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UNIT 1:
ECOSYSTEM INTERACTION AND POPULATION DYNAMICS

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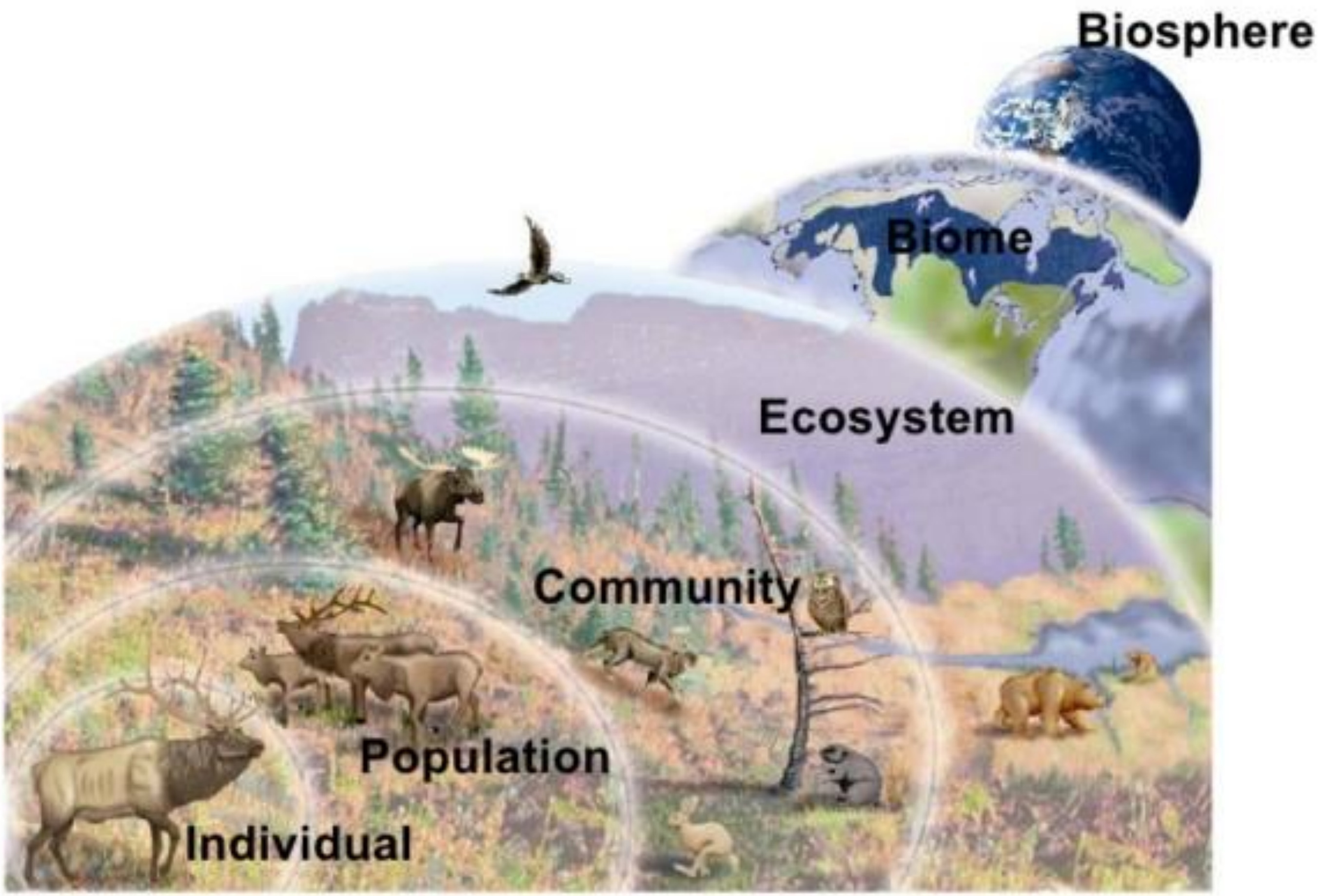
Individuals, Populations, and Communities in Ecosystems

- Ecology the study of interactions of organisms with one another and their environment.
- Species organisms capable of interbreeding and producing fertile offspring
- binomial nomenclature a system in which a two-word name (genus and species) is used to identify an organism – honeybee: *Apis mellifera*. (Bio 3201)
- population any group of individuals of the same species living in the same geographical area at the same time
- community all the organisms in all the interacting populations in a given area
- ecosystem a community of populations together with the abiotic factors that surround and affect it

Levels of Organization



- biome ecosystem or group of ecosystems in a specific region on Earth that has a particular combination of biotic and abiotic factors
- biosphere all of the areas on Earth (in the air, land, and water) that are inhabited by and that support life

Figure 1.6 The Arctic hare is found in northern Canada where it can survive well in the abiotic and biotic factors of the tundra.

How Energy Enters the Biosphere (Two Ways)

- 1.photosynthesis the process by which plants, algae, and some kinds of bacteria use the Sun's light energy to chemically convert carbon into carbohydrates such as sugars and starches

Photosynthesis	$6CO_2(g)$	+	$6H_2O(\ell)$	+	light energy	$\rightarrow$	$C_6H_{12}O_6(s)$	+	$6O_2(g)$
	carbon dioxide	+	water	+	light energy	$\rightarrow$	carbohydrates (sugars and starches)	+	oxygen

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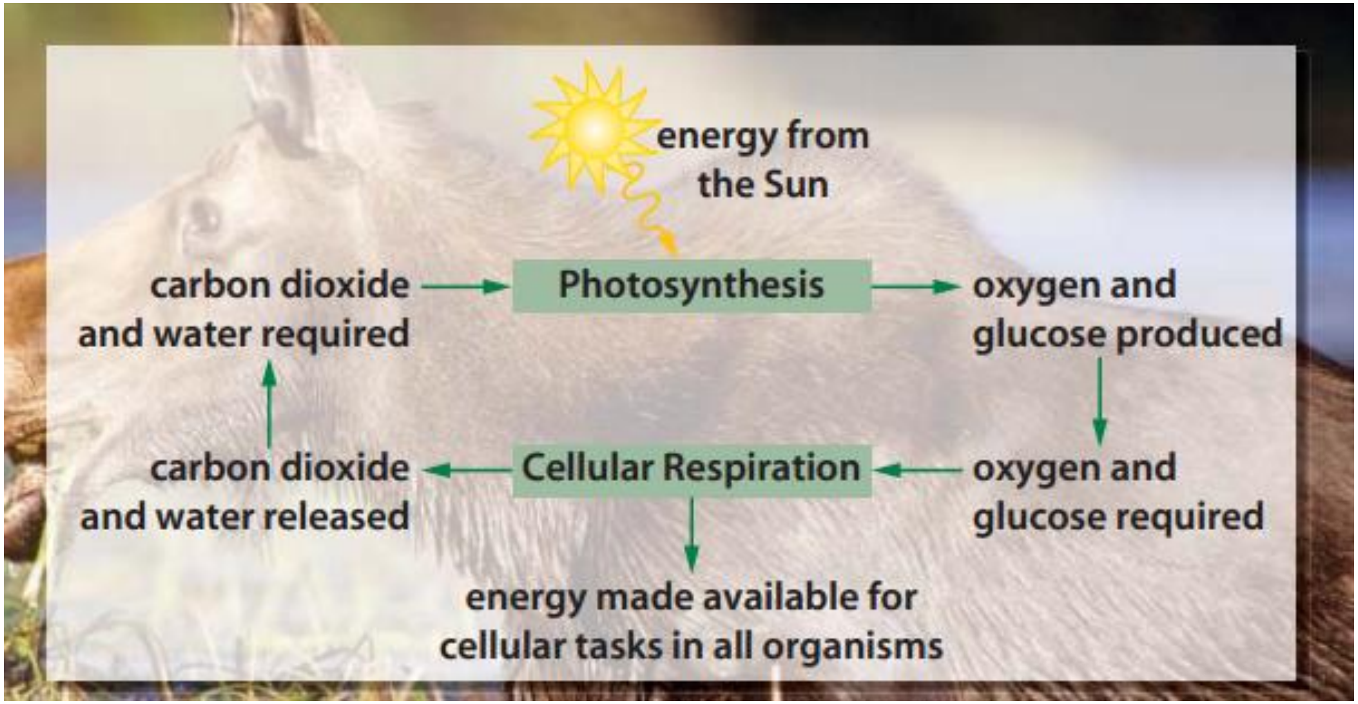
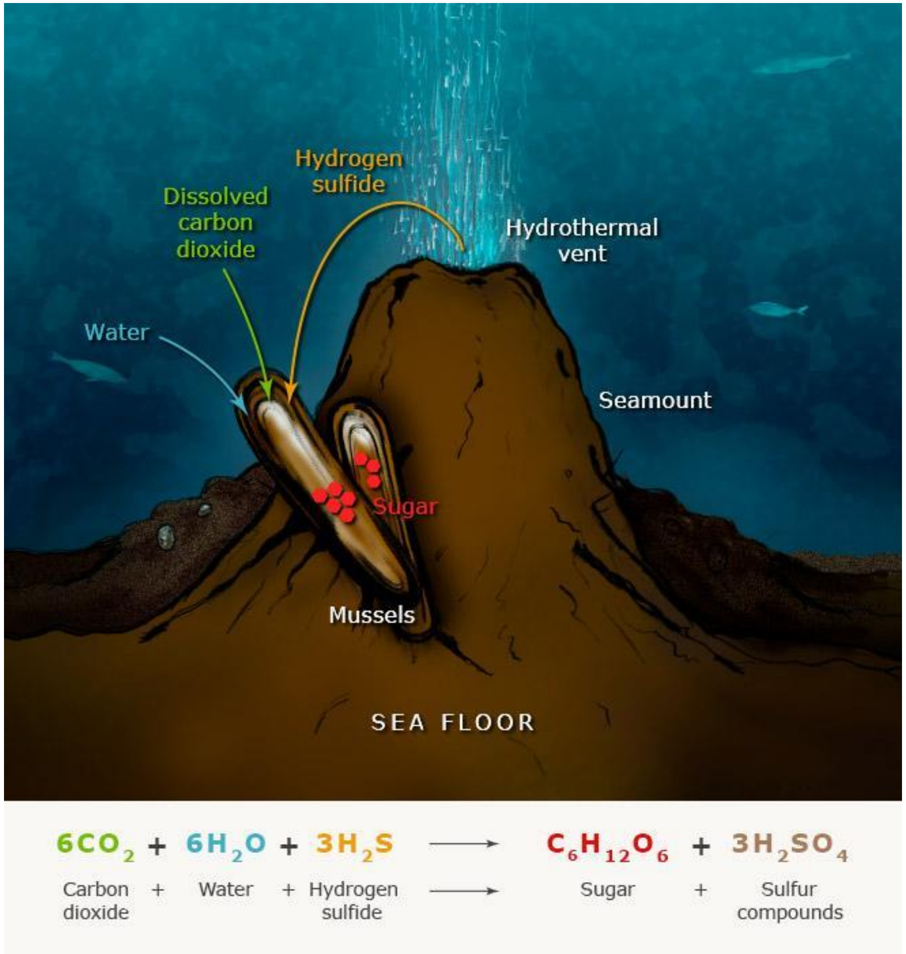
Figure 1.9 Energy from the Sun is captured by photosynthetic organisms (producers). These organisms convert this energy to glucose, which provides energy and matter for the producers themselves, as well as for consumers of the producers. Notice that photosynthesis and cellular respiration are almost the reverse of each other. They are often considered complementary processes. Both processes use the same matter, but the form of energy used and released is different.



- 2. chemosynthesis the process by which certain fungi and bacteria use the energy from chemical nutrients to chemically convert carbon into carbohydrates such as sugars and starches in the absence of sunlight



Cellular Respiration

- cellular respiration process in which mitochondria in the cells break down carbohydrates and other energy-rich products derived from them

Cellular Respiration	$C_6H_{12}O_6(s)$	+	$6O_2(g)$	→	$6CO_2(g)$	+	$6H_2O(\ell)$	+ energy
	carbohydrates (sugars and starches)	+	oxygen	→	carbon dioxide	+	water	+ energy

Cellular Respiration cont

- Herbivore, carnivores and omnivores acquire their energy from the energy rich molecules (such as glucose) that are present in the food they eat.
- This chemical energy can then be converted into a more usable form of biological energy called ATP (Adenosine Tri Phosphate) through a process called cellular respiration.
- This process occurs in the mitochondria of body cells.
- ATP is used to fuel many cellular processes such as cellular transport, muscle contraction, and transmission of nerve impulses.
- Cellular Respiration is complementary to the process of photosynthesis in that they both produce molecules that are required at reactants in each process.

Remember from Science 1206

- primary consumer organism that obtains energy by eating plants (herbivore)
- secondary consumer organism that eats primary consumers (carnivores)
- tertiary consumer organism that eats secondary consumers (carnivores)
- decomposer organism that obtains energy by consuming dead plant and animal matter or waste (fungi, bacteria, earthworms, and insects)

- Career Focus Worksheet

Energy does not and cannot cycle as matter does. Energy follows a one-way path through the biosphere

- energy cannot be created or destroyed. It can only be converted from one form to another or transferred from one object to another.
- This idea is known as the first law of thermodynamics.
- For example, radiant energy from the Sun may be converted into the chemical energy stored in the bonds of carbohydrate molecules. That chemical energy may be converted into motion (kinetic energy) and heat.

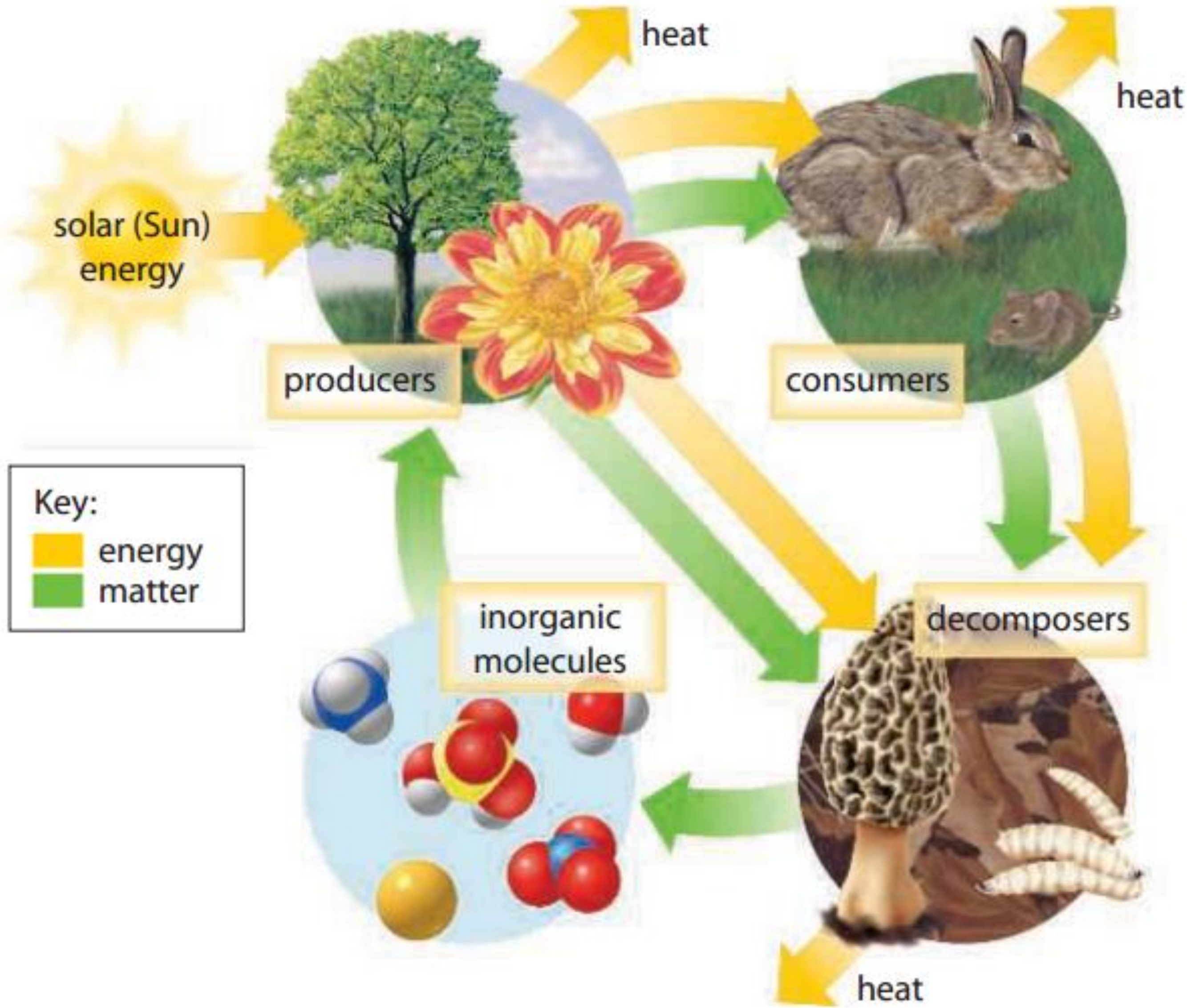


Figure 1.13 Matter cycles within the biosphere, but energy passes through it. As chemical energy is transferred from producers to consumers to decomposers, all the energy eventually dissipates into the environment as heat.

- No process of energy conversion is 100 percent efficient, however. With each conversion of energy, there is less energy available to do useful work.
- This idea is known as the second law of thermodynamics.
- as energy is transferred from one organism to another, much of it is lost as unusable heat to the environment.

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- Each time a cell uses energy to perform a function, some of that energy is dispersed ("lost") as unusable heat. The universe is cooling and there is nothing we can do to stop it ☹ heat death of the universe is inevitable 10^{106} years from now.
- A constant supply of energy, therefore, is necessary to sustain life.
- This is why producers are essential to life on Earth.
- Producers are the means by which all organisms are connected to each other through the transfer of energy.

How Energy Is Transferred in the Biosphere

- trophic level
  feeding level in an ecosystem through which energy and matter are transferred

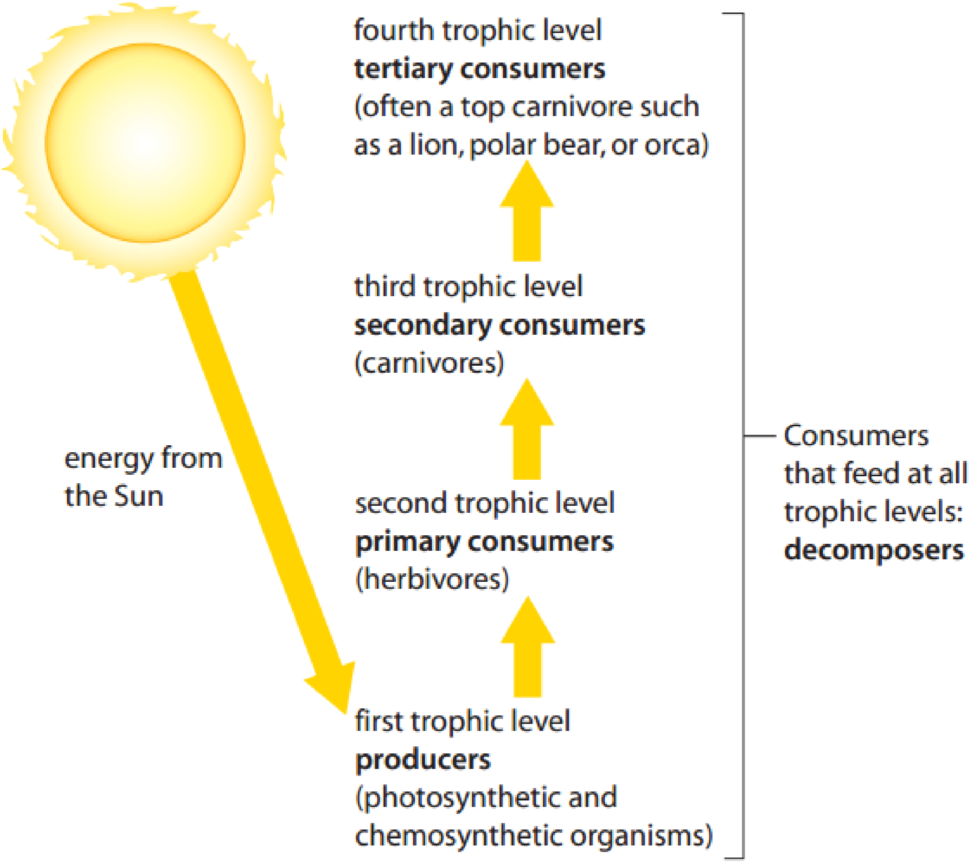


Figure 1.14 Organisms in an ecosystem may be identified by how they obtain their food, or by consumer level, or by trophic level.

- Only about 1% of the suns energy is captured and used by primary producers

- The efficiency with which energy is transferred from one trophic level to the next varies among different kinds of organisms.

- It usually ranges between 5 percent and 20 percent.
- In other words, about 80 percent to 95 percent of the chemical energy that is available at one trophic level is not transferred to the next one.
- We usually use the rule of 10%

- pyramid of energy schematic representation of the relative amount of energy at each trophic level

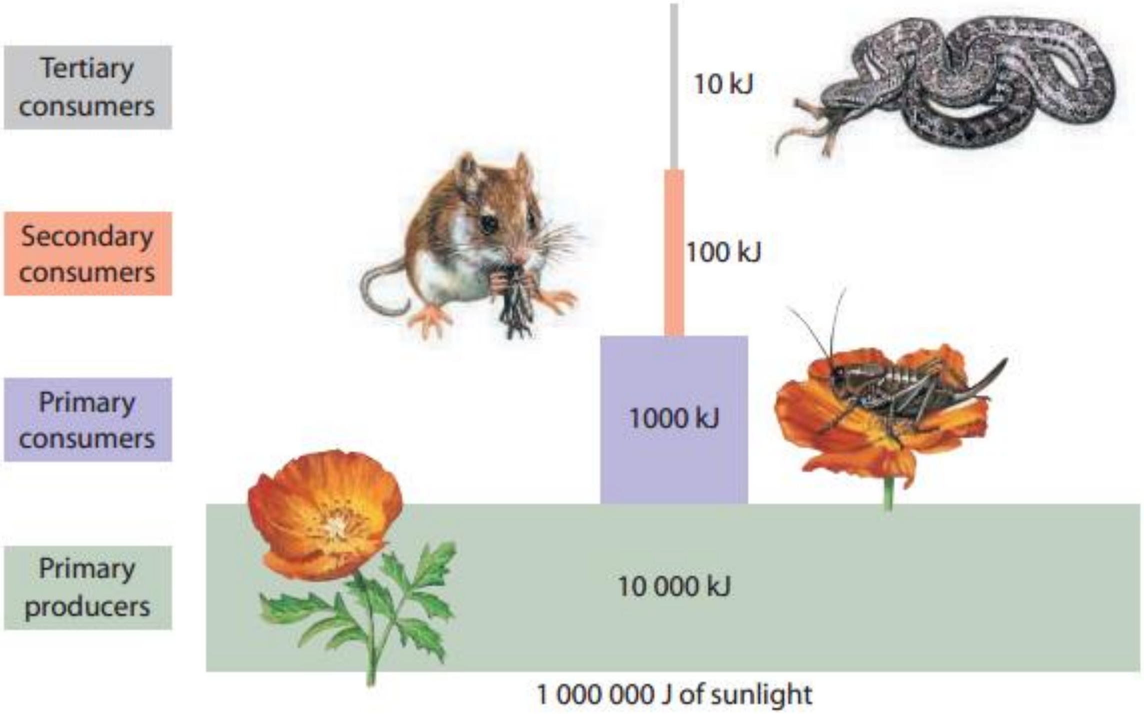


Figure 1.18 This pyramid of energy transfer shows 10 percent efficiency in energy transfer from one trophic level to the next. The rate of efficiency can vary from 5 to 20 percent. This assumes that 1 percent of solar energy is captured by primary producers.

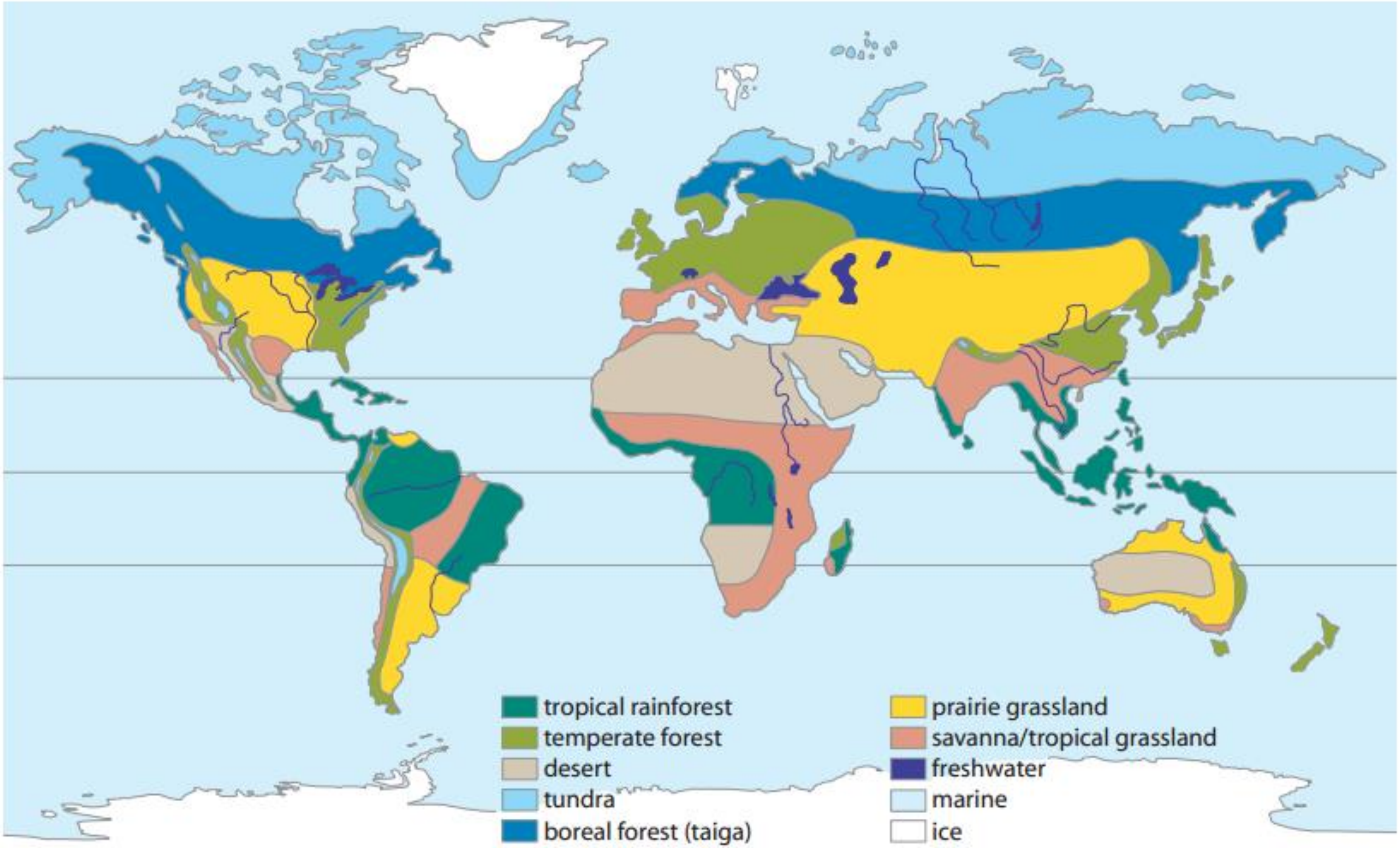
Energy Transfer and Stability in Ecosystems

- changes within one trophic level may affect a higher or lower trophic level and energy transfer through the ecosystem.
- What happens if an organism is removed from a food chain or food web?

Activity 1.3 Examine a food web

Activity 1.2 Analyzing Energy Transfers

Biomes



tropical rainforest
temperate forest
desert
tundra
boreal forest (taiga)
prairie grassland
savanna/tropical grassland
freshwater
marine
ice

- ecotone the area of transition between two biomes

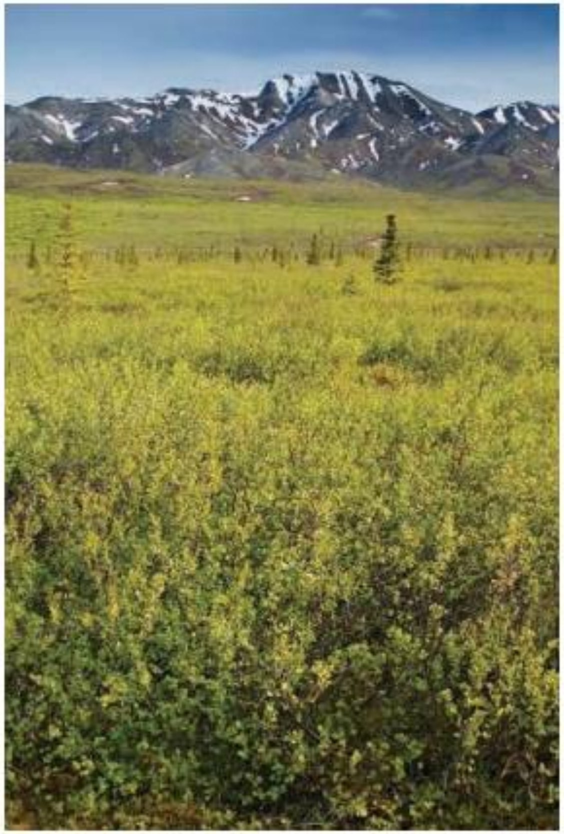
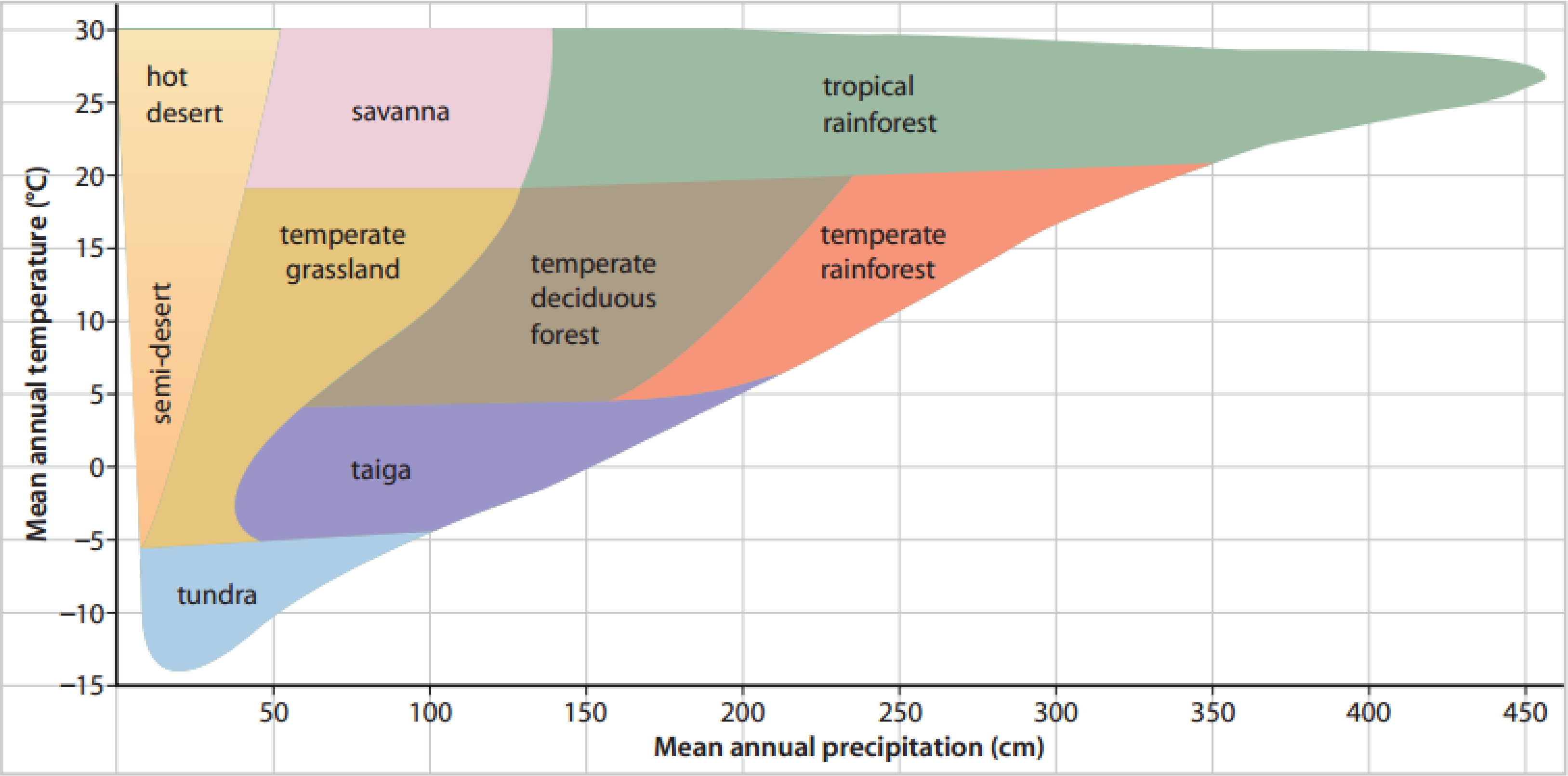


Figure 1.23 The ecotone between the boreal forests and tundra is shown here.

- the abundance of terrestrial life increases as the temperature and amount of precipitation increase.
- An increase in temperature or precipitation will usually also result in increased abundance of organisms but not to the same degree as an increase in both factors (and not when it becomes too hot).
- Thus, the distribution of organisms is directly related to abiotic conditions in the biome.

Terrestrial Biomes According to Temperature and Precipitation



- Analyze Figure 1.21 Worksheet

Terrestrial Biomes

- Tundra
- boreal forest
- temperate deciduous forest
- prairie grassland.

Biomes Video

- 12 minutes and 54 seconds

- Biome Poster Worksheet

Aquatic Biomes

- Marine
- Estuaries
- Freshwater

Marine Biome (two zones)

- 1. neritic zone relatively shallow water found over the continental shelf
- Water in the neritic zone is relatively shallow, typically less than 100 m to 200 m in depth.
- In Canada, the most expansive neritic zones are in the Arctic and Atlantic regions.
- They extend offshore as far as 320 km from Newfoundland and 180 km from parts of Nova Scotia.

- These shallow coastal waters are relatively warm, receive lots of light, and have more nutrients compared to the deeper open ocean.
- The banks receive nutrients from river inputs and from deeper waters that are lifted to the surface by turbulence during windstorms.
- The relatively abundant nutrient supply allows these coastal waters to be productive and to support a much larger biomass of fish and other animals than occurs in the deeper ocean

- 2. oceanic zone which is the open ocean.
- The oceanic zone has several different zones, based on the depth of the water.
  - Between 1000 m and 4000 m on the ocean floor is the bathyal zone. Only a small amount of light reaches the bathyal zone. The pressure is also high due to the amount of water above.
  - The water temperature and salinity are steady at about 4 °C and 3.5 percent.
  - Fish and other organisms in the bathyal zone are adapted to live in darkness.
  - They are usually black or red in colour because these colours are not reflected by the small amount of light that reaches this zone, so red organisms appear black.
  - Eels, squid, crustaceans, and jellyfish are found in the bathyal zone.

- abyssal zone is between 4000 m and 6000 m deep on the ocean floor.
- No light reaches the abyssal zone.
- The water temperature is near freezing and the pressure is immense.
- fish, squid, octopus, worms, and molluscs live in the abyssal zone.
- They are adapted to the conditions and either rely on decomposed materials that drift down from the surface or eat other organisms that eat the decomposed materials.

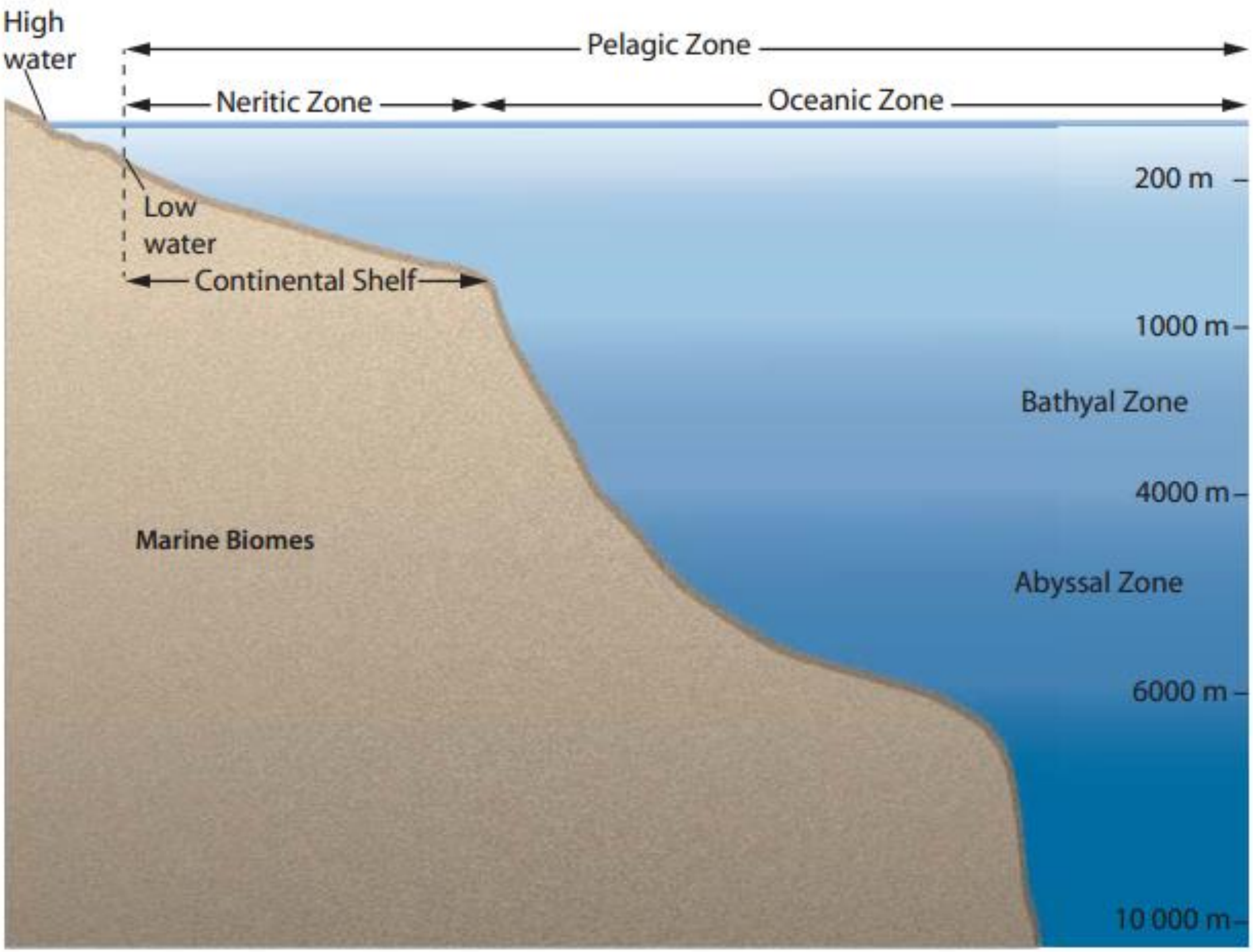


Figure 1.28 Marine biomes include the neritic zone, the pelagic zone, the bathyal zone, and the abyssal zone.

Estuaries

- estuary semi-enclosed coastal ecosystem transitional between marine and freshwater habitats

- An important characteristic of estuaries is their regular fluctuations of salinity due to the daily tidal cycle, along with inflows of fresh water from the nearby land, usually from a river.
- Estuaries retain much of the water-borne input of terrestrial nutrients, and they are highly productive ecosystems.

- In the temperate and boreal climates of Canada, estuaries may support extensive mudflats, beds of eel-grass, and grass-dominated salt marshes.
- In tropical regions, estuaries often sustain mangrove forests. The high productivity of estuaries nourishes many species of fish, including the juvenile stages of some economically important pelagic species, as well as shellfish, crustaceans, and coastal birds.

Figure 1.30 Birds, rare plants, fish, and other aquatic organisms live in and rely on the Grand Codroy Estuary as a habitat.

Freshwater Biomes (two types)

- 1. Lakes and Ponds: contain standing (non-flowing) water. Their shape and volume, nutrient concentration, water transparency, and local climate are key influences on the kind of ecological development that occurs in them.

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Three Zones

- littoral zone region along the shore of a freshwater ecosystem.
  - Gets lots of light and is warmer
  - Plants and other organisms that carry out photosynthesis are found here, along with animals that swim through the water or crawl along the bottom.

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- limnetic zone region with deeper, open waters in a freshwater ecosystem
  - gets light and has phytoplankton, zooplankton, small fish, and larger fish.
- benthic zone region in and just above bottom sediment of aquatic ecosystems
  - Worms, molluscs, and other bottom-dwelling organisms are found here. Bacteria also live in the sediment and help decompose dead organic material. A deep lake is typically much less productive than a shallow one of a comparable surface area

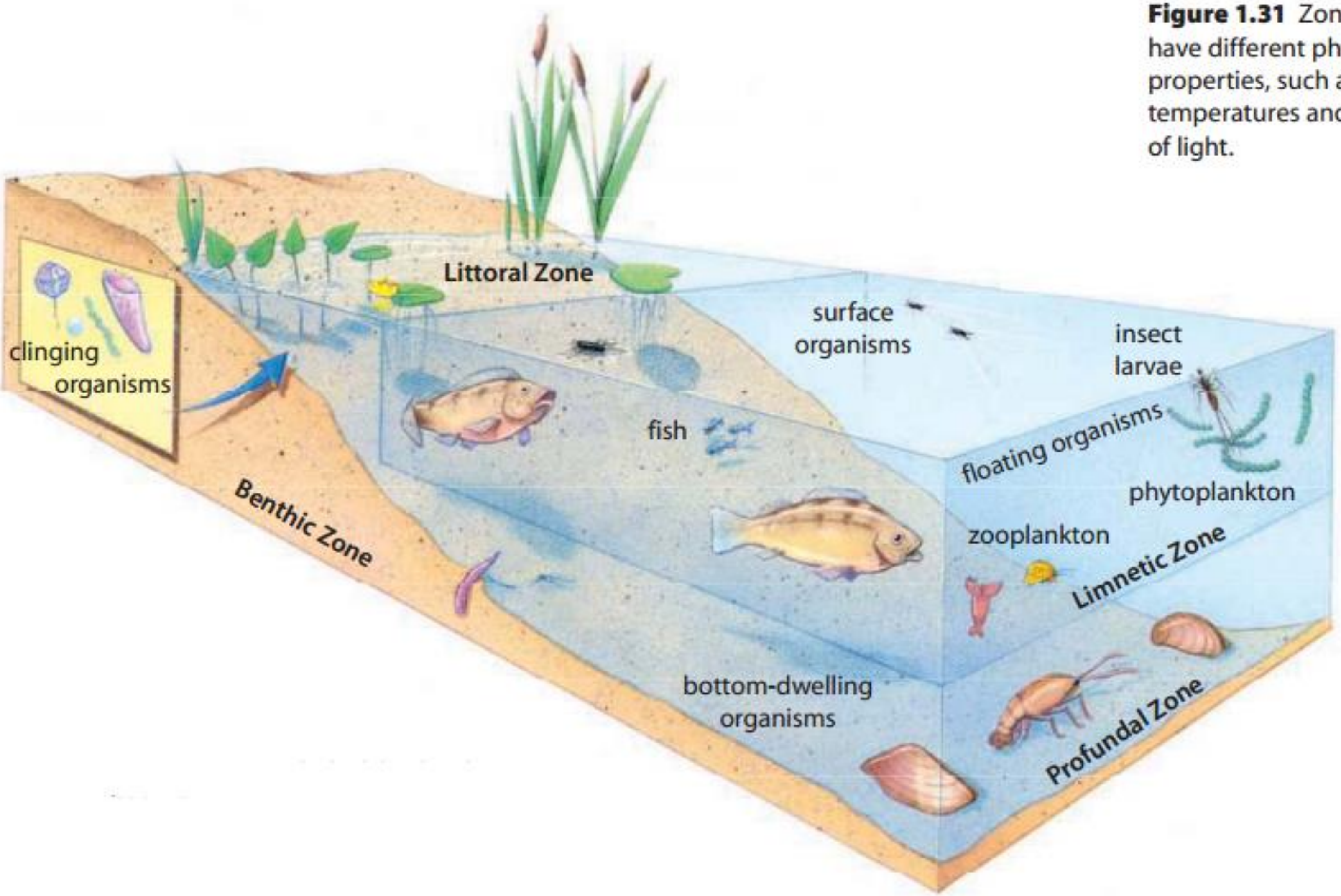

Figure 1.31 Zones in lakes have different physical properties, such as differing temperatures and amounts of light.

Freshwater Biomes (two types)

- 2. Rivers: Flowing water is the distinguishing feature of rivers and streams.
  - The amount of water flow as well as its speed and seasonal variation are particularly important abiotic characteristics.
  - The amount of sediment in the water is also important because it reduces the amount of light that can penetrate into the water and thereby influences producers' ability to carry out photosynthesis.
  - In places with slow flowing water, fine suspended particles are deposited and a muddy bottom develops.
  - In contrast, sediments in water may be high when water flows are strong, and places with vigorous currents have a rocky bottom because fine particles are washed away.
  - Aquatic plants, algae, invertebrates, and fish are all found in rivers.

Quiz

Describing Populations and Their Growth

- population size (N) the number of individuals of the same species living within a specific geographical area
- population density (Dp) the number of individuals per unit of volume or area

Techniques used to sample subsets of larger populations

- transect a long, relatively narrow rectangular area or line used for sampling a population

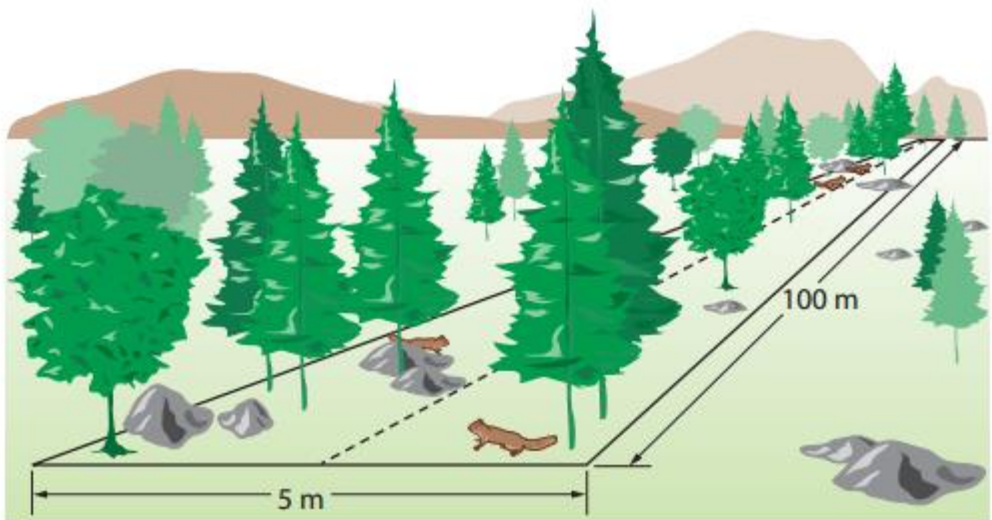

Figure 2.2 In this transect, researchers count individuals of one species within 5 m of a 100 m long transect.

500 m

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- quadrat an area of specific size used for sampling a population; often used to sample immobile organisms or those that move very little
- To determine population density, calculate the sum of individuals in the quadrats (N), and then divide by the total area of the quadrats (A).

$$Dp = \frac{N}{A}$$

Figure 2.3 Quadrats can be used to count the number of individuals of a species within a particular area.

- mark-recapture a method in which animals are captured, marked with a tag, collar, or band, released, and then recaptured at a later time to determine an estimate of population size
- Mark-recapture is particularly useful for highly mobile populations, such as fish or birds

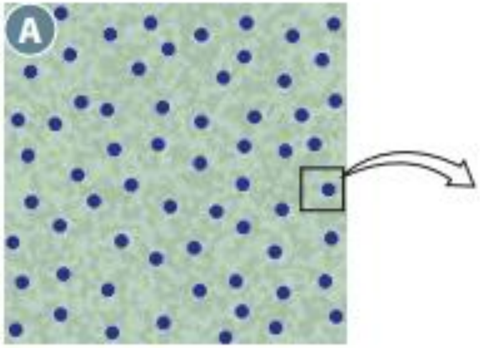
$$\text{Total population } (N) = \frac{\text{Total number marked } (M) \times \text{Size of second sample } (n)}{\text{Number of recaptures } (m)}$$

Figure 2.4 The bird was trapped in a fine nylon net, or a mist net, and banded in a mark-recapture program.

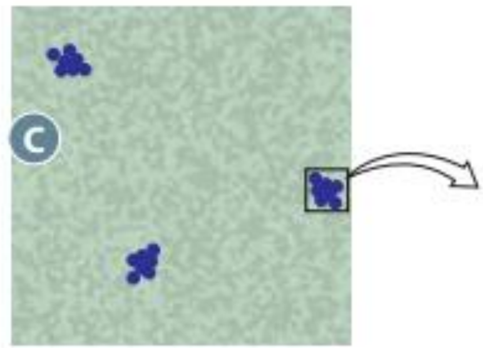
Distribution Patterns (Three Types)

- distribution pattern the pattern in which a population is distributed or spread in an area; three types are uniform, random, and clumped

- 1. Uniform Distribution: resources are evenly
- distributed but scarce



- 2. Clumped Distribution: Since resources are typically unevenly distributed, populations tend to gather near them. Animals may gather near a water source, for instance, and plants tend to cluster in locations where moisture, temperature, and soil conditions are optimal for growth.



- 3. Random Distribution: If resources are plentiful and uniformly distributed across an area, populations exhibit random distribution.
- Since resources are abundant and well distributed, there is no need for individuals to defend their share.
- Random distribution also requires that interactions between individuals are neutral—neither positive nor negative—and that any young disperse more or less equally throughout the area in question.
- These conditions are rarely met in nature.

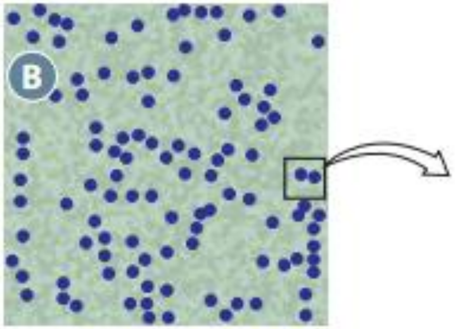


Table 2.1 Distribution Patterns and Population Dynamics

Distribution Pattern	Resource Distribution	Resource Abundance	Interactions between Population Members
clumped	clumped	varies	positive
uniform	uniform	scarce	negative
random	uniform	abundant	neutral

Activity 2.1
Activity 2.2
Activity 2.3
Quadrat Lab
Activity 2.4

Changes in Population Size

- demography the study of population changes
- immigration the movement of individuals into a population
- emigration the movement of individuals out of a population

- A population's size directly depends on how much and how fast it grows.
- Four processes can change the size (number of individuals) of a population (ΔN). Births (b) and immigration (i) cause increases in population size. Deaths (d) and emigration (e) cause decreases in population size.

$$\Delta N = [b + i] - [d + e]$$

ΔN	=	$[b + i]$	−	$[d + e]$
change in population size		births + immigration		deaths + emigration

- A meadow vole population grew from 150 to 245 in one year. If 103 voles were born, 43 emigrated, and 56 immigrated, what was the total mortality for the year?

$$\underset{\text{change in population size}}{\Delta N} = \underset{\text{births + immigration}}{[b + i]} - \underset{\text{deaths + emigration}}{[d + e]}$$

- fecundity the average number of offspring produced by a female member of a population over her lifetime
- This varies widely between species. A female salmon, for instance, produces her lifetime quota of eggs all at once and then dies.
- Annual plants—those that grow for only one season—have a similar pattern. They live for one season, reproduce, and then die.
- In other populations, such as songbirds and elephants, females typically survive their first reproductive event (whether laying eggs or giving birth to live young) and go on to reproduce several more times.
- Perennial plants survive for many years and reproduce each year.

- biotic potential the highest possible per capita growth rate for a population
- It is determined by
- Survivorship - the number or percentage of organisms that typically live to a given age in a given population
  - the number of offspring per reproductive cycle
  - the number of offspring that survive long enough to reproduce
  - the age of reproductive maturity
  - the number of times the individuals reproduce in a life span
  - the life span of the individuals

Population Growth Models

- exponential growth the growth pattern exhibited by a population growing at its biotic potential J-Curve

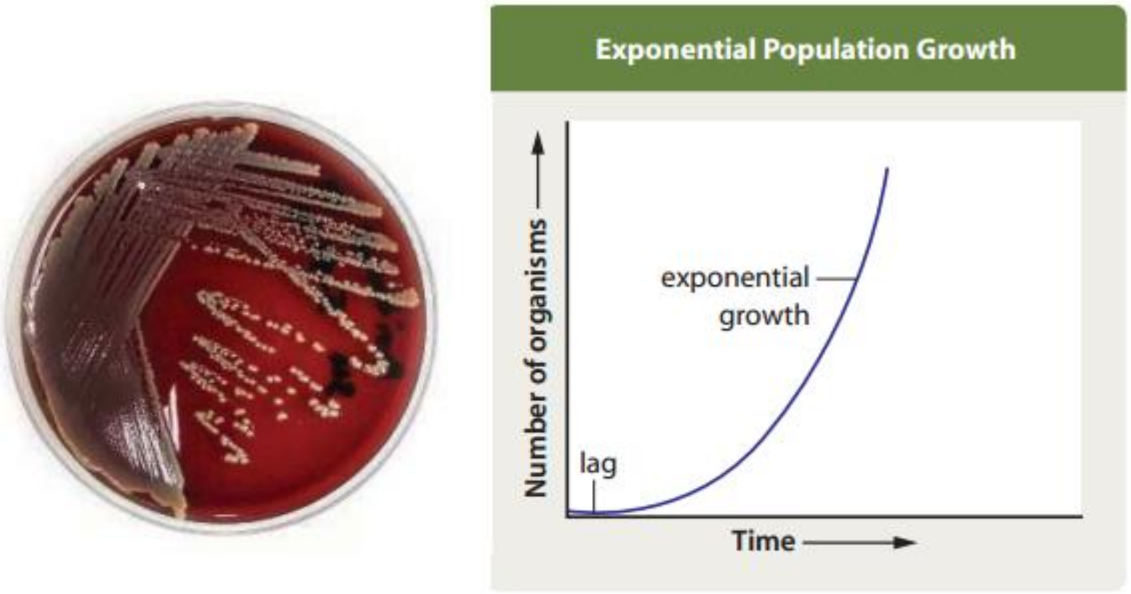


Figure 2.11 Any population that grows at its biotic potential will grow exponentially. This results in a J-shaped growth curve. Bacteria cultured in a laboratory can undergo exponential growth.

Calculator Activity (2 mins)

- If one bacterium divided every 30 minutes, in 20 hours there would be ____?______ bacteria.

- Hint: you wont get it easily unless you have completed exponentials in Math 3201

- 549,755,813,888
- 5 hundred 50 biollion!

- IN 20 HOURS!!!!!!!!!!!!!!!!!

- In four days, the mass of the colony would be larger than our entire planet.
- It sounds like a horror film and, in reality, this scenario cannot occur. Why?

- density-dependent factor biotic factor that limits a habitat’s carrying capacity
- density-independent factor abiotic factor that limits a habitat’s carrying capacity

- The combined effects of various interacting limiting factors is described as the environmental resistance to population growth.
- Environmental resistance prevents a population from growing at its biotic potential and determines the carrying capacity of the habitat.

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Effect of Environmental Resistance on Population Growth

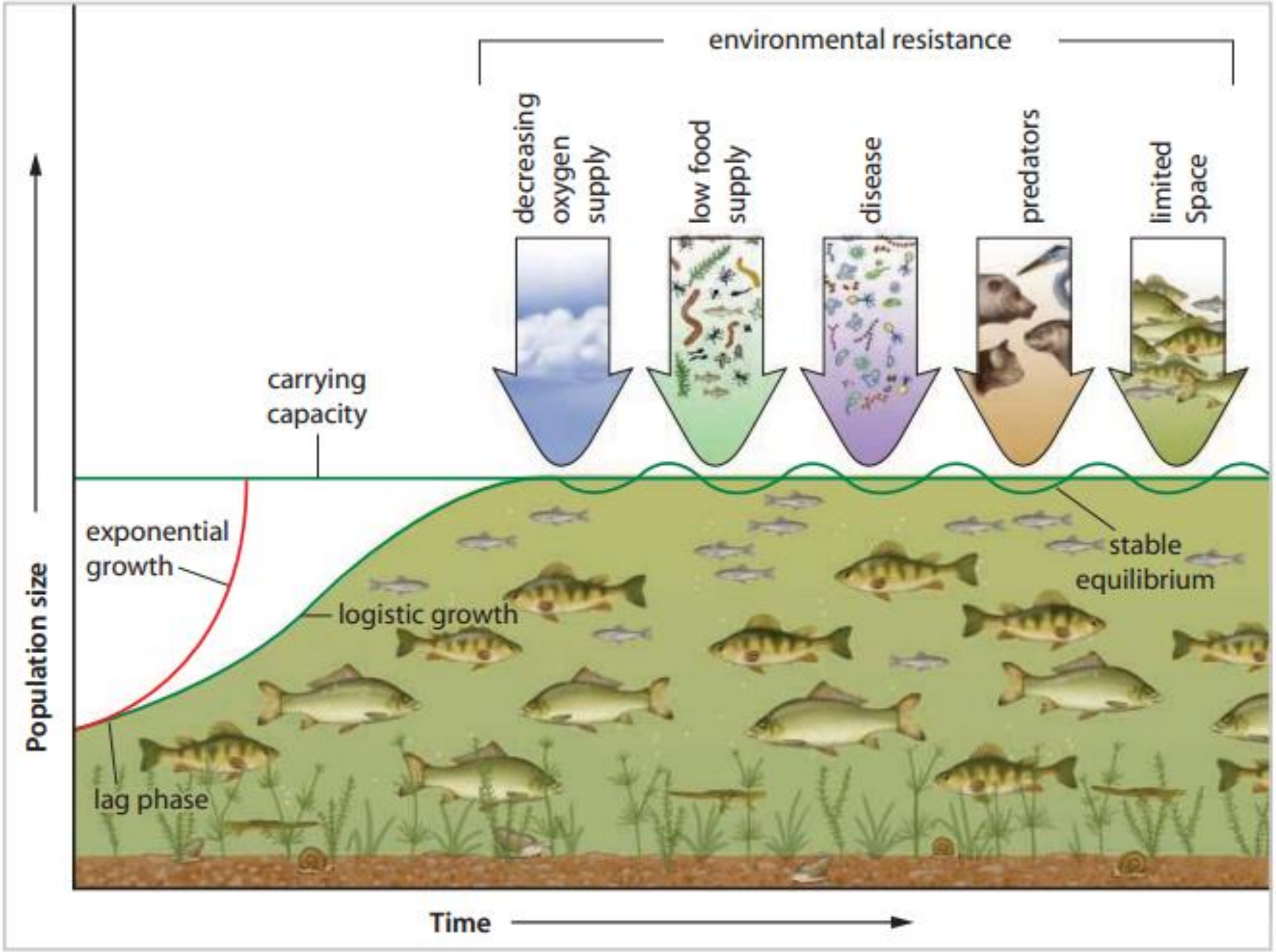

Figure 2.13 Limiting factors keep a population from growing exponentially. Although the number of individuals that an environment will support changes from time to time, such as from season to season, there is always a limit to what the environment can support.

- A population cannot grow at its biotic potential because resources will quickly become limited.

- Eventually, members of the population will compete for resources and the growth rate will slow.
- Lack of food, for example, will limit the energy available for survival and also the energy individuals can put toward reproduction.
- In conditions where resources are limited, a population initially experiences a lag phase of slow growth
- Since there are only a few individuals in the population able to reproduce, the population grows slowly (lag phase). This is followed by a period of rapid growth (exponential growth).

- logistic growth the growth pattern exhibited by a population for which growth is limited by carrying capacity, or limited availability of resources. S-Curve

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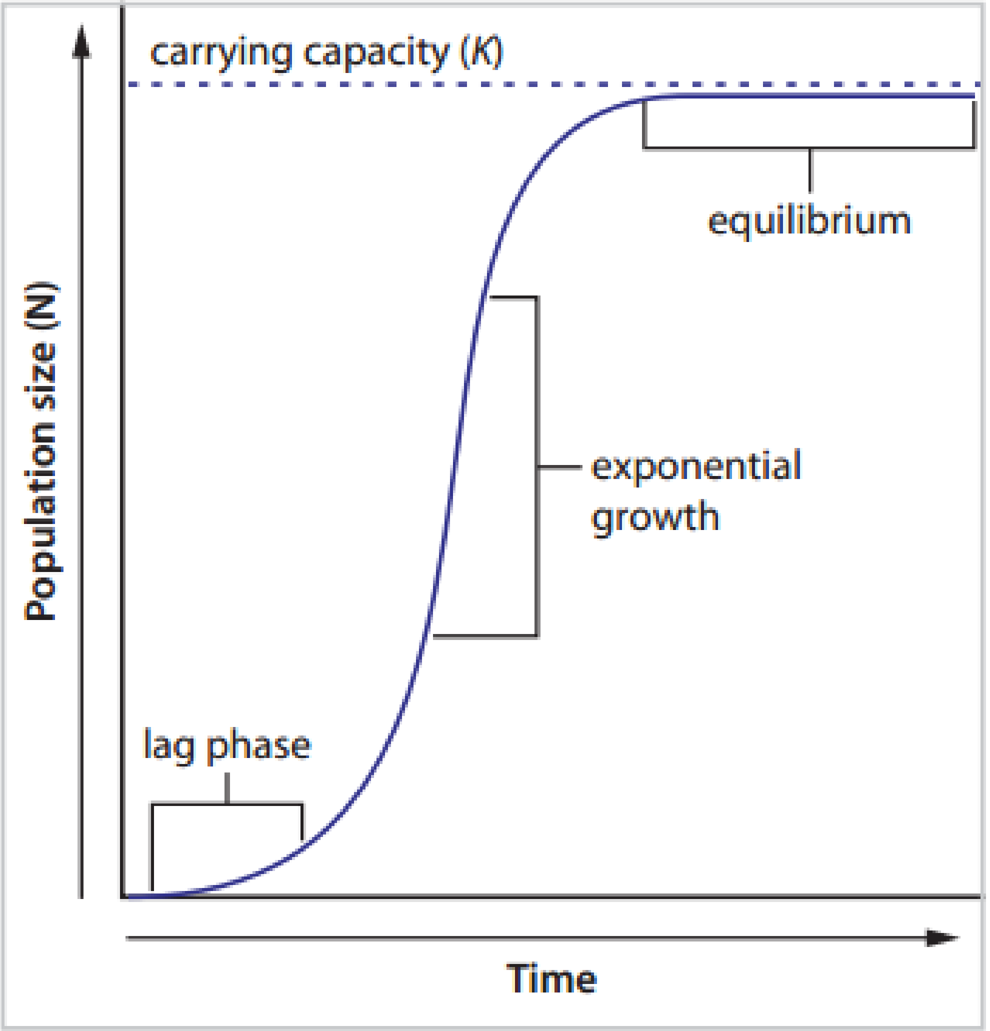
Logistic Population Growth



Life Strategies

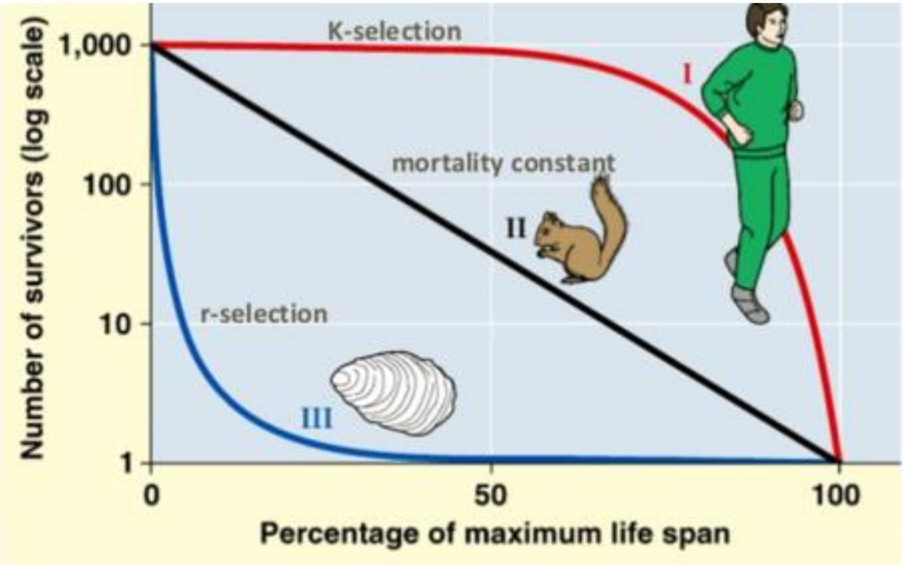
- r-selected strategy a life strategy characterized by a high reproductive rate with little or no attention given to offspring survival. Insects, annual plants, and algae.

- They take advantage of favourable environmental conditions, such as the availability of food, sunlight, or warm summer temperatures, to reproduce quickly.
- In the province’s climate, for example, these organisms experience exponential growth in the summer, but die in large numbers as the summer ends.

- K-selected strategy a life strategy characterized by the production of a few offspring with much attention given to offspring survival. Mammals and birds.

- They have few offspring per reproductive cycle, and one or both parents care for the offspring when young.
- The offspring take a relatively long time to mature and reach reproductive age, and they live a relatively long time.
- Also, they tend to have large bodies, compared with organisms that have r-selected strategies.
- A typical K-selected life strategy is to produce few offspring, but to invest a large amount of energy into helping the offspring reach reproductive age.

- In reality, most populations have a combination of K-selected strategies and r-selected strategies.



- Launch Lab Reproductive Strategies and Population Growth

- Investigation 2A
- Investigation 2D

- competition occurs between or among living things that are all trying to use the same limited resources

- The interactions among individuals, within the same population or from different populations, are a riving force behind population dynamics—**the changes that occur in populations over time**

Interactions in Ecological Communities

- intraspecific competition competition for limited resources among members of the same species

- interspecific competition competition for limited resources among members of different species

Investigation 2B

Non-native species

- Often, when a non-native species is introduced into an environment, it competes with the native species.
- Sometimes, the native species compete successfully against the introduced species, which dies out.
- Other times, however, the introduced species takes over the niches of the native species, thereby changing the structure of the ecological community.

Figure 2.10 When European green crabs were found in Newfoundland waters, scientists acted quickly to survey the population and implement methods to stop its spread.

Symbiotic Relationships

- symbiosis direct or close relationship between individuals of different species that live together; usually involves an organism that lives or feeds in or on another organism (host)

- mutualism a type of symbiotic relationship in which both partners benefit from the relationship, or depend on it in order to survive

Figure 2.23 Stinging ants live in the hollow thorns of certain species of the *Acacia* tree in Latin America. The tree provides food for the ants in the form of a sweet nectar and proteins. The ants protect the tree from herbivores and, as shown here, from being shaded by other plants.

The bees benefit from the pollen and nectar they gather from the flowers and the flowers benefit by the bees transporting their pollen and pollinating other flowers.

These ocellaris clownfish are hiding in an anemone. Clownfish and anemones live together in a mutualistic symbiotic relationship. They protect each other from predators.

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- commensalism a type of symbiotic relationship in which one individual lives close to or on another and benefits, and the host neither benefits nor is harmed
- The cowbirds, however, sometimes pick flies and other parasites from the cattle's skin, which benefits the cattle. Is this relationship really an example of mutualism? There are probably few true cases of commensalism. Both partners in symbiosis are usually affected in some way, although how they are affected may not be clear.

Figure 2.24 The brown-headed cowbird benefits from the insects that are flushed out of the grass by bison and domestic cattle as they graze. Is this an example of commensalism?

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What is Commensalism?

Commensalism is a type of relationship between two living organisms in which one organism benefits from the other without harming it.

- The image shows commensalism between some shark species and pilot fish. Pilot fish will feed on the leftovers in the water after the shark makes a kill, while the shark remains unaffected by this behavior.

- parasitism a type of symbiotic relationship in which an organism benefits by living on or in an organism of a different species that is harmed by the association

Figure 2.25 **(A)** Tapeworms (*Taenia* sp.) are transferred from livestock to humans when people eat infected and undercooked beef or pork. The adult tapeworm's tough cuticle protects it from the digestive enzymes in the small intestine, where it attaches and absorbs nutrients. A tapeworm can lay up to 10 000 eggs each day. The eggs, which are shed in infected individuals' feces, enter the environment where they can be picked up by another host. **(B)** *Giardia* sp. infections are sometimes referred to as beaver fever. *Giardia* sp. enter water in the fecal material of animals such as beavers, muskrats, coyotes, and dogs. If drinking water is contaminated by *Giardia* sp., communities are advised to boil water before drinking it.

- When individuals succumb to parasites, this may help the host population as a whole, because it reduces the density of the population and thus reduces competition for limited resources.
- In addition, weakened hosts may become prey for other animals.

Investigation 2.E

Human Population Growth

- The slight dip in the population from 1347 to 1350 shows the decrease in the population due to bubonic plague.
- The plague killed an estimated one third of the population of Europe.
- A short time after the plague, the population started to grow exponentially. This explosive growth was due to a variety of technological factors.

Estimated Global Population 5000 B.C.E–2000 C.E.

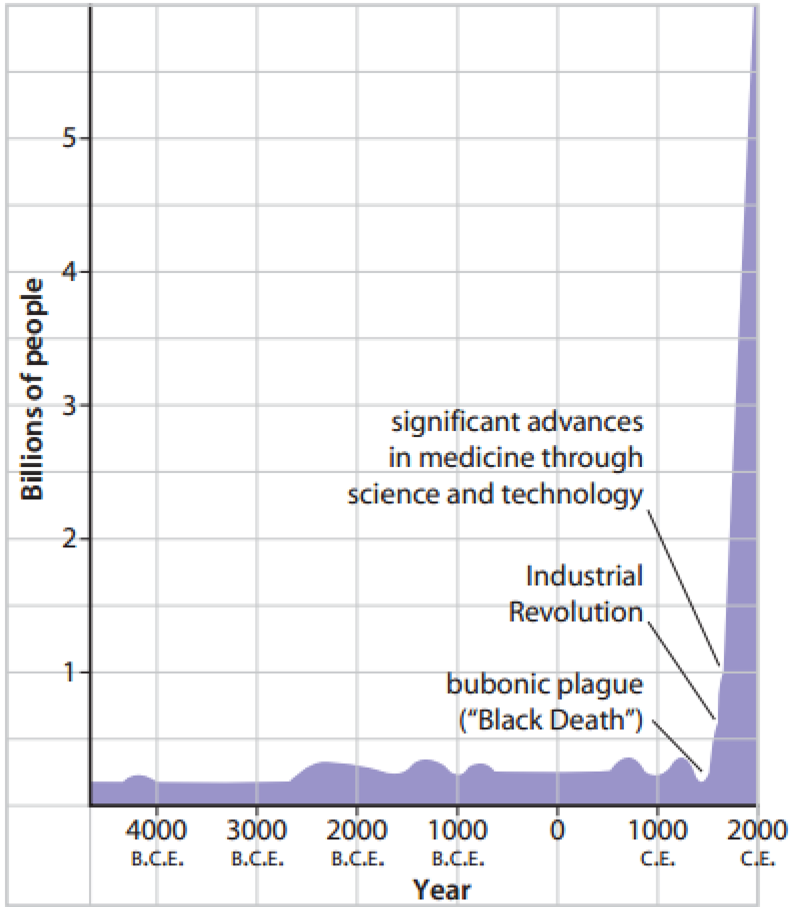


Figure 2.26 The human population was relatively stable until recent times. Then, starting in the 1700s after the Industrial Revolution, the population began to grow at an exponential rate.

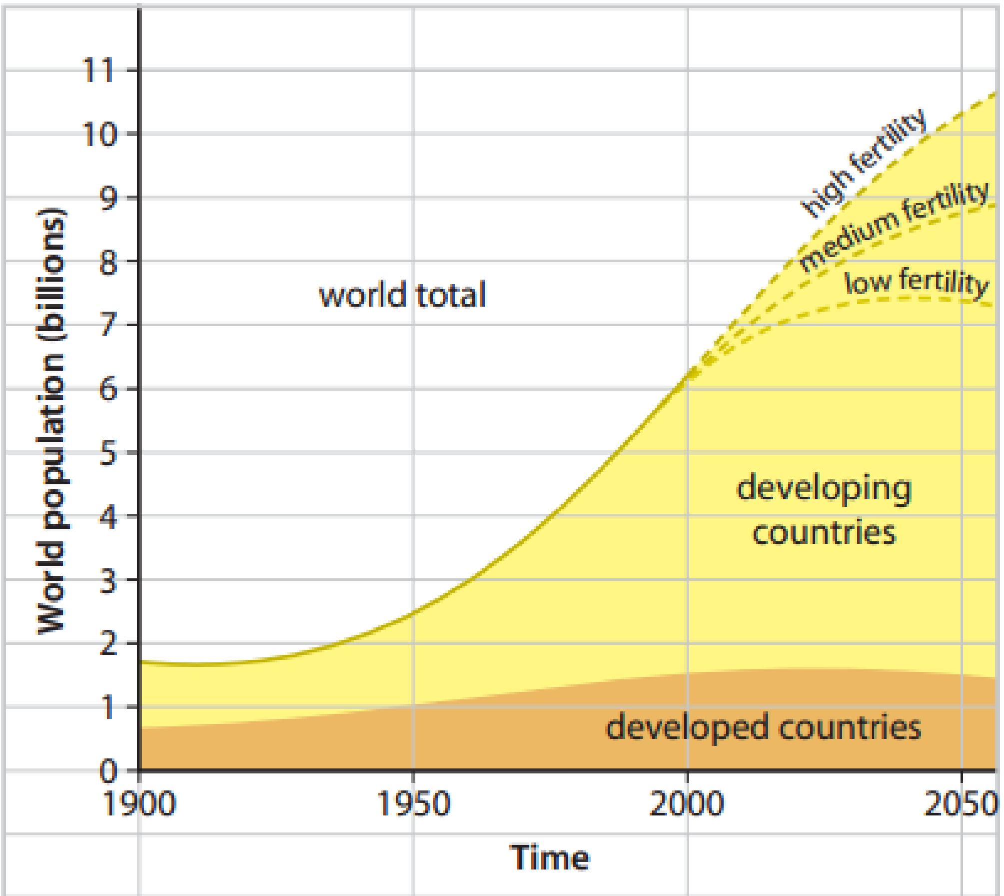
- Starting in the early 1700s in Europe and a little later in North America, humans were able to increase their food supply by improved agricultural methods and the domestication of animals.
- Breakthroughs in medicine in the late 1800s and early 1900s enabled people to be successfully treated for once-fatal illnesses.
- Better shelter protected people from the weather, and improvements in the storage capacity of food helped humans survive times when food was less plentiful.
- All of these factors allowed humans to increase the carrying capacity of their environment and change from a logistic growth pattern to an exponential growth pattern

Exponential Growth

- Because human population growth was no longer as constrained by environmental factors, the growth rate has dramatically increased over the last 300 years.
- In that period of time, the birth rate has remained about the same—about 30 births per 1000 people per year.
- The death rate has decreased from about 20 deaths per 1000 people per year to about 13 per 1000 per year.
- The differences between the birth rate and the death rate resulted in a population growth of about 2 percent per year.
- In recent years, the growth rate has declined to about 1.2 percent per year.

- What do you notice about this graph?

Worldwide Distribution of Population Growth



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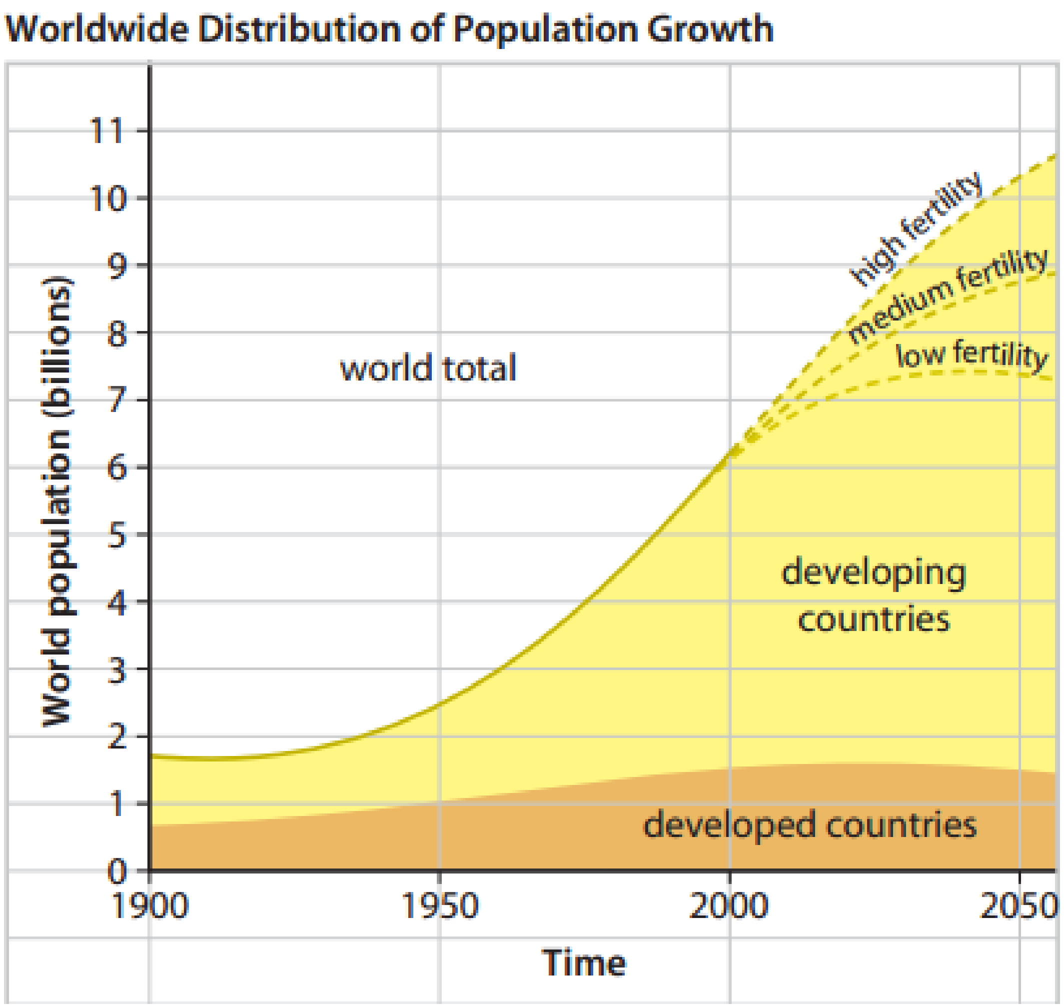

Figure 2.27 In developing countries, such as many of the countries in Asia, Africa, and Latin America, populations are growing much faster than those in developed countries, such as Canada, the United States, England, France, and Sweden.

- Human Population Growth Worksheet

- demographic transition theory that describes the pattern of birth rates, death rates, and growth rates of populations over time

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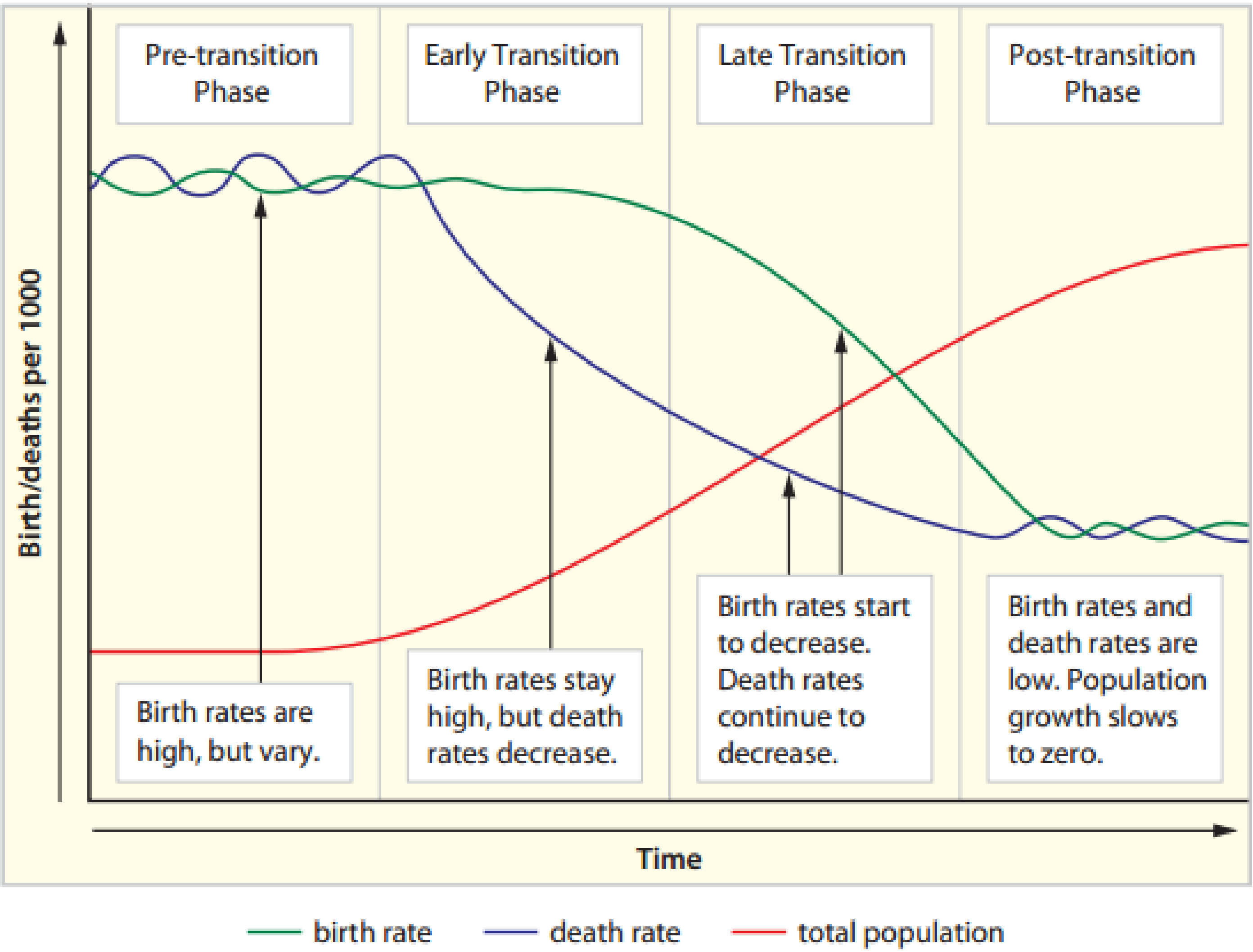
Ecological Footprints



- pre-transition phase
  - birth rates are high and death rates are high but not stable; they vary due to wars or widespread disease
- early transition phase
  - birth rates remain high, while death rates begin to decrease due to the introduction of modern advances such as improved medical care and better food production
- late transition phase
  - birth rates start to decrease, while death rates continue to decrease. The rate of population growth starts to slow down. Most developing countries are in the late transition phase
- post-transition phase
  - both birth rates and death rates are low. Population growth slows to zero or even begins to decrease. Most developed countries are in the post-transition phase.

- population pyramid a type of bar graph that shows the age distribution in a population, which demographers use to study a population

- A population pyramid shows the percentage of males (usually shown on the left) and the percentage of females (usually shown on the right) in different age categories (usually five-year intervals).

- In the graphs, the male population is shown in purple and the female population is shown in green.

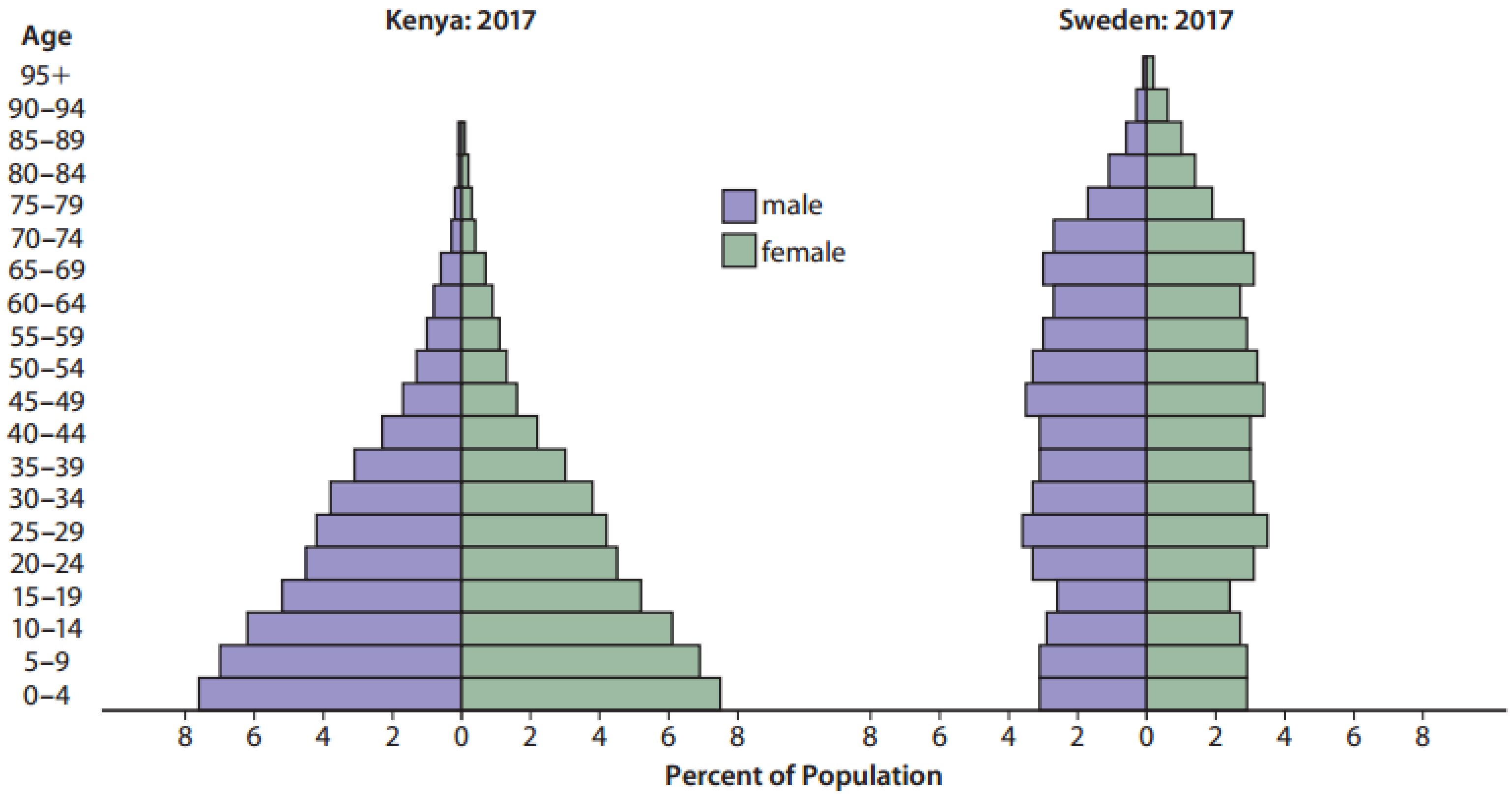
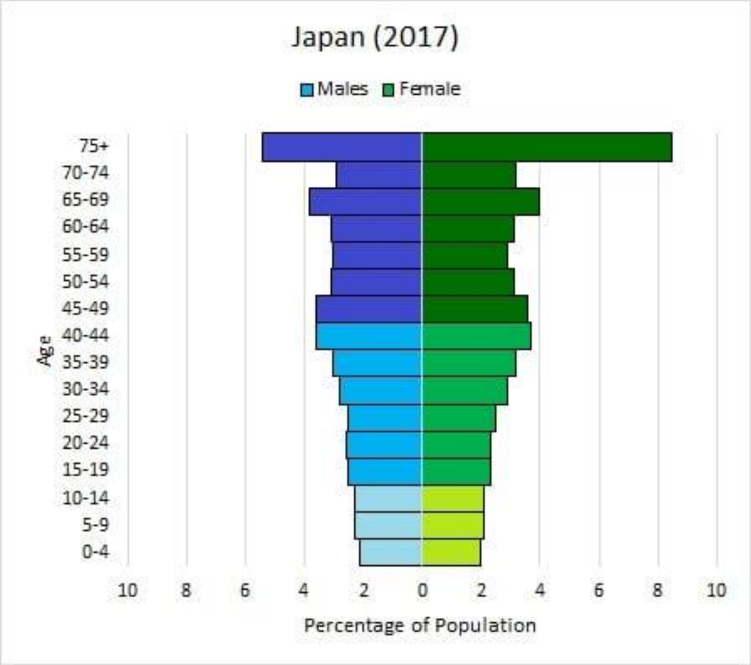


Figure 2.29 Population pyramids are bar graphs that show the age distribution in a population. The age distribution can be used to predict the growth of the population.

- The shape of the population pyramid is used to predict demographic trends in the population.
- For example, the population pyramid for Kenya is a triangular shape.
- A triangular shape predicts a future of explosive growth because a large portion of the population will enter their reproductive years at the same time.
- The pyramid shape also indicates a decreased average life span.
- The rectangular shape of Sweden's graph indicates that the population is not expanding, and it is stable.
- A further analysis of Sweden's age pyramid shows that only 16 percent of Sweden's population is less than 15 years old.
- In comparison, nearly half of all Kenyans are less than 15 years old.

- Another possible shape for a population pyramid is an inverted triangle. An inverted triangle indicates a population that is shrinking. In this type of population, there is a large number of individuals who are past their reproductive years and few individuals in or about to enter their reproductive years. As a result, the population shrinks because there are more deaths than births in the population.



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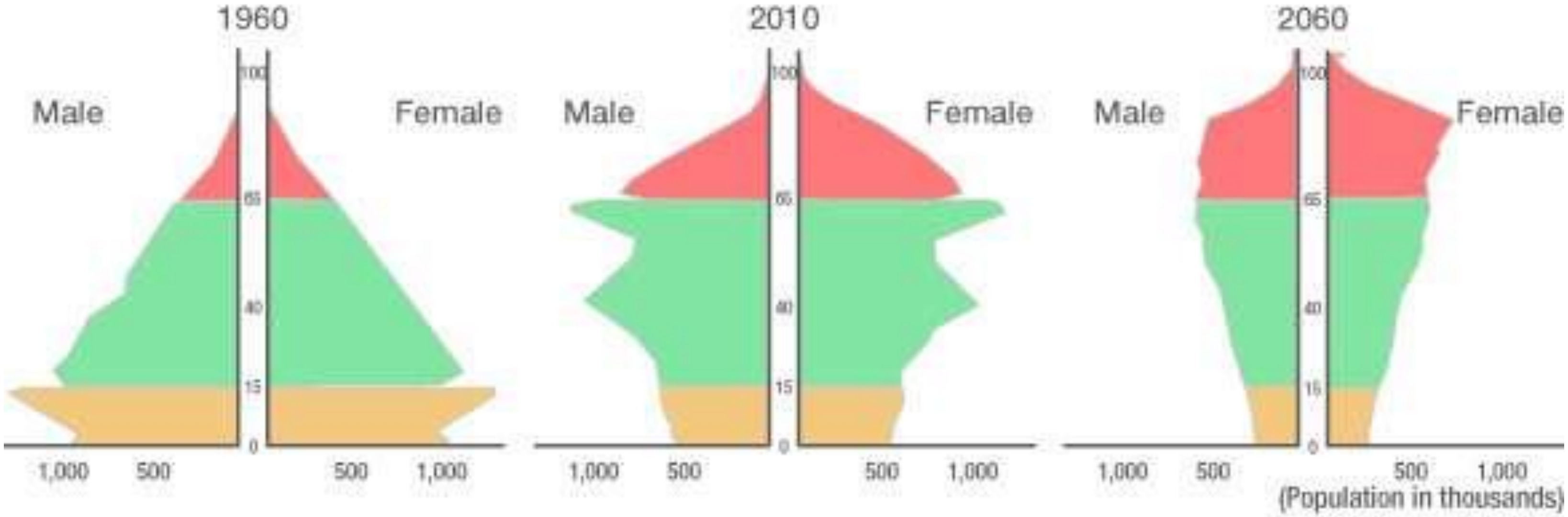
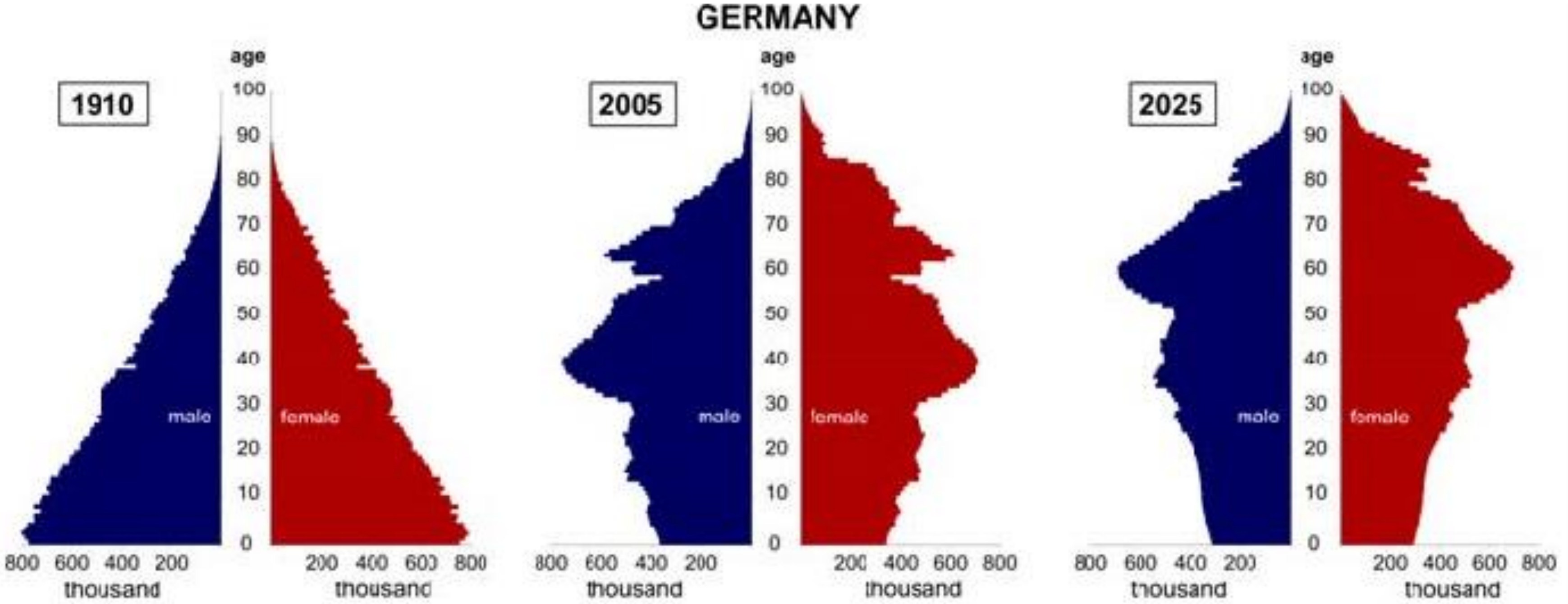
Japan's Changing Population Pyramid (population by age)



Sources: (For 1960 and 2010) Statistics Bureau (Ministry of Internal Affairs and Communications), *Population Census of Japan*; (for 2060 projection) National Institute of Population and Social Security Research, *Population Projections for Japan* (January 2012), based on medium-variant fertility and mortality assumptions.


GERMANY
age
1910
2005
2025
100
90
80
70
60
50
40
30
20
10
0
male
female
800 600 400 200
200 400 600 800
thousand

- **Activity 2.5 What factors affect the growth rate of a human population?**
- **Activity 2.6 Population growth rates in different countries**

Earth's Carrying Capacity

- humans have been able to increase the carrying capacity of Earth, and the population continues to grow exponentially.
- However, all environments have a limit and there is no evidence to suggest that Earth is an exception.
- Today, there is a great disparity among countries in the amount of resources that are used per person.
- People living in the industrialized world use far more resources than people living in developing countries. In fact, the wealthiest 20 percent of the population consumes 86 percent of the world's resources and produces 53 percent of the world's carbon dioxide emissions.
- People living in the poorest countries use about 1.3 percent of the world's resources and produce about 3 percent of the world's carbon dioxide emissions.

Ecological Footprint

- ecological footprint the amount of productive land that is required for each person in a defined area, such as a country, for food, water, transportation, housing, waste management, and other requirements

- The estimated average ecological footprint per person globally is about 2 hectares of land. One hectare equals 10 000 m^2.

- However, this ecological footprint varies widely around the world

- The average person in Canada or the United States requires about 8.2 hectares of land.
- In most developed countries, such as Canada and the United States, the largest component of the footprint is land used for energy production, followed by land for food production, and then forestry requirements.
- Much of the forestry requirement results from the need to absorb the carbon dioxide emitted during the combustion of fossil fuels.

Available biocapacity

- available biocapacity Earth's carrying capacity for the human population

- it includes the following factors:
- cropland, grazing land, fishing grounds, forest land, carbon-absorption land, and building area.
- Low-productivity areas, such as arid regions and open oceans, are not considered biologically productive areas in this calculation.
- It is estimated that about one quarter of Earth's surface, or about 11 billion hectares, constitutes Earth's biocapacity.

Per Capita Ecological Footprint and Biocapacity in 2014

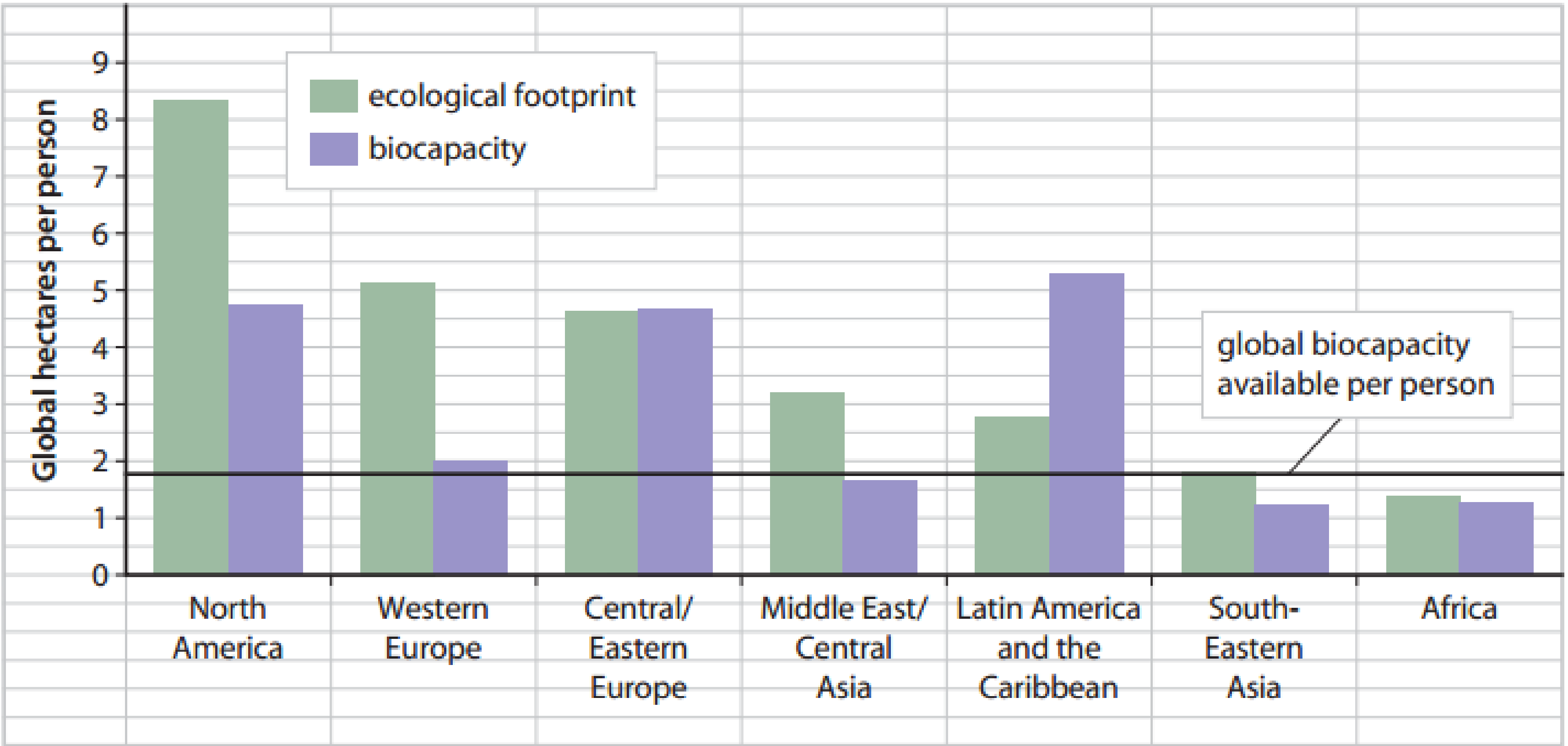


Figure 2.31 Human populations in many countries exceed the biocapacity of their environment. In 2002, the entire human population on Earth exceeded Earth's biocapacity by about 23 percent.

INVESTIGATION 2. F

Effects on Biodiversity

- biodiversity encompasses species diversity, the genetic diversity that exists within each of these species, and the diversity of ecosystems to which these species belong.
- biodiversity stabilizes ecosystems, making them more resilient to change and degradation.
- wetland ecosystems filter and purify the water we drink.
- Marine and forest ecosystems take up atmospheric carbon dioxide, which helps regulate our climate.
- Other ecosystems also provide us with materials to build shelters, food resources, and even medicine.
- If an ecosystem cannot weather change, the consequences can be devastating for humans that rely on its services

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Table 2.2 Threats to Biodiversity

Threat	Description
Habitat Loss	When forests are cut down, wetlands filled, or rivers dredged, all of the organisms that lived in these habitats have lost their homes. Some of the organisms could migrate to nearby habitats. Those that cannot move or do not make it to a new habitat die. When roads are constructed or dams and water diversions are built, the habitat is cut into pieces or fragments. These fragments limit interactions among populations and restrict the movements of large animals that need large areas to find food and mates.
Overexploitation	Overexploitation is the excessive use or removal of a species from its natural environment, until the species no longer exists or has a very small population. One risk of overexploitation of a species is the extinction of the species, which is the disappearance of all members of a species from Earth.
Pollutants	Plastic pollutants and methylmercury in aquatic and marine ecosystems are examples of pollutants. Other organic pollutants, such as PCBs and dioxins, also threaten biodiversity. Pollutants threaten biodiversity by reducing the number of individuals in a population, which can lead to a species' extinction.
Invasive Species	Invasive species are non-native species that relocate to an area and outcompete the native species for resources. Because invasive species usually do not have predators in their new environments, they reproduce in large numbers. Biodiversity within an ecosystem decreases when invasive species threaten the existence of native species.

Effects on Sustainability

- sustainability the quality of causing little or no damage to the environment over a continued period of time
- There is not one solution for providing resources for a growing human population. Many solutions are required that work together to provide the needs of the human population and, at the same time, preserve Earth's resources.
- The first step to finding viable solutions is recognizing the problems humans are creating as they use the resources and deposit wastes haphazardly.

Test