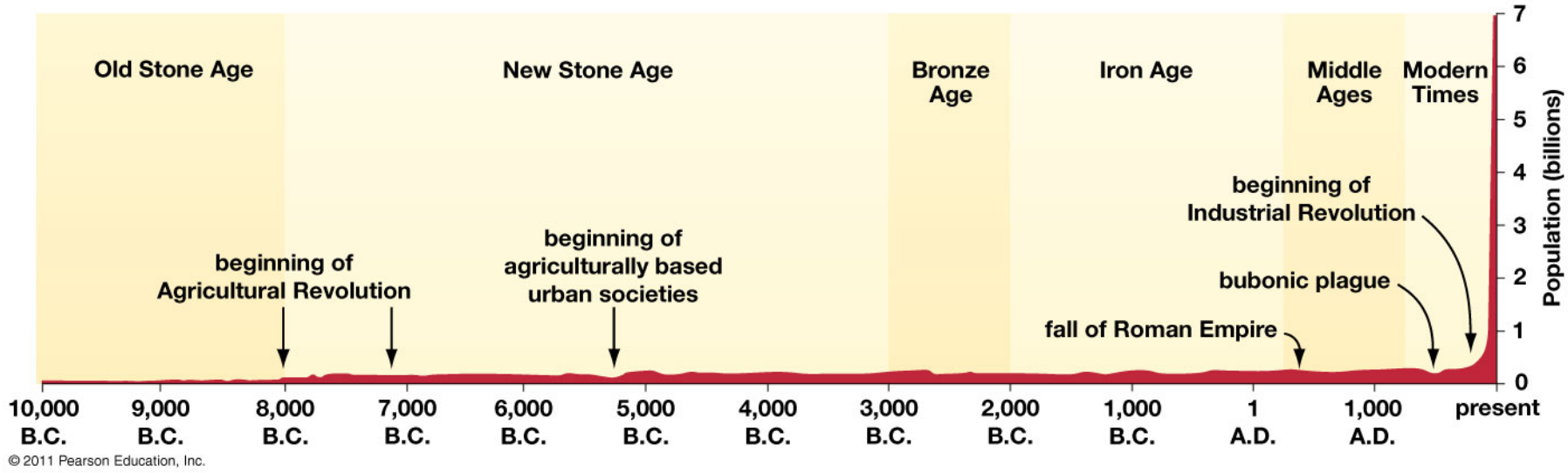


Figure 34.10

Big Changes in Fertility

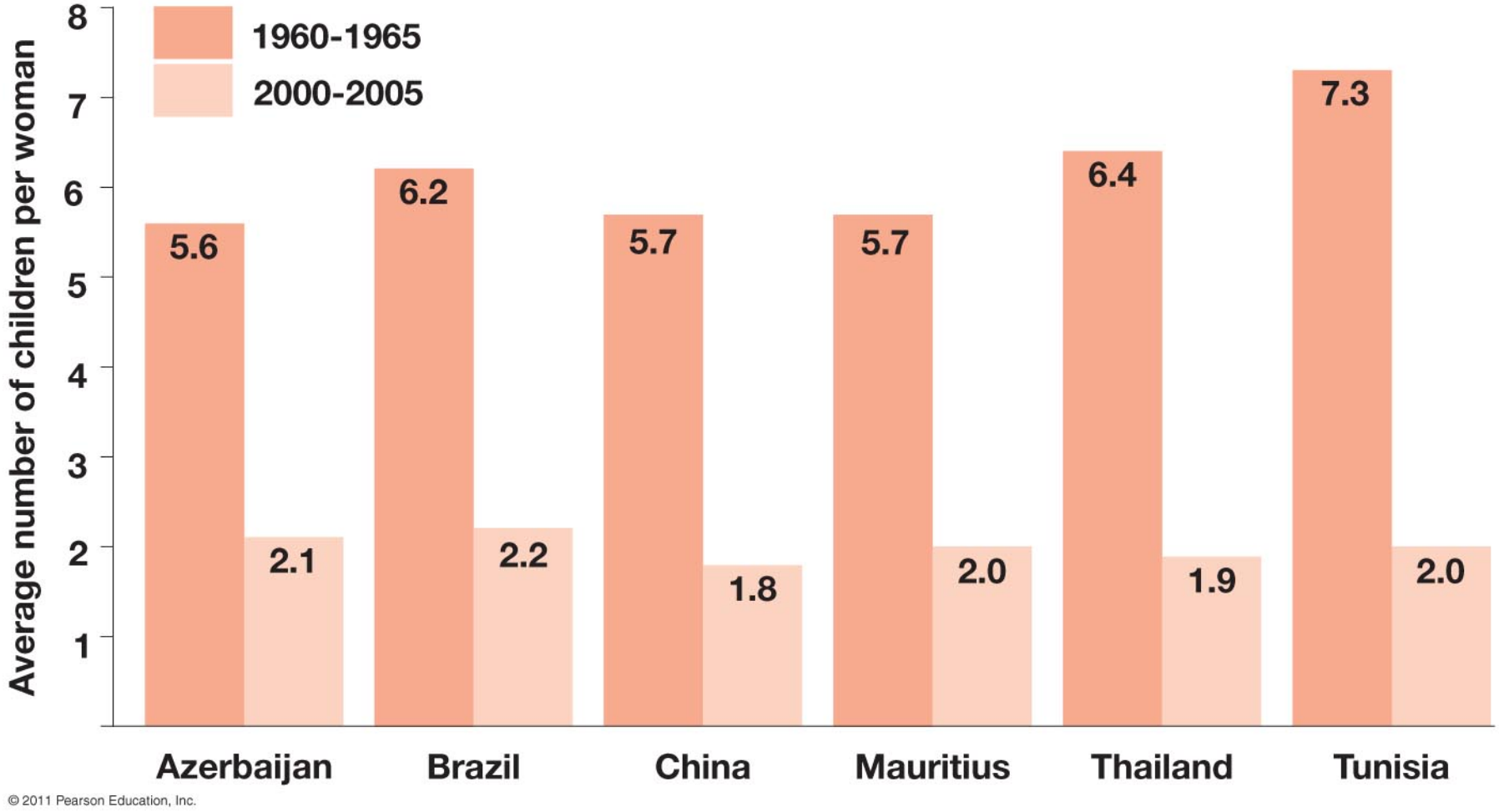


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Figure 34.11

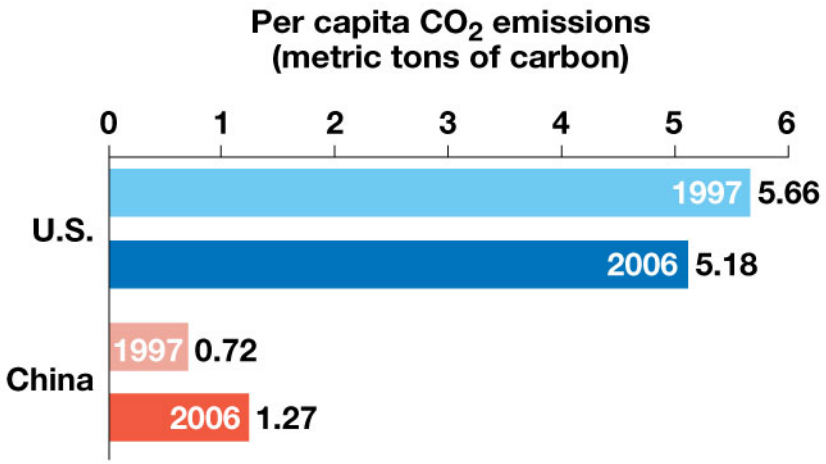
The World's Human Population

- The global reduction in fertility masks enormous, ongoing differences between fertility in more-developed and less-developed countries.

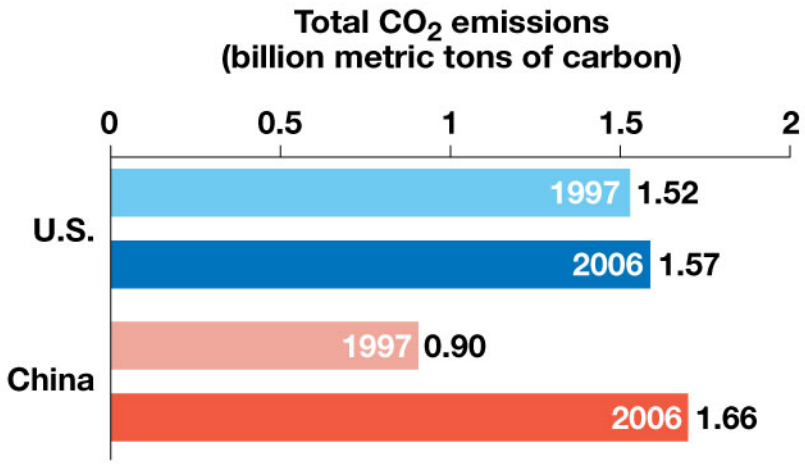
The World's Human Population

- Some scientists believe that there is no greater single threat to the environment than the continued growth of the human population.
- Others argue that a more important concern is the use of natural resources per person.

Per Capita and Total Carbon Emissions



U.S. per capita CO_2 emissions far exceed those in China, but China's per capita emissions grew by 76 percent between 1997 and 2006 . . .



. . . When coupled with China's large population, this per capita growth meant that China's total CO_2 emissions went from 59 percent of those in U.S. in 1997 to 106 percent of those in U.S. in 2006.

Figure 34.12